# Personality nuances and risk of dementia

Evidence from two longitudinal studies

RUNNING HEAD: PERSONALITY NUANCES AND DEMENTIA

# Personality Nuances and Risk of Dementia:

# Evidence from Two Longitudinal Studies

Yannick Stephan[1]*, PhD, Angelina R. Sutin[2], PhD, René Mõttus[3,4], PhD, Martina Luchetti[2], PhD, Damaris Aschwanden[5,6], PhD, & Antonio Terracciano[6], PhD

[1] Euromov, Univ. Montpellier, Montpellier, FRANCE

[2] Department of Behavioral Sciences and Social Medicine, College of Medicine, Florida State University, USA

[3]Department of Psychology, University of Edinburg, Scotland

[4]Institute of Psychology, University of Tartu, Estonia

[5]Center for the Interdisciplinary Study of Gerontology and Vulnerability, University of Geneva, Switzerland

[6] Department of Geriatrics, College of Medicine, Florida State University, USA

Word count text: 4485 words

* Correspondence concerning this article should be addressed to Yannick Stephan, Euromov, University of Montpellier, UFRSTAPS, 700, Avenue du Pic St Loup, 34090 Montpellier, France. E-mail: yannick.stephan@umontpellier.fr

**Declaration of Competing Interest**

None.

**Acknowledgments**

The Health and Retirement Study (HRS) is sponsored by the National Institute on Aging (NIA-U01AG009740) and conducted by the University of Michigan. HRS data are available at https://hrs.isr.umich.edu/data-products. Funding for ELSA is provided by the National Institute of Aging (grants 2RO1AG7644-01A1 and 2RO1AG017644) and a consortium of UK

government departments coordinated by the Office for National Statistics. ELSA data are publicly available from the UK Data Service (UKDS, https://www.ukdataservice.ac.uk/).

**Financial Support**

The research reported in this publication was supported in part by the National Institute on Aging of the National Institutes of Health (grant numbers R01AG068093 and R01AG053297). The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

**Author Contributions**

Yannick Stephan: Conceptualization, Methodology, formal analysis, writing – original draft, Writing-review & editing, visualization, supervision, project administration; Angelina R Sutin: Conceptualization, Methodology, writing –review & editing, visualization; René Mõttus: conceptualization, methodology, Writing-review & editing; Martina Luchetti: Methodology, writing –review & editing, visualization; Damaris Aschwanden: writing –review & editing, visualization; Antonio Terracciano: Conceptualization, Methodology, formal analysis, writing – original draft, Writing-review & editing, visualization, supervision

Abstract

Personality traits are broad constructs composed of nuances, operationalized by personality items, that can provide a more granular understanding of personality associations with health outcomes. This study examined the associations between personality nuances and incident dementia and evaluated whether nuances associations replicate across two samples. Health and Retirement Study (HRS, N = 11,400) participants were assessed in 2006/2008, and the English Longitudinal Study of Ageing (ELSA, N = 7,453) participants were assessed in 2010/2011 on personality and covariates. Dementia incidence was tracked for 14 years in the HRS and 8 years in ELSA. In both HRS and ELSA, higher neuroticism domain and nuances (particularly nervous and worry) were related to a higher risk of incident dementia, whereas higher conscientiousness domain and nuances (particularly responsibility and organization) were associated with a lower risk of dementia. To a lesser extent, higher extraversion (active), openness (broad-minded, curious, and imaginative), and agreeableness (helpful, warm, caring, and sympathetic) nuances were associated with a lower risk of dementia, with replicable effects across the two samples. A poly-nuance score, aggregating the effects of personality items, was associated with an increased risk of incident dementia in the HRS and ELSA, with effect sizes slightly stronger than those of the personality domains. Clinical, behavioral, psychological, and genetic covariates partially accounted for these associations. The present study provides novel and replicable evidence for specific personality characteristics associated with the risk of incident dementia.

Keywords: Personality, dementia, nuances, aging

## 1. Introduction

The number of individuals worldwide living with dementia is expected to triple from the current 50 million to more than 150 million by 2050 (Nichols et al., 2022). Evidence has accumulated in the last two decades for the role of personality traits, which are relatively enduring patterns of thoughts, feelings, and behaviors, in incident dementia risk (Aschwanden et al., 2021; Chapman et al., 2020; Graham et al., 2021; Terracciano et al., 2014, 2017, 2021; Wilson et al., 2007). The Five Factor Model (FFM; McCrae & John, 1992) organizes personality traits into five broad domains (or factors): neuroticism (the tendency to experience distress and negative emotions), extraversion (the tendency to experience positive emotions and to be energetic), openness (the tendency to be curious and unconventional), agreeableness (the tendency to be cooperative and trusting), and conscientiousness (the tendency to be responsible and organized). A recent meta-analysis revealed that higher neuroticism and lower conscientiousness are consistent predictors of higher dementia risk, across dementia types, including Alzheimer's disease (AD), dementia assessment methods, follow-up lengths, and countries (Aschwanden et al., 2021). Likewise, another recent meta-analysis indicated that higher neuroticism and lower conscientiousness increased the vulnerability to AD tau and amyloid neuropathology (Terracciano et al., 2022). There is less robust evidence that higher extraversion, higher openness, and higher agreeableness protect against dementia risk (Aschwanden et al., 2021). This previous research has focused primarily on the five broad domains of personality. The present study extends these findings by examining the contributions of their constituent lower-order traits to incident dementia.

Personality traits are organized hierarchically, with broad FFM domains composed of narrower traits, called facets. A focus on narrower traits could provide a clearer picture of the specific personality characteristics driving the association at the domain level (Mõttus et al., 2017; Seeboth & Mõttus, 2018; Stewart et al., 2022; Vainik et al., 2019). And, indeed, there is

some evidence for associations between more specific facets of personality and dementia risk. For example, the self-discipline, industriousness, and responsibility facets of conscientiousness have been found to be protective against dementia (Sutin et al., 2018), the depression, anxiety, and angry-hostility facets of neuroticism have been associated with a higher risk of AD (Terracciano et al., 2014; Wilson et al., 2011), and the ideas facet of openness and the warmth facet of extraversion have been related to lower risk of cognitive impairment (Terracciano et al., 2022). Facets often have more predictive power than their corresponding domain for various outcomes (Vainik et al., 2019), but there is no support yet for this hypothesis with regard to cognitive impairment (Terracciano et al., 2022).

Facets are not the lowest level of the personality hierarchy because they can be split into more specific, narrower personality characteristics called nuances that are usually operationalized by individual questionnaire items (McCrae, 2015; Mõttus et al., 2017, 2019). Nuances are unique units of personality assessment, displaying trait-like properties of cross-rater agreement, rank-order stability, and heritability (Mõttus et al., 2017, 2019). While much existing research has focused on the five broad domains, many specific nuances are likely to drive their associations with complex outcomes and therefore provide additional information about them (Seeboth & Mõttus, 2018; Stewart et al., 2022). Indeed, nuances have been found to predict health outcomes more accurately than domains (Mõttus et al., 2017; Seeboth & Mõttus, 2018; Stewart et al., 2022). However, the vast majority of research on incident dementia has focused on either personality domains or facets, and no research has yet examined the possible contribution of personality nuances.

Based on two large longitudinal samples of older adults from the United States (US) and England, the present study examined the association between personality nuances and incident dementia. These two samples were included to test the generalizability and replicability of the association between personality nuances and dementia across samples that differ in

measurement of dementia, follow-up interval, and cultural and socioeconomic characteristics. Building upon existing research (McCrae, 2015; Mõttus et al., 2017, 2019), nuances were operationalized by individual personality questionnaire items. Personality measures were harmonized across the two samples, which facilitates evaluating the replicability of the association between nuances and dementia. In line with findings for the broad FFM domains (Aschwanden et al., 2021), it was expected that items assessing higher neuroticism and lower conscientiousness would be associated with a higher risk of incident dementia, but that some specific items may drive these associations and hence reveal their finer-grained details. However, no a priori hypotheses were formulated for the specific items. Similar to polygenic scores that estimate the effects of multiple genetic variants on outcomes (Plomin & Von Stumm, 2018), this study also examined poly-item scores that aggregated the effects of personality items and risk of incident dementia in the two samples. In line with existing research (Seeboth & Mõttus, 2018; Stewart et al., 2022), these poly-item scores were hypothesized to have stronger predictive power than personality domains for incident dementia. Additional analyses were conducted to test whether clinical, behavioral, psychological and genetic risk factors for dementia accounted for the association between personality nuances and incident dementia. For comparison, the association between the five broad domains and incident dementia was also examined in the two samples.

## 2. Method

### 2.1. Participants

Data were from the Health and Retirement Study (HRS) and the English Longitudinal Study of Ageing (ELSA). The HRS was approved by the University of Michigan Institutional Review Board (IRB), and the National Research Ethics Service approved ELSA. These studies were conducted in accordance with the Declaration of Helsinki and all participants provided written informed consent. Given that these datasets are publicly available de-identified data,

the present study was exempt from local Institutional Review Board (IRB). The descriptive statistics for the two samples are in Table 1.

The HRS is a nationally representative longitudinal study of Americans aged 50 and older and their spouses/partners. Personality was first assessed in 2006 for half the sample and in 2008 for the other half. With both waves combined, the baseline sample had 12,656 participants with complete data on personality, demographic factors, and cognitive status. Follow-up data on cognitive status were collected every two years up to the 2020 wave. Of the baseline sample, 11,746 participants had data on cognitive status at follow-up. With participants with dementia at baseline excluded (N= 346), the final analyzed sample was 11,400 participants aged 50 to 99 years (59% women, Mean age= 67.83, SD= 9.50). HRS data are publicly available at https://hrs.isr.umich.edu/data-products.

ELSA is a nationally representative longitudinal cohort of people aged 50 years and over living in England. Complete baseline data on personality, demographic, and cognitive status were obtained from 8,114 participants at wave 5 (2010/2011). Follow-up data on cognitive status were collected every two years up to Wave 9 (2018/2019). A total of 7,501 participants from the baseline sample had follow-up cognitive data. Of this sample, 48 individuals were excluded because they had dementia at baseline. The final analyzed sample was 7,453 participants aged 50 to 89 years (56% women, Mean age= 65.86, SD= 8.53). ELSA data are publicly available at: https://www.ukdataservice.ac.uk/.

### 2.2.Personality

The 26-item Midlife Development Inventory (MIDI) (Zimprich et al., 2012) was used to measure personality in both HRS and ELSA. Four items assessed neuroticism, five items measured extraversion, agreeableness and conscientiousness, and openness was assessed by seven items. Example items are moody (neuroticism), active (extraversion), broad-minded (openness), warm (agreeableness), and responsible (conscientiousness). Participants indicated

how well each item described them on a scale from 1 (*not at all*) to 4 (*a lot*). A complete list of items and descriptive statistics for each item in the two samples are in supplementary materials.

2.3.Dementia

In the HRS, cognitive status was assessed using the modified Telephone Interview for Cognitive Status (TICSm) (Crimmins et al., 2011). A 27-point TICSm score was obtained by summing participants' performances on three tasks: immediate and delayed recall of 10 words (0-20 points), serial 7 subtraction (0-5 points), and backward counting (0-2 points). Participants with scores ≤ 6 were classified as having dementia (Crimmins et al., 2011). ELSA has developed a classification system of dementia cases based on a combination of self-report physician diagnosis of Alzheimer's disease or dementia and/or higher scores on the shortened version of the Informant Questionnaire on Cognitive Decline in the Elderly (IQCODE, Jorm, 1994) (Almeida-Meza et al., 2020; Cadar et al., 2018; Hackett et al., 2018). The IQCODE was used when eligible participants were unable to answer directly, and asked informants to rate the participants' current functioning compared with 10 years ago using a scale ranging from 1 (*much improved*) to 5 (*much worse*). Answers were averaged across the 16 items, with higher scores indicating greater informant-reported decline in functioning. Scores above the threshold of 3.38 were indicative of dementia (Almeida-Meza et al., 2020; Cadar et al., 2018).

2.4.Covariates

Demographic covariates included age (in years), sex (1=female, 0=male), race (1=non-white, 0=white), and education reported in years in the HRS and on a scale from 1 (No qualification) to 7 (NVQ4/NVQ5/Degree or equivalent) in ELSA. Ethnicity (1=Hispanic, 0=not Hispanic) was also included in the HRS.

Additional analyses included clinical (body mass index [BMI], diabetes, blood pressure), behavioral (smoking), and psychological (depressive symptoms) factors as additional covariates. Staff assessment of height and weight were used to compute BMI in $kg/m^2$; self-

reported diagnosis of diabetes and high blood pressure were coded as 1 for yes and 0 for no; smoking was coded as 1 for current/former smoker and 0 for never-smoker. Depressive symptoms were assessed with the 8-item version of the CESD (Wallace et al., 2000). Participants indicated whether they had experienced eight specific symptoms for much of the past week (yes/no). The eight items were summed into an overall depressive symptoms score with higher scores indicating more depressive symptoms. Genetic factors (APOE status) were controlled in the HRS. APOE risk status was coded as 1 (APOE ε4 carrier) and 0 (other).

2.5.Data analysis

Cox regression was used to examine the association between personality (nuances and domains) and incident dementia in the HRS and ELSA. Participants with dementia at baseline were excluded in both samples. Time-to-incidence was coded as the years between baseline and the first reported instance of dementia at follow-up. Participants without dementia at follow-up were censored at their last available assessment. Personality domains and items were examined separately, controlling for demographic factors (Model 1). They were standardized to z-score to facilitate interpretation of the results. Analyses further controlled for clinical, behavioral, and psychological factors (Model 2) and APOE status in the HRS (Model 3). Example scripts are in the supplementary material. Double-entry correlations between the hazard ratios obtained in the HRS and ELSA were computed to evaluate the replicability of the associations across samples. These analyses assessed the replicability of effects across the 26 items as well as across the five factors.

To calculate poly-item risk scores (Seeboth & Mõttus, 2018), in each sample, each item was weighted by that item's unique association with incident dementia (the logarithm of hazard ratio), controlling for age and sex. For each individual, these weighted items were aggregated into a composite poly-item risk score for dementia, defined as that individual’s personality propensity to dementia. The poly-item scores were further standardized to z-scores. Cox

regression was used to predict dementia from the poly-item score in both HRS and ELSA, controlling for demographic factors in the first model, and for clinical, behavioral, psychological, and genetic (HRS) factors in additional models. In supplementary analyses, the same procedure was used to compute a poly-trait score. Each trait was weighted by that trait's unique association with incident dementia, and weighted traits were aggregated in a poly-trait score.

Sensitivity analyses included the five personality domains as additional covariates in the two samples. Furthermore, an alternative method to compute the poly-item scores was tested that used estimates from ELSA as weights to compute poly-item score scores in the HRS, and estimates from the HRS as weights to calculate the poly-item scores in ELSA. Analyses were also conducted excluding individuals younger than 60 years old and those who developed dementia within two years after the baseline personality assessment.

3. Results

The percentage of individuals with incident dementia was 16% in the HRS (N= 1797) over a median follow-up of 11.41 years (109,789 person-years), and 3% in ELSA (N= 256) over a median follow-up of 7.92 years (50,811 person-years). Results of the Cox regression for both the domains and nuances are in Table 2. Figure 1 shows a forest plot with the effects from each sample for each domain and each nuance adjusting for demographic covariates (Panel A and B). Cox regression indicated that the five personality domains were associated with dementia risk in the two samples. Higher neuroticism was associated with a higher risk of incident dementia (Table 2, Model 1), whereas higher extraversion, openness, agreeableness, and conscientiousness were related to a lower risk (Table 2, Model 1). In HRS and ELSA respectively, one standard deviation (SD) increase in neuroticism was associated with a 24% and a 32% higher risk of incident dementia, whereas one SD higher extraversion, openness, agreeableness, and conscientiousness was related to a 6% and 27%, 12% and 28%, 15% and

20%, and 27% and 37% lower risk of dementia. The overall pattern of association was similar in the model that accounted for clinical, behavioral, and psychological covariates (see Table 2, Model 2), and when APOE status was included as a covariate in the HRS (Model 3, Table 2). The double-entry correlation between the HRs for the five domains in HRS and ELSA was r=.87 (p<.001).

There was also a replicable pattern of association between the personality items and incident dementia across the two samples (Table 2). Higher scores on the neuroticism items moody, worrying, and nervous and a lower score on the item calm were related to higher risk of incident dementia in the two samples. Among conscientiousness items, higher scores on organized, responsible, hardworking, and thorough were associated with a lower risk of dementia. Higher scores on the openness items creative, intelligent, curious, broad-minded, and adventurous were also related to lower incident dementia risk in both samples. Finally, the extraversion item active and the agreeableness items helpful, warm, caring, and sympathetic were related to a lower risk of dementia in the two samples.

There were some sample-specific associations between items and incident dementia (Table 2). Specifically, higher scores on careless and lower scores on softhearted were associated with a higher risk of dementia in HRS only, while higher scores on outgoing, lively, and sophisticated were related to a lower risk of incident dementia in ELSA only. Despite some differences across the samples, the pattern of association between items and incident dementia was similar, as indicated by the correlation of r = .74 (p <.001) between the HRs for the 26 items across samples. The overall pattern was also fairly similar for most nuances when clinical, psychological, and behavioral covariates were controlled in both samples (Table 2, Model 2), and when APOE status was entered as an additional covariate in the HRS (Table 2, Model 3).

Cox regression analyses further indicated that the poly-item score was associated with a higher risk of incident dementia in both the HRS and ELSA (Table 2). For every one SD

higher poly-item score, there was a 29% and a 44% higher risk of dementia over time in HRS and ELSA, respectively. These associations persisted when clinical, behavioral, and psychological factors were controlled for (Table 2, Model 2) and when APOE was controlled for in the HRS (Table 2, Model 3). For comparison, supplementary analyses indicated that the poly-trait score was slightly less strongly related to higher incident dementia than the poly-item score in the two samples ($HR_{HRS}$: 1.28, 95%CI: 1.23-1.35, p<.01; $HR_{ELSA}$: 1.43, 95%CI: 1.27-1.60, p<.001). When both scores were included simultaneously, only the poly-item score was significantly related to dementia risk.

Sensitivity analysis indicated that the link between these poly-item scores and incident dementia remained significant when the five domains were included in the model. In addition, the pattern of association between poly-item scores and incident dementia was similar when using a cross-sample poly-item score where associations in the other sample were used as item weights ($HR_{HRS}$: 1.24, 95%CI: 1.18-1.30, p<.001; $HR_{ELSA}$: 1.44, 95%CI: 1.29-1.61, p<.001). Analyses that excluded participants younger than 60 years indicated that the item warm was no longer associated with incident dementia in both the HRS and ELSA, the item curious was no longer associated with dementia in HRS, and the items intelligent and adventurous were no longer associated with dementia in ELSA. The overall pattern of association was unchanged when participants who developed dementia within two years of the personality assessment were excluded from the HRS, whereas the items helpful, warm, intelligent, and adventurous were no longer associated with incident dementia in ELSA.

## 4. Discussion

Based on two national longitudinal cohorts, the purpose of the present study was to examine the role of nuances in the association between personality and incident dementia. To provide a comparison for the nuances results, we first replicated previous findings that higher neuroticism and lower conscientiousness are related to greater risk of dementia. Also, consistent

with past research, higher extraversion, openness, and agreeableness had significant but weaker associations with reduced risk of incident dementia (Aschwanden et al., 2021). The primary and most novel findings were at the nuance level of analysis, the lowest level of the personality hierarchy, which showed associations that were broadly replicable across samples that spanned two countries and two dementia measures. Across the two samples, the strongest associations at the nuance level were for the items nervous, worry, responsible, organized, and active. The study also showed that a poly-item score was predictive of dementia risk. It appears that dementia is a partly poly-nuanced outcome, as indicated by its distinct associations with personality characteristics more specific than the FFM domains.

The overall pattern of association between personality domains and incident dementia is broadly consistent with existing evidence (Aschwanden et al., 2021). The present study extends this literature by adopting a nuance-level approach which allows for a more detailed understanding of the specific personality characteristics driving the association between personality and dementia. These nuance-level associations could be interpreted within the context of past research on personality facets related to cognitive impairment and dementia (Sutin et al., 2018, 2022; Terracciano et al., 2014; 2022; Wilson et al., 2011). Although all neuroticism items were associated with the risk of dementia, stronger replicable links were found for items indicative of nervousness and worry in both samples. Being nervous and worried are nuances of the anxiety facet (Costa & McCrae, 1992), which has been linked to an increased risk of Alzheimer's disease (Terracciano et al., 2014; Wilson et al., 2011). Furthermore, the items measuring responsibility and organization pointed to the strongest conscientiousness nuances associated with dementia. The association with the item responsible is consistent with facet-level associations between higher responsibility (or dutifulness) and lower risk of incident dementia (Sutin et al., 2018; Terracciano et al., 2022). In addition, the organization item is a nuance of the order facet (Costa & McCrae, 1992), which has been linked

with better cognition in some samples (Sutin et al., 2022) but not others (Terracciano et al., 2022).

Although effect sizes were smaller, several items from extraversion, openness, and agreeableness point to distinct nuances of these domains related to incident dementia. The link between extraversion and dementia in the two samples was mainly driven by higher scores on the item representing activity. This finding contrasts with the non-significant association reported between the activity facet and cognitive impairment and dementia (Terracciano et al., 2014; 2022). Higher levels of activity may manifest through higher involvement in physical and social activities, which have been related to reduced dementia risk (Su et al., 2022). Furthermore, higher scores on the agreeableness items referring to being helpful, warm, caring, and sympathetic were associated with lower risk of dementia, in contrast with previously reported null associations between agreeableness facets and cognitive impairment and dementia (Terracciano et al., 2014, 2022). Helpful, warm, caring, and sympathetic individuals are more likely to be engaged in positive social interactions, which may benefit cognition and result in lower risk of incident dementia over time. Finally, the association for openness items that refer to being broad-minded, curious, or imaginative and lower risk of dementia is consistent with existing evidence that links openness facets of curiosity and creative imagination to better cognition (Sutin et al., 2023). Furthermore, being curious and broad-minded is indicative of higher openness to ideas facet (Costa & McCrae, 1992), which has been related to lower risk of cognitive impairment and dementia (Terracciano et al., 2014, 2022).

Although some sample-specific associations were found, the overall pattern of association between the nuances and incident dementia replicated across the HRS and ELSA, as indicated by the correlation between effect size across the two samples (r=.74), which was roughly similar to the correlation obtained for the five domains (r=.87). Therefore, these findings suggest that the link between personality nuances and the risk of dementia replicated

well across the two samples from the US and England, two countries with different cultural and socioeconomic characteristics, including the health care system. The replicability of results across different dementia ascertainment methods also suggests that the findings are robust and not dependent on a specific methodological approach. Consistent with previous research that compared facets to the five domains (Terracciano et al., 2014, 2022), there was little evidence that nuances have larger predictive value than their respective domains. For example, neuroticism had a larger effect size than those observed for the neuroticism items. There were some exceptions, such as the effect size for the extraversion-related nuance active (HR=0.86) was stronger than the effect size of the broad domain (HR=0.94) in the HRS (below 1, smaller HRs reflect larger effect sizes).

Furthermore, the poly-nuance score, which is based upon the aggregated contributions of nuances on dementia and reflects a personality propensity to dementia, was slightly more associated with incident dementia than the personality domains or any of the nuances in the HRS and ELSA. However, these differences were relatively small. Building on past suggestions (Mõttus et al., 2017), it is likely that personality domains, which aggregate multiple behavioral, affective, and cognitive tendencies, could be more strongly related to broad and complex outcomes encompassing multiple components, such as dementia, than lower-level traits. In contrast, nuances may have higher predictive power for specific outcomes, such as eating-related nuances that predict weight-related outcomes (Mõttus et al., 2017; Seeboth & Mõttus, 2018). There are also other plausible explanations. Dementia may be one outcome whose links with personality traits align well with the FFM domains. Another alternative explanation is related to the use of the MIDI for personality assessment. While the MIDI is a reliable measure of personality, it includes few items per domain, which only assesses a limited range of nuances compared to other inventories (e.g., the 240-item NEO-PI-R, Costa & McCrae, 1992). Therefore, it is likely that the predictive value of nuances on incident dementia may be

underestimated due to the limited trait coverage. Scales designed to have a broader coverage of nuances are likely to have more predictive power.

There are several mechanisms through which personality domains and nuances may be related to the risk of dementia. Indeed, personality is related to clinical, psychological, and behavioral risk factors, such as BMI (Vainik et al., 2019), diabetes (Jokela et al., 2013), depressive symptoms (Hakulinen et al., 2015), and smoking (Hakulinen et al., 2015), that have been implicated in dementia risk. Consistent with this explanatory model, additional analyses suggested that these factors partially accounted for the association between personality and incident dementia. Other biological, health-related, and behavioral pathways may also explain part of these relationships. For example, lower inflammation has been found to partially mediate the association between higher extraversion, openness, conscientiousness and better cognition (Stephan et al., 2023a), which may extend to reduced risk of dementia. In addition, higher neuroticism, lower extraversion, openness, and conscientiousness have been associated with worse cognitive performance partly through their association with lower physical activity and worse physical function (Stephan et al., 2023a, 2023b). It is likely that these biological, health-related, and behavioral pathways may also partially explain the association between personality nuances and incident dementia. Finally, higher neuroticism and lower conscientiousness have been found to increase vulnerability to AD neuropathology (Terracciano et al., 2022) and have been related to worse brain health (Terracciano et al., 2023), which may explain their link, as well as those of their respective nuances, with higher risk of incident dementia.

The present study has several strengths, including the first examination of the association between nuances and incident dementia in two large longitudinal samples from two countries and with different dementia classifications. One notable strength was the use of the same personality scale, which made the direct comparison of findings across the two samples possible. Another strength of the study is the inclusion of clinical, behavioral, psychological,

and genetic covariates. There are also limitations. The observational design does not allow for conclusions about causal associations. In particular, one cannot exclude reverse causality between dementia and personality domains and nuances. The analysis was also based on a relatively brief personality measure. Future research should examine whether the findings from the MIDI can be replicated using different questionnaires. The present study used self-reported measures of personality traits, whereas up to about 40% of the variance in single-method personality trait scores is method-specific, besides about 10% of random error; this suggests, that the associations may be underestimated by up to half in self-report-only studies (McCrae, 2015). To mitigate single-method errors and biases, future research may complement self-ratings with informant-rated personality nuances as predictors of incident dementia. In addition, future studies may include dementia diagnosis from medical records. The measurement of dementia also could not differentiate between types of dementia. Future studies should also investigate nuances and type of dementia, including AD and vascular dementia. A methodological limitation of the study was the dementia assessment; differences in the dementia ascertainment could lead to inconsistencies in dementia identification between the two samples and contribute to some heterogeneity in the findings. Yet, despite these differences, the pattern of association between personality and incident dementia was remarkably similar between the two samples. While the HRS and ELSA are representative samples, some participants did not complete all measures, which may reduce the representativeness of the data examined in our analyses. Finally, the present study was based on US and English samples. Additional research is needed to test whether the pattern of association generalizes to other cultures, such as samples from Africa, Asia, or South America.

In sum, the present study extends existing knowledge on the link between personality and dementia by providing a more detailed picture of this association. Personality nuances, such as being nervous, worried, less active, less organized, and less responsible, as well as a poly-

nuance score, were related to a higher risk of incident dementia, a pattern of associations that replicated across two samples.

References

Almeida-Meza P, Steptoe A, Cadar D., 2021. Markers of cognitive reserve and dementia incidence in the English Longitudinal Study of Ageing. Br J Psychiatry 218(5), 243-251. doi:10.1192/bjp.2020.54

Aschwanden, D., Strickhouser, J. E., Luchetti, M., Stephan, Y., Sutin, A. R., Terracciano, A., 2021. Is personality associated with dementia risk? A meta-analytic investigation. Ageing Res Rev. 67, 101269. https://doi.org/10.1016/j.arr.2021.101269

Cadar, D., Lassale, C., Davies, H., Llewellyn, D. J., Batty, G. D., & Steptoe, A., 2018. Individual and Area-Based Socioeconomic Factors Associated With Dementia Incidence in England: Evidence From a 12-Year Follow-up in the English Longitudinal Study of Ageing. JAMA Psychiatry 75(7), 723–732. https://doi.org/10.1001/jamapsychiatry.2018.1012

Chapman, B. P., Huang, A., Peters, K., Horner, E., Manly, J., Bennett, D. A., Lapham, S., 2020. Association Between High School Personality Phenotype and Dementia 54 Years Later in Results From a National US Sample. JAMA Psychiatry 77(2), 148–154. https://doi.org/10.1001/jamapsychiatry.2019.3120

Costa, P. T. Jr, McCrae, R. R. 1992. Revised NEO Personality Inventory (NEO-PI-R) and the NEO Five-Factor Inventory (NEO-FFI) professional manual. Odessa, FL.: PsychologicalAssessment Ressources.

Crimmins E. M., Kim J. K., Langa K. M., Weir D.R., 2011. Assessment of cognition using surveys and neuropsychological assessment: The health and retirement study and the aging, demographics, and memory study. J Gerontol B Psychol Sci Soc Sci., 66(Suppl 1), i162-i171.

Graham, E. K., James, B. D., Jackson, K. L., Willroth, E. C., Luo, J., Beam, C. R., Pedersen, N. L., Reynolds, C. A., Katz, M., Lipton, R. B., Boyle, P., Wilson, R., Bennett, D. A., Mroczek, D. K., 2021. A coordinated analysis of the associations among personality traits,

cognitive decline, and dementia in older adulthood. J Res Pers. 92, 104100. https://doi.org/10.1016/j.jrp.2021.104100

Hakulinen, C., Elovainio, M., Pulkki-Råback, L., Virtanen, M., Kivimäki, M., Jokela, M. , 2015. Personality and depressive symptoms: Individual participant meta-analysis of 10 cohort studies. Depress Anxiety. 32(7), 461–470. https://doi.org/10.1002/da.22376

Hakulinen, C., Hintsanen, M., Munafò, M. R., Virtanen, M., Kivimäki, M., Batty, G. D., Jokela, M., 2015. Personality and smoking: individual-participant meta-analysis of nine cohort studies. Addiction 110(11), 1844–1852. https://doi.org/10.1111/add.13079

Jokela, M., Elovainio, M., Nyberg, S. T., Tabák, A. G., Hintsa, T., Batty, G. D., Kivimäki, M. 2014. Personality and risk of diabetes in adults: pooled analysis of 5 cohort studies. Health Psychol. 33(12), 1618–1621. https://doi.org/10.1037/hea0000003

Jorm A. F., 1994. A short form of the Informant Questionnaire on Cognitive Decline in the Elderly (IQCODE): development and cross-validation. Psychol Med. 24(1), 145–153. https://doi.org/10.1017/s003329170002691x

McCrae, R. R., 2015. A more nuanced view of reliability: Specificity in the trait hierarchy. Pers Soc Psychol Rev. 19(2), 97–112. https://doi.org/10.1177/1088868314541857

McCrae, R. R., John, O. P., 1992. An introduction to the five-factor model and its applications. J Pers. 60(2), 175–215. https://doi.org/10.1111/j.1467-6494.1992.tb00970.x

Mõttus, R., Kandler, C., Bleidorn, W., Riemann, R., McCrae, R. R. , 2017. Personality traits below facets: The consensual validity, longitudinal stability, heritability, and utility of personality nuances. J Pers Soc Psychol. 112(3), 474–490. https://doi.org/10.1037/pspp0000100

Mõttus, R., Sinick, J., Terracciano, A., Hřebíčková, M., Kandler, C., Ando, J., Mortensen, E. L., Colodro-Conde, L., Jang, K. L., 2019. Personality characteristics below facets: A replication and meta-analysis of cross-rater agreement, rank-order stability, heritability, and

utility of personality nuances. J Pers Soc Psychol. 117(4), e35–e50. https://doi.org/10.1037/pspp0000202

Plomin, R., von Stumm, S., 2018. The new genetics of intelligence. Nat Rev Genet. 19(3), 148–159. https://doi.org/10.1038/nrg.2017.104

Seeboth, A., Mõttus, R. , 2018. Successful explanations start with accurate descriptions: Questionnaire items as personality markers for more accurate predictions. Eur J Pers. 32(3), 186–201. https://doi.org/10.1002/per.2147

Stephan, Y., Sutin, A. R., Luchetti, M., Aschwanden, D., Terracciano, A., 2023a. Personality and Cognition: The Mediating Role of Inflammatory Markers. J Gerontol B Psychol Sci Soc Sci.. Advance online publication. https://doi.org/10.1093/geronb/gbad152

Stephan, Y., Sutin, A. R., Luchetti, M., Aschwanden, D., Cabibel, V., Terracciano, A., 2023b. Measures of physical performance as mediators between personality and cognition in two prospective studies. Arch Gerontol Geriatr. 107, 104902. https://doi.org/10.1016/j.archger.2022.104902

Stewart, R. D., Mõttus, R., Seeboth, A., Soto, C. J., Johnson, W., 2022. The finer details? The predictability of life outcomes from Big Five domains, facets, and nuances. J Pers. 90(2), 167–182. https://doi.org/10.1111/jopy.12660

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

Sutin, A. R., Luchetti, M., Aschwanden, D., Sesker, A. A., Zhu, X., Stephan, Y., Terracciano, A., 2023. Five-Factor Model Personality Domains and Facets Associated with Markers of Cognitive Health. J Individ Differ. 44(2), 97–108. https://doi.org/10.1027/1614-0001/a000383

Sutin, A. R., Stephan, Y., Terracciano, A., 2018. Facets of Conscientiousness and risk of dementia. Psychol Med. 48(6), 974–982. https://doi.org/10.1017/S0033291717002306

Terracciano, A., Aschwanden, D., Passamonti, L., Toschi, N., Stephan, Y., Luchetti, M., Lee, J. H., Sesker, A., O'Súilleabháin, P. S., Sutin, A. R., 2021. Is neuroticism differentially associated with risk of Alzheimer's disease, vascular dementia, and frontotemporal dementia?. J Psychiatr Res. 138, 34–40. https://doi.org/10.1016/j.jpsychires.2021.03.039

Terracciano, A., Bilgel, M., Aschwanden, D., Luchetti, M., Stephan, Y., Moghekar, A. R., Wong, D. F., Ferrucci, L., Sutin, A. R., Resnick, S. M., 2022. Personality Associations With Amyloid and Tau: Results From the Baltimore Longitudinal Study of Aging and Meta-analysis. Biol Psychiatry. 91(4), 359–369. https://doi.org/10.1016/j.biopsych.2021.08.021

Terracciano, A., Piras, M. R., Sutin, A. R., Delitala, A., Curreli, N. C., Balaci, L., Marongiu, M., Zhu, X., Aschwanden, D., Luchetti, M., Oppong, R., Schlessinger, D., Cucca, F., Launer, L. J., Fiorillo, E., 2022. Facets of Personality and Risk of Cognitive Impairment: Longitudinal Findings in a Rural Community from Sardinia. J Alzheimers Dis. 88(4), 1651–1661. https://doi.org/10.3233/JAD-220400

Terracciano, A., Stephan, Y., Luchetti, M., Albanese, E., Sutin, A. R., 2017. Personality traits and risk of cognitive impairment and dementia. J Psychiatr Res. 89, 22–27. https://doi.org/10.1016/j.jpsychires.2017.01.011

Terracciano, A., Sutin, A. R., An, Y., O'Brien, R. J., Ferrucci, L., Zonderman, A. B., Resnick, S. M., 2014. Personality and risk of Alzheimer's disease: new data and meta-analysis. Alzheimers Dement 10(2), 179–186. https://doi.org/10.1016/j.jalz.2013.03.002

Terracciano, A., Walker, K., An, Y., Luchetti, M., Stephan, Y., Moghekar, A. R., Sutin, A. R., Ferrucci, L., & Resnick, S. M., 2023. The association between personality and plasma biomarkers of astrogliosis and neuronal injury. Neurobiol Aging. 128, 65–73. https://doi.org/10.1016/j.neurobiolaging.2023.04.011

Vainik, U., Dagher, A., Realo, A., Colodro-Conde, L., Mortensen, E. L., Jang, K., Juko, A., Kandler, C., Sørensen, T. I. A., Mõttus, R., 2019. Personality-obesity associations are driven by narrow traits: A meta-analysis. Obes Rev. 20(8), 1121–1131. https://doi.org/10.1111/obr.12856

Wallace, R., Herzog, A.R., Ofstedal, M.B., Steffick, D., Fonda, S., Langa, K., 2000. Documentation of Affective Functioning Measures in the Health and Retirement Study. Survey Research Center, University of Michigan, Ann Arbor, MI.

Wilson, R. S., Begeny, C. T., Boyle, P. A., Schneider, J. A., Bennett, D. A., 2011. Vulnerability to stress, anxiety, and development of dementia in old age. Am J Geriatr Psychiatry. 19(4), 327–334. https://doi.org/10.1097/JGP.0b013e31820119da

Wilson, R. S., Schneider, J. A., Arnold, S. E., Bienias, J. L., Bennett, D. A., 2007. Conscientiousness and the incidence of Alzheimer disease and mild cognitive impairment. Arch Gen Psychiatry. 64(10), 1204–1212. https://doi.org/10.1001/archpsyc.64.10.1204

Zimprich, D., Allemand, M., Lachman, M. E., 2012. Factorial structure and age-related psychometrics of the MIDUS personality adjective items across the life span. Psychol Assess. 24(1), 173–186. https://doi.org/10.1037/a0025265

Table 1. Descriptive Statistics of the Samples

| | HRS[a] | | ELSA[b] | |
|---|---|---|---|---|
| Variables | *M/%* | *SD* | *M/%* | *SD* |
| Age | 67.83 | 9.50 | 65.86 | 8.53 |
| Sex (%female) | 59% | - | 56% | - |
| Education | 12.97 | 2.82 | 4.22 | 2.22 |
| Ethnicity (% Hispanic) | 7% | - | - | - |
| Race | 11%[c] | - | 2%[d] | - |
| BMI | 29.24 | 9.82 | 28.26 | 5.05 |
| Depressive symptoms | 1.29 | 1.87 | 1.35 | 1.83 |
| Smoking (% current/former) | 53% | - | 16% | - |
| Diabetes (% yes) | 19% | - | 10% | - |
| High blood pressure (% yes) | 58% | - | 42% | - |
| APOE ε4 (% yes) | 27%- | - | - | - |
| Neuroticism | 2.04 | 0.61 | 2.10 | 0.59 |
| Extraversion | 3.21 | 0.55 | 3.16 | 0.55 |
| Openness | 2.96 | 0.54 | 2.89 | 0.55 |
| Agreeableness | 3.54 | 0.47 | 3.51 | 0.48 |
| Conscientiousness | 3.38 | 0.47 | 3.31 | 0.49 |

*Note*. [a] N= 11,400; [b] N= 7,453; [c] % African American; [d] % not white. See method section for differences in measures across the two samples

*Table 2*

*Summary of Cox Regression Analysis Predicting Risk of Incident Dementia from Personality Domains and Items in the Two Samples*

| | HRS | | | ELSA | |
|---|---|---|---|---|---|
| | Model 1[a] | Model 2[c] | Model 3[d] | Model 1[b] | Model 2[c] |
| Personality Domains | | | | | |
| Neuroticism | 1.24*** (1.18-1.30) | 1.10*** (1.04-1.17) | 1.08** (1.02-1.14) | 1.32*** (1.16-1.50) | 1.22* (1.05-1.43) |
| Extraversion | 0.94* (0.90-0.99) | 1.01 (0.96-1.06) | 0.99 (0.94-1.05) | 0.79*** (0.70-0.89) | 0.83** (0.72-0.94) |
| Openness | 0.89*** (0.85-0.94) | 0.93** (0.88-0.98) | 0.92** (0.87-0.97) | 0.78*** (0.69-0.88) | 0.78*** (0.68-0.90) |
| Agreeableness | 0.87*** (0.84-0.92) | 0.90*** (0.85-0.95) | 0.90*** (0.86-0.95) | 0.83** (0.74-0.94) | 0.81*** (0.71-0.92) |
| Conscientiousness | 0.79*** (0.75-0.82) | 0.83*** (0.79-0.88) | 0.84*** (0.80-0.89) | 0.73*** (0.66-0.82) | 0.73*** (0.64-0.83) |
| Personality Items | | | | | |
| Moody | 1.15*** (1.09-1.20) | 1.05 (1.00-1.11) | 1.04 (0.98-1.10) | 1.16* (1.02-1.32) | 1.10 (0.95-1.27) |
| Worrying | 1.17*** (1.12-1.23) | 1.07* (1.01-1.13) | 1.06 (1.00-1.12) | 1.17* (1.04-1.33) | 1.08 (0.94-1.25) |
| Nervous | 1.21*** (1.15-1.26) | 1.08** (1.03-1.14) | 1.06 (1.00-1.12) | 1.19** (1.05-1.34) | 1.07 (0.93-1.24) |
| Calm | 0.89*** (0.85-0.93) | 0.94* (0.89-0.99) | 0.95* (0.90-1.00) | 0.76*** (0.67-0.85) | 0.76*** (0.66-0.87) |
| Outgoing | 0.97 (0.92-1.01) | 1.02 (0.96-1.07) | 1.02 (0.97-1.07) | 0.77*** (0.69-0.87) | 0.80** (0.70-0.91) |
| Friendly | 0.96 (0.92-1.00) | 0.99 (0.94-1.04) | 1.00 (0.95-1.05) | 0.90 (0.80-1.01) | 0.87* (0.77-0.99) |

| | | | | | |
|---|---|---|---|---|---|
| Lively | 0.96 (0.92-1.01) | 1.03 (0.97-1.08) | 1.00 (0.95-1.06) | 0.81*** (0.72-0.91) | 0.88 (0.77-1.01) |
| Active | 0.86*** (0.82-0.90) | 0.91** (0.86-0.96) | 0.89*** (0.84-0.94) | 0.78*** (0.70-0.88) | 0.78*** (0.70-0.88) |
| Talkative | 1.04 (0.99-1.09) | 1.07** (1.02-1.13) | 1.06* (1.01-1.12) | 0.99 (0.88-1.12) | 0.97 (0.85-1.11) |
| Creative | 0.95* (0.90-0.99) | 0.97 (0.93-1.02) | 0.97 (0.92-1.02) | 0.85** (0.76-0.96) | 0.85* (0.74-0.97) |
| Imaginative | 0.90*** (0.86-0.95) | 0.93** (0.89-0.98) | 0.92** (0.88-0.97) | 0.86* (0.77-0.97) | 0.86* (0.75-0.99) |
| Intelligent | 0.91*** (0.87-0.96) | 0.92** (0.88-0.97) | 0.95 (0.90-1.00) | 0.87* (0.77-0.99) | 0.89 (0.77-1.01) |
| Curious | 0.95* (0.91-1.00) | 0.97 (0.92-1.02) | 0.96 (0.92-1.01) | 0.83** (0.74-0.93) | 0.83** (0.73-0.94) |
| Broad-minded | 0.87*** (0.83-0.91) | 0.88*** (0.84-0.93) | 0.88*** (0.83-0.92) | 0.87* (0.77-0.97) | 0.88 (0.78-1.00) |
| Sophisticated | 0.98 (0.94-1.03) | 0.98 (0.93-1.04) | 0.97 (0.92-1.02) | 0.81** (0.72-0.92) | 0.81** (0.70-0.93) |
| Adventurous | 0.94** (0.90-0.98) | 0.99 (0.94-1.04) | 0.96 (0.91-1.01) | 0.88* (0.78-1.00) | 0.89 (0.78-1.03) |
| Helpful | 0.91*** (0.87-0.95) | 0.95* (0.91-1.00) | 0.95 (0.91-1.00) | 0.88* (0.78-0.98) | 0.89 (0.78-1.01) |
| Warm | 0.94** (0.90-0.99) | 0.97 (0.93-1.03) | 0.98 (0.94-1.04) | 0.89* (0.79-0.99) | 0.90 (0.79-1.03) |
| Caring | 0.92*** (0.88-0.96) | 0.93** (0.88-0.97) | 0.92** (0.88-0.97) | 0.84** (0.75-0.94) | 0.80*** (0.71-0.90) |
| Softhearted | 0.91*** (0.87-0.95) | 0.92** (0.87-0.96) | 0.92** (0.87-0.97) | 0.91 (0.80-1.02) | 0.87 (0.76-1.00) |
| Sympathetic | 0.88*** (0.84-0.92) | 0.89*** (0.84-0.93) | 0.89*** (0.84-0.94) | 0.83** (0.74-0.93) | 0.80** (0.70-0.91) |

| | | | | | |
|---|---|---|---|---|---|
| Organized | 0.85*** (0.81-0.89) | 0.87*** (0.83-0.92) | 0.87*** (0.83-0.91) | 0.73*** (0.65-0.81) | 0.74*** (0.66-0.84) |
| Responsible | 0.85*** (0.82-0.89) | 0.87*** (0.84-0.91) | 0.88*** (0.84-0.92) | 0.78*** (0.71-0.87) | 0.83** (0.74-0.93) |
| Hardworking | 0.87*** (0.84-0.91) | 0.92** (0.88-0.97) | 0.93** (0.88-0.97) | 0.83** (0.75-0.93) | 0.84** (0.74-0.94) |
| Careless | 1.13*** (1.08-1.18) | 1.08** (1.03-1.14) | 1.07** (1.01-1.12) | 1.08 (0.96-1.22) | 1.16* (1.02-1.32) |
| Thorough | 0.86*** (0.82-0.89) | 0.89*** (0.85-0.94) | 0.89*** (0.84-0.94) | 0.84** (0.75-0.94) | 0.84** (0.74-0.96) |
| Poly-item score | 1.29*** (1.23-1.35) | 1.20*** (1.13-1.26) | 1.19*** (1.13-1.26) | 1.44*** (1.29-1.61) | 1.41*** (1.24-1.61) |

Note. [a] Model 1 includes age, sex, education, race, and ethnicity; N= 11,400; [b] Model 1 includes age, sex, education, and race, N= 7,453; [c] Model 2 includes Model 1 covariates and BMI, smoking, diabetes, blood pressure, and depressive symptoms, HRS: N= 9736, ELSA: N= 5944; [d] Model3 includes Model 2 covariates and APOE status; N= 9115.
* $p < .05$, ** $p < .01$, *** $p < .001$

Figure1. Forest Plot of the Association between Personality Domains and Nuances and Incident Dementia in the HRS and ELSA, controlling for Demographic Factors.