Title

Personality Traits, Cognitive States, and Mortality in Older Adulthood

Journal

Journal of Personality and Social Psychology, 124(2)

ISSN

0022-3514

Authors

Yoneda, Tomiko

Graham, Eileen

Lozinski, Tristen

et al.

Publication Date

2023-02-01

DOI

10.1037/pspp0000418

HHS Public Access

Author manuscript

J Pers Soc Psychol. Author manuscript; available in PMC 2024 February 01.

Published in final edited form as:

J Pers Soc Psychol. 2023 February ; 124(2): 381–395. doi:10.1037/pspp0000418.

Personality Traits, Cognitive States, and Mortality in Older Adulthood

Tomiko Yoneda[1,2], **Eileen Graham**[2], **Tristen Lozinski**[1], **David A. Bennett**[3], **Daniel Mroczek**[2,4], **Andrea M. Piccinin**[1], **Scott M. Hofer**[1,5], **Graciela Muniz-Terrera**[1,6]

[1]Department of Psychology, University of Victoria, Canada

[2]Department of Medical Social Sciences, Northwestern University

[3]Rush Alzheimer's Disease Center, Rush University Medical Center, Chicago, Illinois

[4]Department of Psychology, Northwestern University

[5]Institute of Aging and Lifelong Health, University of Victoria, Canada

[6]Centre for Dementia Prevention, University of Edinburgh

Abstract

Research suggests that personality traits are associated with mild cognitive impairment (MCI), dementia, and mortality risk, but the timing of when traits are most important in the progression to dementia and the extent to which they are associated with years of cognitive healthspan are unclear. This project applied secondary data analysis to the Rush Memory and Aging Project (n=1954; baseline M_{age}=80 years; 74% female) over up to 23 annual assessments. Multi-state survival modeling examined the extent to which conscientiousness, neuroticism, and extraversion, assessed using the NEO Five Factor Inventory, were associated with transitions between cognitive status categories and death. Additionally, multinomial regression models estimated cognitive healthspan and total survival based on standard deviation units of personality traits. Adjusting for demographics, depressive symptoms, and APOEε4, personality traits were most important in the transition from no cognitive impairment (NCI) to MCI. For instance, higher conscientiousness was associated with a decreased risk of transitioning from NCI to MCI (HR=0.78, 95%CI=0.72, 0.85) and higher neuroticism was associated with an increased risk of transitioning from NCI to MCI (HR=1.12, 95%CI=1.04, 1.21). Additional significant and non-significant results are discussed in the context of the existing literature. While personality traits were not associated with total longevity, individuals higher in conscientiousness and extraversion, and lower in neuroticism, had more years of cognitive healthspan, particularly female participants. These findings provide novel understanding of the simultaneous associations between personality traits and transitions between cognitive status categories and death, as well as cognitive healthspan and total longevity.

Keywords

Cognition; Dementia; Multi-State Survival Models; Rush Memory and Aging Project; Big Five

Correspondence concerning this article should be addressed to Tomiko Yoneda, Department of Psychology, University of Victoria, P. O. Box 1700 STN CSC, V8W 2Y2, Canada.

Introduction

Factors contributing to increased life expectancy, and particularly to extended cognitive healthspan (i.e., years without cognitive impairment), are of high importance to researchers, policy makers, and the general public. The existing literature indicates that personality traits are related to individual differences in longevity (e.g., Graham et al., 2017; Jokela et al., 2013; Wilson et al., 2004) and cognition (e.g., Aschwanden et al., 2020; Baker & Bichsel, 2006; Boyle et al., 2010; Duberstein et al., 2011; Graham et al., 2021; Stephan et al., 2021). Limited research, however, has examined the association between personality traits and cognitive healthspan, the simultaneous risk of personality traits on multiple cognitive outcomes and death, or the transition from mild cognitive impairment (MCI) to no cognitive impairment (NCI) or dementia. To address these gaps in the literature, this project investigates the extent to which conscientiousness, neuroticism, and extraversion are associated with cognitive healthspan, as well as with transitions between cognitive status categories and death using multi-state survival modeling (MSM) and data from the Rush Memory and Aging Project (MAP; Bennett et al., 2012).

Personality traits reflect relatively stable tendencies to think, behave, and react in particular ways (McCrae & Costa, 2004). These enduring patterns of interacting with one's environment permeate many domains of life, and may help shape the course of our lives. Importantly, personality traits affect health behaviours cumulatively across the lifespan, thereby affecting mortality risk (Graham et al., 2017; Wilson et al., 2004). Associations between personality traits and mortality are partially mediated by the social, cognitive, and physical activity patterns distinctive of particular personality traits (Wilson et al., 2005). For instance, a meta-analysis including 194 reports examining conscientiousness and prominent behavioural contributors of mortality (e.g., diet and physical activity, risky driving, violence, drug use) found that conscientiousness was negatively associated with all risky behaviours and positively associated with all health promoting behaviours (Bogg & Roberts, 2004), demonstrating the importance of conscientiousness for mortality and health outcomes affected by behaviour.

Personality traits are also thought to affect cognitive functioning in older adulthood via relatively uniform behavioural and cognitive tendencies across a lifetime (Curtis et al., 2014), similarly to the mechanisms underlying the associations between personality traits and mortality. For instance, the risky health behaviours associated with low conscientiousness (Bogg & Roberts, 2004) may also contribute to cognitive senescence in both healthy and unhealthy aging. Indeed, personality is proposed to impact cognition by moderating the association between risk/protective factors and cognitive functioning (Dixon & Lachman, 2019). The Invest-and-Accrue model of conscientiousness (Hill & Jackson, 2016) provides an excellent explanation underlying the associations between conscientiousness, health, cognition, and mortality. The model posits that individuals high in conscientiousness invest in their future by behaving in ways to maximize future gains (e.g., devoting current resources such as time, energy, and assets). These behaviours may reflect explicit and implicit decisions to avoid or offset short-term compensation and rewards. Subsequently, underlying levels of conscientiousness, which drive investment behaviours,

lead to the association with positive outcomes in the domains of health, relationships, education, and occupation (Hill & Jackson, 2016), which subsequently protect against cognitive decline and risk of mortality.

Theorists also propose that personality may modulate aging effects on brain structures (Jackson et al., 2011) or improve one's ability to withstand symptoms of neuropathology (Dixon & Lachman, 2019). For instance, high conscientiousness is related to larger brain volume and reduced age-related neural decline in prefrontal and medial temporal brain regions (Jackson et al., 2011), suggesting that certain personality traits may moderate neurodegeneration and subsequently lead to reduced likelihood of incident cognitive impairment. Likewise, individuals high in conscientiousness may demonstrate better resilience in the face of dementia symptoms (i.e., more likely to be asymptomatic) despite underlying Alzheimer's disease pathology (Wilson et al., 2015), thereby diminishing the likelihood that individuals may appear to have cognitive impairment. The existing literature documents extensive evidence consistent with the underlying pathways linking conscientiousness and cognitive functioning (e.g., Invest-and-Accrue model; contribution to neural integrity and cognitive reserve). Specifically, research finds a decreased risk of cognitive impairment (Graham & Lachman, 2014; Mendez Rubio et al., 2013), cognitive decline (Luchetti et al., 2016), dementia (Aschwanden et al., 2021; Duberstein et al., 2011; Kaup et al., 2019; Terracciano et al., 2014), and mortality (Graham et al., 2017; Jokela et al., 2013; Kern & Friedman, 2008; Wilson et al., 2004) in individuals high in conscientiousness.

Similarly, the existing literature paints a relatively consistent picture of the adverse impact of neuroticism on cognition and mortality. Characterized by anxiety, depressive symptoms, and a propensity toward negative emotionality (Costa & McCrae, 1992a; Eysenck & Eysenck, 1985), neuroticism may affect cognition and mortality through experience and mediation of perceived stress, and, subsequently, engagement in unhealthy behaviours (e.g., increased risk of smoking; Graham et al., 2017). For instance, individuals high in neuroticism are more likely to experience greater negative affect and daily stress (Mroczek & Almeida, 2004). As stress is associated with unhealthy behaviours, such as unhealthy dietary patterns (Kazmierski et al., 2021), drug use (Lloyd & Striley, 2018), and difficulty sleeping (Weeks et al., 2019), individuals experiencing stress may be at increased risk of cognitive decline and mortality. Relatedly, neuroticism is positively associated with cortisol (Garcia-Banda et al., 2014) and allostatic load (Stephan et al., 2016), both of which further contribute to adverse cognitive outcomes such as impaired cognition, cognitive dysfunction, and dementia (Csernansky et al., 2006; Karlamangla et al., 2014). Likewise, brain-imaging research indicates an age-related association between high neuroticism and smaller regional neural volume, along with greater decreases in brain volume (Jackson et al., 2011), suggesting that neuroticism may contribute to neural degeneration. The existing literature indicates that high or increasing neuroticism is associated with worse cognitive functioning (Boyle et al., 2010; Chapman et al., 2012; Crowe et al., 2006; Graham et al., 2021; Klaming et al., 2017; Meier et al., 2002), cognitive decline (Chapman et al., 2012; Luchetti et al., 2016), dementia (Aschwanden et al., 2021; Duberstein et al., 2011; Johansson et al., 2014; Terracciano et al., 2014; Yoneda et al., 2017; Yoneda et al., 2020), and risk of mortality (Graham et al., 2017; Wilson et al., 2004).

In contrast, research examining the links between extraversion, cognitive functioning, and mortality reveals somewhat inconsistent findings. Extraversion is characterized by social activity, assertiveness, positive emotionality, high activity levels, and sensitivity to reward (Costa & McCrae, 1992a; Eysenck & Eysenck, 1985). Individuals high in extraversion are more driven to be socially active, which may indirectly influence cognitive functioning and mortality, as social engagement protects against cognitive decline (James et al., 2011; Kelly et al., 2017) and mortality (Bennett, 2002; Thomas, 2012). Further, those high in extraversion may perform better on cognitive tasks due to faster responding, assertiveness, and lower general arousal (Chamorro-Premuzic & Furnham, 2004). These hypotheses and supporting evidence are reinforced by research suggesting that higher extraversion is associated with better cognitive functioning (Luchetti et al., 2016) and episodic memory performance (Meier et al., 2002) in older adults. However, research also suggests that lower extraversion (i.e., introversion) is associated with better crystallized ability (Baker & Bichsel, 2006; Soubelet & Salthouse, 2011) and fluid intelligence (2011), and that moderate levels of extraversion are associated with lower risk of cognitive impairment compared to low or high extraversion (Crowe et al., 2006). These inconsistent associations between extraversion and cognition are further reinforced by a meta-analysis suggesting that extraversion is inconsistently associated with dementia risk, depending on country of origin (Aschwanden et al., 2021).

The existing literature provides some evidence that the two additional Big Five personality traits, openness to experience and agreeableness, are also associated with cognitive aging processes and mortality (e.g., Aschwanden et al., 2020; Stephan et al., 2021; Williams et al., 2010). These associations, however, tend to be less consistent both between (e.g., Duberstein et al., 2011; Iwasa et al., 2008; Jokela et al., 2013; Martin et al., 2007; Wilson et al., 2004) and within (e.g., Graham et al., 2017) studies, as well as between studies using the same dataset (e.g., Martin et al. 2007; Martin & Friedman, 2000). Given the inconsistencies, and because the selected dataset for this study was ideal for the analytic approach in numerous ways but did not collect data on openness or agreeableness, the present study focuses on conscientiousness, neuroticism, and extraversion.

Overall, research has typically focused on the independent associations between personality traits and either MCI (e.g., Mendez Rubio et al., 2013), dementia (e.g., Terracciano et al., 2014), or mortality (e.g., Graham et al., 2017). Relatively few studies have examined the simultaneous risk of personality traits on both MCI and dementia (e.g., Neuvonen et al., 2020). Further, to our knowledge, no studies have yet examined the simultaneous risk of personality traits on MCI, dementia, and mortality, though some have adjusted for cognitive functioning in the examination of the association between personality traits and risk of mortality (Wilson et al., 2004; Wilson et al., 2005). While MCI has good predictive ability for risk of dementia (Bruscoli & Lovestone, 2004), the transition from NCI to dementia is heterogeneous; not all older adults will develop MCI, and not all individuals with MCI will develop Alzheimer's disease or other dementias (Kaduszkiewicz et al., 2014; Visser et al., 2006). Further, individuals with MCI may revert to NCI at a later occasion (Welstead et al., 2021), though still remain at higher risk of incident dementia (Koepsell & Monsell, 2012). Moreover, MCI, cognitive decline, and dementia also increase risk of mortality (Rajan et al., 2014; Schupf et al., 2005; Taniguchi et al., 2019; Wilson et al., 2006).

In other words, research investigating the simultaneous associations between personality traits and transitions between NCI, MCI, dementia, and death in older adulthood is critical, as MCI, dementia, and mortality are dependent outcomes and further, the likelihood of each outcome increases alongside older age. Specifically, research investigating the impact of personality on a single outcome, such as dementia, does not account for the added risks of additional outcomes, such as death or MCI, which limits the ability to capture the independent association between personality and the single outcome. Importantly, previous findings suggesting an association between personality and mortality may be conflated with the association between personality and cognitive impairment (as individuals with cognitive impairment are at greater risk of death) or vice versa (as individuals who are more likely to die may be at greater risk of already having cognitive impairment). Further, to our knowledge, limited research has examined whether personality traits contribute to transitioning either back to NCI or forward to dementia following an MCI diagnosis. Finally, elucidating the extent to which personality traits contribute to cognitive healthspan would address a prominent gap in the existing literature, as healthy cognitive functioning is important for quality of life in older adulthood (Cohrdes et al., 2018; Keyes, 2013) and also substantially reduces economic and health care burden (Brookmeyer et al., 2007; Taniguchi et al., 2019; Zissimopoulos et al., 2015).

To address these gaps in the literature, this research implemented MSM to examine the association between personality traits and transitions between cognitive status categories (NCI, MCI, and dementia) and mortality in a longitudinal study of older adults with annual assessment, comprehensive clinical diagnoses based on standardized criteria, and excellent participant retention rates and death data. Additionally, we estimated non-impaired and total life expectancies (LEs) for each personality trait using the transition probabilities estimated by the MSM. Based on previous literature, we predicted that lower conscientiousness and higher neuroticism would be associated with increased risk of transitioning forward through cognitive status categories. Further, we predicted that higher conscientiousness and lower neuroticism would be associated with longer healthspan and overall longevity. While the literature examining extraversion is more variable compared to the research examining conscientiousness and neuroticism, the importance of social engagement is particularly salient for cognitive functioning and mortality (James et al., 2011; Kelly et al., 2017). As such, we also predicted that higher extraversion would be associated with a decreased risk of transitioning forward through cognitive status categories, as well as longer healthspan, and overall longevity.

To our knowledge, only one study has investigated the role of personality traits on backward transitions from MCI to NCI, and this research only included assessment of neuroticism, conscientiousness, and openness to experience. Using logistic regression analyses to compare reverters (N=66) to non-reverters (N=157), results suggest that, adjusting for age and sex, lower neuroticism was associated with reverting from MCI to NCI, but the estimate was no longer significant when additionally adjusting for conscientiousness and openness (p=.078; Sachdev et al., 2013). Given limited research in this area, we did not make firm predictions regarding the backward transitions. However, we made two additional exploratory predictions. First, we expected that higher conscientiousness would be associated with an increased likelihood of the backward transition from MCI to NCI,

as individuals high in conscientiousness may better adhere to physician recommendations. Second, we expected that higher extraversion would be associated with an increased likelihood of transitioning back to NCI from MCI, as existing research suggests that extraverts perceive greater social support (Barańczuk, 2019) and are more likely to seek social support (Connor-Smith & Flachsbart, 2007), which is particularly important for MCI outcomes (Song et al., 2019).

Method

Sample

Data were drawn from the Rush Memory and Aging Project (MAP; Bennett et al., 2012), a longitudinal cohort study of older adults (N=2184; M_{age}=80.0 years; $M_{education}$=14.9 years; 73.5% female; 87% White) living in the greater Chicago metropolitan region and northeastern Illinois. Participants without a formal diagnosis of dementia were recruited from retirement communities, church groups, and subsidized senior housing facilities. Data collection began in 1997, with ongoing recruitment in northeastern Illinois (for information regarding cumulative enrollment by year, see: https://www.radc.rush.edu/documentation.htm). Participants with at least one personality trait assessment and at least two states (i.e., at least two cognitive assessments or one cognitive assessment plus death) met eligibility for the current project, which resulted in excluding 107 and 127 participants, respectively, for a total of 10.5% of individuals (n=230). Included versus excluded participants were not significantly different in regards to baseline age, years of education, sex, or race.

At enrollment, all participants agreed to annual clinical assessments until death. As organ donation is a condition of study entry, and the autopsy rate surpasses 80%, the precise date of death is known for more than four-fifths of deceased participants. In addition to annual assessments, research assistants contacted participants four times per year to track critical changes in health, including death. Finally, the Social Security Administration Databases and National Death Index were regularly reviewed to check for deaths that may have been missed through participant-researcher communications. Across participants, approximately 95% of participants completed annual follow-up assessments (Stewart et al., 2020). The Institutional Review Board of Rush University Medical Center reviewed the study, and all participants signed an informed consent and a repository consent, which allows their data to be used for ongoing projects. Researchers may request to access MAP data (www.radc.rush.edu/res/ext/home.htm).

Measures

MAP (Bennett et al., 2012) includes annual assessments across an extensive variety of biological and neuropsychological variables (for a complete list, see: https://www.radc.rush.edu/docs/var/varIndex.htm). All assessments were completed exclusively in-person using the Blaise computer-assisted interviewing system. When in-person interviews were not possible, a subset of surveys and cognitive tests were administered via telephone-structured interviews. The current project selected the following measures for the planned statistical analyses.

Clinical Diagnoses—Assessment of clinical diagnoses (i.e., cognitive status categories) was based on a three-stage process. First, all participants completed structured clinical evaluations annually, which included an extensive neuropsychological battery of 19 cognitive tests across five cognitive domains (episodic, working, and semantic memory, perceptual speed, and visuospatial ability; for more details, see https://www.radc.rush.edu/docs/var/overview.htm?category=Cognition; Bennett et al., 2006). Trained technicians administered the cognitive tests, which were scored by a computer. Using a decision tree designed to mimic clinical judgement, a rating of impairment severity based on the cognitive test scores was generated. Second, an experienced neuropsychologist, who was blinded to the participants' age, sex, and race, reviewed the impairment rating and other clinical information to assert a clinical judgement regarding the presence of cognitive impairment. In this step, the neuropsychologist also considered the participant's education, occupation, sensory and motor deficits, and effort. Third, all participants who met cognitive impairment criteria in step two were examined in-person by a neurologist, geriatrician, or nurse practitioner who had expertise in evaluation of older adults with and without dementia. After reviewing all available data, the clinician made a final status classification based on criteria of the joint working groups of the National Institute of Neurological and Communicative Disorders and Stroke and the Alzheimer's Disease and Related Disorders Association (NINCDS/ADRDA). Specifically, probable Alzheimer's disease and related dementias were diagnosed if there was evidence of meaningful decline in cognitive functioning relative to previous levels, with impairment in memory and at least one additional cognitive domain. These diagnoses represent State 3 in the current analyses. MCI was diagnosed in the context of cognitive impairment, but when the participant did not meet the criteria for dementia (i.e., State 2 in the current analyses). No cognitive impairment (NCI) referred to individuals without evidence of cognitive impairment (i.e., State 1 in the current analyses).

The standardized cognitive assessments, which were identical across measurement occasions, were used to enhance consistency across examiners and over time. Further, the neuropsychologists' (Step 2) and clinicians' (Step 3) decisions were the result of highly qualified clinical judgement. The predictive value of the three-stage diagnostic procedure employed in MAP is greater than 90% for probable Alzheimer's disease, and between 60–70% for possible Alzheimer's disease, which is comparable to specialty dementia clinics (80% and 65–85%, respectively; Bennett et al., 2006).

Personality—The NEO Five Factor Inventory (NEO-FFI; Costa & McCrae, 1992b) was used to assess conscientiousness, neuroticism, and extraversion. Each subscale includes 12 items, however, to minimize participant burden, only six items from the NEO-FFI extraversion subscale were administered, once, at participants' first measurement occasion. The 12-item neuroticism and conscientiousness subscales were also administered once, starting in 2004 and 2008, respectively, such that participants previously enrolled completed the subscale in 2004 and 2008, while participants enrolled after those occasions completed all three subscales at their baseline occasion. Conscientiousness was assessed with 12 items, such as "*I am a productive person who always gets the job done*." Neuroticism was assessed with 12 items, such as "*I often feel tense and jittery*." Extraversion was assessed with six items, such as "*I like to have a lot of people around me*." Items were rated on a 5-point

scale, ranging from strongly agree to strongly disagree. Negatively worded items were reverse coded, so that higher scores consistently indicate higher levels of each trait. Items were summed to yield a composite score plausibly ranging from 0–48 for conscientiousness and neuroticism, and from 0–24 for extraversion. Reliability estimates for the entire MAP sample indicate good internal consistency across all trait scales (Cronbach's α=.80). For this analysis, personality trait scores were z-standardized in standard deviation (*SD*) units to facilitate the interpretation of hazard ratios (HRs) and estimated life expectancies (LEs).

Covariates—Age and education were measured in years and mean-centered, while sex was dichotomized with female participants as the reference (i.e., female=0; male=1), as 75% of MAP participants are female. Given existing literature suggesting an association between depression and the primary variables, number of depressive symptoms measured at baseline by the Center for Epidemiologic Studies Depression Scale (CES-D; Radloff, 1977) were included in models. Models also adjusted for apolipoprotein (APOE) ε4 genotype (0=does not carry APOE ε4 allele; 1=carrier of one or more ε4 allele). APOE genotypes were determined by investigators who were blinded to clinical and pathological data. Polymorphic DNA Technologies (Alameda, CA) performed genotyping using DNA extracted from peripheral blood (~75%) or post-mortem brain tissue (~25%). There were nearly complete data for age, sex, education, and depressive symptoms (over 99.9%), but individuals without genetic testing (n=291) were significantly higher in conscientiousness ($t(1255)=3.46$, p=.001) and lower in neuroticism ($t(1795)=3.16$, p=.002) compared to individuals with genetic testing.

Post hoc sensitivity analyses additionally adjust for global chronic conditions, which was a computed count variable based on prevalent hypertension, cancer, diabetes, head injury, thyroid conditions, congestive heart failure, vascular disease burden, heart disease, and stroke. All chronic conditions were assessed via self-report, except for history of stroke, which was ascertained by a clinician via review of self-report and interview questions, cognitive testing, and a neurological exam. Chronic conditions were summed, such that higher values indicated having more chronic conditions.

Statistical Analysis

Multi-state survival modeling (MSM; van den Hout, 2016) simultaneously models transitions between multiple states, whereas Cox regression models one transition in one direction (e.g., the risk of death). MSM provides a powerful analytic approach for discriminating the effect of factors (e.g., personality traits) at different stages of cognitive impairment and allows flexibility in transitions between cognitive status categories (e.g., backward transitions, skipping specific stages). Importantly, MSM accounts for death as a competing risk factor in the estimation of transitioning between cognitive status categories, and likewise, accounts for various levels of cognitive impairment as a competing risk factor in the estimation of death. Furthermore, MSM does not include assumptions about time spent in each state, which is particularly desirable when data are interval censored (e.g., survey data). Due to the complexity of modeling several transitions, a limitation of MSM is potential numerical problems when several covariates are included within analyses, especially when there are few individual transitions between states. For this

analysis, a four-state model was applied (State 1=NCI; State 2=MCI; State 3=dementia; State 4=death; see Figure 1, which includes the number of transitions between states). Three MSMs aligned according to chronological age were fit to examine the impact of personality traits (conscientiousness, neuroticism, and extraversion) on transitioning between cognitive status categories and death during up to 23 years of annual follow-up. The MSM package (Jackson, 2011) for R was used to estimate multi-state survival models, applying general purpose optimization, and the Broyden-Fletcher-Goldfarb-Shanno (BFGS) method of algorithm was applied to optimize functioning. MSM requires at least two states and complete demographic data.

To complement the MSM analyses, and to provide an estimate of the impact of personality on total and non-impaired life expectancy (i.e., cognitive healthspan; partial LE), non-impaired and total LEs were estimated for each of three personality traits using the elect package in R (van den Hout et al., 2019). The package fits a multinomial regression model, conditional on age, using the transition probabilities estimated by the MSM for time-invariant covariates (besides age; van den Hout et al., 2019). LEs were estimated for male and female participants at 80 and 90 years of age, at the mean years of education, with no depressive symptoms or APOE ε4 allele, and at three levels of each personality trait (1 SD below the mean, at the mean, and 1 SD above the mean). Besides standardizing personality trait scores, there were no other data transformations.

Post Hoc Sensitivity Analyses

Based on reviewer suggestions, we executed two primary sets of post hoc sensitivity analyses. First, we fit the primary MSMs additionally adjusting for chronic conditions. These analyses examine the extent to which personality traits are associated with transitions between cognitive status categories and mortality above and beyond health. Second, Cox proportional hazard models examined the association between personality traits and survival time to dementia and to death (separately), adjusting for age, sex, education, APOE, and depression symptoms. These analyses aim to provide context for the importance of simultaneous modeling of dementia and death (i.e., MSM) when investigating the role of personality in cognitive aging processes and mortality. Additional post hoc analyses estimated LEs for individuals with depressive symptoms and with at least one APOE allele, which are documented within the online OSF supplemental material.

Transparency and Openness

The longitudinal data analyzed in the current research are drawn from the MAP study (Bennett et al., 2012). We report all measures assessed in MAP that are relevant to the current research, how the sample size from MAP was determined, all data exclusions, and exclusions of variables in our statistical models; we follow Journal Article Reporting Standards (Applebaum et al., 2018). For a comprehensive list of MAP measures, see: https://www.radc.rush.edu/docs/var/varIndex.htm. Access to MAP data (Bennett et al., 2012) may be requested (www.radc.rush.edu/res/ext/home.htm). Data analysis was done in R, version 3.6.3 (R Core Team, 2020), using the MSM package (Jackson, 2011) and the elect package (van den Hout et al., 2019). Data from all participants who had measurement of at least one personality trait, complete demographic information,

and clinical diagnosis at two or more measurement occasions (or one clinical diagnosis and death), were included in the current project. Primary hypotheses, the full pre-registered analytic plan, participant eligibility criteria, criteria for inferential statistics, and analytic scripts in R, are reported on the Open Science Framework: https://osf.io/uadcm/?view_only=b5aaa02d47ce497ca9bbf4747029702a.

Data from the MAP study (Bennett et al., 2012) have been used in prior publications examining personality (e.g., Gaynes et al., 2013), cognition (e.g., Boyle et al., 2013), and mortality (e.g, Stewart et al., 2020). For a comprehensive list of prior publications analyzing MAP data, see: https://www.radc.rush.edu/docs/studyPublications.htm;jsessionid=472F0541B864CBF3C433541521FCED32?studyName=MAP. However, this project is the first implementation of multi-state survival modeling to examine the impact of personality traits on transitions between NCI, clinical diagnoses, and death using MAP data.

Results

Baseline descriptive statistics of the sample are reported in Table 1. During follow up ($M_{occasions}$=8; range=2–23), 54% of the sample died (n=1059). Supplementary Table 1 reports the total number of individual transitions between cognitive status categories and death. The majority of observed transitions were from NCI to NCI (n=7368), MCI to MCI (n=1244), and dementia to dementia (n=876), suggesting that relative stability in cognitive status across measurement occasions was commonplace, which is unsurprising given annual assessment. There were, however, several backward transitions from MCI to NCI (n=725), which may reflect improvement or within-person variability in cognitive functioning, or learning effects. Comparatively, there were few backward transitions from dementia (dementia to MCI, n=114; dementia to NCI, n=12), suggesting that improvement in cognitive status was relatively rare, particularly once an individual progresses to dementia. Supplementary Table 2 reports the correlation matrix of the time-invariant variables included in the current analyses. Estimated HRs (and 95% CIs) of the effect of each personality trait, adjusting for covariates (age, sex, education, depressive symptoms, and APOE ε4 allele), on risk of transitioning between states are presented in Table 2, and the full model results (including estimates for covariates) are reported in Supplementary Table 3. The following subsections report the results of the models across demographics, and then each personality trait. Statistical inference was made as follows: for the neuroticism model, if any of the estimates are above 1.0 and the 95% CI does not contain 1.0 for the transition, we concluded that higher neuroticism is associated with increased likelihood of the transition; for the conscientiousness and extraversion models, if any of the estimates are below 1.0 and the 95% CI does not contain 1.0 for the transition, we concluded that these traits are associated with decreased likelihood of the transition.

Multi-State Survival Models

Demographics—Estimated HRs (and 95% CIs) of the effect of covariates for each personality trait model are reported in Supplementary Table 3, but not reported in text, as estimated HRs vary slightly across the personality trait models. Consistent across

all personality trait models, results suggest that older participants are significantly more likely to transition forward through clinical diagnoses and to death compared to younger participants. Additionally, older participants were less likely to transition from MCI back to NCI consistently across each of the models. In the neuroticism model, older participants were also estimated to be less likely to transition from dementia back to MCI.

Across all trait models, male participants were more likely to transition from dementia to death, and also back to MCI from dementia. In the extraversion model, male participants were also more likely to transition from NCI to death, while female participants were more likely to transition back to NCI from MCI. Education was not significantly associated with transitions within the conscientiousness models, but, in both the neuroticism and extraversion models, higher education was associated with a decreased risk of transitioning from NCI to death, as well as an increased likelihood of transitioning back to NCI from MCI. Being a carrier of an APOE ε4 allele was associated with an increased risk of transitioning from NCI to MCI, and a decreased likelihood of transitioning from MCI back to NCI across all personality trait models. In the conscientiousness and neuroticism models, having an APOE ε4 allele was also associated with an increased risk of transitioning from MCI to dementia. In the extraversion model, having an APOE ε4 allele was associated with a decreased likelihood of transitioning from MCI to death and from dementia back to MCI. Finally, more depressive symptoms at baseline were significantly associated with an increased risk of transitioning from NCI to death in the conscientiousness and neuroticism models. In the extraversion model, more depressive symptoms were associated with an increased risk of transitioning from NCI to MCI, as well as from dementia to death.

Personality Traits

Conscientiousness.: When all covariates were included for all transitions, the conscientiousness model would not converge due to numerical problems. Consistent with our pre-registration, we first excluded APOE ε4 allele from the models, which resulted in model convergence. Estimates from the conscientiousness model, adjusting for age, sex, education, and depressive symptoms (but not APOE ε4 allele) are reported in Table 2. The model also converged when including age, sex, education, and APOE ε4 allele (not depressive symptoms); estimates from this model are reported in Supplementary Table 3 (see Conscientiousness 2). Higher conscientiousness was associated with a decreased risk of transitioning from NCI to MCI (HR=0.78, 95%CIs=0.72, 0.85). However, conscientiousness was not significantly associated with transitions between the other cognitive status categories or death. As such, our findings were partially consistent with our prediction that lower conscientiousness would be associated with increased risk of forward transitions through cognitive status categories. See Supplementary Figure 1.

Neuroticism.: We predicted that higher neuroticism would be associated with increased likelihood of transitioning forward through cognitive status categories. Consistent with this prediction, higher neuroticism was associated with an increased risk of transitioning from NCI to MCI (HR=1.12, 95%CIs=1.04, 1.21). Though we did not make predictions regarding neuroticism and backwards transitions, results suggest that higher neuroticism was associated with a significant decreased likelihood of transitioning from MCI back to

NCI (HR=0.90, 95%CIs=0.81, 1.00; upper CI<1.00 prior to rounding to two decimals). Neuroticism was not significantly associated with transitions between the other cognitive status categories or death. See Supplementary Figure 2.

Extraversion.: We predicted that higher extraversion would be associated with decreased risk of transitioning forward through cognitive status categories; however, this was not the case. Higher extraversion was associated with an increased likelihood of transitioning from MCI back to NCI (HR=1.12, 95%CIs=1.03, 1.22) and with a decreased likelihood of transitioning from dementia back to MCI (HR=0.83, 95%CIs=0.68, 0.99). Further, higher extraversion was associated with an increased risk of transitioning from dementia to death (HR=1.12, 95%CIs=1.04, 1.21), which was inconsistent with our prediction. Extraversion was not significantly associated with transitions between the other cognitive status categories or death. See Supplementary Figure 3.

Life Expectancies

We predicted that higher conscientiousness and extraversion, as well as lower neuroticism, would be associated with longer healthspan and overall longevity. Using the transition probabilities estimated by the MSM, non-cognitively impaired healthspan (i.e., cognitive healthspan; partial LE) and total LEs (i.e., total years of longevity) were calculated for male and female participants at 80 and 90 years of age. Estimates for 80 year olds are reported in Table 3 for those with 15 years of education (sample mean), no depressive symptoms, no APOE ε4 allele, and at three levels for each personality trait (at the mean, as well as 1 SD below and 1 SD above). Estimates for 90 year olds with the same characteristics followed a similar pattern as the participants who were 80 years old (see Supplementary Table 4). Estimated 95% CIs for estimated years of LE that do not overlap between levels of each personality trait (or across sex categories) suggests that the trait (or sex) is significantly associated with (shorter or longer) years of life expectancy.

Conscientiousness.—Female participants one SD below the mean in conscientiousness had shorter non-impaired (7.73 [6.97, 8.07]) and total (12.15 [11.34, 12.86]) LE compared to individuals with average conscientiousness. Further, individuals with average conscientiousness had shorter non-impaired (8.69 [8.17, 9.02]) and total (12.95 [12.24, 13.59]) LE compared to individuals one SD above the mean (partial 9.51 [8.77, 10.22], total 13.49 [12.64, 14.30]). The pattern of results for male and female participants was similar, but with relatively shorter years of non-impaired and total LE for male compared to female participants. Overall, cognitive healthspan and total LE increased linearly with higher levels of conscientiousness, but not significantly at all levels, which was partially consistent with our predictions. Female participants at the mean level of conscientiousness and one SD above had significantly longer healthspan compared to those one SD below the mean, but only male participants one SD above the mean had significantly longer healthspan compared to participants one SD below the mean. Conscientiousness was not substantially related to total longevity.

Neuroticism.—Female participants one SD below the mean had longer partial (8.28 [7.78, 8.85]) and total (11.88 [11.21, 12.63]) LE compared to individuals with average neuroticism,

and individuals with average neuroticism had slightly longer partial (7.78 [7.41, 8.25]) and total (11.85 [11.21, 12.49]) LE compared to individuals one SD above the mean (partial 7.22 (6.61, 7.71), total 11.77 [10.88, 12.40]). The pattern of results for male participants was similar, but with relatively shorter years of non-impaired and total life expectancy compared to female participants. While cognitive healthspan and total LE estimates were relatively shorter for individuals with higher levels of neuroticism, there was no significant difference between participants with mean neuroticism and one SD above or below the mean. However, female participants one SD above the mean were estimated to live substantially longer than female participants one SD below the mean, though there was no substantial difference for male participants who were one SD above or below the mean in neuroticism, which was partially consistent with our predictions. Likewise, level of neuroticism was not substantially related to total longevity.

Extraversion.—Female participants one SD below the mean in extraversion had shorter partial (7.03 [6.57, 7.51]) and total (11.24 [10.55, 11.95]) LE compared to individuals with average extraversion, and individuals with average extraversion had shorter partial (7.56 [7.21, 8.01]) and total (11.63 [11.06, 12.25]) LE compared to individuals one SD above the mean (partial 8.12 [7.52, 8.58], total 12.03 [11.24, 12.57]). The pattern of results between male and female participants was similar, but relatively shorter years of non-impaired and total LE for male compared to female participants. While total LE estimates were relatively longer for individuals higher in extraversion, the difference between levels of extraversion did not substantially affect total longevity. Though female participants one SD below the mean in extraversion had substantially shorter partial LE compared to those one SD above the mean, extraversion was not substantially related to partial or total survival for male participants, which was partially consistent with our predictions.

Sensitivity Analyses

MSMs suggest that chronic conditions were associated with transitioning forward through cognitive statuses and to death; however, adding chronic conditions to the models did not influence the association between neuroticism or extraversion and transitions between cognitive status categories and death (see Supplementary Table 5). The conscientiousness model would not converge when adjusting for all covariates and chronic conditions, but conscientiousness estimates did not meaningfully change when adjusting for chronic conditions in addition to demographics and depressive symptoms *or* APOE. These results suggest that the associations between these personality traits and transitions between cognitive statuses and death are robust to further adjustment for chronic conditions.

Based on Cox proportional hazard models, estimated HRs (and 95% CIs) of the association between personality traits and survival time to dementia and to death, adjusting for age, sex, education, APOE, and depression symptoms, are reported in Supplementary Table 6. Results suggest that higher conscientiousness and extraversion are associated with a decreased risk of dementia and death. Likewise, higher neuroticism is associated with an increased risk of dementia.

Discussion

The current study examined six pre-registered predictions focused on the impact of conscientiousness, neuroticism, and extraversion on cognitive status transitions, cognitive healthspan, and overall longevity. Based on a longitudinal dataset of older adults (n=1954) with up to two decades of annual assessment, our results suggest that baseline conscientiousness is protective against, while neuroticism is a risk factor for, transitioning to MCI. Specifically, scoring approximately six more points on a conscientiousness scale ranging 0 to 48 (1 SD in the scale) is significantly associated with approximately 22% decreased risk of transitioning forward from NCI to MCI. Additionally, scoring approximately seven more points on a neuroticism scale ranging 0 to 48 (1 SD in the scale), is significantly associated with approximately 12% increased risk of transitioning from NCI to MCI. Likewise, our results suggest that while personality traits did not substantially affect total longevity in this dataset, individuals higher in conscientiousness had more years with healthy cognitive functioning (i.e., cognitive healthspan). To our knowledge, previous research has not investigated the impact of personality traits on transitioning to MCI and dementia while simultaneously accounting for death as a competing risk factor, or the extent to which personality traits contribute to cognitive healthspan. The current findings address these gaps in the literature by investigating when conscientiousness, neuroticism, and extraversion may be most important in the progression through clinical diagnoses and mortality in older adulthood.

Multi-State Survival Models

Our results suggest that being higher in neuroticism and lower in conscientiousness was significantly associated with an increased risk of transitioning from NCI to MCI. These findings are consistent with our predictions, which were based, in part, on research suggesting that higher neuroticism and lower conscientiousness are associated with MCI and cognitive decline (Chapman et al., 2012; Luchetti et al., 2016; Mendez Rubio et al., 2013). Personality traits reflect relatively enduring patterns of thinking and behaving (McCrae & Costa, 2004), which may cumulatively affect engagement in healthy and unhealthy behaviours and thought patterns across the lifespan. The accumulation of lifelong experiences may then contribute to susceptibility of particular diseases or disorders (e.g., MCI), or contribute to individual differences in the ability to withstand age-related neurological changes and neurodegeneration (i.e., cognitive reserve; Stern, 2012). However, once an individual progresses to MCI, healthy life choices and behaviours characteristic of particular personality traits may have less power to protect against underlying neurological degeneration. This possibility is consistent with the current findings, which suggest that conscientiousness and neuroticism are associated with cognitive functioning most substantially in the transition from NCI to MCI. Indeed, neither conscientiousness nor neuroticism were significantly associated with the forward transition to clinically diagnosed dementia, nor to death.

Analyses also revealed that extraversion was not significantly protective against forward transitions through clinical diagnoses, nor to death, which was inconsistent with our prediction regarding extraversion. In contrast, analyses suggest that individuals higher in

extraversion are at an increased risk of death once they progress to dementia, as well as a decreased likelihood of transitioning back to MCI from dementia, compared to individuals low in extraversion. Findings also revealed that higher extraversion was associated with an increased likelihood of transitioning from MCI back to NCI, which is consistent with research suggesting that individuals high in extraversion are more likely to perceive and seek social support (Barańczuk, 2019; Connor-Smith & Flachsbart, 2007). As social support is particularly important for MCI outcomes (Song et al., 2019), such as medication adherence (Hudani & Rojas-Fernandez, 2016), higher extraversion may help to mitigate or alleviate some of the symptoms associated with MCI through social support. Together, these findings suggest that higher extraversion (and perhaps the associated social support) is particularly important in the early stages of cognitive impairment, but that the positive impact of social engagement and support may be exhausted by the time an individual progresses to dementia. Further, the transition from dementia back to MCI should be interpreted cautiously, as the transition may reflect a misdiagnosis and/or misclassification, and very few individuals transition from dementia back to MCI in MAP (114 out of 12902 total transitions; <1%). Higher extraversion may also contribute to greater likelihood of MCI misclassification at a particular occasion, as individuals high in extraversion may be more likely to be distracted during neuropsychological clinical testing (Eysenck, 1967; Virzi et al., 2018).

We did not make formal hypotheses regarding the backward transitions from MCI to NCI, nor regarding the transition from dementia back to MCI, as limited previous work has investigated the extent to which personality traits may be protective once an individual is experiencing mild or severe cognitive impairment. We expected, however, that individuals high in conscientiousness and extraversion would be more likely to transition back to NCI from MCI given that social support and engaging in healthy behaviours are associated with these traits. As discussed, higher extraversion was associated with an increased likelihood of transitioning from MCI back to NCI. Conscientiousness, however, was not associated with the backward transition. Once an individual starts to experience cognitive impairment, they may engage in healthier behaviours according to physician recommendations that are protective against further cognitive decline, despite pre-existing personality. While the decision to engage in healthier behaviours may just reflect change in behaviour, it is possible that individuals also experience personality change following a clinical diagnosis. Previous work examining trajectories of change in personality traits preceding and following MCI diagnosis found relative stability in conscientiousness for individuals eventually diagnosed with MCI and dementia (Yoneda et al., 2020). The analysis, however, examined trajectories of conscientiousness aligned according to years preceding and after MCI classification, which did not account for individuals who may have recovered, to some extent, from mild impairment. Future research examining change in conscientiousness and health behaviours surrounding MCI diagnoses, and particularly for individuals who revert to NCI, may provide a more nuanced understanding of this possibility.

Findings also revealed that higher neuroticism was marginally associated with a decreased likelihood of transitioning from MCI back to NCI (HR=0.90, 95%CIs=0.81, 1.00), suggesting that individuals high in neuroticism are less likely to recover from MCI. This finding is consistent with the one previous study that examined characteristics of 234 older adults with MCI who reverted to NCI (Sachdev et al., 2013). Cognitive decline may

elicit stress and anxiety (Banningh et al., 2008; Hwang et al., 2004), individuals high in neuroticism are more vulnerable to anxiety and stress (Jenkins et al., 2021; Mroczek & Almeida, 2004), and stress and anxiety are linked to adverse cognitive outcomes (Aggarwal et al., 2014; Gallacher et al., 2009; Wilson et al., 2011). For instance, a review article (Ouanes & Popp, 2019) synthesizing research examining high cortisol and risk of dementia presents several studies finding an association between high neuroticism and high cortisol (e.g., Garcia-Banda et al., 2014), as well as the existing literature finding an association between high neuroticism and adverse cognitive outcomes. As excess cortisol causes wear-and-tear on the body (Geerlings et al., 2015), particularly the hippocampus (Tatomir et al., 2014), the authors suggest that the association between neuroticism and cortisol may contribute to the adverse cognitive outcomes associated with neuroticism (Ouanes & Popp, 2019).

Life Expectancies

We also examined three pre-registered predictions regarding cognitive healthspan and longevity. Partially consistent with predictions, the LE analyses estimated longer cognitive healthspan at higher levels of conscientiousness and extraversion, though not substantially at all levels. Further, analyses revealed that these traits made a more substantial difference to female participants compared to male participants. For instance, female participants at the mean and one SD above the mean in conscientiousness had substantially longer non-impaired cognitive LE compared to those one SD below the mean, but male participants one SD above the mean only had substantially longer healthspan compared to participants one SD below the mean. These findings may reflect the increased power of the models to estimate transitions in female participants, due to MAP being a predominantly female sample.

Overall, our findings suggest that lower neuroticism, as well as higher conscientiousness and extraversion, are associated with more years of cognitive healthspan to some extent, particularly for female participants. These results are in partial support of our predictions. However, level of each personality trait did not significantly affect total longevity (i.e., the CIs surrounding the point estimates overlapped between SDs of each trait). These finding are inconsistent with our predictions, as well as the previous work suggesting an increased risk of mortality with neuroticism (Graham et al., 2017; Wilson et al., 2004) and decreased risk of mortality with both extraversion (Wilson et al., 2005) and conscientiousness (Graham et al., 2017; Jokela et al., 2013; Kern & Friedman, 2008; Wilson et al., 2004). These inconsistent findings may be due to the existing literature typically considering death as a single outcome, without considering the competing risk of MCI or dementia.

As previous work suggests that MCI increases risk of death (Bin Bae et al., 2018; Yu et al., 2019), and that there is an increased risk of death specifically due to dementia across all MCI subtypes (Contador et al., 2014), the association between personality and mortality may be partially or largely accounted for by the pathway through cognitive decline. Indeed, our sensitivity analyses, which used Cox proportional hazard models to examine the individual associations between each trait and survival time to dementia, and to death, amplify the importance of simultaneously modeling cognitive status categories and

death when investigating the role of personality in cognitive aging processes and mortality. Specifically, the Cox results suggest that higher conscientiousness is associated with a decreased risk of dementia *and* death. In contrast, the MSMs, which account for MCI, dementia, and death in the same model, suggest that conscientiousness is only associated with the transition to MCI. As such, high conscientiousness likely decreases risk of death because individuals high in conscientiousness are also at a decreased risk of dementia. These findings are also consistent with prior work in MAP's sister study, the Religious Orders Study (Bennett et al., 2012), which revealed that adjusting for baseline levels of global cognition attenuated the associations between personality traits and relative risk of death (Wilson et al., 2004). Likewise, further work examining neuroticism, extraversion, and risk of death revealed a reduced association between personality traits and mortality when cognitive activity was added to the models (Wilson et al., 2005).

In addition, the mean age of MAP is nearly 80 years old. Statisticians estimate that life expectancy in the U.S. was 76.43 years in 1997 (World Bank Group, 2021), which marks the year that participant enrollment began for MAP. As such, selection processes may have occurred prior to participants' admission into MAP. That is, results may differ for studies investigating the impact of personality traits on mortality risk that include participants at midlife (e.g., Jokela et al., 2013; N=76,150, M_{age} at baseline=50.9 years) rather than in late life. Future research examining the association between personality traits, cognitive outcomes, and death across the lifespan would benefit the literature.

Strengths and Limitations

To our knowledge, this research is the first to examine the impact of personality traits on cognitive healthspan, as well as the impact of personality traits on the transition from MCI to dementia. This project was pre-registered, and besides post hoc sensitivity analyses that were completed at the request of reviewers (and clearly distinguished as such), there were no deviations from the pre-registration. All authors had some prior knowledge of MAP data, working either directly or indirectly with the dataset, though none of the authors has used the same predictor and outcomes variables all together. Further, the authors involved in study design and pre-registration had not handled or analyzed the data personally.

However, there are some limitations. Namely, personality change may have occurred after the baseline occasion. Although many participants completed all three personality trait subscales at baseline due to continuous enrolment, the neuroticism and conscientiousness subscales were not administered for up to seven and eleven years, respectively, following initiation of the study. Although personality traits are relatively stable after age 30 (Terracciano et al., 2006), the existing literature suggests that a small degree of personality change, development, and variability across several years or decades is characteristic of healthy development (e.g., Berg & Johansson, 2013; Mroczek & Spiro, 2003; Small et al., 2003). More substantial personality change, however, may occur during progression to dementia or after diagnosis (Balsis et al, 2005; Dawson et al, 2000; Lykou et al, 2014; Mahoney et al, 2011; Siegler et al., 1994; Smith-Gamble et al., 2002 Yoneda et al., 2017; Yoneda et al., 2020). This limitation is less of a concern for estimates of neuroticism, as the majority of individuals (71%) completed the neuroticism assessment at baseline or

within 1–2 years of their baseline occasion. In contrast, approximately three quarters of the participants completed the conscientiousness subscale up to five years after their baseline assessment, and 10% completed the subscale up to ten years after their baseline occasion. As such, conscientiousness may have changed to some extent for these individuals following their initial cognitive assessment. Future research investigating the association between conscientiousness assessed at baseline and transitions through cognitive status categories and death, as well as change and development in conscientiousness, particularly in the context of cognitive aging processes, would benefit the existing literature.

Further, as anticipated, there were some numerical problems within the multi-state models. The full conscientiousness model eventually converged after 314,000 iterations, but the APOE ε4 allele estimates and CIs were unreliable. As such, we report the covariate estimates from the model adjusting for age, sex, education, and depressive symptoms in Table 2 and the full model results in Supplementary Table 3 (see Conscientiousness 1). To ensure that the results were not strongly impacted by excluding APOE ε4 allele, we fit an identical model but excluding depressive symptoms and including APOE, and report the full model results in Supplementary Table 3 (see Conscientiousness 2). As the model converged in both cases with four covariates but not five, it is highly likely that the model suffered from numerical problems due to extant parameters. This is not surprising, given that fewer participants (n=1231) completed the conscientiousness scale relative to the neuroticism (n=1710) and extraversion (n=1940) scales, as well as fewer participants with genetic data (n=1663). Interestingly, estimated HRs for the impact of conscientiousness on transitions differed slightly between the two models (see Supplementary Table 3). Specifically, in the model including APOE (and not depressive symptoms), higher conscientiousness was also associated with a decreased risk of transitioning from dementia to death, suggesting that higher conscientiousness may be somewhat protective for individuals diagnosed with dementia, but that baseline depressive symptoms mediate the association. That is, the association between conscientiousness and depressive symptoms may account for shared variability in the model, such that neither uniquely contributes to the transition.

Furthermore, MSM requires no missing data. While we have nearly complete data (over 99.9%) for age, sex, education, and depressive symptoms, only 85% of participants have APOE genetic testing. Missing APOE data may have actually attenuated our findings, as individuals excluded from analyses were significantly higher in conscientiousness and lower in neuroticism. Genotyping was performed using DNA extracted from peripheral blood *or* post-mortem brain tissue. Consistent with our findings, an autopsy report (i.e., which also represents death) may simply be less likely for individuals high in conscientiousness and low in neuroticism (these individuals are still alive).

A primary limitation of the current project was the inability to examine the other two Big Five personality traits, openness to experience and agreeableness, both of which may be associated with cognitive aging processes and mortality. For instance, research suggests that openness is inversely associated with cognitive impairment or decline (Aschwanden et al., 2020; D'lorio et al., 2018; Graham et al., 2021; Nishita et al., 2016; Rouch et al., 2019; Stephan et al., 2021; Williams et al., 2010; Williams et al., 2013) and death (Iwasa et al., 2008; Jackson et al., 2015). Similarly, higher agreeableness may be associated with

cognitive decline (Aschwanden et al., 2020; Stephan et al., 2021; Williams et al., 2010) and mortality (Graham et al., 2017; Jackson et al., 2015). However, additional research suggests that the direction and significance of these associations are less consistent across studies (e.g., Duberstein et al., 2011; Iwasa et al., 2008; Jokela et al., 2013; Martin et al., 2007; Wilson et al., 2004), suggesting less predictive value for cognitive aging processes and mortality compared to conscientiousness, neuroticism, and extraversion. It is possible, however, that the inconsistencies in the literature stem from non-linear associations, or previous research focusing on either cognitive processes *or* mortality, without adjusting for the other as a competing risk.

While the literature would certainly benefit from future research that uses MSM to examine the association between openness and agreeableness on transitions between cognitive status categories and death, the Rush MAP design is ideal for MSM. Consequently, we determined that the strengths outweigh the inability to assess these traits. Specifically, MAP includes comprehensive neuropsychological diagnostic classification, death data from multiple sources, and extensive follow-up until death. Furthermore, MAP includes extensive follow-up assessed annually across a variety of biological (e.g., apolipoprotein ε4 genotype classification) and neuropsychological variables. However, participants included in the sample were mostly female (74%) and Anglo American (86%). Participants were also highly educated, with nearly 15 years of education, on average. Future research conceptually replicating this work in more diverse samples of older adults which include measurement of openness and agreeableness would increase generalizability and may broaden the understanding of the impact of personality traits on healthspan and transitions between cognitive status categories and death.

Conclusions

Previous research suggests that personality traits, particularly low conscientiousness and high neuroticism, are associated with MCI and dementia. Limited research, however, has examined the simultaneous risk of personality traits on MCI and dementia, and to our knowledge, no study has examined the risk of transitioning from MCI to dementia. Further, the existing literature suggests that lower conscientiousness and higher neuroticism are associated with an increased mortality risk. The majority of these studies, however, treat death as a single outcome, without taking the competing risk of MCI or dementia into account. Yet, risk of MCI, dementia, and mortality are dependent outcomes; as such, research accounting for all three outcomes when considering their associations with personality traits has the opportunity to elucidate the timing of when personality traits may be most important in the progression through clinical diagnoses and death in older adulthood. Prior work has examined the association between personality and mortality adjusting for baseline levels of global cognitive functioning or cognitive activities (Wilson et al., 2004; Wilson et al., 2005). In particular, one of these studies reveals the importance of considering cognition, as the association between neuroticism and mortality was reduced by 31% after adjusting for cognitive activity (Wilson et al., 2005).

In contrast to prior work, the current project applies MSM, which is able to estimate the association between personality traits and occasion-specific risk of transitioning to MCI and

dementia, as well as death. In this case, we investigate risk over more than two decades of annual assessments. Our results suggest that conscientiousness and neuroticism are most important in the transition from NCI to MCI. Specifically, higher conscientiousness and lower neuroticism are significantly associated with decreased risk of transitioning from NCI to MCI, but neither is associated with other forward transitions. Further, analyses revealed that higher extraversion is associated with the transition from MCI to NCI, which may reflect the increased social engagement and support characteristic of individuals high in extraversion. Finally, analyses revealed that all three personality traits are associated with non-impaired cognitive healthspan to some degree, particularly for female participants, but that personality traits are not associated with total longevity. Together, these findings provide novel understanding of the simultaneous association between personality traits and transitions between cognitive status categories and death, as well as non-impaired cognitive healthspan and total longevity.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

The research design, hypotheses, and analytic plan for the current study were pre-registered and reported on the Open Science Framework (https://osf.io/uadcm/). The longitudinal data analyzed is drawn from the Rush Memory and Aging Project (MAP; Bennett et al., 2012); researchers may request access to MAP data (www.radc.rush.edu/res/ext/home.htm). These data have been used in prior publications examining personality (e.g., Gaynes et al., 2013), cognition (e.g., Boyle et al., 2013), and mortality (e.g, Stewart et al., 2020). However, this project is the first implementation of multi-state survival modelling to examine the impact of personality traits on clinical diagnoses and death using MAP data, which simultaneously accounts for multiple cognitive states and mortality. Research reported in this publication was financially supported by The Alzheimer Society Research Program, Social Sciences and Humanities Research Council, and the National Institute on Aging of the National Institutes of Health under Award Numbers P01AG043362, R01-AG018436, and R01AG067622. The content is solely the responsibility of the authors and does not necessarily represent the official views of the funding agencies. There are no conflicts of interest to disclose among any of the contributing authors.

References

Aggarwal NT, Wilson RS, Beck TL, Rajan KB, Mendes de Leon CF, Evans DA, & Everson-Rose SA (2014). Perceived stress and change in cognitive function among adults aged 65 and older. Psychosomatic Medicine, 76(1), 80–85. https://dx.doi.org/10.1097%2FPSY.0000000000000016 [PubMed: 24367123]

Applebaum M, Cooper H, Kline RB, Mayo-Wilson E, Nezu AM, & Rao SM (2018). Journal article reporting standards for quantitative research in psychology: The APA publications and communications board task force report. American Psychologist, 73(1), 3–25. 10.1037/amp0000191 [PubMed: 29345484]

Aschwanden D, Strickhouser JE, Luchetti M, Stephan Y, Sutin AR, & Terracciano A (2021). Is personality associated with dementia risk? A meta-analytic investigation. Ageing Research Reviews, 67, 101269. 10.1016/j.arr.2021.101269 [PubMed: 33561581]

Aschwanden D, Sutin AR, Luchetti M, Allemand M, Stephan Y, & Terracciano A (2020). A systematic review and meta-analysis of the association between personality and cognitive failures/complaints. Social and Personality Psychology Compass, 14(11), e12565. 10.1111/spc3.12565 [PubMed: 34326894]

Baker TJ, & Bichsel J (2006). Personality predictors of intelligence: Differences between young and cognitively healthy older adults. Personality and Individual Differences, 41(5), 861–871. 10.1016/j.paid.2006.02.017

Balsis S, Carpenter BD, & Storandt M (2005). Personality change preceded clinical diagnosis of dementia of the Alzheimer Type. Journal of Gerontology: Psychological Sciences, 60(2), P98–P101. 10.1093/geronb/60.2.P98

Banningh LJW, Vernooij-Dassen M, Rikkert MO, & Teunisse JP (2008). Mild cognitive impairment: Coping with an uncertain label. International Journal of Geriatric Psychiatry, 23(2), 148–154. 10.1002/gps.1855 [PubMed: 17578843]

Barańczuk U (2019). The Five Factor Model of personality and social support: A meta-analysis. Journal of Research in Personality, 81, 38–46. 10.1016/j.jrp.2019.05.002

Bennett DA, Schneider JA, Aggarwal NT, Arvanitakis Z, Shah RC, Kelly JF, Fox JH, Cochran EJ, Arends D, Treinkman AD, & Wilson RS (2006). Decision rules guiding the clinical diagnosis of Alzheimer's disease in two community-based cohort studies compared to standard practice in a clinic-based cohort study. Methods in Neuroepidemiology, 27, 169–176. https://doi-org.ezproxy.library.uvic.ca/10.1159/000096129

Bennett D, Schneider J, Buchman A, Barnes L, Boyle P, & Wilson R (2012). Overview and findings from the Rush Memory and Aging Project. Current Alzheimer Research, 9(6), 646–663. 10.2174/156720512801322663 [PubMed: 22471867]

Bennett KM (2002). Low level social engagement as a precursor of mortality among people in later life. Age and Ageing, 31(3), 165–168. 10.1093/ageing/31.3.165 [PubMed: 12006303]

Berg AI, & Johansson B (2013). Personality change in the oldest-old: Is it a matter of compromised health and functioning? Journal of Personality, 82(1) 25–31. 10.1111/jopy.12030 [PubMed: 23336670]

Bin Bae J, Han JW, Kwak KP, Kim BJ, Kim SG, Kim JL, Kim TH, Ryu SH, Moon SW, Park JH, Youn JC, Lee DY, Lee DW, Lee SB, Lee JJ, Jhoo JH, & Kim KW (2018). Impact of mild cognitive impairment on mortality and cause of death in the elderly. Journal of Alzheimer's Disease, 64(2), 607–616. 10.3233/JAD-171182

Bogg T, & Roberts BW (2004). Conscientiousness and health-related behaviors: A meta-analysis of the leading behavioral contributors to mortality. Psychological Bulletin, 130(6), 887–919. 10.1037/0033-2909.130.6.887 [PubMed: 15535742]

Boyle LL, Lyness JM, Duberstein PR, Karuza J, King DA, Messing S, & Tu X (2010). Trait neuroticism, depression, and cognitive function in older primary care patients. American Journal of Geriatric Psychiatry, 18(4), 305–312. 10.1097/JGP.0b013e3181c2941b

Boyle P, Yu L, Wilson R, Schneider J, & Bennett DA (2013). Relation of neuropathology with cognitive decline among older persons without dementia. Frontiers in Aging Neuroscience, 5, 50. 10.3389/fnagi.2013.00050 [PubMed: 24058343]

Brookmeyer R, Johnson E, Ziegler-Graham K, & Arrighi H (2007). Forecasting the global burden of Alzheimer's disease. Alzheimer's & Dementia, 3(3), 186–191. 10.1016/j.jalz.2007.04.381

Bruscoli M, & Lovestone S (2004). Is MCI really just early dementia? A systematic review of conversion studies. International Psychogeriatrics, 16(2), 129–140. 10.1017/S1041610204000092 [PubMed: 15318760]

Chamorro-Premuzic T, & Furnham A (2004). A possible model for understanding the personality-intelligence interface. The British Journal of Psychology, 95(2), 249–264. 10.1348/000712604773952458

Chapman B, Duberstein P, Tindle HA, Sink KM, Robbins J, Tancredi DJ, & Franks P (2012). Personality predicts cognitive function over 7 years in older persons. American Journal of Geriatric Psychiatry, 20(7), 612–621. 10.1097/JGP.0b013e31822cc9cb

Cohrdes C, Mensink GBM, & Hoelling H (2018). How you live is how you feel? Positive associations between different lifestyle factors, cognitive functioning, and health-related quality of life across adulthood. Quality of Life Research, 27(12), 3281–3292. 10.1007/s11136-018-1971-8 [PubMed: 30136071]

Connor-Smith JK, & Flachsbart C (2007). Relations between personality and coping: A meta-analysis. Journal of Personality and Social Psychology, 93(6), 1080–1107. 10.1037/0022-3514.93.6.1080 [PubMed: 18072856]

Contador I, Bermejo-Pareja F, Mitchell AJ, Trincado R, Villarejo A, Sánchez-Ferro Á, & Benito-León J (2014). Cause of death in mild cognitive impairment: A prospective study (NEDICES). European Journal of Neurology, 21(2), 253–259. 10.1111/ene.12278 [PubMed: 24128182]

Costa PT, & McCrae RR (1992a). Four ways five factors are basic. Personality and Individual Differences, 13(6), 653–665. 10.1016/0191-8869(92)90236-I

Costa PT, & McCrae RR (1992b). Revised NEO Personality Inventory (NEO-PIR) and NEO Five Factor Inventory (NEO-FFI) professional manual. Psychological Assessment Resources. http://www.highriskdepression.org/forms/NEO%20Five%20Factor%20Personality%20Inventory.pdf

Crowe M, Andel R, Pedersen NL, Fratiglioni L, & Gatz M (2006). Personality and risk of cognitive impairment 25 years later. Psychology and Aging, 21(3), 573–580. 10.1037/0882-7974.21.3.573 [PubMed: 16953718]

Csernansky JG, Dong HX, Fagan AM, Wang L, Xiong CJ, Holtzman DM, & Morris JC (2006). Plasma cortisol and progression of dementia in subjects with Alzheimer-type dementia. American Journal of Psychiatry, 163(12), 2164–2169. https://doi/full/10.1176/ajp.2006.163.12.2164 [PubMed: 17151169]

Curtis RG, Windsor TD, & Soubelet A (2014). The relationship between Big-5 personality traits and cognitive ability in older adults - A review. Aging, Neuropsychology, and Cognition, 22(1), 42–71. 10.1080/13825585.2014.888392

Dawson DV, Welsh-Bohmer KA, & Siegler IC (2000). Premorbid personality predicts level of rated personality change in patients with Alzheimer Disease. Alzheimer Disease and Associated Disorders, 14(1), 11–19. https://journals-lww-com/alzheimerjournal/Fulltext/2000/01000/Premorbid_Personality_Predicts_Level_of_Rated.2.aspx [PubMed: 10718200]

Dixon RA, & Lachman ME (2019). Risk and protective factors in cognitive aging: Advances in assessment, prevention, and promotion of alternative pathways. In Larkin G. Samanez (Ed.), The aging brain: Functional adaptation across adulthood. American Psychological Association.

D'Iorio A, Garramone F, Piscopo F, Baiano C, Raimo S, & Santangelo G (2018). Meta-analysis of personality traits in Alzheimer's disease: A comparison with healthy subjects. Journal of Alzheimer's Disease, 62(2), 773–787. 10.3233/JAD-170901

Duberstein PR, Chapman BP, Tindle HA, Sink KM, Bamonti P, Robbins J, Jerant AF, & Franks P (2011). Personality and risk for Alzheimer's disease in adults 72 years of age and older: A 6-year follow-up. Psychology and Aging, 26(2), 351–362. 10.1037/a0021377 [PubMed: 20973606]

Eysenck HJ (1967). The biological basis of personality. Charles C. Thomas.

Eysenck HJ & Eysenck MW (1985). Personality and individual differences: A natural science approach. Plenum Press.

Gallacher J, Bayer A, Fish M, Pickering J, Pedro S, Dunstan F, Ebrahim S, & Ben-Shlomo Y (2009). Does anxiety affect risk of dementia? Findings from the Caerphilly Prospective Study. Psychosomatic Medicine, 71(6), 659–666. 10.1097/PSY.0b013e3181a6177c [PubMed: 19553290]

Garcia-Banda G, Chellew K, Fornes J, Perez G, Servera M, & Evans P (2014). Neuroticism and cortisol: Pinning down an expected effect. International Journal of Psychophysiology, 91(2), 132–138. 10.1016/j.ijpsycho.2013.12.005 [PubMed: 24361230]

Gaynes BI, Shah R, Leurgans S, & Bennett D (2013). Neuroticism modifies the association of vision impairment and cognition among community-dwelling older adults. Neuroepidemiology, 40(2), 142–146. 10.1159/000342762 [PubMed: 23221773]

Geerlings MI, Sigurdsson S, Eiriksdottir G, Garcia ME, Harris TB, Gudnason V, & Launer LJ (2015). Salivary cortisol, brain volumes, and cognition in community-dwelling elderly without dementia. Neurology, 85(11), 976–983. https://dx.doi.org10.1212%2FWNL.0000000000001931 [PubMed: 26291281]

Graham EK, James BD, Jackson KL, Willroth EC, Luo J, Beam CR, Pedersen NL, Reynolds CA, Katz M, Lipton RB, Boyle P, Wilson R, Bennett DA, & Mroczek DK (2021). A coordinated analysis of the associations among personality traits, cognitive decline, and dementia in older adulthood. Journal of Research in Personality, 92, 104100. 10.1016/j.jrp.2021.104100 [PubMed: 34083845]

Graham EK, Rutsohn JP, Turiano NA, Bendayan R, Batterham PJ, Gerstorf D, Katz MJ, Reynolds CA, Sharp ES, Yoneda TB, Bastarache ED, Elleman LG, Zelinski EM, Johansson B, Kuh D, Barnes LL, Bennett DA, Deeg DJH, Lipton RB, … Mroczek DK (2017). Personality predicts mortality

risk: An integrative data analysis of 15 international longitudinal studies. Journal of Research in Personality, 70, 174–186. 10.1016/j.jrp.2017.07.005 [PubMed: 29230075]

Graham EK, & Lachman ME (2012). Personality stability is associated with better cognitive performance in adulthood: Are the stable more able? The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences, 67(5), 545–554. 10.1093/geronb/gbr149 [PubMed: 22357641]

Hill PL, & Jackson JJ (2016). The invest-and-accrue model of conscientiousness. Review of General Psychology, 20(2), 141–154. 10.1037/gpr0000065

Hudani ZK, & Rojas-Fernandez CH (2016). A scoping review on medication adherence in older patients with cognitive impairment or dementia. Research in Social and Administrative Pharmacy, 12(6), 815–829. 10.1016/j.sapharm.2015.11.011 [PubMed: 26797263]

Hwang TJ, Masterman DL, Ortiz F, Fairbanks LA, & Cummings JL (2004). Mild cognitive impairment is associated with characteristic neuropsychiatric symptoms. Alzheimer Disease & Associated Disorders, 18(1), 17–21. https://journals.lww.com/alzheimerjournal/Fulltext/2004/01000/Mild_Cognitive_Impairment_is_Associated_With.00004.aspx [PubMed: 15195459]

Iwasa H, Masui Y, Gondo Y, Inagaki H, Kawaai C, & Suzuki T (2008). Personality and all-cause mortality among older adults dwelling in a Japanese community: A five-year population-based prospective cohort study. The American Journal of Geriatric Psychiatry, 16(5), 399–405. 10.1097/JGP.0b013e3181662ac9 [PubMed: 18403571]

Jackson C (2011). Multi-state models for panel data: The msm package for R. Journal of Statistical Software, 38(8), 1–28. 10.18637/jss.v038.i08

Jackson J, Balota DA, & Head D (2011). Exploring the relationship between personality and regional brain volume in healthy aging. Neurobiology of Aging, 32(12), 2162–2171. 10.1016/j.neurobiolaging.2009.12.009 [PubMed: 20036035]

Jackson JJ, Connolly JJ, Garrison SM, Leveille MM, & Connolly SL (2015). Your friends know how long you will live: A 75-year study of peer-rated personality traits. Psychological Science, 26(3), 335–340. 10.1177/0956797614561800 [PubMed: 25583945]

James BD, Wilson RS, Barnes LL, & Bennett DA (2011). Late-life social activity and cognitive decline in old age. Journal of the International Neuropsychological Society, 17(6), 998–1005. 10.1017/S1355617711000531 [PubMed: 22040898]

Jenkins A, Tree J, & Tales A (2021). Distinct profile differences in subjective cognitive decline in the general public are associated with metacognition, negative affective symptoms, neuroticism, stress, and poor quality of life. Journal of Alzheimer's Disease, 80(3), 1231–1242. 10.3233/JAD-200882

Johansson L, Guo X, Duberstein PR, Hällström T, Waern M, Östling S, & Skoog I (2014). Midlife personality and risk of Alzheimer disease and distress: A 38-year follow-up. Neurology, 83(17), 1538–1544. 10.1212/WNL.0000000000000907 [PubMed: 25274849]

Jokela M, Batty GD, Nyberg ST, Virtanen M, Nabi H, Singh-Manoux A, & Kivimaeki M (2013). Personality and all-cause mortality: Individual-participant meta-analysis of 3,947 deaths in 76,150 adults. American Journal of Epidemiology, 178(5), 667–675. 10.1093/aje/kwt170 [PubMed: 23911610]

Kaduszkiewicz H, Eisele M, Wiese B, Prokein J, Luppa M, Luck T, Jessen F, Bickel H, Mösch E, Pentzek M, Fuchs A, Eifflaender-Gorfer S, Weyerer S, König H-H, Brettschneider C, van de Bussche H, Maier W, Scherer M, & Riedel-Heller SG (2014). Prognosis of mild cognitive impairment in general practice: Results of the German AgeCoDe study. The Annals of Family Medicine, 12(2), 158–165. https://dx.doi.org/10.1370%2Fafm.1596 [PubMed: 24615312]

Karlamangla AS, Miller-Martinez D, Lachman ME, Tun PA, Koretz BK, & Seeman TE (2014). Biological correlates of adult cognition: Midlife in the United States (MIDUS). Neurobiology of Aging, 35(2), 387–394. 10.1016/j.neurobiolaging.2013.07.028 [PubMed: 24011541]

Kaup AR, Harmell AL, & Yaffe K (2019). Conscientiousness is associated with lower risk of dementia among Black and White older adults. Neuroepidemiology, 52(1–2), 86–92. 10.1159/000492821 [PubMed: 30602170]

Kazmierski KFM, Gillespie ML, Kuo S, Zurita T, Felix D, & Rao U (2021). Stress-induced eating among racial/ethnic groups in the United States: A systematic review. Journal of Racial and Ethnic Health Disparities, 8, 912–926. 10.1007/s40615-020-00849-w [PubMed: 32839895]

Kelly ME, Duff H, Kelly S, Power JEM, Brennan S, Lawlor BA, & Loughrey DG (2017). The impact of social activities, social networks, social support and social relationships on the cognitive functioning of healthy older adults: A systematic review. Systematic Reviews, 6(1), 259–259. 10.1186/s13643-017-0632-2 [PubMed: 29258596]

Kern ML, & Friedman HS (2008). Do conscientious individuals live longer? A quantitative review. Health Psychology, 27(5), 505–512. 10.1037/0278-6133.27.5.505 [PubMed: 18823176]

Keyes CLM (2013). Mental well-being: International contributions to the study of positive mental health. Springer. 10.1007/978-94-007-5195-8

Klaming R, Veltman DJ, & Comijs HC (2017). The impact of personality on memory function in older adults-results from the Longitudinal Aging Study Amsterdam: Impact of personality on memory in older adults. International Journal of Geriatric Psychiatry, 32(7), 798–804. 10.1002/gps.4527 [PubMed: 27329835]

Koepsell TD, & Monsell SE (2012). Reversion from mild cognitive impairment to normal or near-normal cognition: Risk factors and prognosis. Neurology, 79(15), 1591–1598. 10.1212/WNL.0b013e31826e26b7 [PubMed: 23019264]

Lloyd SL, & Striley CW (2018). Marijuana use among adults 50 years or older in the 21st century. Gerontology and Geriatric Medicine, 4, 1–14. 10.1177/2333721418781668

Luchetti M, Terracciano A, Stephan Y, & Sutin AR (2016). Personality and cognitive decline in older adults: Data from a longitudinal sample and meta-analysis. The Journals of Gerontology. Series B: Psychological Sciences and Social Sciences, 71(4), 591–601. 10.1093/geronb/gbu184 [PubMed: 25583598]

Lykou E, Rankin KP, Chatziantoniou L, Boulas C, Papatriantafyllou O, Tsaousis I, Neuhaus J, Karageorgiou C, Miller BL, & Papatriantafyllou JD (2013). Big 5 personality changes in Greek bvFTD, AD, and MCI patients. Alzheimer Disease and Associated Disorders, 27(3), 258–264. https://dx.doi.org/10.1097%2FWAD.0b013e31826e5504 [PubMed: 23060360]

Mahoney CJ, Rohrer JD, Omar R, Rossor MN, & Warren JD (2011). Neuroanatomical profiles of personality change in frontotemporal lobar degeneration. The British Journal of Psychiatry, 198(5), 365–372. 10.1192/bjp.bp.110.082677 [PubMed: 21372059]

Martin LR, Friedman HS, & Schwartz JE (2007). Personality and mortality risk across the life span: The importance of conscientiousness as a biopsychosocial attribute. Health Psychology, 26(4), 428–436. 10.1037/0278-6133.26.4.428 [PubMed: 17605562]

Martin LR, & Friedman HS (2000). Comparing personality scales across time: An illustrative study of validity and consistency in life-span archival data. Journal of Personality, 68, 85–110. 10.1111/1467-6494.00092 [PubMed: 10820682]

McCrae RR, & Costa PT (2004). A contemplated revision of the NEO Five-Factor Inventory. Personality and Individual Differences, 36(3), 587–596. 10.1016/S0191-8869(03)00118-1

Meier B, Perrig-Chiello P, & Perrig W (2002). Personality and memory in old age. Aging, Neuropsychology, and Cognition, 9(2), 135–144. 10.1076/anec.9.2.135.9544

Mendez Rubio M, Antonietti JP, Donati A, Rossier J, & von Gunten A (2013). Personality traits and behavioural and psychological symptoms in patients with mild cognitive impairment. Dementia and Geriatric Cognitive Disorders, 35(1–2), 87–97. 10.1159/000346129 [PubMed: 23364170]

Mroczek DK, & Almeida DM (2004). The effect of daily stress, personality, and age on daily negative affect. Journal of Personality, 72(2), 355–378. 10.1111/j.0022-3506.2004.00265.x [PubMed: 15016068]

Mroczek DK, & Spiro A (2003). Modeling intraindividual change in personality traits: Findings from the normative aging study. Journal of Gerontology, 58(3), P153–P165. 10.1093/geronb/58.3.P153

Neuvonen E, Hall A, Tolppanen A, Ngandu T, Rusanen M, Laatikainen T, Soininen H, Kivipelto M, & Solomon A (2020). Late-life personality traits, cognitive impairment, and mortality in a population-based cohort. International Journal of Geriatric Psychiatry, 35(9), 989–999. 10.1002/gps.5321 [PubMed: 32363652]

Nishita Y, Tange C, Tomida M, Otsuka R, Ando F, & Shimokata H (2016). Personality and global cognitive decline in Japanese community-dwelling elderly people: A 10-year longitudinal study. Journal of Psychosomatic Research, 91, 20–25. 10.1016/j.jpsychores.2016.10.004 [PubMed: 27894458]

Ouanes S, & Popp J (2019). High cortisol and the risk of dementia and Alzheimer's disease: A review of the literature. Frontiers in Aging Neuroscience, 11, 43. 10.3389/fnagi.2019.00043 [PubMed: 30881301]

R Core Team (2020). "Holding the windsock" (Version 3.6.3). The R Foundation for Statistical Computing.

Radloff LS (1977). The CES-D scale: A self-report depression scale for research in the general population. Applied Psychological Measurement, 1(3), 385–401. 10.1177/014662167700100306

Rajan KB, Aggarwal NT, Wilson RS, Everson-Rose SA, & Evans DA (2014). Association of cognitive functioning, incident stroke, and mortality in older adults. Stroke, 45(9), 2563–2567. 10.1161/STROKEAHA.114.005143 [PubMed: 25104848]

Rouch I, Padovan C, Pongan E, Boublay N, Laurent B, Dorey JM, & Krolak-Salmon P (2019). Personality traits are related to selective cognitive impairment in early Alzheimer's disease. Journal of Alzheimer's Disease, 71(4), 1153–1162. 10.3233/JAD-190459

Sachdev PS, Lipnicki DM, Crawford J, Reppermund S, Kochan NA, Trollor JN, Wen W, Draper B, Slavin MJ, Kang K, Lux O, Mather KA, Brodaty H, & Team AS (2013). Factors predicting reversion from mild cognitive impairment to normal cognitive functioning: A population-based study. PLoS ONE, 8(3). 10.1371/journal.pone.0059649

Schupf N, Tang M, Albert S, Costa R, Andrews H, Lee J, & Mayeux R (2005). Decline in cognitive and functional skills increases mortality risk in nondemented elderly. Neurology, 65(8), 1218–1226. 10.1212/01.wnl.0000180970.07386.cb [PubMed: 16247048]

Siegler IC, Dawson DV, & Welsh KA (1994). Caregiver ratings of personality change in Alzheimer's disease Patients: A replication. Psychology and Aging, 9(3), 464–466. 10.1037/0882-7974.9.3.464 [PubMed: 7999331]

Small BJ, Hertzog C, Hultsch DF, & Dixon RA (2003). Stability and change in adult personality over 6 years: Findings from the Victoria Longitudinal Study. Journal of Gerontology: Psychological Sciences, 58(3), P166–P176. 10.1093/geronb/58.3.P166

Smith-Gamble V, Baiyewu O, Perkins AJ, Gureje O, Hall KS, Ogunniyi A, Hui S, & Hendrie HC (2002). Informant reports of changes in personality predict dementia in a population-based study of elderly African Americans and Yoruba. The American Journal of Geriatric Psychiatry, 10(6), 724–732. 10.1097/00019442-200211000-00011 [PubMed: 12427581]

Song D, Yu DSF, Li PWC, & Sun Q (2019). Identifying the factors related to depressive symptoms amongst community-dwelling older adults with mild cognitive impairment. International Journal of Environmental Research and Public Health, 16(18), 3449. 10.3390/ijerph16183449 [PubMed: 31533269]

Soubelet A, & Salthouse TA (2011). Personality-cognition relations across adulthood. Developmental Psychology, 47(2), 303–310. 10.1037/a0021816 [PubMed: 21142358]

Stephan Y, Sutin AR, Luchetti M, & Terracciano A (2021). Memory and personality development in adulthood: Evidence from four longitudinal studies. The Journals of Gerontology. Series B: Psychological Sciences and Social Sciences, 76(1), 88–97. 10.1093/geronb/gbaa086 [PubMed: 32896862]

Stephan Y, Sutin AR, Luchetti M, & Terracciano A (2016). Allostatic load and personality: A 4-year longitudinal study. Psychosomatic Medicine, 78(3), 302–310. 10.1097/PSY.0000000000000281 [PubMed: 26716813]

Stern Y (2012). Cognitive reserve in ageing and Alzheimer's disease. Lancet Neurology, 11(11), 1006–1012. 10.1016/S1474-4422(12)70191-6 [PubMed: 23079557]

Stewart CC, Yu L, Lamar M, Wilson RS, Bennett DA, & Boyle PA (2020). Associations of health and financial literacy with mortality in advanced age. Aging Clinical and Experimental Research, 32(5), 951–957. 10.1007/s40520-019-01259-7 [PubMed: 31273677]

Taniguchi Y, Kitamura A, Ishizaki T, Fujiwara Y, Shinozaki T, Seino S, Mitsutake S, Suzuki H, Yokoyama Y, Abe T, Ikeuchi T, Yokota I, Matsuyama Y, & Shinkai S (2019). Association of trajectories of cognitive function with cause-specific mortality and medical and long-term care costs. Geriatrics & Gerontology International, 19(12), 1236–1242. 10.1111/ggi.13802 [PubMed: 31746115]

Tatomir A, Micu C, & Crivii C (2014). The impact of stress and glucocorticoids on memory. Clujul Medical, 87(1), 3. https://dx.doi.org/10.15386%2Fcjm.2014.8872.871.at1cm2 [PubMed: 26527987]

Terracciano A, Costa PT, & McCrae RR (2006). Personality plasticity after age 30. Personality & Social Psychology Bulletin, 32(8), 999–1009. 10.1177/0146167206288599 [PubMed: 16861305]

Terracciano A, Sutin AR, An Y, O'Brien R, Ferrucci L, Zonderman AB, & Resnick SM (2014). Personality and risk of Alzheimer's disease: New data and meta-analysis. Alzheimer's & Dementia, 10, 179–186. 10.1016/j.jalz.2013.03.002

Thomas PA (2012). Trajectories of social engagement and mortality in late life. Journal of Aging and Health, 24(4), 547–568. 10.1177/0898264311432310 [PubMed: 22219207]

van den Hout A (2016). Multi-state survival models for interval-censored data. CRC Press.

van den Hout A, Sum Chan M, & Matthews F (2019). Estimation of life expectancies using continuous-time multi-state models. Computer Methods and Programs in Biomedicine, 178, 11–18. 10.1016/j.cmpb.2019.06.004 [PubMed: 31416539]

Virzi N, Rouse SV, & Miller-Perrin C (2018). The relationship between extraversion and listening comprehension under high- and low-salience visual distraction conditions. Psi Chi Journal of Psychological Research, 23(3), 209–218. 10.24839/2325-7342.JN23.3.209

Visser PJ, Kester A, Jolles J, & Verhey F (2006). Ten-year risk of dementia in subjects with mild cognitive impairment. Neurology, 67(7), 1201–1207. 10.1212/01.wnl.0000238517.59286.c5 [PubMed: 17030753]

Weeks P, Hayley A, & Stough C (2019). Do individual differences in state and trait anxiety predict sleep difficulties in healthy older adults? Personality and Individual Differences, 144, 141–146. 10.1016/j.paid.2019.03.004

Welstead M, Luciano M, Muniz-Terrera G, Saunders S, Mullin DS, & Russ TC (2021). Predictors of mild cognitive impairment stability, progression, or reversion in the Lothian birth cohort 1936. Journal of Alzheimer's Disease, 80(1), 225–232. 10.3233/JAD-201282

Williams PG, Suchy Y, & Kraybill ML (2013). Preliminary evidence for low openness to experience as a pre-clinical marker of incipient cognitive decline in older adults. Journal of Research in Personality, 47(6), 945–951. 10.1016/j.jrp.2013.09.006

Williams PG, Suchy Y, & Kraybill ML (2010). Five-factor model personality traits and executive functioning among older adults. Journal of Research in Personality, 44(4), 485–491. 10.1016/j.jrp.2010.06.002

Wilson RS, Begeny CT, Boyle PA, Scheider JA, & Bennett DA (2011). Vulnerability to stress, anxiety, and development of dementia in old age. The American Journal of Geriatric Psychiatry, 19(4), 327–334. 10.1097/JGP.0b013e31820119da [PubMed: 21427641]

Wilson RS, Boyle PA, Yu L, Segawa E, Sytsma J, & Bennett DA (2015). Conscientiousness, dementia related pathology, and trajectories of cognitive aging. Psychology and Aging, 30(1), 74–82. 10.1037/pag0000013 [PubMed: 25664558]

Wilson RS, de Leon C, Bienias J, Evans D, & Bennett D (2004). Personality and mortality in old age. The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences, 59(3), P110–P116. 10.1093/geronb/59.3.P110 [PubMed: 15118013]

Wilson RS, Krueger K, Gu L, Bienias J, De Leon C, & Evans D (2005). Neuroticism, extraversion, and mortality in a defined population of older persons. Psychosomatic Medicine, 67(6), 841–845. 10.1097/01.psy.0000190615.20656.83 [PubMed: 16314587]

Wilson RS, Li Y, Aggarwal NT, McCann JJ, Gilley DW, Bienias JL, Barnes LL, & Evans DA (2006). Cognitive decline and survival in Alzheimer's disease. International Journal of Geriatric Psychiatry, 21(4), 356–362. 10.1002/gps.1472 [PubMed: 16534773]

World Bank Group (2021). World development indicators. The World Bank. https://datatopics.worldbank.org/world-development-indicators/

Yoneda T, Rush J, Berg AI, Johansson B, & Piccinin AM (2017). Trajectories of personality traits preceding dementia diagnosis. The Journals of Gerontology. Series B: Psychological Sciences and Social Sciences, 72(6), 922–931. 10.1093/geronb/gbw006 [PubMed: 26945005]

Yoneda T, Rush J, Graham EK, Berg AI, Comijs H, Katz M, Lipton RB, Johansson B, Mroczek DK, & Piccinin AM (2020). Increases in neuroticism may be an early indicator of dementia: A

coordinated analysis. The Journals of Gerontology. Series B: Psychological Sciences and Social Sciences, 75(2), 251–262. 10.1093/geronb/gby034 [PubMed: 29608748]

Yu L, Boyle PA, Leurgans SE, Wilson RS, Bennett DA, & Buchman AS (2019). Incident mobility disability, mild cognitive impairment, and mortality in community-dwelling older adults. Neuroepidemiology, 53(1–2), 55–62. 10.1159/000499334 [PubMed: 30986783]

Zissimopoulos J, Crimmins E, & St. Clair P (2015). The value of delaying Alzheimer's disease onset. Forum for Health Economics and Policy, 18(1), 25–39. 10.1515/fhep-2014-0013

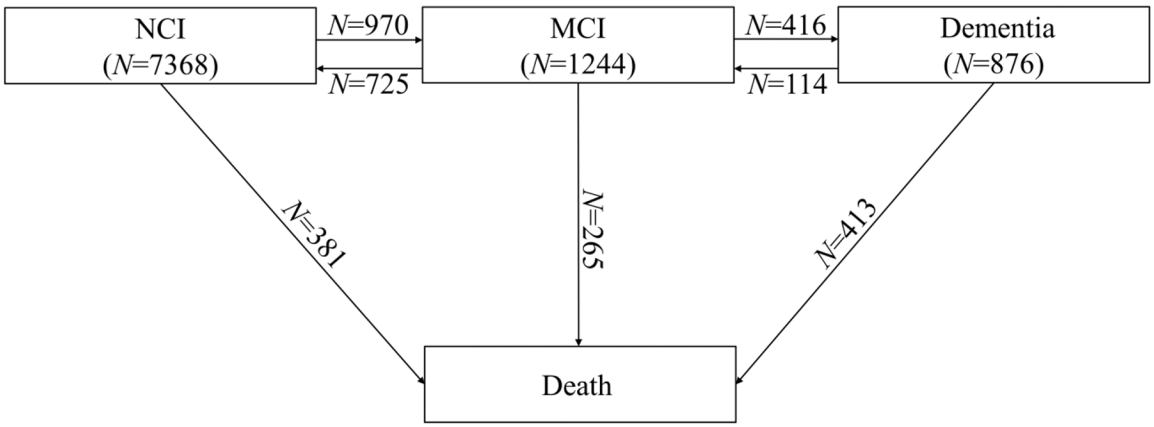

Figure 1.

Number of Transitions between Cognitive Status Categories and Death in the Four-State Model

Note. Values represent the individual number of transitions between states (e.g., NCI to NCI=7368; NCI to MCI=970). NCI=no cognitive impairment; MCI=mild cognitive impairment.

Table 1

Characteristics of the Rush Memory and Aging Project Study Participants

Variable	*N*	Mean (*SD*)	Range or %
Baseline age	1954	79.93 (7.57)	53.35–100.47
Education in years	1954	14.93 (3.32)	0.00–30.00
Sex			
Female	1441		73.70
Male	513		26.30
Race			
White	1696		86.80
Black or African American	105		5.40
Other	18		1.00
Baseline depressive symptoms	1951	1.13 (1.66)	0.00–9.00
APOE			
ε4 carrier	392		20.10
ε4 non-carrier	1271		65.00
Chronic Conditions	1952	1.53 (1.16)	0.00–7.00
Personality traits			
Conscientiousness	1231	33.77 (5.89)	6.00–48.00
Neuroticism	1710	15.20 (7.07)	0.00–45.00
Extraversion	1940	15.86 (3.05)	5.00–24.00
Cognitive status categories at baseline			
NCI	1386		70.90
MCI	486		24.90
Dementia	82		4.20
Age at death	1059	90.13 (6.44)	65.91–108.26
Total number of states	1954	7.61 (4.51)	2.00–24.00

Note. Raw personality scores are reported, though SDs were used within the analyses; Other race=Indigenous, Alaska Native, Other; APOE ε4=apolipoprotein ε4 genotype; NCI=no cognitive impairment; MCI=mild cognitive impairment; states refers to cognitive status categories and death.

Table 2

Hazard Ratio and 95% Confidence Intervals for the Effect of Each Personality Trait on Transitions between Cognitive Status Categories and Death

Transition	Conscientiousness	Neuroticism	Extraversion
	Hazard Ratio (95% CI)		
NCI—MCI	0.78 (0.72, 0.85) *	1.12 (1.04, 1.21) *	0.97 (0.91, 1.04)
NCI—Death	1.16 (0.94, 1.45)	0.89 (0.74, 1.06)	0.88 (0.75, 1.03)
MCI—NCI	1.01 (0.91, 1.11)	0.90 (0.81, 1.00) *	1.12 (1.03, 1.22) *
NCI—Dementia	0.96 (0.85, 1.09)	1.12 (1.00, 1.26)	0.97 (0.88, 1.06)
MCI—Death	0.72 (0.50, 1.03)	0.99 (0.70, 1.41)	0.83 (0.63, 1.09)
Dementia—MCI	1.01 (0.79, 1.29)	1.19 (0.92, 1.53)	0.83 (0.68, 0.99) *
Dementia—Death	0.89 (0.76, 1.03)	0.94 (0.82, 1.07)	1.13 (1.02, 1.25) *

Note. Analyses adjust for age, sex, education, depressive symptoms, and APOE ε4 allele, except for the Conscientiousness model, which adjusts for age, sex, education, and depressive symptoms; NCI=no cognitive impairment; MCI=mild cognitive impairment; *$p \leq .05$; CI values=1.00, with *, were significant prior to rounding; CI values=1.00, without *, were non-significant prior to rounding.

Table 3

Estimates of Life Expectancies in Years for Female and Male Participants at 80 Years Old With Mean Years of Education, No Depressive Symptoms, No APOE ε4 Allele, and Standard Deviations of Personality Traits

	Life expectancies in years (95% CIs)			
	Non-impaired cognitive healthspan		Total estimated life expectancy	
	80 year old female	80 year old male	80 year old female	80 year old male
Conscientiousness				
−1SD	7.73 (6.97, 8.07)	6.95 (6.21, 7.61)	12.15 (11.34, 12.86)	10.84 (9.88, 11.63)
Mean	8.69 (8.17, 9.02)	7.84 (7.19, 8.55)	12.95 (12.24, 13.59)	11.57 (10.78, 12.39)
+1SD	9.51 (8.77, 10.22)	8.57 (7.80, 9.68)	13.49 (12.64, 14.30)	12.04 (11.02, 13.17)
Neuroticism				
−1SD	8.28 (7.78, 8.85)	7.00 (6.33, 7.77)	11.88 (11.21, 12.63)	10.31 (9.57, 11.27)
Mean	7.78 (7.41, 8.25)	6.58 (5.99, 7.17)	11.85 (11.21, 12.49)	10.30 (9.49, 11.05)
+1SD	7.22 (6.61, 7.71)	6.12 (5.31, 6.72)	11.77 (10.88, 12.40)	10.25 (9.18, 11.14)
Extraversion				
−1SD	7.03 (6.57, 7.51)	5.74 (5.11, 6.33)	11.24 (10.55, 11.95)	9.18 (8.38, 10.03)
Mean	7.56 (7.21, 8.01)	6.20 (5.71, 6.74)	11.63 (11.06, 12.25)	9.56 (8.90, 10.21)
+1SD	8.12 (7.52, 8.58)	6.68 (6.01, 7.26)	12.03 (11.24, 12.57)	9.94 (9.16, 10.65)

Note. *SD*=standard deviation; CI=confidence interval.