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Research Article

Five-Factor Model Personality Traits and the Trajectory of Episodic Memory: Individual-Participant Meta-Analysis of 471,821 Memory Assessments from 120,640 Participants

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Abstract

Objectives: Five-factor model (FFM) personality traits are associated with concurrent memory function and risk of incident dementia but are less consistently associated with the change in episodic memory. The present research analyzes multiple large-scale studies with a consistent analytic approach to evaluate the association between personality and change in episodic memory over time.

Method: Across nine public longitudinal data sets, 120,640 participants provided 471,821 memory assessments over up to 26 years (age range 18–108). FFM traits were tested as predictors of the average level (intercept) and change over time (slope) of episodic memory. Results from the individual samples were meta-analyzed to summarize the associations.

Results: Consistent with expectations for the intercept, higher neuroticism was associated with worse memory performance, whereas higher openness and conscientiousness were associated with better performance; extraversion and agreeableness were also associated with better performance. Higher neuroticism and lower conscientiousness were related to declines in memory only in samples with more than two assessments of memory. The other three traits were unrelated to memory slope. The pattern was similar when participants with dementia were excluded from the analysis, and the association with the slope was not moderated by age.

Discussion: FFM traits have a robust association with average memory performance. Higher neuroticism and lower conscientiousness were associated with declines in memory performance only among samples with more than two memory assessments. The heterogeneity across studies suggests that multiple memory assessments are needed to reliably detect change over time, which may be one reason for past inconsistencies across studies.

Keywords: Cognitive aging, Conscientiousness, Memory decline, Neuroticism

Maintenance of episodic memory is considered one critical marker of successful aging (Nyberg & Pudas, 2019). Likewise, loss of memory function is one defining characteristic of Alzheimer's disease (Jahn, 2013), and a factor that reduces the ability to live independently in the community (Toot et al., 2017). There are both normal and pathological changes in memory function across adulthood and older age. That is, normal aging is associated with modest declines in episodic memory (memory for episodes, list of objects, or words) in young and middle adulthood and an accelerated

decline after about age 60 (Salthouse, 2019). The decline in memory with age, however, is not necessarily indicative of impending impairment. There is great interest in better understanding factors that help or harm memory function to be able to better support healthier cognitive aging and stop or at least stall significant cognitive impairment. Identifying factors associated with individual differences in the rate of memory decline, however, is difficult. For example, systematic reviews of longitudinal studies suggest the rate of memory decline is not associated with education (Lenehan et al., 2015) or anxiety (Gulpers et al., 2016), even though lower educational attainment (Xu et al., 2016) and greater anxiety (Sutin et al., 2018) are risk factors for dementia.

Five-factor model (FFM; McCrae & John, 1992) personality traits have been associated with episodic memory function when measured cross-sectionally (Curtis et al., 2015) and with risk of Alzheimer's disease and related dementias (ADRD) when measured longitudinally (Aschwanden et al., 2021). In general, individuals higher in neuroticism (the tendency toward negative emotions) tend to perform worse on standard episodic memory tasks (e.g., word list tasks; Allen et al., 2019; Luchetti et al., 2021; Meier et al., 2002; Sutin, Stephan, Luchetti et al., 2019); although not all studies find this association (Chapman et al., 2017; Hülür et al., 2015). In contrast, individuals higher in either conscientiousness (the tendency to be organized and responsible) or openness (the tendency to be creative and unconventional) tend to perform better on episodic memory tasks (Allen et al., 2019; Luchetti et al., 2021; Sutin, Stephan, Luchetti et al., 2019). There are less consistent associations between the other two traits, extraversion (the tendency to be sociable and assertive) and agreeableness (the tendency to be friendly and trusting) and episodic memory (Allen et al., 2019; Chapman et al., 2017; Sutin, Stephan, Luchetti et al., 2019). FFM traits are also implicated in the risk of ADRD: higher neuroticism is associated with an increased risk of incident dementia, whereas higher conscientiousness is protective (Aschwanden et al., 2021). Although there is some evidence that extraversion, openness, and agreeableness are also protective, these associations tend to be less robust than for neuroticism and conscientiousness (Aschwanden et al., 2021). This literature thus indicates personality traits, which are thought to be relatively stable across adulthood (Terracciano et al., 2006), are associated with concurrent memory function and risk of crossing the clinical threshold for cognitive impairment.

Less clear, however, is how personality is associated with the change in memory over time. That is, evidence for how personality is associated with gradual changes in memory over time is less robust than evidence for its association with impairment. Some studies, for example, find that higher neuroticism is associated with greater declines in episodic memory (Allen et al., 2019; Caselli et al., 2016; Luchetti et al., 2016; Wilson et al., 2006; Wilson, Schneider, Boyle, et al., 2007), whereas other studies find no association between this trait and episodic memory change (Hock et al., 2014; Hülür et al., 2015). Likewise, some studies find conscientiousness (Allen et al., 2019; Caselli et al., 2016; Hock et al., 2014; Luchetti et al., 2016; Wilson, Schneider, Arnold, et al., 2007) and openness (Allen et al., 2019; Luchetti et al., 2016) associated with less decline in episodic memory over time, whereas others do not find this association for either conscientiousness (Hülür et al., 2015) or openness (Hock et al., 2014; Hülür et al., 2015; Sharp et al., 2010). Extraversion and agreeableness tend to be unrelated to changes in episodic memory (Hock et al., 2014; Hülür et al., 2015; Luchetti et al., 2016). There could be several reasons for the inconsistency across studies, including short follow-up intervals, the number of assessments, the sometimes relatively small sample sizes, and differences in analytic approaches to assessing memory change (e.g., regression vs. difference scores vs. multilevel modeling).

Still, there are theoretical reasons why personality traits may be associated with memory change over time. First, models of personality and health (Friedman et al., 2014) emphasize the role of health-related behaviors in how personality contributes to health outcomes. Among health behaviors, physical activity is one of the most robust predictors of cognition in older adulthood (Erickson et al., 2019), and it has been associated consistently with personality (Sutin et al., 2016): individuals with lower neuroticism and higher in conscientiousness and openness tend to be more physically active (Wilson & Dishman, 2015) and less sedentary (Allen et al., 2017). Over time, this greater physical activity may be protective of memory (Infurna & Gerstorf, 2013), and, conversely, sedentary behavior may be harmful (Bakrania et al., 2018). Second, several personality traits tend to be associated with engagement in cognitively stimulating activities. Individuals higher in openness tend to spend time engaging in mentally (e.g., reading) and socially (e.g., visiting friends) stimulating activities, whereas individuals higher in neuroticism tend to spend time watching television (Rohrer & Lucas, 2018). Such cognitive engagement may support maintaining memory over time, whereas less engagement may hasten decline (Verghese et al., 2003). Third, personality is associated with social resources that help protect cognition. Individuals higher in conscientiousness and extraversion, for example, are less likely to feel lonely and have more developed social networks, whereas individuals higher in neuroticism are more likely to feel lonelier and have fewer social connections (Buecker et al., 2020). Over time, such social interactions (or lack of) may help maintain (diminish) memory function (Maharani et al., 2019).

Processes associated with the traits suggest other theoretical reasons why personality, especially neuroticism and conscientiousness, may be associated with performance on memory tasks mainly assessed in the laboratory. Individuals higher in neuroticism, for example, tend to be anxious, particularly around others who may be evaluating them (Eldesouky & English, 2019). As such, anxiety might interfere with their ability to do the task in the presence of the

interviewer. This anxiety may be compounded by their belief that their memory function is declining (Koller et al., 2019). Furthermore, neuroticism is associated with greater stress (Ebstrup et al., 2011) that can harm memory (Korten et al., 2017). Over time, these factors may culminate in worse objective memory performance. Individuals higher in conscientiousness tend to be organized, including in their thinking (McCrae & Costa, 2003). They also may be used to keeping track of important information because they tend to take on a lot of responsibilities (Jackson et al., 2010). Individuals higher in conscientiousness are planful and methodical. It is possible that such individuals adopt and efficiently use strategies that help with memory tasks, such as grouping and organizing the words to retrieve. Again, over time, these tendencies may serve to protect memory function.

The purpose of the present research is to test whether personality traits are associated with the trajectory of episodic memory over time. We take a robust approach to this question and use large-scale public data sets, the same analytic approach in each sample, and summarize the results with a meta-analysis. Based on the literature on personality traits and risk of ADRD (Aschwanden et al., 2021) and their association with memory performance in general (Allen et al., 2019; Chapman et al., 2017; Sutin et al., 2019), we expect that higher neuroticism will be associated with worse memory (intercept) and greater declines in memory over time (slope), whereas higher conscientiousness will be associated with better memory (intercept) and less decline in memory over time (slope). We also expect higher openness to be associated with better memory (intercept) because this relation has been found in the past (e.g., Allen et al., 2019; Luchetti et al., 2016), but do not expect this trait to be associated with change in memory (slope) because previous large-scale studies found it to be unrelated to memory change (Hülür et al., 2015; Luchetti et al., 2016; Sharp et al., 2010). Finally, given the inconsistent associations between extraversion and agreeableness and memory performance (Hock et al., 2014; Hülür et al., 2015; Luchetti et al., 2016), we do not expect these traits will be associated with level or change in memory but include them for the sake of completeness. In sensitivity analyses, we excluded participants who developed dementia during the study to address whether memory change associated with personality was driven mainly by clinical changes associated with the development of dementia.

Method

Participants

Participants from nine samples from eight publicly available, longitudinal cohort studies were included in this study. The cohorts were the Health and Retirement Study (HRS; https://hrs.isr.umich.edu/), the Midlife Development in the United States study (MIDUS; http://midus.wisc.edu/), the Wisconsin Longitudinal Study Graduate and Sibling samples (WLSG, WLSS; https://www.ssc.wisc.edu/wlsresearch/), the National Health and Aging Trends Study (NHATS; https://www.nhatsdata.org/), the National Social Health and Aging Project (NSHAP; http://www.norc.org/Research/Projects/Pages/national-social-life-health-and-aging-project.aspx), the English Longitudinal Study of Ageing (ELSA; https://www.elsa-project.ac.uk/), the Survey of Health, Ageing and Retirement in Europe (SHARE; http://www.share-project.org/), and Cognitive Function and Ageing Studies in Wales (CFAS; https://beta.ukdataservice.ac.uk/datacatalogue/studies/study?id=8281). Data for each study can be obtained upon free user registration through these websites. Participants in each study were included in the analytic sample if they had valid personality scores, an assessment of memory, and information on relevant sociodemographic characteristics (age, sex, education, and race and ethnicity [where applicable]). See Supplementary Material for a detailed description of each sample.

Our group and others published previously on personality and memory in these cohorts. Specifically, we examined personality as a predictor of dementia (Terracciano et al., 2017) and change in memory between two assessments using a regression approach (Luchetti et al., 2016) in HRS, the reciprocal relation between personality and memory in HRS, MIDUS, and WLS (Stephan et al., 2021), the prospective relation between personality and memory in WLS and MIDUS (Stephan et al., 2020), risk of dementia in ELSA (Aschwanden et al., 2020), and the cross-sectional association with memory performance in SHARE (Luchetti et al., 2021). The relation between personality and change in memory using regression has also been reported in ELSA (Allen et al., 2019) and using multilevel modeling in HRS (Hülür et al., 2015). The current research builds on these past analyses by using all memory data available in each study and the same analytic approach to facilitate summarizing relations in a meta-analysis. We further evaluate whether dementia drives the associations between personality and memory change by excluding participants with dementia in supplemental analyses.

Measures

Personality

All five FFM personality traits were measured with well-validated questionnaires in each sample. See Supplementary Material for detailed information about the questionnaires in each sample.

Episodic memory

A standard episodic memory task was administered in each cohort. Participants were read a list of words that they had to recall immediately and again after a brief delay. A list of 10 words was used, and the episodic memory score was the number of words recalled correctly summed across the immediate and delayed recall tasks for a maximum score of 20. The same task was used in most cohorts, except for NSHAP, which used a five-word instrument with

a maximum of two immediate recall events used for the final score, for a maximum score of 10; MIDUS, which used a 15-item list, for a maximum score of 30; and CFAS, which used a three-word instrument with immediate recall repeated up to seven times or until all words were remembered and had a maximum score of 6.

Dementia status

Dementia status was available in HRS, NHATS, NSHAP, SHARE, ELSA, and CFAS. Each of these samples had standard criteria for the identification of participants with dementia. See Supplementary Material for detailed information on dementia status in each sample.

Covariates

Sociodemographic covariates were concurrent with personality and included age in years, sex (male = 0, female = 1), race and ethnicity, and education. Race in HRS, NHATS, NSHAP, and MIDUS was coded into two dummy-coded variables as Black (= 1) and otherwise identified (= 1) both compared to White (= 0). Race in ELSA was coded into one variable that compared non-White (= 1) to White (= 0); ELSA does not release more specific information on race/ethnicity. SHARE does not provide information on race/ethnicity, and CFAS and WLS are White. In HRS, NHATS, NSHAP, and MIDUS, Hispanic ethnicity (= 1) was compared to non-Hispanic ethnicity (= 0). The other cohorts do not collect information on Hispanic ethnicity. Education was reported in years in HRS, SHARE, CFAS, and WLS and as categories in ELSA. Education was reported on a scale from 1 (no schooling completed) to 9 (master's, professional, or doctoral degree) in NHATS, from 1 (less than high school) to 4 (bachelor's or more) in NSHAP, and from 1 (no school/some grade school) to 12 (doctoral or professional degree) in MIDUS.

Analytic Strategy

Analyses were performed in *R* 3.5.1 (R Core Team, 2018). Linear mixed-effects (variable intercept) models were tested using *lmer* from the *lme4* 1.1-23 (Bates et al., 2015) package. Personality scores (one time point per individual) were converted to *z*-scores for all analyses. The association between personality and the intercept (mean episodic memory) and slope (change in episodic memory over time) were tested with each trait entered individually with the covariates. All available measurements of episodic memory were used in the analysis, including those that preceded the first available measurement of personality. The time parameter (in years) was centered at the time of personality measurements. All models contained the sociodemographic covariates and interactions between personality traits and time, age (at the time of personality assessment), sex, education in years, and race/ethnicity (where available). The *summary* function in *jtools* 2.1.1 (Long, 2020) was used to calculate Satterthwaite degrees of freedom and structure outputs. Results from the individual samples were summarized in random-effect meta-analyses using STATA. Metaregression was used to test whether the association between personality and the slope of memory varied by the number of memory assessments (two assessments vs. >two assessments), length of follow-up interval, length of personality inventory, alpha reliability of the trait measure (Revelle, 2022), and location (United States vs. Europe). In addition, within each sample, age was tested as a moderator of the relation between personality and both the intercept and slope and meta-analyzed to summarize the association.

Sensitivity analyses evaluated the robustness of the associations. First, for cohorts that had information on dementia status (HRS, NHATS, NSHAP, SHARE, ELSA, and CFAS), participants who developed dementia at any point in the study were excluded from the analysis. Second, participants younger than 50 in HRS, ELSA, and SHARE were excluded because they did not meet the age requirement for the parent study. Third, the five traits were tested simultaneously (all traits entered at the same time). Fourth, to test potential temporal biases associated with using episodic memory measurements prior to the measurement of personality, the temporally inclusive model in HRS was contrasted with models that excluded episodic memory either prior to or after personality, respectively. Finally, NHATS and HSHAP both used subsets of items used to construct personality traits in HRS. To test for biases associated with items to measure the traits, the HRS model was contrasted with models using NHATS and NSHAP personality traits constructed from the relevant subset of HRS data.

Results

Descriptive statistics for all study variables in each sample are in Table 1. Across all samples, there were a total of 471,821 memory assessments from 120,640 participants over up to 26 years of assessments. The number of memory assessments per sample ranged from ~4,000 in CFAS to >200,000 in SHARE, and the average follow-up time ranged from ~3 years in NSHAP to ~15 years in WLSG. Across the nine samples, memory declined on average by about 0.071 (95% confindence interval [CI] = −0.114, −0.028) recalled words per year.

The relation between personality traits and the intercept and slope of episodic memory in each sample and summarized in the meta-analysis are in Table 2. Consistent with our hypothesis, the meta-analysis indicated neuroticism was associated with both the average level of memory and change in memory performance over time: participants higher in neuroticism tended to perform worse on the memory task and declined in memory performance over the follow-up. We likewise found support for our hypothesis about openness: openness was associated positively with the intercept of memory but was unrelated to the slope. There was mixed support for our hypothesis about conscientiousness: conscientiousness was associated with better average memory performance

Table 1. Descriptive Statistics for of Each Sample

	CFAS	ELSA	HRS	MIDUS	NHATS	NSHAP	SHARE	WLSG	WLSS
Age (years)	75.99 (6.53)	66.28 (9.39)	64.33 (10.95)	56.01 (12.33)	79.22 (7.36)	72.96 (7.44)	67.64 (9.80)	64.87 (2.08)	64.53 (7.36)
Age range	67–99	29–97	18–104	28–84	67–103	50–95	22–108	63–74	34–92
Gender (female)	51.78 (1,118)	56.05 (4,960)	59.07 (13,091)	54.25 (2,260)	58.21 (1,585)	52.80 (1,529)	57.50 (41,748)	53.95 (2,912)	52.62 (1,473)
Education	11.85[a] (2.78)	[b]	12.78[a] (3.11)	7.27[c] (2.52)	5.22[d] (2.26)	2.66[e] (1.04)	11.12[a] (4.16)	14.12[a] (2.53)	14.25[a] (2.62)
Race (White)	100.00 (2,159)	97.44[f] (8,623)	74.76 (16,517)	91.55 (3,814)	72.47[g] (1,961)	74.24 (2,150)	NA	100.00 (5,398)	100.00 (2,799)
Race (Black)	NA	NA	17.43 (3,850)	3.66 (152)	20.25[g] (548)	13.19 (382)	NA	NA	NA
Race (other)	NA	NA	7.81 (1,725)	4.41 (183)	2.37[g] (64)	2.21 (64)	NA	NA	NA
Hispanic	NA	NA	11.88 (2,628)	2.95 (123)	4.92 (133)	10.05 (291)	NA	NA	NA
Neuroticism	2.77[h] (1.34)	2.10[i] (0.60)	2.06[j] (0.63)	2.06[k] (0.62)	2.20[l] (0.85)	1.18[m] (0.59)	2.66[n] (1.01)	2.64[o] (0.81)	2.68[o] (0.78)
Extraversion	4.32[h] (1.49)	3.15[i] (0.56)	3.22[j] (0.55)	3.10[k] (0.57)	3.15[l] (0.75)	2.20[m] (0.56)	3.49[n] (0.92)	3.83[o] (0.89)	3.75[o] (0.90)
Openness	4.62[h] (1.24)	2.84[i] (0.58)	2.96[j] (0.56)	2.91[k] (0.54)	2.46[l] (0.67)	1.89[m] (0.65)	3.29[n] (0.94)	3.63[o] (0.80)	3.58[o] (0.75)
Agreeableness	5.63[h] (1.11)	3.51[i] (0.48)	3.52[j] (0.48)	3.45[k] (0.50)	3.58[l] (0.53)	2.45[m] (0.52)	3.66[n] (0.83)	4.77[o] (0.73)	4.69[o] (0.74)
Conscientiousness	5.84[h] (1.09)	3.30[i] (0.50)	3.37[j] (0.48)	3.39[k] (0.46)	3.24[l] (0.71)	2.34[m] (0.55)	4.12[n] (0.80)	4.85[o] (0.69)	4.74[o] (0.72)
Episodic memory[p]	5.38[q] (0.85)	10.67 (3.36)	9.97 (3.26)	11.20[r] (4.62)	8.23 (3.54)	7.49[s] (1.97)	8.96 (3.69)	10.06 (3.67)	9.73 (3.69)
Memory assessments (MA)	2.00 (0.07)	6.26 (1.70)	7.44 (3.32)	1.65 (0.48)	6.63 (1.82)	1.73 (0.44)	2.94 (1.54)	1.73 (0.44)	1.66 (0.47)
MA (range)	1–2	1–8	1–13	1–2	1–8	1–2	1–6	1–2	1–2
Length of follow-up[t]	NA	4.76 (2.04)	6.33 (4.10)	6.14 (4.60)	3.21 (1.76)	3.31 (2.40)	NA	15.04 (5.16)	12.98 (5.73)
Max follow-up[t]	NA	11	13	14	5	7	NA	21	26
Time[u]	2.14 (0.39)	11.02 (3.40)	13.22 (6.87)	6.14 (4.60)	5.66 (1.80)	3.64 (2.27)	4.89 (4.22)	15.13 (4.95)	13.15 (5.45)
Max time[u]	4	19	25	14	7	7	14	21	26
Dementia status (yes)	3.71 (80)	3.02 (267)	7.70 (1702)	NA	11.75 (320)	3.42 (99)	2.14 (1554)	NA	NA
N	2,159	8,850	22,251	4,166	2,723	2,896	72,604	5,398	2,799

Notes: Numbers are means (standard deviations) or percentages (*n*) of available data, that is, data are missing for some respondents. HRS = Health and Retirement Study; NHATS = National Health and Aging Trends Study; NSHAP = National Social Life Health and Aging Project; SHARE = Survey of Health, Ageing and Retirement in Europe; ELSA = English Longitudinal Study of Ageing; MIDUS = Midlife in the United States; CFAS = Cognitive Function and Ageing Study in Wales; WLSG = Wisconsin Longitudinal Study Graduate sample; WLSS = Wisconsin Longitudinal Study Sibling sample.

[a]Education in years.

[b]Education in nonordered categories.

[c]Education on a scale from 1 (no school/some grade school) to 12 (doctoral or professional degree).

[d]Education on a scale from 1 (no schooling completed) to 9 (master's, professional, or doctoral degree).

[e]Education on a scale from 1 (less than high school) to 4 (bachelor's or more).

[f]Non-White was only category present.

[g]Non-Hispanic.

[h]Ten-item Personality Inventory (TIPI).

[i]Midlife Development Inventory (MIDI; all items).

[j]MIDUS and International Personality Item Pool (IPIP) items scored on a scale of 1–4.

[k]MIDUS-I personality items (MIDUS-II items for conscientiousness).

[l]MIDI personality scale items (2) per trait, scored from 1 to 4.

Table 1. Continued

[m]MIDI personality scale items (4–5) per trait, scored from 0 to 3.
[n]Ten-item Big Five Inventory (BFI), scored from 1 to 5.
[o]Twenty-nine item BFI, scored from 1 to 6.
[p]Ten-word instrument with a maximum score of 20 unless otherwise noted.
[q]Three-word instrument with immediate recall repeated up to seven times until all words were remembered, maximum score of 6.
[r]Fifteen-word instrument; maximum score of 30.
[s]Five-word instrument with maximum of two immediate recall events used for final score; maximum score of 10.
[t]Years from personality assessment.
[u]Years from first memory assessment.

(intercept) but was unrelated to change over time (slope). Finally, although not hypothesized, both extraversion and agreeableness were associated with the intercept of memory: participants who were either more extraverted or more agreeable had better episodic memory. For all traits, there was significant heterogeneity on both the intercept and slope.

The results of the metaregressions are in Table 3. Importantly, the number of memory assessments moderated the association between both neuroticism and conscientiousness and change in memory over time. For neuroticism, there was no association in samples with only two assessments (estimate = 0.001; 95% CI −0.007, 0.009), but higher neuroticism was associated with steeper declines in memory in samples with more than two assessments (estimate = −0.008; 95% CI −0.012, −0.004; Figure 1). Similarly, conscientiousness was unrelated to the slope in samples with only two memory assessments (estimate = −0.010; 95% CI −0.025, 0.004) but was associated with preserving memory (less decline) over time in samples with more than two assessments (estimate = 0.012; 95% CI 0.005, 0.018; Figure 2). As such, our hypothesis for personality and memory change was supported among samples with numerous assessments of memory but not in those with two assessments. Interestingly, this moderation was specific to a number of assessments and not the length of follow-up interval. Length of the scale, alpha reliability of the personality measure, and location were not significant moderators.

The meta-analysis of age interactions within each sample for the intercept and slope were nonsignificant with one exception: the association between openness and the intercept of memory was slightly stronger with age (Supplementary Table S1).

The supplementary analyses generally supported this pattern of associations. First, the pattern was similar when participants with dementia were excluded from the analysis (Supplementary Table S2). Second, the pattern was similar when participants younger than 50 in HRS, ELSA, and SHARE were excluded from the analysis (Supplementary Table S3). Third, when all traits were entered in the analysis simultaneously, the pattern was the same, except agreeableness was no longer associated with the intercept but was associated with memory decline (Supplementary Table S4). Finally, further analysis on HRS indicated the pattern for neuroticism, openness, and conscientiousness was similar when memory assessments were limited to either memory assessed at the same time as personality and later or at the same time as personality and prior or if personality was scored limiting items to those in NHATS or NSHAP (Supplementary Table S5). There were some inconsistencies for extraversion and agreeableness, again suggesting less robust associations for these two traits.

Discussion

The present research examined the association between personality and memory decline in nine samples that

Table 2. Association Between Personality Traits and the Intercept and Slope of Episodic Memory

Study	Intercept			Slope		
	Estimate	*SE*/95% CI	*p*	Estimate	*SE*/95% CI	*p*
	Neuroticism					
CFAS	-0.034	0.029	.240	0.001	0.009	.946
ELSA	−0.250	0.024	<.001	−0.012	0.002	<.001
HRS	−0.275	0.014	<.001	−0.005	0.001	<.001
MIDUS	−0.269	0.091	.003	−0.006	0.009	.551
NHATS	−0.066	0.101	.514	−0.011	0.008	.141
NSHAP	−0.074	0.045	.102	0.000	0.008	.977
SHARE	−0.246	0.011	<.001	−0.009	0.002	<.001
WLSG	−0.356	0.102	<.001	0.006	0.008	.442
WLSS	−0.170	0.120	.155	0.002	0.010	.816
Meta-analytic association	−0.192	−0.266, −0.117	<.001	−0.007	−0.010, −0.003	<.001
Heterogeneity						
Q	73.67	—	<.001	13.58	—	.093
I^2	92.91	—	—	44.94	—	—
	Extraversion					
CFAS	0.077	0.030	.010	0.009	0.009	.308
ELSA	0.151	0.025	<.001	0.009	0.002	<.001
HRS	0.182	0.014	<.001	−0.005	0.001	<.001
MIDUS	0.283	0.086	<.001	0.003	0.009	.774
NHATS	0.129	0.100	.196	−0.002	0.008	.762
NSHAP	0.074	0.046	.114	−0.002	0.008	.826
SHARE	0.175	0.011	<.001	0.006	0.002	<.001
WLSG	0.436	0.105	<.001	−0.037	0.008	<.001
WLSS	0.346	0.115	.002	−0.014	0.009	.133
Meta-analytic association	0.170	0.117, 0.223	<.001	−0.003	−0.012, 0.006	.515
Heterogeneity						
Q	25.97	—	.001	74.09	—	<.001
I^2	84.47	—	—	94.08	—	—
	Openness					
CFAS	0.019	0.030	.527	−0.010	0.009	.260
ELSA	0.181	0.025	<.001	0.004	0.002	.066
HRS	0.280	0.015	<.001	0.001	0.001	.636
MIDUS	0.296	0.087	<.001	−0.005	0.009	.617
NHATS	0.037	0.100	.714	−0.004	0.007	.569
NSHAP	0.041	0.046	.369	0.002	0.008	.816
SHARE	0.379	0.011	<.001	0.016	0.002	<.001
WLSG	0.488	0.105	<.001	−0.021	0.008	.012
WLSS	0.503	0.125	<.001	−0.017	0.010	.086
Meta-analytic association	0.235	0.119, 0.351	<.001	−0.002	−0.009, 0.006	.682
Heterogeneity						
Q	209.23	—	<.001	79.20	—	<.001
I^2	97.35	—	—	91.28	—	—
	Agreeableness					
CFAS	−0.017	0.030	.575	0.010	0.010	.282
ELSA	0.004	0.025	.884	0.002	0.002	.372
HRS	0.166	0.015	<.001	−0.004	0.001	.002
MIDUS	0.206	0.091	.024	−0.006	0.010	.553
NHATS	0.085	0.103	.410	−0.001	0.008	.872
NSHAP	0.046	0.047	.329	0.014	0.008	.091
SHARE	0.084	0.011	<.001	−0.000	0.002	.971
WLSG	0.163	0.101	.105	−0.023	0.008	.004
WLSS	0.051	0.118	.661	−0.002	0.010	.841
Meta-analytic association	0.076	0.021, 0.132	.007	−0.001	−0.005, 0.003	.594

Table 2. Continued

Study	Intercept			Slope		
	Estimate	*SE*/95% CI	*p*	Estimate	*SE*/95% CI	*p*
Heterogeneity						
Q	54.78	—	<.001	18.71	—	.016
I^2	85.29	—	—	52.16	—	—
	Conscientiousness					
CFAS	0.042	0.030	.152	−0.000	0.009	.963
ELSA	0.227	0.025	<.001	0.016	0.002	<.001
HRS	0.316	0.014	<.001	0.004	0.001	<.001
MIDUS	0.354	0.084	<.001	0.002	0.009	.817
NHATS	0.240	0.103	.019	0.010	0.008	.182
NSHAP	0.152	0.046	.001	−0.002	0.008	.758
SHARE	0.157	0.011	<.001	0.016	0.002	<.001
WLSG	0.419	0.094	<.001	−0.034	0.008	<.001
WLSS	0.317	0.113	.005	−0.015	0.009	.118
Meta-analytic association	0.229	0.151, 0.308	<.001	0.001	−0.010, 0.011	.909
Heterogeneity						
Q	120.50	—	<.001	82.68	—	<.001
I^2	93.71	—	—	95.77	—	—

Notes: *SE* = standard error; CI = confidence interval; CFAS = Cognitive Function and Ageing Study in Wales; ELSA = English Longitudinal Study of Ageing; HRS = Health and Retirement Study; MIDUS = Midlife in the United States; NHATS = National Health and Aging Trends Study; NSHAP = National Social Life Health and Aging Project; SHARE = Survey of Health, Ageing and Retirement in Europe; WLSG = Wisconsin Longitudinal Study Graduate sample; WLSS = Wisconsin Longitudinal Study Sibling sample.

collectively ranged in age from 18 to 108, with an average age of about 67. With up to 14 repeated assessments of episodic memory, there were a total of 471,821 memory assessments from 120,640 participants. When memory was measured with just two assessments, personality was unrelated to change in memory over time. When measured with more than two assessments, however, neuroticism was associated with a greater decline in episodic memory over time, and conscientiousness was associated with less decline. We also found consistent evidence that personality was associated with the intercept of memory: as expected, lower neuroticism, higher openness, and higher conscientiousness were associated with better memory performance. Surprisingly, extraversion and agreeableness were associated with the intercept of episodic memory, although the latter was reduced to nonsignificance when all traits were entered simultaneously.

Previous meta-analytic research on personality and cognitive outcomes in older adulthood has found higher neuroticism and lower conscientiousness associated with the risk of dementia and more modest associations with dementia risk for the other three traits (Aschwanden et al., 2021). Likewise, a fairly consistent pattern has emerged for cross-sectional associations between personality and episodic memory (Allen et al., 2019; Luchetti et al., 2021; Meier et al., 2002; Sutin, Stephan, Luchetti et al., 2019). Less clear in this literature has been the association between personality and change in episodic memory over time. There are normative age-related declines in memory (Nyberg & Pudas, 2019), and attention is directed at maintaining memory function because it is critical for health, well-being, and independence in older adulthood. Although several studies examined the association between personality and change in memory, results have been somewhat mixed (Allen et al., 2019; Hock et al., 2014; Hülür et al., 2015; Luchetti et al., 2016), as has the association with change in global cognition (Graham et al., 2021). The present research sought to use the same analytic approach using large-scale studies to unify the literature and provide more robust estimates of how personality is associated with memory decline over time.

We found the expected association between personality and memory decline for neuroticism and conscientiousness, but only in samples with more than two assessments of memory. Importantly, this association was not due to the length of follow-up, as it was not apparent in samples with long follow-ups but only two memory assessments. Repeated assessments have higher reliability and given the slow decline and typical noise in cognitive assessments, many longitudinal data points are needed to detect a reliable signal. As such, the association between neuroticism and conscientiousness and memory decline may only be detectable when trajectories are more reliable. This finding has implications for future work on memory decline. Specifically, fewer than three assessments of episodic memory may not be sufficient to detect reliable change. Future research that addresses predictors (personality or otherwise) of memory decline should aim to include multiple assessments of episodic memory, and findings based on two measurements should be interpreted with caution

Table 3. Metaregressions Testing Sample-Level Moderators of the Personality–Memory Associations

	Coefficient	*SE*	*p*
	Neuroticism		
#Memory assessments	−0.012	0.006	.043
Follow-up time	0.000	0.000	.241
Length of personality scale	−0.000	0.000	.217
Alpha reliability	0.017	0.023	.242
Location (United States vs. Europe)	−0.003	0.003	.337
	Extraversion		
#Memory assessments	0.012	0.011	.257
Follow-up time	−0.001	0.001	.263
Length of personality scale	0.000	0.001	.595
Alpha reliability	−0.040	0.031	.263
Location (United States vs. Europe)	0.012	0.009	.187
	Openness		
#Memory assessments	0.014	0.009	.143
Follow-up time	0.000	0.001	.756
Length of personality scale	0.000	0.001	.951
Alpha reliability	0.011	0.017	.528
Location (United States vs. Europe)	0.006	0.008	.428
	Agreeableness		
#Memory assessments	0.004	0.009	.656
Follow-up time	−0.001	0.001	.286
Length of personality scale	0.000	0.001	.655
Alpha reliability	0.006	0.011	.597
Location (United States vs. Europe)	0.004	0.008	.600
	Conscientiousness		
#Memory assessments	0.025	0.009	.007
Follow-up time	−0.001	0.001	.212
Length of personality scale	0.000	0.001	.569
Alpha reliability	−0.055	0.039	.152
Location (United States vs. Europe)	0.008	0.008	.331

Notes: *SE* = standard error; *p* = *p* value.

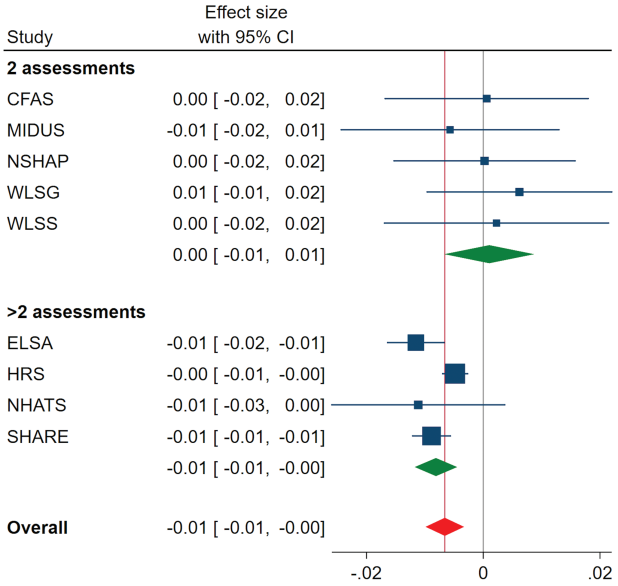

Figure 1. Forest plot of the association between neuroticism and the slope of episodic memory by number of memory assessments. CI = confidence interval; CFAS = Cognitive Function and Ageing Studies in Wales; MIDUS = Midlife Development in the United States study; NSHAP = National Social Health and Aging Project; WLSG = Wisconsin Longitudinal Study Graduate; WLSS = Wisconsin Longitudinal Sibling samples; ELSA = English Longitudinal Study of Ageing; HRS = Health and Retirement Study; NHATS = National Health and Aging Trends Study; SHARE = Survey of Health, Ageing and Retirement in Europe.

until replicated. Of note, in the current study, samples with more than two memory assessments had at least six repeated measurements, so it is not clear how many repeated assessments are needed to detect a reliable association.

The present research does, though, provide empirical support for the theoretical prediction that higher neuroticism is associated with greater and higher conscientiousness is associated with less decline in memory over time. These associations are consistent with the literature on the cognitive correlates of these traits (Chapman et al., 2017; Sutin, Stephan, Luchetti et al., 2019) and evidence that neuroticism and conscientiousness are risk/protective factors for dementia (Aschwanden et al., 2021). Individuals higher in neuroticism are prone to feelings of anxiety and depression that can interfere with memory performance (Zlomuzica et al., 2016). Lower neuroticism and higher conscientiousness are also associated with behavioral profiles (e.g., greater physical activity; Allen et al., 2017), engagement in cognitively stimulating activities (Sutin et al., 2022), and healthier social relationships (Buecker et al., 2020) that help maintain cognitive function with age. A slower rate of memory decline may be one intermediary pathway that helps delay the risk of impairment.

As expected, openness was associated with better average memory performance with an effect size that was one of the largest among the five traits. The moderation analysis indicated this association was stronger at older ages. There may be a cohort effect such that openness mattered more for average episodic memory performance for older generations, perhaps because of fewer educational opportunities earlier in life. We could not, however, disentangle age from a cohort in the current analyses. This moderation should also be interpreted cautiously until replicated, as it was only significant in one sample and is not apparent for other cognitive outcomes (Aschwanden et al., 2021; Sutin, Stephan, Damian et al., 2019). Given the consistent cross-sectional association between openness and episodic memory (Allen et al., 2019; Luchetti et al., 2016; Sutin, Stephan, Damian et al., 2019), and the cognitively stimulating behavioral profiles associated with this trait (Rohrer & Lucas, 2018), it is surprising that it would not support better maintenance of memory function. And yet the null association for the slope is consistent with the extant literature on openness and memory change (e.g., Sharp et al., 2010). It may be that individuals higher in openness start out with better memory and thus have more to decline with age but also have protective factors that help push against decline. These forces may cancel each other out and thus the null association with the slope.

Although modest, both extraversion and agreeableness were associated with the intercept of memory. That is,

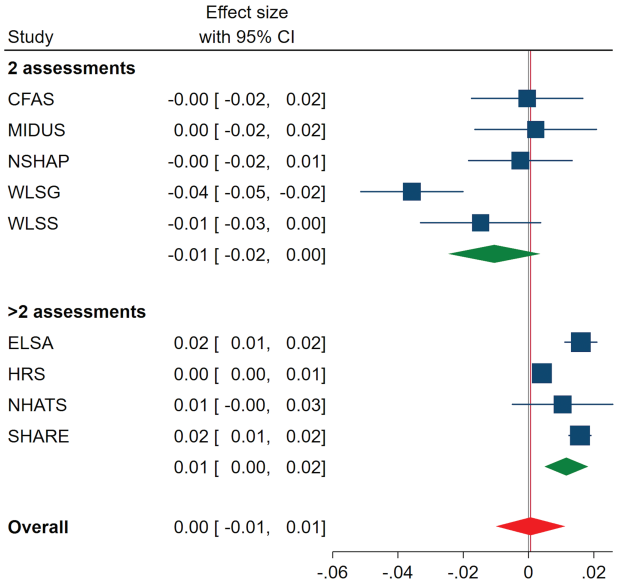

Figure 2. Forest plot of the association between conscientiousness and the slope of episodic memory by number of memory assessments. CI = confidence interval; CFAS = Cognitive Function and Ageing Studies in Wales; MIDUS = Midlife Development in the United States study; NSHAP = National Social Health and Aging Project; WLSG = Wisconsin Longitudinal Study Graduate; WLSS = Wisconsin Longitudinal Sibling samples; ELSA = English Longitudinal Study of Ageing; HRS = Health and Retirement Study; NHATS = National Health and Aging Trends Study; SHARE = Survey of Health, Ageing and Retirement in Europe.

individuals who are more sociable and individuals who are friendlier tend to perform better on episodic memory tasks. Consistent with the literature, however, these two traits were unrelated to changes in memory over time. These associations were also less robust than for the other traits. In particular, agreeableness was unrelated to the intercept in supplemental analysis when all five traits were entered simultaneously. That is, when all traits were considered together, the processes associated with other traits may have been more strongly related to memory function than those associated with agreeableness, which suggests agreeableness is less relevant for episodic memory than other traits. In contrast, the positive association between extraversion and the intercept remained significant. This association was not expected given the mixed findings on extraversion and memory. Still, greater social integration tends to be associated with better cognitive outcomes (Sutin et al., 2020) and a general disposition toward sociability may facilitate episodic memory performance.

Of note, the pattern of associations was similar when participants who developed dementia were excluded from the analysis. These findings suggest the observed associations between personality and memory are more likely to reflect normative aging-related decline and are less likely driven by the clinical changes that occur with the development of dementia. Note, however, that dementia was measured in different ways across studies and often with a performance-based measure; future research would benefit from a more robust assessment of dementia, particularly a clinical diagnosis. In contrast, there may be an accelerated decline in memory due to neurodegenerative processes with the onset and course of ADRD. Interestingly, personality is unrelated to changes in global cognitive function prior to dementia onset (Graham et al., 2021). Although Graham et al. used a measure that was a composite of several cognitive domains, the pattern may be similar for memory. Future research needs to better distinguish between age-related cognitive decline and decline due to ADRD in older adulthood.

FFM personality traits are thought to be relatively stable across adulthood but also show the change that could be shaped, in part, by cognitive function (Stephan et al., 2021). As such, bidirectional associations between personality and episodic memory are possible, with memory shaping personality change across adulthood. Notably, however, personality was measured at various ages within and across studies, and, with one exception, age did not moderate the association between personality and either the intercept or slope of memory. This pattern suggests that even if personality is shaped partly by episodic memory across adulthood, neuroticism and conscientiousness, regardless of age when measured, predict change in memory over time, suggesting the findings are not simply a reflection of personality change associated with memory. Still, the bidirectional relation between personality and memory is an important question for future research to address.

In addition, the observed associations are unlikely to be driven by reverse causation. That is, if personality change was caused by approaching impairment, the association between the traits and change in memory could reflect the underlying disease process. This scenario is unlikely because the results were similar when participants with dementia were removed from the analysis. Furthermore, a 36-year longitudinal study found no change in personality in the preclinical phase for individuals who later developed ADRD (Terracciano et al., 2017). Finally, we did not find that the association between personality and the slope of memory was stronger at older ages, which would be expected if the associations were driven by reverse causation because cognitive impairment is more prevalent at older ages.

The present research had several strengths, including multiple large-scale national samples, longitudinal data on objective memory performance, and the same analytic approach in all samples. There are also some limitations to consider. First, although sensitivity analyses excluded participants who developed dementia during the study period, some participants may have been included who were having difficulties but had not yet been diagnosed. Second, all samples were from Western countries. Some samples were designed to be nationally representative (e.g., HRS), whereas others were not (e.g., MIDUS). Furthermore, attrition and missing data may have reduced representativeness. The findings may thus be limited in generalizability because of the participants included in the analysis. Still, it is of note that some associations were consistent across diverse

samples, and there was no moderation by location. More work needs to ensure generalizability, particularly samples from other world regions to determine how well these associations extend to non-Western populations. Third, we examined personality traits and the intercept and slope of memory but not the mechanisms of the associations. Future research could address pathways through which neuroticism and conscientiousness are associated with memory decline. Fourth, there may be other moderators of change. There was significant heterogeneity across samples, and future work could identify what accounts for it, beyond the moderators tested in the current research. Fifth, we focused on episodic memory because it is critical in everyday life, from remembering what to buy at a grocery store and where one parked at the store to reminiscing about meaningful experiences earlier in one's life and, as such, is considered a marker of successful aging (Nyberg & Pudas, 2019). It would be worthwhile to extend this work to other cognitive domains. Finally, the cohorts generally relied on short measures of personality feasible in large-scale studies. Of note, all measures were standard, well-validated scales of all five traits. Interestingly, there was no evidence that the associations were moderated by number of items or the reliability of the scale. Still, future research would benefit from detailed personality measures that include personality facets to identify whether more specific components of the traits are associated with age-related memory change. For example, the conscientiousness facets of industriousness and responsibility are more strongly associated with cross-sectional cognitive performance than the traditionalism and virtue facets (Sutin et al., 2022). Furthermore, in addition to the main effect of personality on memory decline, future research may consider interactions between the traits, such as high neuroticism and high conscientiousness or high openness and high conscientiousness on memory.

Despite these limitations, the present research provides a robust examination of the association between personality traits and changes in memory over time. The pattern that emerged indicates that personality had pervasive associations with average memory performance. Regarding the central question of this study, a trait disposition toward negative emotionality was associated with greater memory decline, and a trait disposition toward organization and responsibility was associated with less memory decline in samples with more than two memory assessments.

Supplementary Material

Supplementary data are available at *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences* online.

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Conflict of Interest

None declared.

References

Allen, M. S., Laborde, S., & Walter, E. E. (2019). Health-related behavior mediates the association between personality and memory performance in older adults. *Journal of Applied Gerontology*, **28**, 232–252. doi:10.1177/0733464817698816

Allen, M. S., Walter, E. E., & McDermott, M. S. (2017). Personality and sedentary behavior: A systematic review and meta-analysis. *Health Psychology*, **36**(3), 255–263. doi:10.1037/hea0000429

Aschwanden, D., Strickhouser, J. E., Luchetti, M., Stephan, Y., Sutin, A. R., & Terracciano, A. (2021). Is personality associated with dementia risk? A meta-analytic investigation. *Ageing Research Reviews*, **67**, 101269. doi:10.1016/j.arr.2021.101269

Aschwanden, D., Sutin, A. R., Luchetti, M., Stephan, Y., & Terracciano, A. (2020). Personality and dementia risk in England and Australia. *GeroPsych*, **33**(4), 197–208. doi:10.1024/1662-9647/a000241

Bakrania, K., Edwardson, C. L., Khunti, K., Bandelow, S., Davies, M. J., & Yates, T. (2018). Associations between sedentary behaviors and cognitive function: Cross-sectional and prospective findings from the UK Biobank. *American Journal of Epidemiology*, **187**(3), 441–454. doi:10.1093/aje/kwx273

Bates, D., Mächler, M., Bolker, B., & Walker, S. (2015). Fitting linear mixed-effects models using lme4. *Journal of Statistical Software*, **67**(1), 1–48. doi:10.18637/jss.v067.i01

Buecker, S., Maes, M., Denissen, J. J. A., & Luhmann, M. (2020). Loneliness and the big five personality traits: A meta-analysis. *European Journal of Personality*, **34**, 8–28. doi:10.1002/per.2229

Caselli, R. J., Dueck, A. C., Locke, D. E., Henslin, B. R., Johnson, T. A., Woodruff, B. K., & Geda, Y. E. (2016). Impact of personality on cognitive aging: A prospective cohort study. *Journal of the International Neuropsychological Society*, **22**(7), 765–776. doi:10.1017/S1355617716000527

Chapman, B. P., Benedict, R. H., Lin, F., Roy, S., Federoff, H. J., & Mapstone, M. (2017). Personality and performance in specific neurocognitive domains among older persons. *American Journal of Geriatric Psychiatry*, **25**(8), 900–908. doi:10.1016/j.jagp.2017.03.006

Curtis, R. G., Windsor, T. D., & Soubelet, A. (2015). The relationship between Big-5 personality traits and cognitive ability in older adults—A review. *Neuropsychology Development and Cognition B Aging Neuropsychology and Cognition*, **22**(1), 42–71. doi:10.1080/13825585.2014.888392

Ebstrup, J. F., Eplov, L. F., Pisinger, C., & Jørgensen, T. (2011). Association between the five factor personality traits and perceived stress: Is the effect mediated by general self-efficacy? *Anxiety Stress Coping*, **24**(4), 407–419. doi:10.1080/10615806.2010.540012

Eldesouky, L., & English, T. (2019). Individual differences in emotion regulation goals: Does personality predict the reasons why people regulate their emotions? *Journal of Personality*, **87**(4), 750–766. doi:10.1111/jopy.12430

Erickson, K. I., Hillman, C., Stillman, C. M., Ballard, R. M., Bloodgood, B., & Conroy, D. E. (2019). Physical activity, cognition, and brain outcomes: A review of the 2018 Physical Activity Guidelines. *Medical Science and Sports Exercise*, **51**(6), 1242–1251. doi:10.1249/MSS.0000000000001936

Friedman, H. S., Kern, M. L., Hampson, S. E., & Duckworth, A. L. (2014). A new life-span approach to conscientiousness and health: Combining the pieces of the causal puzzle. *Developmental Psycholgy*, **50**(5), 1377–1389. doi:10.1037/a0030373

Graham, E. K., James, B. D., Jackson, K. L., Willroth, E. C., Luo, J., Beam, C. R., & Mroczek, D. K. (2021). A coordinated analysis of the associations among personality traits, cognitive decline, and dementia in older adulthood. *Journal of Research in Personality*, **92**, 104100. doi:10.1016/j.jrp.2021.104100

Gulpers, B., Ramakers, I., Hamel, R., Köhler, S., Oude Voshaar, R., & Verhey, F. (2016). Anxiety as a predictor for cognitive decline and dementia: A systematic review and meta-analysis. *American Journal of Geriatric Psychiatry*, **24**(10), 823–842. doi:10.1016/j.jagp.2016.05.015

Hock, R. S., Lee, H. B., Bienvenu, O. J., Nestadt, G., Samuels, J. F., Parisi, J. M., & Spira, A. P. (2014). Personality and cognitive decline in the Baltimore Epidemiologic Catchment Area follow-up study. *American Journal of Geriatric Psychiatry*, **22**(9), 917–925. doi:10.1016/j.jagp.2012.12.217

Hülür, G., Hertzog, C., Pearman, A. M., & Gerstorf, D. (2015). Correlates and moderators of change in subjective memory and memory performance: Findings from the Health and Retirement Study. *Gerontology*, **61**(3), 232–240. doi:10.1159/000369010

Infurna, F. J., & Gerstorf, D. (2013). Linking perceived control, physical activity, and biological health to memory change. *Psychology and Aging*, **28**(4), 1147–1163. doi:10.1037/a0033327

Jackson, J. J., Wood, D., Bogg, T., Walton, K. E., Harms, P. D., & Roberts, B. W. (2010). What do conscientious people do? Development and validation of the Behavioral Indicators of Conscientiousness (BIC). *Journal of Research in Personality*, **44**(4), 501–511. doi:10.1016/j.jrp.2010.06.005

Jahn, H. (2013). Memory loss in Alzheimer's disease. *Dialogues in Clinical Neuroscience*, **15**(4), 445–454. doi:10.31887/DCNS.2013.15.4/hjahn

Koller, O. M., Hill, N. L., Mogle, J., & Bhang, I. (2019). Relationships between subjective cognitive impairment and personality traits: A systematic review. *Journal of Gerontological Nursing*, **45**(2), 27–34. doi:10.3928/00989134-20190111-04

Korten, N. C., Comijs, H. C., Penninx, B. W., & Deeg, D. J. (2017). Perceived stress and cognitive function in older adults: Which aspect of perceived stress is important? *International Journal of Geriatric Psychiatry*, **32**(4), 439–445. doi:10.1002/gps.4486

Lenehan, M. E., Summers, M. J., Saunders, N. L., Summers, J. J., & Vickers, J. C. (2015). Relationship between education and age-related cognitive decline: A review of recent research. *Psychogeriatrics*, **15**(2), 154–162. doi:10.1111/psyg.12083

Long, J. A. (2020). *jtools: Analysis and presentation of social scientific data*. In Version R package version 2.1.1. https://cran.r-project.org/package=jtools

Luchetti, M., Terracciano, A., Stephan, Y., Aschwanden, D., & Sutin, A. R. (2021). Personality and memory: A multilevel analysis across 27 countries from the Survey of Health, Ageing and Retirement in Europe. *Psychological Science*, **32**(7), 1047–1057. doi:10.1177/0956797621993101

Luchetti, M., Terracciano, A., Stephan, Y., & Sutin, A. R. (2016). Personality and cognitive decline in older adults: Data from a longitudinal sample and meta-analysis. *Journals of Gerontology, Series B: Psychological Sciences and Social Sciences*, **71**, 591–601. doi:10.1093/geronb/gbu184.

Maharani, A., Pendleton, N., & Leroi, I. (2019). Hearing impairment, loneliness, social isolation, and cognitive function: Longitudinal analysis using English Longitudinal Study on Ageing. *American Journal of Geriatric Psychiatry*, **27**(12), 1348–1356. doi:10.1016/j.jagp.2019.07.010

McCrae, R. R., & Costa, P. T. (2003). *Personality in adulthood: A Five-Factor Theory perspective* (2nd ed.). Guilford Press.

McCrae, R. R., & John, O. P. (1992). An introduction to the five-factor model and its applications. *Journal of Personality*, **60**(2), 175–215. doi:10.1111/j.1467-6494.1992.tb00970.x

Meier, B., Perrig-Chiello, P., & Perrig, W. (2002). Personality and memory in old age. *Aging, Neuropsychology, and Cognition*, **9**, 135–144. doi:10.1076/anec.9.2.135.9544

Nyberg, L., & Pudas, S. (2019). Successful memory aging. *Annual Review of Psychology*, **70**, 219–243. doi:10.1146/annurev-psych-010418-103052

R Core Team. (2018). *R: A language and environment for statistical computing*.

Revelle, W. (2022). *psych: Procedures for psychological, psychometric, and personality research*. Northwestern University, Evanston, Illinois. R package version 2.2.5, https://CRAN.R-project.org/package=psych

Rohrer, J. M., & Lucas, R. E. (2018). Only so many hours: Correlations between personality and daily time use in a representative German panel. *Collabra: Psychology*, **4**(1). doi:10.1525/collabra.112

Salthouse, T. A. (2019). Trajectories of normal cognitive aging. *Psychology and Aging*, **34**(1), 17–24. doi:10.1037/pag0000288

Sharp, E. S., Reynolds, C. A., Pedersen, N. L., & Gatz, M. (2010). Cognitive engagement and cognitive aging: Is openness protective? *Psychology and Aging*, **25**, 60–73. doi:10.1037/a0018748

Stephan, Y., Sutin, A. R., Luchetti, M., & Terracciano, A. (2020). Personality and memory performance over twenty years: Findings from three prospective studies. *Journal of Psychosomatic Research*, **128**, 109885. doi:10.1016/j.jpsychores.2019.109885

Stephan, Y., Sutin, A. R., Luchetti, M., & Terracciano, A. (2021). Memory and personality development in adulthood: Evidence from four longitudinal studies. *Journals of Gerontology, Series B: Psychological Sciences and Social Sciences*, **76**(1), 88–97. doi:10.1093/geronb/gbaa086

Sutin, A. R., Aschwanden, D., Stephan, Y., & Terracciano, A. (2022). The association between facets of conscientiousness and performance-based and informant-rated cognition, affect, and activities in older adults. *Journal of Personality*, **90**(2), 121–132. doi:10.1111/jopy.12657

Sutin, A. R., Stephan, Y., Luchetti, M., Artese, A., Oshio, A., & Terracciano, A. (2016). The five factor model of personality and physical inactivity: A meta-analysis of 16 samples. *Journal of Research in Personality*, **63**, 22–28. doi:10.1016/j.jrp.2016.05.001

Sutin, A. R., Stephan, Y., Luchetti, M., & Terracciano, A. (2019). Five-factor model personality traits and cognitive function in five domains in older adulthood. *BMC Geriatrics*, **19**(1), 343. doi:10.1186/s12877-019-1362-1

Sutin, A. R., Stephan, Y., Damian, R. I., Luchetti, M., Strickhouser, J. E., & Terracciano, A. (2019). Five-factor model personality traits and verbal fluency in 10 cohorts. *Psychology and Aging*, **34**, 362–373. doi:10.1037/pag0000351

Sutin, A. R., Stephan, Y., Luchetti, M., & Terracciano, A. (2020). Loneliness and risk of dementia. *Journals of Gerontology, Series B: Psychological Sciences and Social Sciences*, **75**(7), 1414–1422. doi:10.1093/geronb/gby112

Sutin, A. R., Stephan, Y., & Terracciano, A. (2018). Psychological distress, self-beliefs, and risk of cognitive impairment and dementia. *Journal of Alzheimer's Disease*, **65**(3), 1041–1050. doi:10.3233/JAD-180119

Terracciano, A., Costa Jr, P. T., & McCrae, R. R. (2006). Personality plasticity after age 30. *Personality and Social Psychology Bulletin*, **32**, 999–1009. doi:10.1177/0146167206288599

Terracciano, A., Stephan, Y., Luchetti, M., Albanese, E., & Sutin, A. R. (2017). Personality traits and risk of cognitive impairment and dementia. *Journal of Psychiatric Research*, **89**, 22–27. doi:10.1016/j.jpsychires.2017.01.011

Toot, S., Swinson, T., Devine, M., Challis, D., & Orrell, M. (2017). Causes of nursing home placement for older people with dementia: A systematic review and meta-analysis. *International Psychogeriatrics*, **29**(2), 195–208. doi:10.1017/S1041610216001654

Verghese, J., Lipton, R. B., Katz, M. J., Hall, C. B., Derby, C. A., Kuslansky, G., & Buschke, H. (2003). Leisure activities and the risk of dementia in the elderly. *New England Journal of Medicine*, **348**(25), 2508–2516. doi:10.1056/NEJMoa022252

Wilson, K. E., & Dishman, R. K. (2015). Personality and physical activity: A systematic review and meta-analysis. *Personality and Individual Differences*, **27**, 230–242. doi:10.1016/j.paid.2014.08.023

Wilson, R. S., Arnold, S. E., Schneider, J. A., Kelly, J. F., Tang, Y., & Bennett, D. A. (2006). Chronic psychological distress and risk of Alzheimer's disease in old age. *Neuroepidemiology*, **27**, 143–153. doi:10.1159/000095761

Wilson, R. S., Schneider, J. A., Arnold, S. E., Bienias, J. L., & Bennett, D. A. (2007). Conscientiousness and the incidence of Alzheimer disease and mild cognitive impairment. *Archives of General Psychiatry*, **64**, 1204–1212. doi:10.1001/archpsyc.64.10.1204

Wilson, R. S., Schneider, J. A., Boyle, P. A., Arnold, S. E., Tang, Y., & Bennett, D. A. (2007). Chronic distress and incidence of mild cognitive impairment. *Neurology*, **68**(24), 2085–92. doi:10.1212/01.wnl.0000264930.97061.82

Xu, W., Tan, L., Wang, H. F., Tan, M. S., Li, J. Q., Zhao, Q. F., & Yu, J. T. (2016). Education and risk of dementia: Dose–response meta-analysis of prospective cohort studies. *Molecular Neurobiology*, **53**(5), 3113–3123. doi:10.1007/s12035-015-9211-5

Zlomuzica, A., Preusser, F., Totzeck, C., Dere, E., & Margraf, J. (2016). The impact of different emotional states on the memory for what, where and when features of specific events. *Behavior Brain Research*, **298**(Pt B), 181–187. doi:10.1016/j.bbr.2015.09.037