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Special Article

Memory and Personality Development in Adulthood: Evidence From Four Longitudinal Studies

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Abstract

Objectives: Personality traits have been related to concurrent memory performance. Most studies, however, have focused on personality as a predictor of memory; comparatively less is known about whether memory is related to personality development across adulthood. Using 4 samples, the present study tests whether memory level and change are related to personality change in adulthood.

Method: Participants were drawn from 2 waves of the Wisconsin Longitudinal Study Graduates (WLSG; N = 3,232, mean age = 64.28, SD = 0.65) and Wisconsin Longitudinal Study Siblings (WLSS; N = 1,570, mean age = 63.52, SD = 6.69) samples, the Midlife in the United States (MIDUS; N = 1,901, mean age = 55.43, SD = 10.98), and the Health and Retirement Study (HRS; N = 6,038, mean age = 65.47, SD = 8.28). Immediate and delayed recall and the 5 major personality traits were assessed at baseline and follow-up.

Results: There was heterogeneity in the associations across samples. A meta-analysis of latent change in the four samples indicated that lower baseline memory performance was related to an increase in neuroticism (B = –0.002; 95% CI = –0.004, –0.0008) and a decrease in agreeableness (B = 0.004; 95% CI = 0.002, 0.007) and conscientiousness (B = 0.005; 95% CI = 0.0008, 0.010). In addition, declines in memory were related to steeper declines in extraversion (B = 0.06; 95% CI = 0.003, 0.11), openness (B = 0.04; 95% CI = 0.007, 0.069), and conscientiousness (B = 0.05; 95% CI = 0.019, 0.09).

Discussion: The present study indicates that poor memory and declines in memory over time are related to maladaptive personality change. These associations, however, were small and inconsistent across samples.

Keywords: Adulthood, Longitudinal, Memory, Personality development

Memory function is a crucial determinant of healthy aging. Poor memory and decline in memory function are related to a range of worse outcomes in old age, including higher functional limitations (Aigbogun et al., 2017; Zahodne et al., 2013), frailty (Gale et al., 2017; Robertson et al., 2014), and depressive symptoms (Jajodia and Borders, 2011). Furthermore, a decline in memory function predicts higher risk of incident dementia (Aggarwal et al., 2005; Josefsson et al., in press) and mortality (Sabia et al., 2010). Despite these associations, little is known about the extent to which memory may be related to changes in individuals relatively enduring patterns of thoughts, feeling, and behaviors, that is their personality traits. Existing research has focused mostly on personality as a predictor of memory, which has shown that higher neuroticism is related to lower memory performance, whereas

higher conscientiousness and openness have been associated with better memory in adults (Caselli et al., 2016; Chapman et al., 2017; Hock et al., 2014; Klaming et al., 2017; Luchetti et al., 2016; Sutin, Stephan, Luchetti, et al., 2019). We reported previously that higher neuroticism and lower openness are related to worse memory performance assessed 20 years later in the Midlife in the United States (MIDUS) study and the Wisconsin Longitudinal Study (WLS) (Stephan et al., 2020) and that higher neuroticism and lower openness and conscientiousness are related to a steeper decline in memory over time in the Health and Retirement Study (HRS; Luchetti et al., 2016; Stephan et al., 2020). Comparatively less is known about whether memory is related to change in personality traits.

Research on the factors that may contribute to personality development are crucially informative for theories of personality (Denissen et al., 2019; McCrae et al., 2000; Specht et al., 2014). Several biological, behavioral, and health-related factors have recently been associated with personality development across adulthood. Beyond demographic factors, biological dysfunction, physical inactivity, smoking, alcohol consumption, depressive symptoms, sensory deficits, physical impairments, and frailty have been related to maladaptive personality changes across adulthood, such as increases in neuroticism and steeper declines in extraversion, openness, agreeableness, and conscientiousness (Allen et al., 2017; Hakulinen and Jokela, 2019; Hakulinen et al., 2015; Letzring et al., 2014; Mueller et al., 2018; Stephan et al., 2014, 2016, 2019; Stephan, Sutin, Bosselut, et al., 2017; Stephan, Sutin, Canada, et al. 2017). Although there is some evidence that cognition is related to personality development in older adults, the evidence is mixed. In a recent 12-year longitudinal study, lower cognitive abilities (including processing speed, crystallized, and fluid intelligence) were related to decreases in extraversion and openness and increases in neuroticism over time and were not related to change in agreeableness and conscientiousness (Wettstein et al., 2017). In contrast, Wettstein et al. (in press) found that higher cognitive abilities were related to declines in agreeableness and conscientiousness over 20 years. In addition, health moderated these relationships. Low cognitive abilities were related to increases in agreeableness and stability in conscientiousness among individuals with very good or good health, whereas they were associated with a steeper decline in both traits among individuals with poor health (Wettstein et al., in press). Furthermore, lower cognitive abilities were associated with an increase in neuroticism among individuals with poor health (Wettstein et al., 2017). There was no relationship with changes in extraversion and openness. Another recent study that assessed only neuroticism found poorer cognitive performance (including picture completion, block design, spatial ability, information, and similarities task) was related to increasing neuroticism over a 12-year period (Aschwanden et al., 2018). Other studies have found that higher IQ at age 79 attenuated the decline of conscientiousness among older individuals from age 81 to 87 and was unrelated to change in neuroticism, extraversion, openness, and agreeableness. (Mõttus et al., 2012). In contrast, single measures of perceptual speed were found to be unrelated to personality development (Mueller et al., 2016).

Theoretical models on personality and health focus mostly on the predictive role of personality for health and cognitive outcomes (Friedman and Kern, 2014). However, reciprocal relationships are also likely to exist. Despite inconsistencies across the previous studies, there are theoretical reasons to hypothesize that memory function could contribute to personality development in older adulthood. First, memory may have a direct role for the basic processes and tendencies that are core aspects of the traits (e.g., memory is crucial for punctuality and persistence on tasks, which are core aspects of conscientiousness), and changes in memory may lead to changes in the traits themselves. Memory problems, for example, may increase anxiety and stress both because it is more difficult to accomplish everyday tasks and because there may be worry that others will notice the difficulty remembering things. Such anxiety and stress may increase overall emotional instability over time. Individuals with lower memory performance may also experience more difficulties in planning and organization and be less persistent in their daily tasks and activities that results in decreases in conscientiousness over time. Memory problems may further restrict individuals to familiar and routine activity that consolidates into lower openness. In addition to potential direct effects, memory may have an indirect effect on trait changes. Indeed, poor memory has implications for a range of factors that have been related to personality development. For example, poor memory is related to functional decline (Zahodne et al., 2013), frailty (Gale et al., 2017), and depressive symptoms (Jajodia and Borders, 2011) that have been implicated in increased neuroticism, decreased conscientiousness, and openness over time (Hakulinen et al., 2015; Mueller et al., 2016, 2018; Stephan, Sutin, Canada, et al., 2017.). Whether through direct or indirect pathways, a link between memory function and personality change can provide a broader understanding of the factors associated with personality development across adulthood. This research is thus exploratory in that our rationale and hypotheses are based on the personality and memory literatures and informed by life-span models of personality but not a theoretical framework that articulates specifically how personality and memory are related over time.

The present study aims to examine the association between cognition and personality change in adulthood. Part of the heterogeneity in the results of previous studies could be due to the variety of cognitive tasks used and the differences in statistical approach. To reduce heterogeneity, in this study, we focused on one key cognitive domain: episodic memory. To increase replicability (Graham et al., 2017), a coordinated analysis of four samples was conducted to test

the study hypotheses. Specifically, in all samples, we used the same Latent Change Score (LCS) model to test whether (a) memory level and (b) change in memory level are associated with change in personality. The estimates from each sample were then combined with meta-analysis. It was hypothesized that lower memory function and worsening memory would be related to increased neuroticism and decreased conscientiousness and openness over time.

Method

This study was preregistered at https://osf.io/u8r7y. The disclosure table is presented in Table 1. The present study makes use of four datasets that we have used in our previous research, including our research on personality and memory. Specifically, we used the HRS in a previous study on cross-sectional associations between personality and cognition and baseline personality as a predictor of cognition 4 years later (Luchetti et al., 2016) and risk of cognitive impairment and dementia up to 8 years later (Terracciano, Stephan et al., 2017). We also used the MIDUS and the Wisconsin Longitudinal Study Graduates (WLSG) and Wisconsin Longitudinal Study Sibling (WLSS) samples to test the relation between personality at baseline and memory performance measured approximately 20 years later (Stephan et al., 2020). We have also used the HRS and MIDUS samples to examine change in personality in relation to other health-related factors (e.g., physical activity, sensory impairment) (Stephan et al., 2014; Stephan, Sutin, Bosselut, et al., 2017). As such, we have significant exposure to both the personality data and the cognitive data in these datasets. Before preregistration, however, we had never examined memory at baseline and memory change as predictors of personality change. In addition, our familiarity with the dataset was one reason that we sought to use multiple datasets to address this research question. That is, we have had differential exposure to the various variables across the datasets. We hoped to minimize the potential bias of exposure to data in any one sample by addressing the research question with the same analytic approach in multiple datasets.

Participants

Participants were drawn from the WLSG and WLSS samples, the MIDUS, and the HRS. In each sample, participants with complete demographic data (age, sex, education, and race where available), baseline memory and personality, and follow-up memory and personality data were included. Descriptive statistics for the four samples are presented in Table 2. Attrition analyses are presented in Supplementary Material.

The WLS is a long-term study of a random sample of men and women who graduated from Wisconsin high schools in 1957 (WLSG) as well as selected siblings (WLSS) of some of the graduates. The WLS sample is broadly representative of white, non-Hispanic American men, and women who have completed at least a high school education. The word recall module was first administered to a randomly selected 80% subsample in the 2003–2005 wave in the WLSG and the 2004–2007 wave in the WLSS. In the WLSG, a total of 4,587 participants provided complete baseline demographic, personality, and memory data in 2003–2005. Among these participants, 3,232 individuals provided personality and memory data in 2011 (54% women, mean age = 64.28, *SD* = 0.65). In the WLSS, complete baseline data were obtained from 2,338 individuals in 2004–2007. A total of 1,570 participants from this sample also provided personality and memory data in 2011 (54% women, baseline mean age = 63.52, *SD* = 6.69).

Table 1. Disclosure Table

Questions	Answer
Can you document (with data contract or something similar) that all team members have never had any exposure to the data before the preregistration was created?	No
Do you assert, even if no verifiable evidence exists, that all team members have never had any exposure to the data before the preregistration was created?	No
Do you assert that the author of the preregistration document did not have any exposure to the data before the preregistration, even if some co-authors have worked with the data?	No
Do you assert that the authors of the paper have had no exposure to the primary variables (including calculating descriptive statistics) in the analyses, even if they have worked with other variables from the same sample?	No
Do you assert that the authors of the paper have had no exposure to one or more primary variables (including calculating descriptive statistics), even if they have worked with some of the primary variables?	No
Do you assert that the authors of the paper have had exposure to all the primary variables, but that they have never done any analyses that examined their associations?	Yes
Does the primary analysis involve data from new waves of assessment that have never been analyzed (even if similar variables from prior waves had been examined by study authors)?	Yes
Have authors had exposure to variables in the same dataset that might be expected to correlate relatively strongly with those used in the primary analysis for this paper (e.g., depression and loneliness; self-esteem and life satisfaction)?	Yes
Are you analyzing data from a subset of participants (e.g., a hold-out sample) who you have not studied before?	No

Table 2. Characteristics of the Samples

	WLSG		WLSS		MIDUS		HRS	
Variables	*M*/%	*SD*	*M*/%	*SD*	*M*/%	*SD*	*M*/%	*SD*
Age (years)	64.28	0.65	63.52	6.69	55.43	10.98	65.47	8.28
Sex (% women)	54%	–	54%	–	56%	–	60%	–
Race (% white)	100%	–	100%	–	96%	–	87%	–
Education	13.90	2.43	14.19	2.55	7.64	2.51	13.33	2.70
Baseline memory	10.40	3.55	10.55	3.19	11.86	4.41	10.87	2.87
Baseline neuroticism	2.97	0.91	3.03	0.86	2.02	0.61	2.02	0.59
Baseline extraversion	3.82	0.88	3.74	0.86	3.12	0.56	3.23	0.54
Baseline openness	3.62	0.77	3.58	0.73	2.93	0.52	3.00	0.53
Baseline agreeableness	4.81	0.69	4.73	0.68	3.45	0.50	3.55	0.46
Baseline conscientiousness	4.80	0.67	4.72	0.67	3.44	0.43	3.42	0.44
Follow-up memory	9.17	2.82	9.29	3.00	11.27	4.78	9.68	3.27
Follow-up neuroticism	3.02	0.91	3.01	0.91	2.03	0.61	1.92	0.59
Follow-up extraversion	3.79	0.88	3.77	0.90	3.12	0.56	3.17	0.58
Follow-up openness	3.47	0.76	3.48	0.74	2.90	0.54	2.90	0.57
Follow-up agreeableness	4.81	0.71	4.80	0.69	3.44	0.50	3.51	0.50
Follow-up conscientiousness	4.75	0.70	4.74	0.69	3.42	0.46	3.36	0.49

Note: HRS = Health and Retirement Study (*N* = 6,038); MIDUS = Midlife in the United States (*N* = 1,901); WLSG = Wisconsin Longitudinal Study Graduates (*N* = 3,232); WLSS = Wisconsin Longitudinal Study Siblings (*N* = 1,570). See *Method* section for differences in the assessment and coding of memory, personality, and education in each sample.

The MIDUS is a longitudinal study of non-institutionalized, English-speaking U.S. adults. The second (2004–2006, MIDUS II) and third waves (2013–2014, MIDUS III) were used in the present study because memory assessments were available starting from the MIDUS II. A total of 3,342 individuals provided complete data on personality, demographic information, and memory at baseline. Of these participants, 1,901 also had complete data on personality and memory at follow-up (56% women, baseline mean age = 55.43, *SD* = 10.98).

The HRS is a national longitudinal study of Americans older than 50 years and their spouses. In 2006, an enhanced face-to-face interview was implemented for a random half of the sample that included a personality assessment. The other half of the sample was interviewed in 2008. Therefore, personality, demographic factors, and memory were assessed at baseline for half of the sample in 2006, and from the other half in 2008. Data from both waves were combined as baseline, resulting in a sample of 12,282 participants with complete data. The 2014 and the 2016 waves were used as follow-up for the 2006 and the 2008 participants, respectively. Of the baseline sample, a total of 6,038 participants provided complete personality and memory data at follow-up (60% women, baseline mean age = 65.47, *SD* = 8.28).

Measures

Personality

In the WLS samples, personality traits were assessed using a 29-item version of the Big Five Inventory (BFI; John et al., 1991). Participants were asked to indicate their agreement or disagreement with descriptive statements assessing neuroticism (e.g., "To what extent do you agree that you see yourself as someone who can be tense?"), extraversion (e.g., "To what extent do you agree that you see yourself as someone who is full of energy?"), openness (e.g., "To what extent do you agree that you see yourself as someone who has an active imagination?"), agreeableness (e.g., "To what extent do you agree that you see yourself as someone who is generally trusting?"), and conscientiousness (e.g., "To what extent do you agree that you see yourself as someone who tends to be disorganized?") on a 6-point scale, from 1 (*disagree strongly*) to 6 (*agree strongly*). The Midlife Development Inventory (MIDI; Zimprich et al., 2012) was used in the MIDUS and the HRS. Participants were asked to indicate how well 26 adjectives described themselves that assessed neuroticism (e.g., moody), extraversion (e.g. , lively), openness (e.g. , curious), agreeableness (e.g. , caring), and conscientiousness (e.g. , organized). A scale ranging from 1 (*not at all*) to 4 (*a lot*) was used. The mean was computed across items for each trait in the direction of the trait label. Test–rest reliability ranged from .61 to .80 across the four samples.

Memory

In the four samples, memory function was assessed with the sum of performance on immediate and delayed recall. In the WLS samples, participants were asked to repeat as many words as they could from a list of 10 words, both immediately and after a delay of approximately 12 min at the first wave and 9 min at the second wave. In the MIDUS, a list of 15 words was read to participants, with a delay of approximately 12 min between immediate and delayed

recall. In the HRS, participants were asked to recall a list of 10 words immediately and after a delay of approximately 5 min. In the four samples, the number of words recalled correctly for immediate and delayed recall were summed.

Covariates

In the four samples, age, sex, and education were included as covariates. In the MIDUS, education was measured on a scale ranging from 1 (No schooling completed) to 9 (Master's, professional or doctoral degree). Education was reported in years in the WLSG, the WLSS, and the HRS. Race was available in the MIDUS and the HRS and was coded as 1 for white and 0 for other.

Data Analysis

Preregistered analyses included simple regressions, correlations of residual change scores, and latent change approach. The purpose of these different analytic approaches was to test whether the pattern of associations between memory and personality development was robust across analytic methods. To streamline reporting, the *Results* section focuses on the findings from the latent change approach because it is more flexible and comprehensive than the regression approach. We report the results from the regression analysis and the residual change scores in Supplementary Tables S7 and S8. To test the hypotheses, we fitted LCS models using Mplus, version 8 (Muthén and Muthén, 1998–2017). Following prior work (Henk and Castro-Schilo, 2016; McArdle, 2009), we modeled change between baseline and follow-up as a latent factor (i.e., the difference between scores at baseline and follow-up) for both personality and memory in each of the four samples. We first fitted six unconditional models (without covariates) to characterize change in each of the variable under study: the five personality traits and memory. The models were specified to estimate (a) the mean of the latent change between baseline and follow-up (μ_{Δ}); (b) the variance of the change between baseline and follow-up (σ^2_{Δ}); (c) the covariance between the baseline score and latent change ($\sigma_{1\Delta}$); and (d) mean score at baseline (μ_{T1}) (Henk and Castro-Schilo, 2016). Significant μ_{Δ} indicates that, on average, individuals either increase (if the mean is positive) or decrease (if negative) on a variable over time. Significant σ^2_{Δ} indicates interindividual variability around the mean change. Then, to examine whether changes in each of the traits were associated with changes in memory over time, we estimated five bivariate latent change models, one for each personality trait. The bivariate models estimated three additional parameters: (e) the correlation between an individual's scores of personality and memory at baseline; (f) the cross-lagged paths between baseline scores and change scores (i.e., the association between memory at baseline and change scores of personality and personality at baseline and change scores of memory); and (e) the correlation between latent changes. This latter model further included age, sex, education, and race (when applicable) as covariates (see Syntax in Supplementary Material). Results from the four samples were combined in a random effects meta-analysis with the Comprehensive Meta-Analysis software.

Results

The model fit indices were adequate for most models tested across the four samples (see Supplementary Tables S2–S6). Unconditional LCS models revealed decreases in memory and for most personality scores and significant variability in the rate of change across participants in all samples (see Supplementary Table S1, for details). For personality, openness decreased in all samples, extraversion and conscientiousness decreased in three samples, and neuroticism and agreeableness had no clear pattern of changes across the samples.

When examining the bivariate models, we noted that better memory at baseline was associated with lower neuroticism and higher extraversion, openness, agreeableness, and conscientiousness in most samples (see Supplementary Tables S2–S6). However, the primary hypothesis of an association between memory level and changes in neuroticism, openness, and conscientiousness were only partially supported (Table 3; Supplementary Tables S2–S6). As observed in the meta-analysis, memory performance at baseline was related negatively to change in neuroticism and related positively to change in conscientiousness and not to change in openness (Table 3). Unexpectedly, there was a positive relationship between baseline memory and change in agreeableness (see Table 3). These results suggest that lower memory performance at baseline is related to increases in neuroticism and decreases in agreeableness and conscientiousness over time. The associations, however, were inconsistent across the four samples and did not reach statistical significance in most samples (see Table 3 and Supplementary Tables S2–S6).

Meta-analytic results indicated that memory decline was related to declines in openness and conscientiousness (Table 4). In contrast to expectations, memory decline was unrelated to change in neuroticism but was related to decreases in extraversion. In addition to being small in absolute size, the associations varied across samples, with significant associations observed in the HRS and the MIDUS but not in the WLSS and WLSG (see Table 4 and Supplementary Tables S2–S6).

Findings from regression analyses and correlations between residual change scores were similar to the overall pattern of associations found with the latent change analysis (see Supplementary Tables S7 and S8). A few differences were found, specifically significant associations between baseline memory and change in agreeableness in the WLSS and change in openness in the HRS. In addition, significant associations were found between change in memory and change in neuroticism, openness, and conscientiousness in

Table 3. Latent Change Analysis Predicting Change in Personality Traits From Baseline Memory in Each Individual Study and Meta-analysis

	Neuroticism	Extraversion	Openness	Agreeableness	Conscientiousness
WLSG[a]	0.001 (0.003)	–0.001 (0.003)	–0.004 (0.003)	0.001 (0.003)	0.001 (0.003)
WLSS[a]	–0.001 (0.005)	0.003 (0.004)	0.002 (0.004)	0.006 (0.004)	0.011* (0.004)
MIDUS[b]	–0.002 (0.003)	0.003 (0.002)	0.001 (0.002)	0.003 (0.002)	0.002 (0.002)
HRS[b]	–0.003 (0.001)	0.009*** (0.002)	0.009*** (0.002)	0.007*** (0.002)	0.009*** (0.002)
Meta-analysis					
Random effect	–0.002** (0.0009)	0.004 (0.002)	0.002 (0.003)	0.004** (0.001)	0.005* (0.002)
95% CI	–0.004, –0.0008	–0.0006, 0.008	–0.003, 0.008	0.002, 0.007	0.0008, 0.010
Heterogeneity Tau	0	0.004	0.005	0.001	0.004

Notes: HRS = Health and Retirement Study (*N* = 6,038); MIDUS = Midlife in the United States (*N* = 1,901); WLSG = Wisconsin Longitudinal Study Graduates (*N* = 3,232); WLSS = Wisconsin Longitudinal Study Siblings (*N* = 1,570). Coefficients are unstandardized coefficients. *SE*s are in parentheses.
[a]Adjusted for age, sex, and education. [b]Adjusted for age, sex, education, and race.
*$p < .05$, **$p < .01$, ***$p < .001$.

Table 4. Latent Change Analysis of the Relationship Between Change in Memory and Change in Personality in Each Individual Study and Meta-analysis

	Neuroticism	Extraversion	Openness	Agreeableness	Conscientiousness
WLSG[a]	–0.023 (0.031)	–0.019 (0.026)	0.012 (0.024)	–0.006 (0.026)	0.05 (0.026)
WLSS[a]	0.049 (0.043)	0.040 (0.036)	0.003 (0.033)	–0.010 (0.036)	–0.011 (0.035)
MIDUS[b]	0.03 (0.041)	0.133*** (0.034)	0.091** (0.033)	0.072* (0.033)	0.062* (0.031)
HRS[b]	–0.035* (0.016)	0.075*** (0.004)	0.046*** (0.013)	0.056*** (0.013)	0.078*** (0.013)
Meta-analysis					
Random effect	–0.008 (0.019)	0.06* (0.027)	0.04* (0.016)	0.03 (0.020)	0.05** (0.017)
95% CI	–0.046, 0.029	0.003, 0.11	0.007, 0.069	–0.008, 0.07	0.019, 0.09
Heterogeneity tau	0.02	0.05	0.05	0.03	0.02

Notes: HRS = Health and Retirement Study (*N* = 6,038); MIDUS = Midlife in the United States (*N* = 1,901); WLSG = Wisconsin Longitudinal Study Graduates (*N* = 3,232); WLSS = Wisconsin Longitudinal Study Siblings (*N* = 1,570). Coefficients are unstandardized coefficients. *SE*s are in parentheses.
[a]Adjusted for age, sex, and education. [b]Adjusted for age, sex, education, and race.
*$p < .05$, **$p < .01$, ***$p < .001$.

the WLSG. The significant association between change in memory and change in agreeableness found in the MIDUS with the latent change models was not found with the correlated residual change scores.

Discussion

Based on a coordinated analysis of four large longitudinal samples, the present study examined whether memory function was related to personality development across adulthood. The results suggested that memory level and change were related weakly and inconsistently to change in personality traits. Still, the meta-analysis of the four samples indicated that lower baseline memory performance was associated with small increases in neuroticism and small decreases in agreeableness and conscientiousness and that declines in memory were related to declines in extraversion, openness, and conscientiousness.

Although the meta-analysis suggested associations between memory and personality change, there was heterogeneity in the association between memory and personality change across the four samples. Such inconsistency matches the mixed findings in current literature (Mõttus et al., 2012; Mueller et al., 2016; Wettstein et al., 2017, in press). An examination of the patterns observed in each sample suggests that the meta-analytic findings were mostly driven by the HRS. Indeed, most significant relationships between memory level and change and personality change were found in this sample, which may be due to its larger size and power to detect such associations. Therefore, the results obtained in this cohort may provide a relatively accurate picture of the overall pattern of results of the study. As a result, knowledge about the findings in this cohort may inform about the overall phenomenon of the link between memory and personality development. Further, the size of these associations was relatively small, which is consistent with prior studies that failed to find a link between a single cognitive marker, such as processing speed, and personality development (see Mueller et al., 2016). It is likely that global cognitive functioning, including level of performance and change across different cognitive domains, may have a more powerful contribution to personality

change than performance on a single cognitive task, such as a recall task. Indeed, other cognitive functions may help to compensate for lower memory function and decline in memory function may compensate and attenuate the potential association with personality change.

The small effect size suggests that objective memory performance may be a distal predictor of personality change, and that other memory-related factors may play a more proximal role. Personality, for example, is related to cognitive complaints, which are negative judgments and feelings about one's cognitive performance (Pearman et al., 2014). It is possible that cognitive complaints may have stronger associations with personality change compared to objective cognitive performance. Consistent with this speculation, Aschwanden et al. (2018) found that worse cognitive performance was related to more complaints about one's cognition, that in turn was associated with greater emotional instability over time. Personality traits are also related to perceived memory failures and lapses in everyday life (Sutin et al., 2020) that could be stronger predictors of personality change. More studies are needed to test these possibilities.

Memory may be related to change in personality traits through the basic tendencies associated with the traits. For example, lower memory function may generate daily distress and anxiety and ultimately higher neuroticism over time. Lower memory performance and reduced memory over time may impair individuals' planning and organization skills resulting in reduced conscientiousness over time. Worsening memory over time may restrict individuals' search for novelty and tendency toward exploratory behaviors, leading to decreases in openness. Furthermore, lower memory may reduce individual's talkativeness and sociability and limit social interactions, resulting in decreases in extraversion and agreeableness over time. Health-related and behavioral pathways may also explain part of this relationship. Lower memory may increase the likelihood of frailty (Gale et al., 2017; Robertson et al., 2014) and depressive symptoms (Jajodia and Borders, 2011), resulting in increased neuroticism and decreased extraversion, openness, agreeableness, and conscientiousness over time (Hakulinen et al., 2015; Stephan, Sutin, Canada, et al., 2017). Furthermore, it is likely that individuals with lower and declining memory function may be less actively engaged in a range of activities, including being physically inactive, which may lead to lower extraversion, agreeableness, openness, and conscientiousness (Stephan et al., 2014).

These findings should be interpreted in the context of the literature on dementia and personality (Segerstrom, 2020). Memory decline is a hallmark sign of clinical dementia, and although less emblematic, personality and behavioral changes are also core clinical criteria for Alzheimer's disease and related dementias (McKhann et al., 2011). In this study, it is possible that the decline in memory and the correlated declines in extraversion, openness, and conscientiousness could be signs of an underlying neurodegenerative disease. Of note, long-term longitudinal data suggest that personality change does not begin in the preclinical phase of dementia (Terracciano, An, et al., 2017). An increase in neuroticism, but not for the other traits, has been reported at the time of the diagnosis of mild cognitive impairment and dementia (Yoneda et al., 2020). Somewhat contrary to these past prospective studies, the changes we observed could be driven by those who developed cognitive impairment. With the notable exception of neuroticism, the pattern we observed is consistent in direction—but not in magnitude—with the personality change observed in people with cognitive impairment and dementia. Indeed, a recent meta-analysis found that caregivers observe moderate personality changes in individuals with mild cognitive impairment and very large ($d \geq 1$ *SD*) personality changes in individuals with dementia (Islam et al., 2019). Future research should test the hypothesis that the reported associations are driven by incident cognitive impairment.

We primarily followed the preregistration with few deviations. Perhaps the largest deviation was the decision to report the regression analyses in the Supplemental Material. While developing the preregistration, there was some discussion among the authors about which analytic approach to use. Ultimately, for the preregistration, we decided that it would be useful to analyze the data in multiple ways that are common in the literature on personality change. This approach would be helpful for both placing the findings within the context of these two analytical models and for examining whether the associations are robust across different analytical approaches. With few exceptions, the results were fairly consistent across analytic models, and for clarity and brevity, we decided to focus on the latent change models in the *Results* section because they are more robust and unbiased than the regression models. We had few deviations from our preregistration, in part, because our extensive previous research on personality change. That is, we had familiarity with how to frame the question and how to analyze the data with multiple analytic approaches. We also had familiarity with how the four datasets used in the present research were structured. Although beneficial for the preregistration, there are also potential significant biases in this research that could occur with such familiarity. Even if we had never tested these specific models before, we cannot exclude the bias related to the knowledge we have developed about these data sets (Weston, Ritchie, Rohrer, & Pryzybylski, 2019). This knowledge is accompanied by an awareness of the overall pattern of relations between variables or the characteristics of the samples in each cohort. Such knowledge may have influenced the way we conducted analysis and how we interpreted the findings. In particular, we had the most extensive experience with the HRS dataset, which is also the sample that had the strongest associations and drove most of the associations in the meta-analysis. This knowledge

may have biased the research because we knew from this sample that there were relations between personality and memory, even if we had not specifically examined their reciprocal relations. This knowledge may have informed our decision to pursue a project on these reciprocal relations. Again, we strove to reduce this bias by analyzing the data in multiple ways and sought to run the same analyses in other cohort studies to ensure that findings were not based on a single cohort. Although the findings were strongest in HRS, the report of the associations in three other cohorts let readers evaluate the robustness of the associations. Presumably, the bias we may have for one individual dataset would not necessarily apply to other datasets. We strove to use the same inclusion criteria and same analytic approach across the four cohorts. The preregistration process and the coordinated analyses of multiple large open-access longitudinal studies are research approaches that can help improve the robustness and replicability of research findings. And, in fact, we may have reached a different conclusion if only one dataset had been analyzed.

The present study has several strengths, including the analysis of four longitudinal samples, each including at least 1,000 individuals with longitudinal data. There are several limitations to consider when interpreting the results. First, the observational design of this study limits causal interpretation. Although we modeled changes in both memory and personality over time, there could be a third variable that accounts for the pattern of associations. Second, the longitudinal samples were characterized by positive selection, with included participants having more favorable baseline personality profile and memory performance, which could limit the generalizability of the findings. Third, we examined personality change using only two measurement occasions, which produce less reliable estimates compared to studies with three or more assessments. Fourth, the present study only examined change in the broad personality domains. Future research with more detailed personality assessments is needed to examine whether memory is related to personality change at the facet level. Further research may also test whether the association between memory and personality change varies depending on individuals' cognitive status. Moreover, the present study focused on measures of episodic memory, assessed through immediate and delayed recall, to predict personality change. There were both theoretical and practical reasons for focusing on memory. Theoretically, episodic memory is critical for many processes associated with the traits (e.g., following through on commitments). Practically, immediate and delayed recall measures were available in all samples. Future research needs to test whether other cognitive functions are related to changes in personality change. For example, similar to episodic memory, executive function is critical for many of the processes that define the traits (e.g., the cognitive flexibility that is characteristics of openness). Verbal fluency, which may, in part, reflect executive function (Gustavson et al., 2019), has been related to both personality (Sutin, Stephan, Damian, et al., 2019) and risk of cognitive impairment (Sutin, Stephan, and Terracciano, 2019), and may be cognitive correlate of personality changes. In conclusion, this study found modest evidence that change in memory function is related to change in personality across adulthood. Poor concurrent and worsening memory were associated with maladaptive personality change. The associations, however, were small and inconsistent across samples. Therefore, the present study provides only weak evidence for the role of memory in personality development across adulthood.

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.

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