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Longitudinal Evaluation of Perceived Stress and Memory Complaints in the Einstein Aging Study

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Abstract

Background: Perceived stress decreases memory performance and escalates the risk of developing cognitive impairment. Despite these concerning cognitive outcomes, longitudinal assessment of the relationship between perceived stress and memory complaints within a racially diverse sample remains scant.

Method: 391 cognitively intact older adults ($M = 77.31$, $SD = 4.75$) from the Einstein Aging Study were measured annually for up to nine years. Memory complaint items included self-reported frequency of forgetfulness, one-year memory decline, and ten-year memory decline. Multilevel models examined between-person and within-person associations between perceived stress and memory complaints while controlling for demographic differences and neuroticism.

Results: Strong between-person associations emerged such that older adults with generally higher perceived stress were more likely to report memory complaints, and vice versa. No significant concurrent within-person associations emerged. One lagged association emerged showing that within-person increases in perceived stress translated to a higher likelihood of reporting ten-year memory decline at the next annual screening.

Conclusion: Older adults with higher perceived stress are at risk for memory complaints over time. Further research into the relationship between perceived stress and memory complaints is necessary to augment our understanding of how risk factors of cognitive decline present throughout the aging process.

Keywords

perceived stress; memory complaints; cognitive decline; Einstein Aging Study; multilevel modeling

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Introduction

Perceived stress continues throughout older adulthood due to emergent stressors, such as health complications, financial uncertainty, loneliness, grief, and concerns about maintaining independence (McHugh et al., 2013; Zhang et al., 2017). Unfortunately, chronic stress is known to negatively impact memory performance (Wolf et al., 2005) and increase risk of cognitive impairment (Katz, et al., 2016). This is likely because stress influences how we perceive memory challenges, eventually disrupting performance through task interference from worries about memory abilities (Eysenck & Calvo, 1992) or breakdowns in automatic memory processes (Masters, 1992). Indeed, one in three older adults report memory complaints which doubles their cognitive decline risk (Buckley et al., 2016; Hohman et al., 2011; Reisberg, Shulman, Torossian, Leng, & Zhu, 2010). This highlights a need to understand how stress and memory complaints, as risk factors for cognitive decline, temporally associate in older adulthood at a between- and within-person level. Specifically, do individuals with generally high perceived stress report more memory complaints than their counterparts (*between-person association*)? Additionally, at times when individuals perceive higher stress, are they also more likely to report memory complaints (*within-person association*)? Understanding such associations would help inform interventions to prevent memory complaints associated with stress that can precede cognitive decline.

Perceived stress involves explicit ratings of irritation and concern arising from stressors, as well as the inability to control and cope with such feelings (Cohen, Gianaros, & Manuck, 2016; Lazarus & Folkman, 1984). According to Cohen's (2016) heuristic model of stress reaction, stressors are filtered through implicit beliefs about severity of demands (e.g., *how challenging is this problem?*) and their adaptive capacities (e.g., *how well can I overcome this problem?*). Perceived stress develops when perceived demands outweigh adaptive capacities. Thus, older adults who report higher perceived stress are more likely to see life challenges as overwhelming and insurmountable, which might make them more likely to feel the same about memory tasks despite capable cognitive abilities. Furthermore, at times when individuals show higher perceived stress, they might be more likely to report memory problems even if they never reported such issues before. Moreover, individuals with higher perceived stress may experience task-irrelevant thoughts that may inhibit their ability to effectively use cognitive resources and contribute to the perception of memory difficulty (Eysenck, Derakshan, Santos, & Calvo, 2007; Potter et al., 2009). This lack of cognitive resources and task interference from stress might help explain the association between cognitive decline and memory complaints over time. Understanding temporal associations between perceived stress and memory complaints might elucidate trajectories that are important to consider when examining factors contributing to risk for cognitive decline. Furthermore, if memory complaints represent beliefs about demands and adaptability to general stressors, then techniques reframing these beliefs might prove beneficial (Frankenmolen et al., 2018; Lachman, Weaver, Bandura, Elliot, & Lewkowicz, 1992).

Cross-sectional studies with older adults show an established positive association between perceived stress and different types of memory complaints (Bazargan & Barbre, 1994; Mahoney, Dalby, & King, 1998; Piquard, Derouesné, Lacomblez, & Le Poncin, 2012), such as forgetfulness (Potter, Hartman, & Ward, 2008; (Gilewski, Zelinski, & Schaie, 1990;

Santos et al., 2012) as well as retrospective and prospective reported memory errors among cognitively-intact older adults (Steinberg et al., 2013). Some studies show this association even after accounting for negative affect (i.e., depression; Bazargan & Barbre, 1994; Gilewski, Zelinski, & Schaie, 1990; Santos et al., 2012), bolstering the idea that perceived stress is an important psychological factor to consider, over and above depressive symptoms. Nonetheless, it remains unclear how perceived stress and memory complaints affect each other over time, especially in a racially diverse sample.

Whereas cross-sectional studies show a positive between-person association between perceived stress and memory complaints, these studies cannot illuminate whether associations reflect overlapping between-person differences or within-person covariation. Longitudinal studies can better discern whether perceived stress influences memory complaints independent of negative affect. Neupert, Mroczek, & Spiro (2008), in their longitudinal study examining daily stressors across eight weeks and their impact on everyday memory failures, showed that on days when older adults reported more daily stressors than usual, they reported more memory failures. Similar findings were shown by Rickenbach and colleagues (2014), using 12-week daily diary data from the Boston Longitudinal Study. Further, Ronnlund et al. (2013) conducted one of the first longitudinal evaluations that included perceived stress and spanned multiple years. Among a cognitively-intact sample of middle-aged and older adults, those who reported higher perceived stress at baseline endorsed more memory complaints 10 years later, independent of changes in depressive symptoms.

Despite this previous research, limitations preclude a full understanding. First, much work entailed small samples ($ns < 120$) or short timeframes (i.e., weeks; Neupert et al., 2008; Rickenbach et al., 2014). Small samples make strength of effects uncertain and multi-year studies are needed to understand effects across long-term aging. Concerning measurement, most studies quantify memory complaints by summing the total number of different complaints (e.g., Neupert et al., 2008). As explained by Rabin et al. (2015), this approach might be problematic because cognitive complaints are common in older adults and a count may not capture the important characteristics of complaints (e.g., severity) that are associated with the outcomes of interest. Instead, asking about specific types of memory problems might prove more informative. As shown by Ronnlund et al. (2013), who examined types of memory complaints distinctly, compared to individuals with low perceived stress, individuals with high perceived stress reported significantly worse memory than peers (age-anchored comparison), worse memory than five years ago (perceived five-year memory decline), and more frequency of prospective/retrospective memory errors. Supporting the importance of complaint type, individuals with higher perceived stress showed greatest differences from individuals with low perceived stress when measuring frequency of prospective/retrospective memory errors ($d = .73$), perceived five-year memory decline ($d = .59$), and age-anchored comparisons ($d = .50$), respectively. Overall, their statistical models suggest concurrent development, such that when people developed higher stress, they simultaneously reported more memory problems. While this supports the idea that these factors positively covary in older adults, lagged within-person associations could further evaluate temporal ordering. Specifically, it is possible that increases in perceived stress lead to higher memory complaints in later years as people reflect backwards on more

stressful periods. Moreover, to our knowledge no study has explored possible bi-directional, lagged associations even though older adults report seeking medical help due to stress from memory complaints (Begum et al., 2013).

As an effort to advance literature in this area, this study examined longitudinal bi-directional associations between perceived stress and memory complaints in a large diverse sample of older adults. We wanted to explore three possible relationships: 1) between-person associations (i.e., do individuals with higher perceived stress in general report more memory complaints, and vice-versa?); 2) within-person associations (i.e., at times when individuals perceive higher stress than usual, do they report more memory complaints, and vice-versa?); 3) lagged within-person associations (i.e., if individuals report higher stress in a given year, do they report more memory complaints the following year, and vice-versa?). First, we hypothesized that between persons, older adults with higher perceived stress would report more memory complaints. Second, we hypothesized that at times when older adults reported higher perceived stress, they would report more memory complaints than times when they had lower perceived stress. Third, we hypothesized that at times when older adults reported higher perceived stress, they would be more likely to report memory complaints in the next year. These hypotheses align with Cohen's (2016) heuristic model of stress reaction, i.e., that general feelings of greater perceived demands coupled with poor adaptability would generalize to how older adults think about specific abilities like memory. We do not provide hypothesis for the associations with perceived stress as the outcome as these associations were exploratory. Lastly, to ensure these relationships were unique for perceived stress, we additionally controlled for general negative affect (i.e., neuroticism) and demographic differences as done previously (Neupert, Mroczek, & Spiro, 2008).

Methods

Participants

Our study sample was derived from the Einstein Aging Study (EAS), fully described elsewhere (Katz et al., 2016). In brief, EAS is a longitudinal cohort study examining cognitive aging and dementia incidence in community-dwelling older adults (70+ years) in New York City. Participants were recruited annually for comprehensive medical and neuropsychological exams. All procedures were ethically approved by the Albert Einstein College of Medicine Institutional Review Board. The current study includes a subsample from the parent study that received and completed measures of perceived stress after providing informed consent (Katz et al., 2016); these participants additionally completed routine EAS measures of memory complaints described below. Overall, 650 EAS participants completed measures of perceived stress, neuroticism, and memory complaints. We then removed participants classified as having amnestic/non-amnestic mild cognitive impairment or dementia (n = 236, 36.3%), missing diagnostic information (n = 1; <1%), or missing demographic information (n = 32). We further removed individuals identifying as a race other than Black or White (n = 22; <1%) as extremely unbalanced comparisons would harm accurate testing. Thus, the current study sample included 391 participants aged 70 years and over (M_{age} = 77.31, SD = 4.75; 70.8% White; 29.2% Black; 62.4% female) without a clinical diagnosis of mild cognitive impairment or dementia throughout the study

period. Overall, participants had an average of 14.82 years (*SD* = 3.16) of education, 10.2% received an annual income less than $15,000, 34.9% made between $15,000 to $30,000, and 55.8% made over $30,000. Regarding follow-up assessments, up to nine waves of data were included for each participant (*M* = 3.41, *SD* = 2.18). From the second to fourth follow-up, retention was high (85.9%) to modest (57.0%). However, by the fifth follow-up, less than 40.7% of the sample provided data. This attrition is common in longitudinal studies with older participants (Banks, Muriel, & Smith, 2011; Chatfield, Brayne, & Matthews, 2005).

Measures

Participant characteristics and descriptive statistics for the study measures described below are provided in Supplementary Table 1.

Perceived stress.—The 14-item Perceived Stress Scale (PSS-14; Ezzati et al., 2014) was used to measure perceived stress at each timepoint. Items capture appraisals about the degree that life over the last month has felt uncontrollable and overwhelming. These appraisals specifically include not coping well with stressors (e.g., *How often have you felt confident about your ability to handle your personal problems?*) and feeling distress therefrom (e.g., *How often have you felt nervous and stressed?*). Seven items are negatively worded and ranked on a four-point Likert-type scale (0 = never, 1 = almost never, 2 = sometimes, 3 = fairly often, and 4 = very often); seven other items are positively worded and ranked in the reverse direction. All items are summed to produce a total score (0 to 56) where higher values indicate more perceived stress. The PSS-14 shows less than moderate associations with negative emotions like depression and anxiety supporting divergent validity from general negative affect (Ezzati et al., 2014), and shows weak-to-moderate associations with stressor counts, supporting divergent validity to tap into a unique aspect of stress experience (Lee, 2012). It also correlates highly with another perceived stress rating (DASS21-Stress Subscale, $r = .64$), demonstrating convergent validity (Andreou et al., 2011). The PSS-14 shows moderate to strong test-retest reliability, important for our longitudinal evaluation (see Lee, 2012). Moreover, this scale has been validated in older adults (Ezzati et al., 2014) with good reliability in the EAS sample ($\alpha = .82$; Katz et al., 2016).

Memory complaints.—Memory complaints were measured using three items at each timepoint. One item captured frequency of forgetting over the last year, "*In the past year, how often did you have trouble remembering things*." Participants indicated frequency on a four-point Likert-type scale (1 = never, 2 = rarely, 3 = sometimes, 4 = frequently). Participants then estimated their perceived one-year memory decline, *"Compared with one year ago, do you have trouble remembering things more often, less often, or about the same?"* followed by perceived ten-year memory decline, "*Compared with ten years ago, do you have trouble remembering things more often, less often, or about the same?*" Participants rated perceived decline on a three-point Likert-type scale: −1 = less often, 0 = about the same, +1 = more often. Ratings were re-coded into two categories: absent (0 = less often/about the same) or affirmed perceived memory decline (1 = more often).

Neuroticism.—To control for negative affect, we used the 10-item Neuroticism Subscale from the International Personality Item Pool (IPIP) questionnaire (Goldberg, 1992).

Neuroticism best captures negative affect as it measures tendencies to anticipate, experience, ruminate about distress. Questions included five negatively worded items (e.g., "*I often feel blue*") and five positively worded items (e.g., "*I seldom feel blue"*). Positively worded items were reverse scored. Respondents answered how accurate statements were for them on a five-point scale: 1 = very inaccurate, 2 = moderately inaccurate, 3 = neither inaccurate nor accurate, 4 = moderately accurate, 5 = very accurate. Responses were summed into a total score in which higher values represent higher neuroticism.

Statistical analysis

We initially examined distributions of main outcomes and predictors (i.e., perceived stress and memory complaints) at timepoint 1. Descriptives included means, standard deviations, medians, and interquartile ranges for continuous and ordinal data followed by frequencies and percentages for categorical group membership. Next, we calculated demographic differences on these variables using *t*-tests and analysis of variance for continuous/ordinal variables (perceived stress and frequency of forgetting) and chi-square independence tests for categorical variables (perceived one-year decline and perceived ten-year decline). For group comparisons with more than two factor levels, post-hoc Tukey tests determined pairwise differences. Effect sizes were calculated for all comparisons (Cohen's *d*, η^2, or *OR*).

Prior to model building, we calculated intercorrelations between main variables and demographic variables. Along with group comparisons, this allowed us to quantify baseline associations between variables on similar scales (*r*s). Supplementary Table 2 provides Kendall Tau estimates which also correct for the categorical nature of variables (e.g., sex). Intercorrelations helped examine potential multicollinearity between predictors for main analytical models.

Prior to main analytical models, we assessed possible non-random missingness related to attrition. This was done by predicting missingness at any wave from initial values on key study variables via multilevel models. Additionally, we conducted sensitivity analyses for main analytical models restricted to waves with lower rates of attrition (second to fourth follow-up) to determine possible influence of data from waves with high attrition (fifth to ninth follow-up).

Our main analytical models involved multilevel linear modeling (MLM) performed in SAS (SAS Institute Inc., 2014). Such models examine longitudinal associations among variables while accounting for an uneven number of follow-ups and associations nested within individuals. We first specified empty models ($Y_{ti} = \beta 0_i + e_{ti}$; i = individual observation, t = timepoint) to calculate intraclass correlation coefficients, a metric of the proportion of variance due to individuals relative to total variance in the outcome variable. Next, four unconditional time-based growth models ($Y_{ti} = \beta 0_i + \beta 1_i(time_{ti}) + e_{ti}$) were analysed to determine how perceived stress and memory complaints (i.e., frequency of forgetting and perceived one- and ten-year decline) changed over time. We then specified three conditional growth models that examined within-person (concurrent occasion-specific values [perceived $stress_{ti}$ – perceived $stress_{i\ t=1}$]) and between-person (grand-mean centered value from

baseline [perceived stress$_{t=1}$]) associations of perceived stress with the three types of memory complaints as the outcome (see Table 1).

Assessing bidirectional relationships, three conditional time-based growth models then examined within-person and between-person associations of the three types of memory complaints with perceived stress as the outcome (see Table 2). After accounting for the concurrent within-person and between-person relationships, we examined lagged effects of perceived stress on memory complaints in separate models. Specifically, we examined if perceived stress from the previous year (perceived stress$_{(t-1)i}$) predicted future memory complaints (i.e., Y_{ti}). To test bidirectional relationships, we also examined lagged effects of memory complaints on perceived stress. Multilevel time-based growth models with autoregressive structures showed small autocorrelations between perceived stress observations (AR(1) = .10) or memory complaint observations (AR(1)s range from .03 to .11) over time, supporting inclusion of concurrent and lagged within-person variables in simultaneous models. However, we present models with concurrent effects with and without inclusion of lagged variables for comparison. Multilevel models controlled for neuroticism and demographic covariates (age, sex, race, years of education, and income level) provided at baseline.

Concerning variable specification, we employed SAS mixed fitted Gaussian distributions for continuous outcomes of perceived stress and frequency of forgetting, and SAS proc glimmix fitted binary distributions with a logit link for categorical outcomes for perceived one-year and ten-year memory decline. Continuous within-person predictors (e.g., perceived stress and frequency of forgetting) were baseline centered by subtracting each individual's baseline values from values at each timepoint (concurrent: $X_{ti} - X_{i\ [baseline]}$; lagged: $X_{(t-1)i} - X_{i\ [baseline]}$; Sliwinski & Buschke, 1999), creating occasion-specific change scores. Thus, 0 represents baseline scores and other values represent deviations therefrom. Categorical within-person predictors (i.e., occasion-specific perceived one- and ten-year memory decline) were entered as raw variables. For these, the 0 point meaningfully represents no perceived decline within individuals. Categorical between-person covariates were entered as dummy variables with meaningful reference groups selected. Furthermore, continuous between-person covariates were grand mean centered so that 0 represented average sample means. Significance testing was conducted with alpha at .05; marginal findings were denoted with alpha at .10. In models with continuous outcomes, between- and within-person effect sizes were calculated using the method endorsed by Selya et al. (2012) that produces Cohen's f^2. For Cohen's f^2, values of 0.02, 0.15, and 0.35 represent small, medium, and large effect sizes (Cohen, 1988), respectively. For models with categorical outcomes, odds ratios (OR) from between- and within-person effects were used as effect sizes. For OR, values of 1.68, 3.45, and 9.00, represent small, medium, and large effect sizes, respectively (Chen, Cohen, & Chen, 2010).

Results

Descriptive statistics

Baseline comparisons and intercorrelations.—We first compared demographic differences when perceived stress was initially measured (see Supplementary Table 1),

finding few differences. Regarding memory complaints, females reported higher frequency of forgetting than males (female: $M = 2.74$, $SD = 2.55$; male: $M = 2.55$, $SD = 0.75$; $z = -2.31$, $p = .02$, $d = .27$); and White older adults also reported marginally higher frequency of forgetting compared to Black older adults (White: $M = 2.71$, $SD = .65$; Black: $M = 2.55$, $SD = .71$; $z = -2.00$, $p = .05$, $d = .23$). Perceived one-year or ten-year decline did not differ by demographic characteristics (ps > .10), except that females were more likely to endorse perceived ten-year decline than males (female: 69.4%; males: 58.9%; $\chi^2(1) = 4.41$, $p = .04$). Perceived stress, meanwhile, was higher for White older adults than Black older adults (White: M =17.69, $SD = 7.14$; Black: $M = 15.23$, $SD = 7.69$; $z = -2.99$, $p = .003$, $d = .33$) but appeared comparable across sex, income, and marital status (ps > .10). Intercorrelations showed that memory complaints were significantly associated with perceived stress and neuroticism but not demographic variables (see Supplementary Table 2). No multicollinearity was apparent for planned predictors.

Missingness analysis

Multilevel models predicting missingness found that persons lost to follow-up did not differ on perceived stress or memory complaints (ps > .60). Furthermore, sensitivity analysis restricting analyses to the follow-up with greater than 50% retention (follow-up waves 1–4) did not find a differing pattern of results.

Multilevel models

Next, we ran our main multilevel models (equations can be seen in Supplementary Table 3).

Intraclass correlation coefficients (ICCs).—Before evaluating within-person coupling between perceived stress and memory complaints, ICCs were calculated. Overall, 63.70% of the variation in perceived stress, 51.95% of the variation in frequency of forgetting, 51.78% of the variation in perceived one-year memory decline, and 52.86% of the variation in perceived ten-year memory decline were due to individual differences. As a result, 36.3% to 47.1% of variation in our outcomes can be attributed to within-person changes.

Unconditional time-based growth models.—First, four unconditional time-based growth models tested whether participants' memory complaints and perceived stress changed over time. On average, likelihood of perceiving one-year memory decline (OR = 1.08, 95% CI: 1.002 to 1.162) and ten-year memory decline (OR = 1.23, 95% CI: 1.048 to 1.210) increased over time. By contrast, on average, reports of frequency of forgetting and perceived stress were stable over time (ps >.10). For these last two continuous outcomes, analyses revealed no significant changes in mean change (ps > .07) but significant variance in slopes (ps < .001).

Conditional Time-Based Growth models

Next, conditional time-based growth curve models examined the between-person and within-person associations of perceived stress with memory complaints and whether perceived stress had a lagged effect on future memory complaints and vice versa (see Supplementary Tables 2 and 3).

Perceived stress and frequency of forgetting.—The model examining perceived stress as the predictor (see Table 1) showed that, after adjusting for the covariates, higher perceived stress was significantly related to rating higher frequency of forgetting on the five-point Likert-type scale (1 “Never” to 4 “Frequently”) at the between-person level ($b = 0.01$, $SE = 0.004$, $p = .02$). Furthermore, this association was moderated by participant’s age ($b = -0.002$, $SE = 0.001$, $p < .01$). Examination of simple slopes at values plus and minus one standard deviation in age at baseline showed that only adults who were younger at baseline (< ~72 years) showed this association ($b = 0.02$, $SE = 0.006$, $p < .01$). For adults older at baseline (> ~ 82 years), perceived stress and frequency of forgetting were not related ($b = 0.001$, $SE = 0.005$, $p = .84$). At a within-person level, perceived stress and frequency of forgetting were not significantly related ($b = 0.004$, $SE = 0.003$, $p = .18$). In other words, intraindividual deviations in perceived stress from baseline values were not coupled with variability in frequency of forgetting in older adults. Additionally, perceived stress did not have a lagged effect on frequency of forgetting ($b = 0.002$, $SE = 0.004$, $p = .60$). The model examining frequency of forgetting as a predictor had similar findings (see Table 2). We did not find a significant lagged effect of frequency of forgetting on perceived stress ($b = 0.26$, $SE = 0.32$, $p = .42$). Between-person associations between perceived stress and frequency of forgetting showed moderate effect sizes (frequency of forgetting as outcome: $f^2 = .09$; perceived stress as outcome: $f^2 = .14$).

Perceived stress and perceived one-year memory decline.—The model examining perceived stress as the predictor (see Table 1) showed a significant association of perceived stress with endorsing the presence of perceived one-year decline at a between-person level ($OR = 1.09$; 95% CI= 1.04 – 1.14), such that, on average, older adults with higher perceived stress were more likely to report one-year memory decline. Within-person changes in perceived stress were not significantly related to within-person changes in perceived one-year decline over time ($OR = 1.004$; 95% CI = 0.97 – 1.04). Perceived stress did not have a significant lagged effect on perceived one-year memory decline ($OR = 1.008$; 95% CI = 0.97 – 1.05). The model examining perceived one-year decline as a predictor had similar findings (see Table 2). Perceived one-year memory decline did not have a significant lagged effect on perceived stress ($b = 0.32$, $SE = 0.48$, $p = .50$). Between-person associations between perceived stress and one-year memory decline showed small effect sizes (one-year memory decline as outcome: $OR = 1.09$; perceived stress as outcome: $f^2 = .09$).

Perceived stress and perceived ten-year memory decline.—The model examining perceived stress as the predictor (see Table 1) showed a significant association of perceived stress with endorsing the presence of perceived ten-year decline at a between-person level ($OR = 1.06$; 95% CI= 1.02 – 1.11), such that, on average, older adults with higher perceived stress were more likely to report perceived ten-year memory decline. Within-person changes in perceived stress were not significantly related to within-person changes in perceived ten-year decline ($OR = 1.01$; 95% CI = 0.98 – 1.04); however, perceived stress had a significant lagged effect on perceived ten-year decline ($OR = 1.06$; 95% CI = 1.02 – 1.11), such that older adults who perceived more stress at a given wave were more likely to perceive a ten-year decline at the subsequent wave. The model examining perceived ten-year decline as a predictor had similar findings showing significant between-person associations between

perceived ten-year memory decline and perceived stress (see Table 2), except that there was no significant lagged effect of perceived ten-year decline on perceived stress ($b = -0.39$, $SE = 0.42$, $p = .36$). Between-person associations between perceived stress and ten-year memory decline showed small effect sizes (ten-year memory decline as outcome: $OR = 1.06$; perceived stress as outcome $f^2 = .08$).

Discussion

Stress and memory complaints are pervasive in older adults and can indicate higher risk of cognitive decline (Buckley et al., 2016; Katz et al., 2006). One major endeavour, therefore, is to understand how these factors might influence each other as older adults age. Providing clarification in this area, we examined longitudinal associations in adults 70 years and over without cognitive impairment with one dominant finding: Positive associations between perceived stress and memory complaints appear largely as overlapping between-person differences rather than positive within-person covariances, at least in this older diverse sample. One lagged within-person association emerged such that when older adults reported higher perceived stress than usual, they were more likely to report perceived ten-year memory decline the next year. Below we integrate our results with previous literature, explain findings with theory, and discuss potential implications.

Our findings on the temporal associations between perceived stress and memory complaints both complements and advances previous work. For the last three decades, cross-sectional studies have illustrated positive correlations between perceived stress and memory complaints (e.g., Piquard, Derouesné, Lacomblez, & Le Poncin, 2012; Potter et al., 2008), but whether associations represent within-person co-development (*when older adults report more stress, they report more memory complaints*) or overlapping between-person differences (*people who are more generally stressed will report more memory complaints*) remained undetermined. Addressing important knowledge gaps, this study advanced previous literature with convergent and contrasting findings. Regarding convergence, our study found mostly between-person associations between perceived stress and memory complaints, aligning with Ronnlund et al.'s (2013) study in middle-aged adults. In contrast, our study did not identify many within-person associations previously found in daily diary studies (Neupert et al., 2008; Rickenbach et al., 2014). This might mostly reflect the greater sensitivity provided from daily diary assessment from increased sampling rates, compared to annual assessment over an average of four years. Furthermore, it might indicate the unique value in asking about specific stressors to detect specific stressor-related changes that impact memory complaints at yearly intervals. Asking about memory complaints across a broad timeframe (one and ten years) might tap more into general perceptions of life challenges, measured by perceived stress between-persons, rather than recent within-person (i.e., situational) changes. Nonetheless, within-person increases in perceived stress did increase the likelihood of reporting ten-year memory decline at later waves, suggesting that minute changes in general stress perception might affect broad perceptions about memory decline over time.

Significant associations between perceived stress and memory complaints can be explained through theorectical incorporation. Foremost, in the model proposed by Cohen et al. (2016),

perceived stress represents how one typically interprets stressors or challenges in their environments. For this reason, perceived stress represents a consistent (and perhaps trait-like) thought pattern that might be more informative for explaining between-person differences in outcomes of interest rather than recent within-person changes related to new stressors (Cohen et al., 2016, Cohen, 1986). Specifically, we found that older adults with generally more perceived stress reported more memory complaints than older adults with lower perceived stress. This suggests that older adults who perceive daily challenges as demanding and overwhelming generalize this perception to their thoughts about memory challenges. This aligns with research showing that people who report perceived memory decline generally believe that demands get harder and coping becomes fallible with age (Kite & Wagner, 2002). Still, while mostly stable, some individuals might experience changes in their perceived stress influenced by significant life events (e.g., financial uncertainty, emerging health conditions) that might impact their view about memory. For example, when younger older adults (< ~72 years) reported higher perceived stress, they were more likely to report greater frequency of forgetting. Likewise, lead-lagged within-person analyses showed that when older adults experienced higher perceived stress, their likelihood to report ten-year memory decline increased the next year, even if they never reported such a complaint previously. This suggests that when an older adult reflects on wide ranges of memory problems, beliefs about stressors can inform how they self-evaluate their memory.

Alternatively, positive between-person associations might reflect that memory complaints serve as enduring stressors for older adults. Specifically, several studies show that memory complaints operate as stable factors in adults (Pearman, Hertzog, & Gerstorf, 2014) and negative views about memory in older adulthood likely reflect concerns about potential dementia (Kinzer & Suhr, 2016). Applied to Cohen's model, this could mean that older adults might largely refer to enduring memory concerns and dementia worries when making judgments about perceived demands and adaptability to life stressors. Future research could clarify this possibility by asking older adults to describe specific obstacles or fears reflected upon when estimating perceived stress as done earlier with younger populations (Hirvikoski, Lindholm, Nordenström, Nordström, & Lajic, 2009; Van Eck, Berkhof, Nicolson, & Sulon, 1996).

If memory complaints based on year-long reflections either (1) represent negative beliefs from stress or (2) contribute to higher perceived stress in cognitively intact older adults, then targeted interventions might reduce memory complaints when no impairment exists. One promising technique would be cognitive restructuring, a technique helping participants to become aware of their negative memory beliefs and reframing them into more accurate viewpoints (Clark, 2014). This approach has shown preliminary success: in community-dwelling older adults, cognitive restructuring using persuasion and encouraging mastery experiences can make memory beliefs more positive and improve objective memory performance (Frankenmolen et al. 2018, Lachman et al., 1992). Furthermore, making older adults aware of their memory beliefs, especially in the context of negative aging attitudes, can lead to more accurate memory ratings than memory training alone (Best, Hamlett, & Davis, 1992). Previous meta-analysis supports that cognitive restructuring techniques remain most effective at reducing memory complaints, even above memory training and exercise

(Metternich, Kosch, Kriston, Härter, & Hüll, 2010). Furthermore, adding restructuring techniques can make memory training more impactful (Floyd & Scogin, 1997). Thus, interventions targeting memory beliefs might be beneficial in persons with typically high perceived stress, although future research is needed to examine this possibility.

As a last noteworthy finding to discuss, neuroticism played a universal role in predicting between-person differences in memory complaints – highlighting the strong role of personality traits in memory self-reports. This finding is by no means surprising given cross-sectional studies showing similar results (Bazargan & Barbre, 1994; Mahoney, Dalby, & King, 1998; Piquard, Derouesné, Lacomblez, & Le Poncin, 2012; Potter et al., 2009) and opens an important discussion about the unique contribution of perceived stress. Some theorists postulate that associations between negative psychological expressions like high perceived stress on health ratings are redundant reflections of the neurotic phenotype; but correlations between stress reports and neuroticism remain moderate (rs ~.50; Morgan, Umberson, & Hertzog, 2014). Furthermore, research over the last two decades has shown this to be more complex. Specifically, like other psychological constructs (i.e., intelligence; Cattell, 1963), neuroticism has been shown to include a general distress factor (g) and more specific expressions (s) that include moods like depression and anxiety (Uliaszek, Hauner, Zinbarg, Craske, Mineka, Griffith, & Rose, 2009). Perceived stress is likely another specific manifestation that involves how distressful inclinations and moods operate with external obstacles. Indeed, like intelligence, although neuroticism and perceived overlap conceptually, perceive stress has unique genetic determinants and psychobehavioral correlates (Rietschel, Zhu, Kirschbaum, Strohmaier, Wüst, Rietschel, & Martin, 2014). Nonetheless, the field of stress finds it integral to control for general neuroticism in order to make specific claims about expressions of perceived stress. This study showed that, while overlapping, perceived stress can modestly predict memory complaints additive to general neuroticism.

Limitations

Alongside research caveats, study results should be considered alongside limitations. The current analyses are based on a subset of individuals who completed a perceived stress measure that was added later in the parent study. Participants who were most likely to report higher levels of perceived stress may have been more likely to leave the study early and thus not have data on this measure. This would restrict the range of individuals included in the current analyses impacting the generalizability of our results. However, missingness analyses did not support this association. Another limitation is the use of single item measures to assess memory complaints. While this approach is common in the literature, single item measures are less reliable relative to standardized scales designed to assess different types of memory complaints (Rabin et al., 2015). Similarly, the single item measures in the current study used limited response scales which makes it difficult to identify change over time as participants have few options to choose from when they do perceive a change in their memory functioning. Although our intraclass correlations suggest sufficient variation for detecting changes, these analyses should be replicated in datasets with validated measures of memory complaints. Moreover, we were able to establish temporal relationships between perceived stress and memory complaints, but it remains

difficult to identify a specific causal pathway for linking these experiences. It is possible that a third variable we did not account for (e.g., stressful life experiences) is playing a role in the temporal relationships observed. We did include other important covariates that capture similar constructs to attempt to account for the influence of these variables, however a clear causal connection cannot be determined. Finally, datasets with larger samples and greater follow-ups might be powerful enough to test more complex research questions as done with other neuroticism-related factors like depression (e.g., Hülür, Hertzog, Pearman, Ram, & Gerstorf, 2014). We hope that this study will provide a foundation for such work while answering unaddressed questions about the longitudinal nature of stress and memory complaints in a diverse group of older adults.

Conclusions and Future Directions

We found that reports of frequency of forgetting and perceived memory decline slightly derived from perceived stress measured between persons in cognitively intact older adults. This suggests that memory complaints are partly influenced by negative thoughts about handling life stressors (i.e., *life challenges are demanding and hard to overcome*). Further research should explore which domain of perceived stress connects most closely to memory complaints: Do stressed older adults see daily memory tasks as overly taxing (high perceived demands) or do they view themselves less able use memory strategies (low perceived adaptability)? Furthermore, because perceived stress and memory complaints can increase the risk for cognitive decline for many older adults, an important future direction is to understand how the connection between stress and memory complaints impacts objective memory performance. For example, perceived stress might disrupt memory recall through task-related interference from anticipatory worries about memory lapses (Eysenck & Calvo, 1992) or attempts to consciously control automated memory processes (Masters, 1992). Future work could additionally explore potential biological mechanisms: Persons with high perceived stress, for example, might show stronger sympathetic responses in response to memory challenges which harms neural substrates for memory through atypical hormone releases (i.e., glucocorticoids; Ulrich-Lai et al., 2009). Incorporating more objective measures would be the logical next step for this research line. As a starting point, this study suggests that how cognitively intact older adults generally experience stress informs how they think about memory abilities and change.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1.

Results of Multilevel Models Examining Between and Within-Person Associations of Perceived Stress (Predictor) and Memory Complaints (Outcome) across Waves (n = 391).

	Outcomes		
	Frequency of Forgetting	**Perceived 1-year Decline**	**Perceived 10-year Decline**
Predictors	***b (SE)***	***OR (95%CI)***	***OR (95%CI)***
Time	0.004 (0.007)	1.09 * (1.01 to 1.18)	1.13 *** (1.05 to 1.22)
Perceived Stress			
Between-person Effect	.01 * (.004)	1.09 *** (1.04 to 1.14)	1.06 ** (1.02 to 1.11)
Between-person Effect * Age	−.002 ** (.001)		
Within-person Effect	0.004 (0.003)	1.004 (0.97 to 1.04)	1.01 (0.98 to 1.04)
Neuroticism	0.01 * (0.01)	1.05 *** (1.001 to 1.10)	1.03 (.98 to 1.08)
Female (ref = male)	0.13 * (0.06)	1.15 (0.67 to 1.97)	1.76 * (1.02 to 3.06)
Education (years)	0.02 (0.01)	1.12 * (1.02 to 1.22)	1.04 (.95 to 1.13)
Age (years)	−0.01 (0.01)	0.93 ** (0.88 to 0.98)	0.96 (0.91 to 1.01)
Black (ref = White)	−0.05 (0.07)	0.73 (0.39 to 1.38)	0.74 (0.40 to 1.37)
Income < $15,000 (ref = $15,001 – $30,000)	0.14 (0.19)	1.76 (0.66 to 4.73)	1.46 (0.57 to 3.71)
Income >$30,000 (ref = $15,001 – $30,000)	0.10 (0.10)	1.63 (0.76 to 5.11)	1.85 (.74 to 4.61)

Note. All models were analyzed separately.

*** $p \leq .001$,

** $p \leq .01$,

* $p \leq .05$,

† $p \leq .10$.

Table 2.

Results of Multilevel Models Examining Between and Within-Person Associations of Memory Complaints (Predictor) and Perceived Stress (Outcome) across Waves (n = 391).

Outcome: Perceived Stress			
Predictors	***b (SE)***	***b (SE)***	***b (SE)***
Time	−0.13 (0.07)	−.14* (.07)	−0.15* (0.07)
Between-person Effects			
Frequency of Forgetting	1.43*** (.42)		
Age*Frequency of Forgetting	−0.19* (.08)		
Perceived 1-year Decline		2.26** (0.79)	
Perceived 10-year Decline			1.76** (0.03)
Within-person Effects			
Frequency of Forgetting	0.10 (.28)		
Perceived 1-year Decline		0.01 (0.40)	
Perceived 10-year Decline			0.11 (0.37)
Neuroticism	0.52*** (0.05)	.52*** (.05)	0.53*** (0.05)
Female (ref = male)	0.02 (0.60)	0.47 (0.60)	0.36 (0.60)
Education (years)	−0.05 (0.09)	−0.05 (0.09)	−0.02 (0.09)
Age (years)	0.16** (0.06)	0.18** (0.06)	0.17** (0.06)
Black (ref = White)	−1.48* (0.66)	−1.78** (0.66)	−1.71* (0.66)
Income < $15,000 (ref = $15,001 – $30,000)	−2.37* (1.00)	−2.13* (1.02)	−1.80 (1.03)
Income >$30,000 (ref = $15,001 – $30,000)	−1.37 (0.99)	−1.30 (1.00)	−0.99† (1.01)

Note. All models were analyzed separately.

*** $p \leq .001$,

** $p \leq .01$,

* $p \leq .05$,

† $p \leq .10$.