

THESIS

AGE DIFFERENCES IN NEGATIVE AFFECTIVE REACTIVITY: DO STRESSOR TYPES  
MATTER?

Submitted by

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## ABSTRACT

### AGE DIFFERENCES IN NEGATIVE AFFECTIVE REACTIVITY: DO STRESSOR TYPES MATTER?

**Background and Objectives:** Stress may predict poorer health through increased negative affect (NA), which is formally termed as NA reactivity. Age is an important factor associated with different emotional advantages. However, findings about age differences in NA reactivity are mixed in the literature, such that some studies show older adults exhibit more NA reactivity than younger adults, whereas others show a reverse trend or no age-related differences at all. The current study tested this inconsistency by exploring how age differences in NA reactivity vary by stressor type.

**Design and Methods:** Participants were from the Health and Daily Experiences (HEADE) study, which included 56 younger adults (19-35) and 106 older adults (60+) who completed three lab sessions and eight consecutive days of ecological momentary assessments (EMA) surveys. Three stressor types, cognitively demanding stressors, interpersonal stressors, and general daily life stressors, were studied through repeated measures ANOVA on the collected data.

**Results:** We found that stressor type significantly moderated age differences in NA reactivity. More specifically, older adults showed more NA reactivity while facing cognitively demanding stressors. However, the age differences were not statistically significant for interpersonal and general daily life stressors. Also, no statistically significant result was found for the moderating effect of stressor severity on the association between age differences and NA reactivity.

**Discussion and Conclusions:** Overall, younger adults and older adults display different emotional advantages depending on different types of stressors. Thus, specific age-related health recommendations could be proposed based on different stressor types, and studying age differences in NA reactivity about other types of stressors would be a future direction.

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# AGE DIFFERENCES IN NEGATIVE AFFECTIVE REACTIVITY: DO STRESSOR TYPES MATTER?

Formally, stress is defined as an organism's non-specific response to the demands placed on it, and the stimulus that triggers the stress is referred to as a stressor (Selye, 1976). Stress is often associated with increased negative affect (NA), which in turn predicts poorer health (Charles et al., 2013; Chiang et al., 2018; Parrish et al., 2011; Schilling & Diehl, 2015; Wichers et al., 2009). These findings highlight the importance of studying negative affective reactivity (NA reactivity), which is formally defined as increases in NA, such as anger, guilt, sadness, and nervousness, in response to stressors (Leger et al., 2018). Researchers have also been interested in understanding age differences in NA reactivity to stressors, but findings have been mixed, such that some studies show that older adults exhibit less affective reactivity than younger adults (e.g., Birditt et al., 2005), whereas others show the opposite pattern (e.g., Mroczek & Almeida, 2004) or even no age differences (e.g., Wrzus et al., 2014). One possible explanation for this inconsistency is that younger and older adults may display different emotional (dis)advantages across various stressor types, such as cognitively demanding stressors, interpersonal stressors, or general daily life stressors. The current study investigated this possible explanation by focusing on how age differences in NA reactivity might differ by stressor type.

## **Cognitively Demanding Stressors: Age-Related Vulnerabilities in Downregulating Affective Reactivity**

Cognitively demanding stressors refer to situations or tasks that require significant mental effort processing and cognitive resources, which may elicit affective reactivity (Wrzus et al., 2013). These stressors may include challenging words or spatial puzzles, mental arithmetic tasks, or public speaking tasks (e.g., Parrish & Bryd, 2022; Saslow et al., 2014). Older adults are

more likely to exhibit greater NA reactivity compared to younger adults in response to cognitively demanding stressors (e.g., Kunzmann & Richter, 2009; Minton et al., 2023; Wrzus et al., 2013). These age differences may be explained by the vulnerabilities of aging described in the Strength and Vulnerability Integration (SAVI) model, which include having lower physiological flexibility and cognitive resources to handle stressors (Charles, 2010). These vulnerabilities may be especially pronounced when dealing with cognitively demanding stressors and weaken older adults' abilities to regulate their emotions, thereby exhibiting similar or even higher NA reactivity compared to younger adults. This pattern has been substantiated in numerous empirical studies. For example, in a study involving a cognitively challenging and stereotype-threatening lab stressor, older adults reported greater NA reactivity compared to younger adults (Minton et al., 2023). Moreover, in another two lab studies, older adults exhibited greater sadness while watching film clips depicting losses at different life stages (Kunzmann & Grühn, 2005; Kunzmann & Richter, 2009), presumably because these losses were more relevant and threatening to them, and cognitive abilities were important for downregulating NA in these situations (Kunzmann & Richter, 2009). More specifically, older adults with poorer cognitive functioning displayed greater NA reactivity compared to younger adults or older adults with greater cognitive functioning (Kunzmann & Richter, 2009).

In a study of daily life unpleasant events, researchers found older adults showed higher NA reactivity than young adults while facing more complex daily life unpleasant events (i.e., stressors that affected multiple life domains; Wrzus et al., 2013). In contrast, they found no age differences in NA reactivity to circumscribed events (i.e., situations impacting only one aspect of life; Wrzus et al., 2013). These findings highlight that more highly demanding stressors, such as more complex stressors, may tax older adults' cognitive resources and put them at a disadvantage

in downregulating their NA reactivity compared to younger adults. These results also closely align with SAVI's predictions concerning the challenges presented by cognitively demanding stressors (Scott et al., 2013), such that older adults are more vulnerable to the negative impacts of extended or severe stress (Charles, 2010).

### **Interpersonal Stressors: Age-Related Strengths in Downregulating Affective Reactivity**

Interpersonal stressors refer to stressful situations between two or more individuals, such as conflicts, disagreements, tense interactions, and/or worry about causing emotional harm to others (Kato, 2013). Research comparing interpersonal stressors in daily life to other types of stressors indicated that, unlike cognitively demanding stressors, older adults may exhibit lower NA reactivity in this domain (Birditt et al., 2005; Hay & Diehl, 2010). The result suggests that older adults may be better able to mitigate stress reactivity to interpersonal stressors.

Researchers have proposed a number of reasons why older adults may manage their emotions more effectively in response to interpersonal stressors. For one, older adults are less likely to report experiencing interpersonal stressors in the first place compared to younger adults (Birditt & Fingerman, 2003; Birditt et al., 2005; Blanchard-Fields & Coats, 2008; Luong et al., 2011). That work is in line with predictions by Socioemotional Selectivity Theory (SST), which posits that as individuals get older, they are more likely to focus on emotionally meaningful goals due to shrinking time horizons that narrow their motivations to focus on shorter-term goals (Carstensen et al., 1999). With the changes in time perspective in mind, older adults are more likely to avoid arguments than younger adults (Witzel & Stawski, 2021). Research suggests that older adults gain more benefits if they avoid arguments compared to younger adults (Charles et al., 2009). This interpretation can also be explained by the strengths of aging outlined by the SAVI model. Building upon SST (Carstensen et al., 1999), SAVI (Charles, 2010) suggests that

one strength of aging is that older adults are more likely to reduce the risk of being exposed to negative events and experience better affective outcomes because their accrued life experience helps them to learn how to avoid stressors. Also, avoiding arguments allows older adults to reduce engagement in conflict, which is associated with reduced emotional reactivity (Witzel & Stawski, 2021). Even when they experience interpersonal stressors, however, older adults exhibit less NA reactivity compared to younger adults (Birditt et al., 2005). Aligned with SST (Carstensen et al., 1999), older adults demonstrated less NA reactivity while experiencing a lab-based negative social interaction compared to younger adults (Luong & Charles, 2014). This effect was partially mediated by age differences in motivations, whereby older adults were more motivated to perform well on this task compared to younger adults (Luong & Charles, 2014). In contrast, younger adults tend to prioritize knowledge-related goals to help bank resources for a longer future, even at the expense of their emotional well-being (Charles et al., 2009). These shifts in priorities and social behaviors with age may lead to older adults focusing more on cultivating rewarding social relationships and maintaining positive emotional states in interpersonal contexts. Therefore, it seems older adults have less response to interpersonal stressors and perform better emotion regulation.

### **General Daily Life Stressors: A Mixed Literature**

Daily life stressors refer to everyday challenges and hassles (Piazza et al., 2013) and may include different life domains, such as home, work, health, and financial stressors. Many researchers have studied age differences in NA reactivity to daily life stressors by combining stressors across domains (e.g., Almeida et al., 2023; Jiang et al., 2023; Mroczek & Almeida, 2004; Piazza et al., 2015; Scott et al., 2017), ignoring unique stressor types, such as cognitively demanding stressors or interpersonal stressors. As discussed above, older adults are more likely

to exhibit greater NA reactivity in situations requiring greater cognitive resources (demanding tasks) (e.g., Kunzmann & Richter, 2009; Minton et al., 2023). Yet, older adults exhibit less NA reactivity than younger adults in more controllable situations or events they have greater life experience with, such as interpersonal stressors. However, unlike cognitively demanding stressors and interpersonal stressors, the age-related patterns are less clear regarding general daily life stressors. For example, some studies show that older adults report experiencing less NA reactivity to general stressors in daily life than younger adults, which is consistent with the assumptions from SST (Almeida et al., 2023; Brose et al., 2015; Jiang et al., 2023; Stawski et al., 2019). However, some studies show the opposite pattern, such that older adults exhibit more NA reactivity to general daily life stressors compared to younger adults (e.g., Mroczek & Almeida, 2004). By analyzing the data from the National Study of Daily Experiences (NSDE), the association between daily stress and NA was found to be stronger among older adults compared to younger adults, and older adults with high neuroticism showed the highest reactivity to stress (Mroczek & Almeida, 2004). Still, other studies indicate that older and younger adults exhibit similar levels of NA reactivity to general daily life stressors (Scott et al., 2017; Diehl & Hay, 2010; Röcke et al., 2009; Schilling & Diehl, 2014; Stawski et al., 2008).

One possible reason why the pattern of age differences in NA reactivity to general daily life stressors is mixed is that the specific characteristics of those stressors, such as their severity and importance, were not considered in past studies. Aggregating multiple stressor types may mask important characteristics of those stressors that may influence age differences in abilities to regulate emotions and reduce affective reactivity. For example, in a longitudinal study of emotional responses to daily stressors, the severity of daily stress was linked to higher NA

reactivity, and this was especially true for older adults (Sliwinski et al., 2009). Thus, we may expect that older age is related to greater NA reactivity to relatively more severe stressors.

### **The Current Study**

Despite decades of research on age differences in NA reactivity, the pattern of findings remains inconsistent (e.g., Minton et al., 2023; Birditt et al., 2005; Scott et al., 2017). Most previous research studies only focused on one stressor type, such as cognitively demanding stressors, interpersonal stressors, or general daily life stressors. In these study designs, researchers studied different samples of people experiencing different stressors, especially when stressor types were not specified (e.g., general daily life stressors). It is unclear how age-related patterns of NA reactivity may show different patterns when the same set of participants experiences different types of stressors. Therefore, in the current study, we focused on how different types of stressors might moderate age differences in NA reactivity. To investigate this primary research question, the same set of participants was observed in their NA reactivity across three different stressors (cognitively demanding stressors, interpersonal stressors, and general daily life stressors). As an exploratory follow-up question, we also tested how age differences might moderate the association between stressor severity and NA reactivity for interpersonal and general daily life stressors, given that previous research suggested that stressor severity might be more predictive of NA reactivity for older vs. younger adults (Sliwinski et al., 2009).

We hypothesized that: (1) Regarding cognitively demanding stressors, older adults would exhibit *more* NA reactivity than younger adults. (2) Regarding interpersonal stressors, older adults would exhibit *less* NA reactivity than younger adults, consistent with the literature (e.g., Birditt et al., 2005). (3) Regarding general daily life stressors, the age patterns in NA reactivity would be less clear. We would conduct exploratory follow-up studies that investigate the extent

to which the association between stressor severity and NA reactivity would be further moderated by the age differences. That is, we hypothesized that greater severity of general daily life stressors would predict greater reactivity, and the effect would be more pronounced for older, relative to younger adults. We would also examine the degree to which greater severity of interpersonal stressors might be related to higher NA reactivity, and the extent to which this effect would be stronger for older, compared to younger, adults. These predictions are in line with SAVI (Charles, 2010), which posits that prolonged and severe stress has a greater negative impact on older adults, making it more challenging for older adults to downregulate their NA reactivity.

## METHOD

### Participants

Participants ( $N = 247$ ) were from the Health and Daily Experiences (HEADE) study (Luong et al., 2023), who were recruited from a mid-sized county in the Midwest of the United States using several recruitment methods. These methods included a university pool for human participants (limited to younger adults), email listservs, newspaper advertisements, community flyers, and recommendations through word-of-mouth. The final sample consisted of the 162 participants who completed the two major study procedures: laboratory sessions and the ecological momentary assessment (EMA) surveys in daily life. Participants were eligible for the study if they met the age criteria (as either a younger adult (18-35 years old) or older adult (60+ years old)) and passed a cognitive screening test.

During the recruitment process, the Mini-Mental State Examination (Folstein et al., 1975) was used to screen participants for potential cognitive impairments. People who had serious psychological disorders or any cardiovascular health conditions were also excluded. The final sample (as shown in Table 1) consisted of 56 younger adults (19-35 years old) and 106 older adults (60-90 years old) who met the study criteria and completed the two major study procedures. More than half of the sample were women (56.8%), and the rest were men (43.2%). The majority of the participants were non-Hispanic White (79.0%), and the rest (21.0%) identified as belonging to minoritized ethnic or racial groups. Most participants (79.6%) had a bachelor's degree or above. The median income of participants was between \$40,000 and \$49,999.

## Procedures

To meet the ethical requirements of ensuring human participants' rights and welfare, the study received approval from the university Institutional Review Board. Before the study began, participants were provided with an informed consent form and notified that they might decline participation in the study at any time without loss or penalty. We also explained more detailed information about the study, such as the purpose and procedure of the study, and answered questions they had during the overview session. After participants signed the informed consent forms, they completed the study procedures which took place over the course of about a week, including eight consecutive days of EMA surveys in daily life (one practice day and seven study days) and five laboratory visits (one study overview session, three lab sessions, and a follow-up/equipment return day).

All three lab sessions were held at the main university campus, and each lab session lasted about 1.5 hours. Participants were asked to come at the same time in the day (e.g., 10:00 a.m.-11:30 a.m.) for each lab session to avoid the influence of time on their performance. After participants arrived at the lab, we took baseline assessments via questionnaires, such as demographic information and their current positive and negative affect (baseline). After participants reported their baseline affect, they were instructed to complete a standardized psychosocial cognitive lab stressor – the Trier Social Stress Test (TSST; Kirschbaum et al., 1993). The TSST included a public speech task and a mental arithmetic task, each lasting 5 minutes. First, participants were notified that they would have five minutes to prepare for a five-minute speech given to an expert evaluator. Their cardiovascular activity (e.g., heart rate variability) would be recorded, and their performance would be videotaped. Three speech topics were administered in counterbalanced order across the three lab sessions, including 1) “Explain

why you should be hired as a volunteer for a charitable organization,” 2) “Describe a situation in which you did something shameful,” and 3) “Describe your major shortcomings.” During the speech, the evaluator (a research assistant) pretended to evaluate the speech in a serious and stoic way by keeping eye contact but not smiling or nodding. If participants stopped talking, they were told to continue. After the 5-minute speech task, participants were instructed to complete a mental arithmetic task in which participants had five minutes to count backward by a specific subtrahend starting at a large number. If they stated an incorrect number, the evaluator would ask them to start over until the time ran out. Right after finishing TSST, participants reported their current affect again by completing the questionnaire packets. The procedure for the other two lab sessions was similar, except that the speech topics and math problems were counterbalanced.

We also collected data on participants’ daily life experiences via EMA surveys. Overlaid across the same week, participants completed EMA surveys using smartphones (Samsung J3) that we loaned to them during the overview session. The phones pinged six times each day for eight consecutive days to administer the EMA surveys to participants. Each survey required about two minutes to finish, so the time to finish all 48 surveys was about 1.5 hours total across the week. The surveys were programmed to occur semi-randomly during the waking hours reported by participants but not during their scheduled lab visits. The interval between the two surveys was no less than thirty minutes but no more than four hours. Out of 7,104 surveys completed, 36 were only partially finished, and no more than 10% were missing (Luong et al., 2023). In EMA surveys, we asked participants to report their daily life experiences, such as the occurrences of stressors, momentary emotional experiences (negative affect), the contexts of stressful events, and the severity (importance) of the stressors, which were the focus of the current study.

During the follow-up/equipment return session, we debriefed participants on the true purpose of the study, including the use of deception during the TSST. Compensation was sent out in different ways. College students from university human participants pools received up to six extra credit units for completing the study, including the bonus compensation if they completed at least 90% of the daily life EMA surveys, whereas community participants received up to \$200 if they completed all lab visits and at least 90% of the daily life EMA surveys.

## **Measures**

**Age Group.** The main predictor variable was age group, which was self-reported by participants. Participants were classified as either younger adults (from 18 to 35 years old) or older adults (from 60 to 90 years old; 0 = *younger adults*, 1 = *older adults*).

**Stressor Types.** As discussed above, we studied three different stressors: cognitively demanding stressors (TSST lab stressors), interpersonal stressors, and general daily life stressors. We assessed interpersonal stressors and general daily life stressors through EMA surveys. In daily life, we distinguished whether participants responded to interpersonal stressors or general daily life stressors by evaluating their responses to the question, “Which of the following best describes the stressful event you experienced?” This question was only asked if participants reported that they had experienced any unpleasant or stressful events since waking up or since the last survey. Participants could select among the following stressor domains, including “other people, work/school/university, health, finances/assets, future plans, day-to-day hassles (e.g., unexpected problems), and other.” Participants who selected “other people” were classified as experiencing interpersonal stressors, even if other options were also selected; all other stressor domains were considered to be general daily life stressors as long as “other people” was not selected.

**Severity (Importance) of stressors.** We collected data on stressor severity through EMA surveys to answer the exploratory question testing the moderation of age differences on stressor severity and NA reactivity for interpersonal and general daily life stressors. In this work, we assessed severity through importance, as in the previous work (Wrzus et al., 2015). In the EMA surveys (daily surveys), if participants endorsed that a stressor had occurred since the last survey, they were asked the follow-up question, “How important was the stressful event for you?” on a zero (*not at all important*) to six (*very important*) scale to indicate the severity of interpersonal stressors or general daily life stressors they reported experiencing.

**NA reactivity.** The dependent variable in this study was NA reactivity, and we assessed that by measuring participants’ state NA before and after the stressors occurred and calculating the difference. To compute state NA, a modified version of the Emotion Sampling Booklet (Carstensen et al., 2000) was used to assess to what degree the participants were experiencing each emotion at that moment. The original scale consisted of nineteen emotions, including eleven negative emotions and eight positive emotions, ranging from 1 = *not at all* to 7 = *extremely*; however, we revised it and kept seven negative emotions and seven positive emotions in the HEADE study. For the current study, we only focused on four negative emotions, which were anger, sadness, anxiety/worry, and boredom, because these items overlapped across both study procedures (lab sessions and daily life EMA surveys).

We defined the NA reactivity to cognitively demanding stressors assessed in the lab as the difference between the participants’ task NA (taken immediately after the TSST) and their baseline NA ( $affect_{task} - affect_{baseline}$ ), and we computed a single person-level NA reactivity score by averaging each participant’s NA reactivity scores across the three lab sessions. Additionally, NA reactivity to daily life stressors (interpersonal stressors as well as general daily

life stressors) were defined as the variation in NA on occasions when those specific types of stressors were present (interpersonal or general daily life stressors, respectively), as compared to their average level of NA experienced on occasions without stressors ( $affect_{occasions\ with\ stressors} - affect_{occasions\ without\ stressors}$ ), and we computed a single person-level NA reactivity score by averaging each participant's NA reactivity across the eight EMA survey days.

The Cronbach's alpha values for this measure of NA have ranged from 0.84 to 0.90, demonstrating good to excellent levels of internal consistency (Luong & Charles, 2014). In addition, Riediger et al. (2009) showed that their results were consistent with the same NA construct, which indicated the validity of the measurements we used.

**Covariates.** Education, gender (0 = *men*, 1 = *women*), and race/ethnicity (0 = *White non-Hispanic*, 1 = *Hispanic/Latino*, 2 = *Other minoritized racial or ethnic background*) were collected through the demographic survey during the first lab session. We adjusted for these covariates due to the known associations between these individual difference variables and affective reactivity in previous studies (Birditt & Fingerhant, 2003; Luong et al., 2020; Rodriguez-Stanley & Zilioli, 2023).

## RESULTS

### **Data Analysis Strategy**

We used repeated-measures ANOVA to address our primary research question, assessing to what extent age differences in NA reactivity are moderated by stressor type. Participants included in these analyses attended at least one lab session and completed at least some EMA surveys. To leverage the use of repeated measures ANOVA, which requires balanced data (i.e., all participants have data on all three stressor types), we imputed NA reactivity scores for cases in which participants were missing or did not report interpersonal or general daily life stressors. Several steps were included in the imputation process. The program first fit a regression model based on observed data. Then, it predicted values for both missing and observed values and matched each missing value to observed ones with similar predicted values. Finally, missing values were imputed using an actual value from a matched observed value. For the exploratory research question regarding age group as a moderator of the association between stressor severity and NA reactivity for interpersonal and general daily life stressors, we analyzed the raw data using multiple regression.

### **Descriptive Statistics**

A total of 162 participants, including 56 younger adults and 106 older adults, attended at least one lab session, meaning all of them had NA reactivity scores to the cognitively demanding stressors. Although all participants provided some data from the EMA surveys, as shown in Table 1, 64% reported experiencing at least one interpersonal stressor, among which, younger adults reported an average of 2.89 occasions, whereas older adults reported 2.97 occasions; 93% reported experiencing general daily life stressors, among which, younger adults reported an average of 5.29 occasions, whereas older adults reported 4.79 occasions. Comparing across the

age groups, fewer older adults (54%) reported experiencing any interpersonal stressors compared to younger adults (82%), which is in line with the literature, and this difference was statistically significant,  $t = 3.998, p < .001$ . Seven participants reported that they experienced neither interpersonal nor general daily life stressors in the EMA surveys. Other demographic information (categorical variable) is also listed in Table 1. Table 2 lists the mean and standard deviation for each key variable in this study by age group. In general, older adults reported experiencing more severe interpersonal stressors,  $t = -3.725, p < .001$ , and general daily stressors,  $t = -3.752, p < .001$ , than younger adults, and the results were statistically significant.

Table 1  
*Percentage of participants in each level for each categorical variable by age group*

Variable	Percentage of Participants	
	Younger Adults ( $n = 56$ )	Older Adults ( $n = 106$ )
Gender (Women)	59% (33)	56% (59)
Race / Ethnicity		
White Non-Hispanic	59% (33)	90% (95)
Hispanic/Latino	34% (19)	8% (9)
Other	7% (4)	2% (2)
Stressor Type		
Lab Stressor	100% (56)	100% (106)
Interpersonal Stressor*	82% (46)	54% (57)
General Daily Stressor	91% (51)	93% (99)

*Note. Asterisk denotes statistically significant age group differences. \*  $p < .001$*

Table 2  
*Mean and standard deviation for each I/R variable by age group*

Variable	Mean (SD)	
	Younger Adults	Older Adults
Age	27.93 (3.89)	69.78 (6.59)
Education Level	7.79 (1.20)	7.63 (1.94)
Negative Affective Reactivity		
Lab Stressor	0.01 (0.39)	0.37 (0.57)
Interpersonal Stressor	0.45 (0.57)	0.59 (0.51)
General Daily Stressor	0.42 (0.39)	0.53 (0.57)
Stressor Importance		
Lab Stressor	-	-
Interpersonal Stressor*	2.75 (1.45)	3.73 (1.14)
General Daily Stressor*	2.25 (1.40)	3.13 (1.29)

*Note.* Asterisks denote statistically significant age group differences. \*  $p < .001$

### **Primary Research Question: Testing Stressor Type as a Moderator of Age Differences in NA Reactivity**

We only imputed NA reactivity scores for participants who were missing or did not report interpersonal stressors and/or general daily life stressors. Then, we used a between-subjects ANOVA to test the extent to which NA reactivity varies by age group. The result revealed a statistically significant moderate-sized effect of age groups on NA reactivity scores  $F(1, 160) = 12.11, p < .001, \eta^2 = .070$ . Post-hoc pairwise comparisons showed that older adults exhibited more NA reactivity than younger adults, on average,  $t(160) = -3.480, p = .001$ .

Moreover, we tested the degree to which NA reactivity differed by stressor type using a one-way repeated-measures ANOVA. The result showed a statistically significant effect of stressor types on NA reactivity scores with a moderate effect size, indicating that NA reactivity responses varied across different stressor types,  $F(1.94, 312.20) = 20.77, p < .001, \eta^2 = .070$ . Post-hoc pairwise comparisons (as shown in Table 3) showed significant differences between

some stressor types (Lab vs. Interpersonal, Lab vs. General Daily Life), suggesting that NA reactivity varied by type of stressor.

Table 3  
*Follow-Up Pairwise Comparisons*

Variable	<i>estimate</i>	<i>SE</i>	<i>df</i>	<i>t ratio</i>	<i>p</i>
Lab vs. Interpersonal	-0.327	0.053	161	-6.208	<.001
Lab vs. General Daily Life	-0.252	0.057	161	-4.393	<.001
Interpersonal vs. General Daily Life	0.076	0.049	161	1.538	0.378

Furthermore, we performed a mixed repeated-measures ANOVA, including age groups and stressor types in one model predicting NA reactivity. We treated age groups as the between-subjects factor and different stressor types as the within-subjects factor. As shown in Table 4, stressor type significantly moderated the relationship between age groups and NA reactivity with a small effect size,  $F(1.95, 311.69) = 3.70, p = .027 < .05, \eta^2 = .014$ . Please see Figure 1 for an illustration of the moderation effect.

Table 4  
*Repeated measures ANOVA results for NA reactivity across two age groups and three stressor types*

Variable	<i>df</i>	<i>MSE</i>	<i>F</i>	$\eta^2$	<i>p</i>
Age Group	1, 160	0.31	12.11	0.030	<.001
Stressor Type	1.95, 311.69	0.23	24.53	0.084	<.001
Age Group $\times$ Stressor Type	1.95, 311.69	0.23	3.70	0.014	0.027

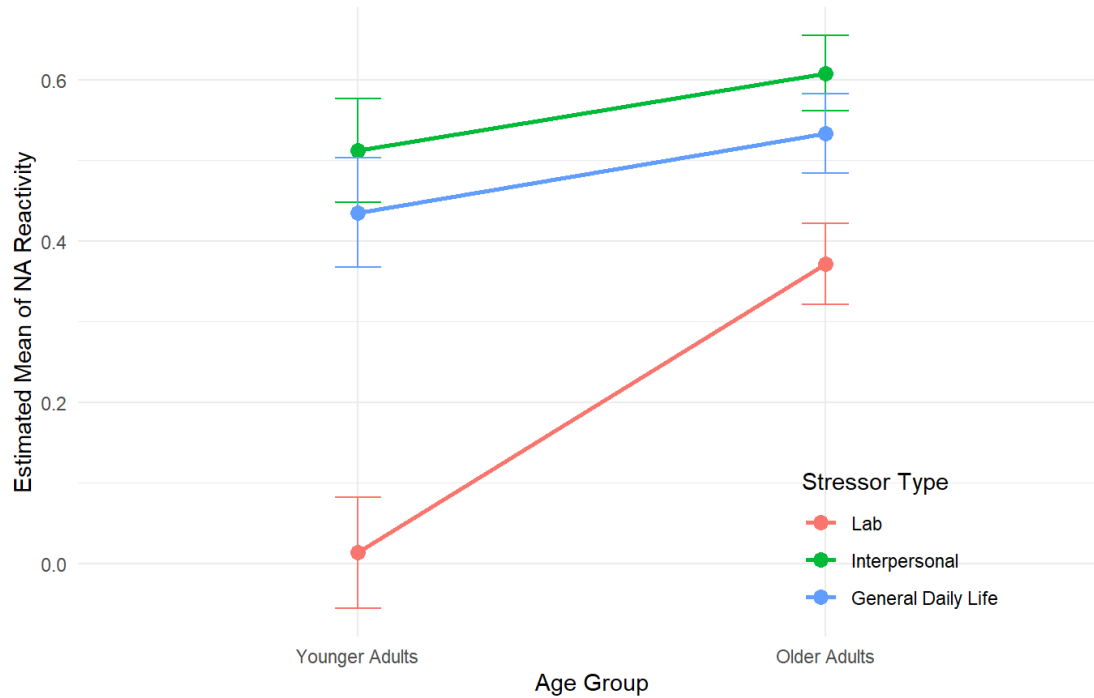


Figure 1. Moderation Effect of Stressor Type on Age Differences in NA Reactivity

As age differences in NA reactivity were moderated by stressor type, to better interpret this statistically significant interaction term (Age Group  $\times$  Stressor Type), we did three simple regressions to test age differences in NA reactivity separately for the three stressor types. The simple regression revealed that older adults exhibited more NA reactivity than younger adults in response to the cognitively demanding lab stressors,  $B = .358, SE = .085, p < .001, R^2 = .099$ . In contrast, we found no age group differences in NA reactivity to interpersonal stressors or general daily stressors.

Next, we tested the extent to which this moderation effect is robust when including covariates. The results still showed statistically significant main effects of age groups,  $F(1, 150) = 6.05, p = .015 < .05, \eta^2 = .016$ , and stressor types,  $F(1.96, 294.50) = 7.46, p < .001, \eta^2 = .029$ , on NA reactivity, but the interaction between age groups and stressor types was no longer statistically significant. Notably, none of the covariates, including

gender, education, and race/ethnicity, had a statistically significant effect on NA reactivity (as shown in Table 5).

Table 5  
*Repeated measures ANOVA results for NA reactivity across two age groups and three stressor types with covariates*

Variable	<i>df</i>	<i>MSE</i>	<i>F</i>	$\eta^2$	<i>p</i>
Gender	1, 150	0.30	1.97	.005	.163
Race/Ethnicity	2, 150	0.30	0.07	<.001	.932
Education	7, 150	0.30	1.80	.032	.091
Age Group	1, 150	0.30	6.05	.016	.015
Stressor Type	1.96, 294.50	0.23	7.46	.029	<.001
Age Group × Stressor Type	1.96, 294.50	0.23	2.45	.010	.089
Gender × Stressor Type	1.96, 294.50	0.23	0.26	.001	.763
Race Ethnicity × Stressor Type	3.93, 294.50	0.23	0.83	.007	.508
Education × Stressor Type	13.74, 294.50	0.23	0.66	.018	.808

**Exploratory Research Question: Testing the Moderating Effects of Age Group on the Association between Stressor Severity and NA Reactivity**

We tested the exploratory question to assess whether age group moderates the association between severity of stressors and NA reactivity for interpersonal stressors as well as general daily life stressors through two separate multiple regression analyses. None of the multiple regressions showed a statistically significant main effect of severity or age group, nor of their interaction term on NA reactivity for interpersonal,  $B = .056, SE = .081, p = .494$ , or general daily life stressors,  $B = .092, SE = .065, p = .158$ . Thus, severity did not predict NA reactivity for either interpersonal or daily life stressors, nor were there moderating effects by age group.

## DISCUSSION

The current study investigated the extent to which age differences in NA reactivity are moderated by stressor type, including cognitively demanding stressors, interpersonal stressors, and general daily life stressors. We found that older adults exhibited more NA reactivity than younger adults in response to cognitively demanding lab stressors, but there were no age differences in NA reactivity to interpersonal and general daily life stressors. Also, we explored the degree to which there may be age differences in how stressor severity predicts NA reactivity, given previous work suggesting that more stressor severity is related to greater NA reactivity. These analyses revealed that there were no age group by stressor severity effects on NA reactivity, nor any statistically significant main effects of stress severity on NA reactivity to daily life stressors (interpersonal or general).

### **Cognitively Demanding Stressors**

In line with the literature (e.g., Kunzmann & Richter, 2009; Minton et al., 2023; Wrzus et al., 2013) and our hypothesis, we found that older adults exhibited more NA reactivity than younger adults while dealing with cognitively demanding stressors. Some researchers argue that public speaking tasks and math tasks (such as those included in the TSST) involve cognitive challenges in addition to a social-evaluative threat (see review by Dickerson & Kemeny, 2004). In our lab settings, we had research assistants pretending to evaluate participants' speech and math tasks, which may have made participants feel stressed due to the social-evaluative threat, as they might want to perform well and make a good impression with the research assistant. Although we categorized this stressor as "cognitively demanding," it may have been threatening on multiple levels, as it also included the social evaluative threat that was repeated multiple times throughout the week. The SAVI model (Charles, 2010) predicts an age-related vulnerability with

aging, including limited cognitive resources to handle demanding stressors, such as the TSST, which requires higher-ordered executive functioning, including working memory during the arithmetic task. In addition to the cognitive demands, older participants may be especially threatened by this task as it may prime them to think about age-related cognitive declines or internalized ageism (Henry et al., 2023).

### **Interpersonal Stressors**

As discussed in the introduction section, many studies (e.g., Birditt et al., 2005; Luong & Charles, 2014) indicate that older adults show less NA reactivity than younger adults while facing interpersonal stressors, consistent with predictions by SST (Carstensen et al., 1999) and SAVI (Charles, 2010). Counter to our hypotheses, however, in our study, no age differences in NA reactivity were found regarding interpersonal stressors. One possible reason is that a smaller subset of participants reported experiencing any interpersonal stressors during the study period ( $n = 103$ ), which might lead to lower power to detect age differences in NA reactivity. According to the power analysis, we need 394 participants in each age group to detect a small effect or 64 participants in each group to detect a medium effect. However, even after we imputed the data, we only had 56 NA reactivity scores for younger adults and 106 NA reactivity scores for older adults with respect to interpersonal stressors. Additionally, when conducting repeated-measures ANOVA, we imputed NA reactivity scores for participants who did not report interpersonal stressors during the study period, which might not represent their real NA reactivity. Although imputation is a useful technique for inferring missing data values, it has several weaknesses. For example, it may underestimate variability, leading to biased statistical inferences (Marks-Anglin et al., 2024). We collected data for interpersonal stressors through participants' daily lives (EMAs), which could be much noisier than the lab data. Imputation might not perform well

based on the limited observed data due to the highly unpredictable daily life. Thus, the small sample size lowered the power to detect age differences, and the imputation might make inaccurate inferences, which might contribute to no statistically significant age differences in NA reactivity. However, even though we did not detect statistically significant age differences in NA reactivity for interpersonal stressors, partially due to the small sample size, our finding is consistent with the literature, such that previous studies have shown that older adults may be more adept at avoiding interpersonal stressors than younger adults (e.g., Witzel & Stawski, 2021). That could be why fewer older adults than younger adults reported experiencing interpersonal stressors, as shown in our study.

### **General Daily Life Stressors**

We hypothesized that age differences in NA reactivity would be less clear regarding general daily life stressors, as the literature evidenced mixed results. Supporting our hypothesis, we did not detect statistically significant age differences in NA reactivity for general daily life stressors. One possibility is that this category included all other daily life stressors that were not classified as interpersonal stressors, which may have led to less specificity and signal to detect age group differences in NA reactivity. Some participants also reported experiencing stressors during daily life in different domains, such as financial stressors, health stressors, or work/academic stressors. We classified general daily life stressors in this way because we did not have enough observations to detect differences in each type of stressor and because this scheme has been most commonly used in the literature. Another possibility for the null effects is the imputation issue, as discussed above. Thus, age differences in NA reactivity were less clear for general daily life stressors, but this pattern of findings is consistent with previous research.

## **Testing Age Differences in Severity-Reactivity Links**

Previous work (Sliwinski et al., 2009) suggests that greater stressor severity predicts more NA reactivity in daily life. According to our t-test results, older adults reported experiencing more severe interpersonal and general daily life stressors. To further learn about age patterns for interpersonal and general daily life stressors, we tested an exploratory question to study how age group may moderate the association between stressor severity and NA reactivity. The results revealed that severity did not predict NA reactivity for either stressor type in daily life, and these effects were also not moderated by age group. One of the possible reasons for the non-significant results is that we averaged the severity scores for each stressor type to make sure that each participant had one severity score for interpersonal and general daily life stressors, respectively, if they reported experiencing any stressors in those types. Although averaging severity scores made the data analysis process easier and more convenient, we lost some information, especially with respect to within-person variability across different stressor occasions. That is, participants may sometimes experience highly severe stressors, and in other cases, they experience low-level hassles, and by averaging the severity index for each participant, we were unable to detect age differences in these within-person differences. Future research could leverage these intensive data by examining how younger and older adults are varying their affective responses across situations.

## **Limitations and Future Directions**

Although our hypotheses were partially supported, there were some notable limitations in the current study. First, the sample size was relatively small. Our final sample included 162 participants who all completed at least one cognitively demanding lab stressor; however, fewer people reported an interpersonal stressor ( $n = 103$ ) or general daily life stressors ( $n = 150$ ), which

could have limited our ability to detect age differences. Also, the general daily life stressors lumped several domains together, which may have made it more difficult to detect differences, but this is because we did not have enough participants reporting each type of other stressor. Thus, future research may include a larger sample size, and stressor types can be defined more precisely by asking more specific questions with details to explore more different stressor types.

In addition, we had intensive, nested data on our participants but used a data analytic approach that provided only a single summary NA reactivity score for each participant for each type of stressor. For example, participants attended three lab sessions, so they actually had three NA reactivity scores to the cognitively demanding task, but we simplified the analyses by averaging these values into a single score for each participant. Also, they completed up to 48 EMA surveys across eight days, but we averaged their NA reactivity scores by daily life stressor type (interpersonal vs. general daily life stressors) instead of using the rich time series data we had available to us. In addition, regarding the data of stressor severity we collected from the EMA surveys, we also averaged them and used a single score representing the importance of interpersonal and general daily life stressors they experienced for each participant, respectively. Moreover, we constrained the analyses to only the 162 participants (out of 244) who provided data across lab sessions and EMA daily life contexts, which also led to reductions in statistical power. These approaches were used to simplify the data analysis plan so that we could use repeated-measures ANOVA, but future studies should leverage multilevel modeling approaches that account for nested and missing data more flexibly, allowing us greater ability to detect age group differences in NA reactivity across stressor types, if they exist.

## **Implications**

These findings have important implications for testing SAVI's predictions regarding how patterns of age differences in stress reactivity can vary by different stressors, even among the same set of participants. The strengths and vulnerabilities of aging described by SAVI suggest that there should be different emotional functioning benefits for individuals in different age groups. Previous studies in the literature, even those using the same theory, such as SAVI, to guide their research questions and hypotheses, have found inconsistent patterns of age differences in NA reactivity to stressors (e.g., Minton et al., 2023; Scott et al., 2017). The current study included the same set of participants experiencing different stressors to better understand how age differences in affective reactivity may depend on stressor types, which may help us better understand inconsistent findings in the literature. In addition, these findings shed light on increasing our knowledge of different emotional response patterns to different stressors and providing age-specific health recommendations. For example, older adults may be influenced more negatively by cognitively demanding stressors, which may be recommended as a particular kind of stressor that older adults may want to avoid. Keeping that in mind, some preventive measures can be proposed to protect older adults.

In conclusion, the current study provides a foundation for future work in explaining why age differences in NA reactivity show different patterns. That is, age differences in NA reactivity are moderated by stressor type. More specifically, older adults show more NA reactivity while dealing with cognitively demanding stressors than younger adults but react similarly while dealing with interpersonal and general daily life stressors. Future research can benefit from exploring age differences in NA reactivity to more different types of stressors. If successful, the research can ultimately provide the foundation for understanding how to promote individuals'

mental and physical health by leveraging what is known about age-related advantages and disadvantages across different stressor types and contexts.

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## DECLARATION OF GENERATIVE AI IN THE WRITING PROCESS

During the preparation of this thesis, I used Grammarly to check the grammar of my writing and ChatGPT to obtain R code templates for data analysis. However, the thesis was written entirely by myself, and I take full responsibility for its content.