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Association of personality facets and cognition in the Lifelines population-based cohort study

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ABSTRACT

Background: Personality traits have been associated with cognitive functioning and risk of cognitive decline. Fewer studies have investigated how personality facets are associated with cognition in large cohorts with a prospective design.

Methods: The association between eight personality facets and cognition (speed measures reflecting psychomotor speed and visual attention; hit rate measures reflecting visual learning and working memory) was analyzed in middle-aged adults from the Lifelines cohort (N = 79911; age 43 ± 11 years).

Results: High hostility, high vulnerability, low excitement seeking, and low competence were associated with worse cognitive performance on all tasks. Impulsivity-related facets had weak and differential associations, with self-discipline negatively associated with accuracy and deliberation negatively associated with speed. These associations remained largely unchanged when accounting for lifestyle factors (smoking, alcohol consumption, physical activity). The associations with cognition were stronger in older people for impulsiveness, deliberation, and hostility, while stronger in younger people for excitement seeking, self-discipline, and vulnerability.

Conclusion: In a large population-based sample with a broad age range, the associations of personality facets with cognitive functioning had small effect sizes, were independent of lifestyle factors, and varied with age and among facets within the same personality domain. These findings highlight the importance of developmental stages and facet-level research in personality-cognition associations.

1. Introduction

Personality refers to lasting differences in behaviors, thoughts, and feelings (Costa and McCrae, 2013a; Sutin et al., 2011). Five basic traits are described by the Five-Factor Model, namely neuroticism, extraversion, openness, agreeableness, and conscientiousness (Costa and McCrae, 2013b). Increasing evidence points to an association between personality traits and cognitive decline and dementia (Aschwanden et al., 2021; Terracciano and Sutin, 2019). Personality traits are fundamental predictors of life outcomes, such as disease development, since they influence human behaviors and they are stable across most adult lifespan (Strickhouser et al., 2017). Several modifiable risk factors for dementia described by the Lancet Commission (Livingston et al., 2020) are affected by an individual's behaviors, which are strongly related to one's personality (Goodwin et al., 2023; Kinyanjui and Sum, 2023). Interestingly, personality traits already measured during adolescence were associated with later-life dementia, 54 years later (Chapman et al., 2020).

Previous studies have confirmed the relationship between personality traits and cognitive functioning cross-sectionally (Curtis et al., 2015; Sutin et al., 2022b) and longitudinally (Graham et al., 2021; Schaie et al., 2004; Angelina R. Sutin et al., 2023; Terracciano et al., 2022b). In healthy adults, positive associations were found between all cognitive abilities and openness and between processing speed and conscientiousness (Simon et al., 2020). Negative associations were found between general cognitive abilities, reasoning, and language with extraversion, and between general cognitive abilities and reasoning and neuroticism (Simon et al., 2020). However, verbal fluency has been

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found to be positively associated with extraversion, openness, and conscientiousness (Sutin et al., 2019). The trait of agreeableness, instead, has the weakest associations with cognition (Simon et al., 2020; Stanek and Ones, 2023; Sutin et al., 2022b).

The five basic personality traits broadly describe one's personality, although these are composed of many specific characteristics, called facets (Costa and McCrae, 2013a; He, 2019; Stewart et al., 2022). Personality facets are related to well-being (Marrero Quevedo and Carballeira Abella, 2011), affective disorders (Lyon et al., 2021), and health markers, including adiposity and performance measures of fitness (Angelina R. Sutin et al., 2018). Studies examining the relationship between cognition and personality at the facet level are scarce (Graham and Lachman, 2014), especially in large cohorts, but they are needed to better interpret findings about the association between cognition and personality (Graham and Lachman, 2014; Simon et al., 2020). At the facet level, only two studies examined the relationship between cognition and facets from all five domains (N = 1671) (Terracciano et al., 2014) and (N = 1668) (Terracciano et al., 2022b); one among the facets of neuroticism (N = 785) (Wilson et al., 2011); and one on the facets of conscientiousness (N = 11181) (A. R. A. R. Sutin et al., 2018). Depression, a facet of neuroticism, and dutifulness, a facet of conscientiousness, were among the strongest predictors of poor cognitive performance (Terracciano et al., 2022b). Previous studies have also shown that differences exist in the relationship between cognition and facets belonging to the same domain (Sutin et al., 2022a). For instance, within the conscientiousness domain, industriousness and responsibility had stronger relationships with general cognition compared to the facets of self-control, order, virtue, and traditionalism (Sutin et al., 2022a).

Examining the relationship of personality with cognition at the facet level could explain some of the heterogeneities in findings in the personality literature, since lower-order traits, like the facets, might have stronger associations compared to the broader domains (Stewart et al., 2022). However, some studies have not found facets to be stronger predictors of cognitive measures (Terracciano et al., 2022b). Few studies have also looked at the effects of age on the relationship between personality and cognition (Simon et al., 2020). A study found that age moderated the association between cognition and neuroticism (Graham and Lachman, 2014), while two other studies found that associations between personality and cognition were similar across all age spans (Simon et al., 2020; Soubelet, 2011; Terracciano et al., 2022b).

The present study assesses whether personality facets are associated with cognitive measures of speed and accuracy in a large population-based sample with a broad age range. Based on the findings of previous studies (Curtis et al., 2015; Graham and Lachman, 2014), we test the hypothesis that lower hostility, impulsiveness, vulnerability, self-consciousness, and competence are related to better cognitive functioning. Some past research (Sutin et al., 2011; Terracciano and Costa, 2004) suggests a more nuanced pattern could emerge for some impulsivity-related facets: high excitement seeking and low deliberation could be related to better speed but worse accuracy, while higher self-discipline to better accuracy but worse speed. In addition to demographic covariates, the study explores to what extent the associations are attenuated by lifestyle covariates, which could be potential mediators or confounding factors of eventual personality-cognition associations. Additionally, we test moderation with age to investigate whether age modifies this possible association.

2. Methods

2.1. Study population

This study was performed using data from the Lifelines Cohort Study. Lifelines is a multi-disciplinary prospective population-based cohort study examining in a unique three-generation design the health and health-related behaviours of 167,729 persons living in the North of the Netherlands. It employs a broad range of investigative procedures in assessing the biomedical, socio-demographic, behavioural, physical and psychological factors which contribute to the health and disease of the general population, with a special focus on multi-morbidity and complex genetics (Sijtsma et al., 2022). Its collection process has been described elsewhere (Lifelines Biobank). All Lifelines procedures followed the Declaration of Helsinki and were approved by the Medical Ethics Committee of the University Medical Center Groningen. All participants gave written informed consent. The current study uses data from participants older than 18 years who visited the research centers between 2007 and 2017. Several assessment waves have been conducted; in this study, we used data from wave 1a (2007–2013) and wave 2a (2014–2017). Data may be obtained from a third party and are not publicly available. Researchers can apply to use the Lifelines data used in this study. More information about how to request Lifelines data and the conditions of use can be found on their website (https://www.lifelines.nl/researcher/how-to-apply). Access to the R codes used for this study can be requested from the authors and Lifelines research management team.

2.2. Participants inclusion

Participants that took part in Lifelines and completed the personality questionnaires during wave 1a (personality_neo [Lifelines Wiki] (rug.nl)) and CogState examinations at 2a were included in our study.

2.3. Assessment of personality facets

Personality was assessed using 64 self-rated items from the Revised NEO Personality Inventory (NEO-PI-R). The abbreviated NEO-PI-R version used in Lifelines assessed eight facets: four belonging to the neuroticism domain (hostility, self-consciousness, impulsiveness, vulnerability to stress), one to the extraversion domain (excitement seeking), and three to the conscientiousness domain (competence, self-discipline, and deliberation). A definition of each facet is provided in Table 1. Facets from the openness and agreeableness domains were not available in the Lifelines database. In this study, we include all personality facets assessed by Lifelines; more detailed information on the data available can also be found here: personality_neo [Lifelines Wiki]

Table 1
Facets definitions.

Facet	Definition and description
Hostility (Costa and McCrae, 1995)	Defined as the tendency to be nervous and apprehensive. Rated with items referring to the tendency of being irritable, frustrated, or angry.
Self-Consciousness (Costa and McCrae, 1995)	Defined as the tendency to experience discomfiture and shame. Rated with items on one's feeling in relation or presence of others.
Impulsiveness (Costa and McCrae, 1995)	Defined as the tendency to be unable to control desires. Rated with items on one's attitude to temptation and controlled behavior.
Vulnerability (Costa and McCrae, 1995)	Defined as the tendency to be susceptible to stress. Rated with items on the control of emotions and the ability to make decisions also under stress.
Excitement seeking (Costa and McCrae, 1995)	Defined as the wish for strong thrills and stimulations. Rated with items that present examples of different situations which are more or less thrilling.
Competence (Costa et al., 1991)	Defined as one's sense of being accomplished, sensible, and capable. Rated with items on efficiency and control at work or in other life situations.
Self-Discipline (Costa et al., 1991)	Defined as persistence, the ability to continue with a task despite distractions. Rated with items on one's ability to bring projects to an end and on productivity.
Deliberation (Costa et al., 1991)	Defined as thoughtfulness, caution, and planning. Rated with items on one's approach in making a decision or in dealing with answers and plans.

(rug.nl).

2.4. Measures of cognition

Cognition was measured using the CogState Brief Battery (CBB), a computerized test that allows the measurement of cognitive performance in large cohorts. The CBB has good test-retest reliability and can be used in healthy and cognitively impaired patients (Darby et al., 2012; Mielke et al., 2015). The test consists of 4 tasks: a detection task (DET), an identification task (IDN), a one-back task (OCL), and a one-card learning task (ONB). A description of the tasks is given in Table 2. The DET and IDN scores have been inversed, therefore, for all four outcomes, a higher score indicates better cognitive performance. Afterwards, two composite scores were created averaging the two tasks measuring speed (DET and IDN) and the two tasks measuring hit rate (OCL and ONB); speed and hit rate were used as the two outcomes in analyses.

2.5. Covariates

All models were corrected for age, sex, education (expressed as low, intermediate, and high), and time interval between 1a and 2a. To assess whether the relationship between personality facets and cognition was independent of lifestyle factors (smoking, alcohol, and physical activity), these variables were added as covariates in a following analysis. Smoking was a categorical variable indicating never, former, and current smokers. Alcohol was indicated as the number of alcohol glasses per month. Physical activity was measured using the Short Questionnaire to Assess Health-enhancing physical activity (SQUASH), a questionnaire developed by the Dutch National Institute of Public Health and the Environment to give an indication of habitual physical activity levels. SQUASH has data on the frequency, type, duration, and intensity of activity in a normal week in the preceding months. Physical activity questions were distributed over four categories: commuting (including walking and bicycling to and from work), leisure time (walking, biking, gardening, odd jobs, and sports), household, and work and school. The Ainsworth's Compendium of Physical activities assigned metabolic equivalent values to activities classifying them as moderate (MET value of 4 to <6.5) or vigorous intensity (MET value of ≥ 6.5) (Ainsworth et al., 2011). We used moderate physical activity scores that were calculated by multiplying the MET value with duration (minutes per week) for statistical analyses (squash_sum_scores [Lifelines Wiki]) (Byambasukh, 2020). Vigorous physical activity scores were also used to create an averaged physical activity score used in a supplementary analysis (Supplementary Table S2).

2.6. Statistical analyses

All statistical analyses were performed in R version 4.2.0 (R Core Team, 2020). All predictors (hostility, self-consciousness, impulsiveness, vulnerability, excitement seeking, competence, self-discipline, deliberation) and outcome measures (speed and hit rate) were standardized by dividing the difference between the individual value and the population mean by the population standard deviation. Eight separate linear regression models were run for each one of the eight personality facets for the cognitive outcome speed and other eight models for the outcome hit rate; models were corrected for age, age squared, sex, education level, and time interval between the two assessments. Missing data for the covariates ranged from 0.76% for age to 8.8% for smoking habit and were imputed 10 times with 20 iterations using chained equations in the MICE R package (van Buuren and Groothuis-Oudshoorn, 2011). The distribution of covariates was similar in the imputed and non-imputed datasets. To assess whether the relationship between personality facets and cognition was independent of lifestyle factors (smoking, alcohol, and physical activity), these variables were added as covariates in a second model. Finally, to assess whether the relationship between personality and cognition was moderated by age, we tested the interaction

Table 2
CogState Brief Battery.

Test	Domain	Outcome measure	Task	Procedure
Detection task (DET)	Psychomotor function	Speed of performance in milliseconds (normalized using the mean of the log10 transformed reaction times for correct responses).	Simple reaction time paradigm: the on-screen instructions ask: "Has the card turned over?". A playing card is presented face down in the center of the screen. The card flips over so it is face up. As soon as the card flips over the participant must press "Yes".	The task ended after 35 correct trials were recorded.
Identification task (IDN)	Visual attention	Speed of performance (normalized using the mean of the log10 transformed reaction times for correct responses).	Choice reaction time paradigm: The on-screen instructions ask: "Is the card red?". A playing card is presented face down in the center of the screen. The card flips over so it is face up. As soon as it flips over the participant must decide whether the card is red or not. If it is red the participant should press "Yes", and if it is not red the participant should press "No".	The task ended after 30 correct trials were recorded.
One-back task (ONB)	Working memory	Accuracy of performance (arcsine transformation of the square root of the proportion of correct responses).	N-back paradigm: the on-screen instructions ask: "Is the previous card the same?". A playing card is presented face up in the center of the screen. The participant must decide whether the card is the same as the previous	The task ended after 30 trials.

(continued on next page)

Table 2 (*continued*)

Test	Domain	Outcome measure	Task	Procedure
			card. If the card is the same the participant should press "Yes", and if it is not the same the participant should press "No".	
One-card learning task (OCL)	Visual learning	Accuracy of performance (arcsine transformation of the square root of the proportion of correct responses).	Pattern separation paradigm: the on-screen instructions ask: "Have you seen this card before in this test?". A playing card is presented face up in the center of the screen and the participant must decide whether they have seen the card before in this test.	The task ended after 42 trials.

Note. More information and a visualization of the respective tasks can be found at: Digital Cognitive Assessments | Cogstate | Clinical Trials. During all four tests, participants are encouraged to work as quickly as they can and be as accurate as possible.

of age with each personality facet in separate models. All analyses considered a two-tailed significance level of $\alpha = 0.05$. Correlation plots were made to assess the bivariate association between study variables, using the corrplot R package (Taiyun Wei and Viliam Simko, 2017).

3. Results

The sample's mean age was 43 years (SD = 10.8), with 59.5% of participants being women. Education level was low for 24.2%, intermediate for 42.6%, and high for 33.2% of the sample. The time interval between examinations 1a and 2a ranged from 7 months to 11 years (M = 4.05, SD = 11.7). Table 3 shows the characteristics of the study population. Bivariate correlations between study variables are displayed in Supplementary Fig. S1.

3.1. Associations of personality facets and cognition

Models I, adjusted for age, age squared, sex, education, and time interval, revealed that hostility ($\beta = -0.04$, $p < 0.05$), vulnerability ($\beta = -0.02$, $p < 0.05$), excitement seeking ($\beta = 0.01$, $p = 0.03$), competence ($\beta = 0.02$, $p < 0.05$), and self-discipline ($\beta = -0.01$, $p < 0.05$) were related to hit rate. Instead, hostility ($\beta = -0.05$, $p < 0.05$), self-consciousness ($\beta = -0.03$, $p < 0.05$), vulnerability ($\beta = -0.05$, $p < 0.05$), excitement seeking ($\beta = 0.03$, $p < 0.05$), competence ($\beta = 0.03$, $p < 0.05$), and deliberation ($\beta = -0.01$, $p < 0.05$) were related to speed.

In Models II, adjusting for age, age squared, sex, education, time interval, alcohol, smoking, and physical activity, results remained unchanged. Results for Models I and Models II are presented in Table 4 and Supplementary Table S3. Results for both models I and II remained

Table 3
Study population characteristics at 1a.

	Study population (N = 79911)
Age (years)	43 ± 10.8
Female sex	47586 (59.5%)
Education	
Low	19338 (24.2%)
Intermediate	34076 (42.6%)
High	26497 (33.2%)
Race	
White/East and West European	70921 (88.75%)
White/Mediterranean or Arabic	218 (0.27%)
Black	113 (0.14%)
Asian	330 (0.41%)
Other	638 (0.80 %)
Unknown	7691 (9.62 %)
Alcohol (number of glasses per month)	3.9 ± 1.9
Smoking	
Never	35912 (44.9%)
Former	31291 (39.2%)
Current	12708 (15.9%)
Physical activity score (moderate intensity)	1927.9 ± 2990.6
NEO, hostility	18.6 ± 4.3
NEO, self-consciousness	19.8 ± 4.6
NEO, impulsivity	22.2 ± 3.9
NEO, vulnerability	18.2 ± 4.1
NEO, excitement	22.2 ± 4.6
NEO, competence	29.7 ± 3.4
NEO, self-discipline	29.3 ± 4.3
NEO, deliberation	28.4 ± 4.2
CogState IDN	2.7 ± 0.1
CogState DET	2.6 ± 0.2
CogState ONB	1.3 ± 0.2
CogState OCL	1.0 ± 0.1

Note. DET = detection; IDN = identification; OCL = one-back task; ONB = one-card learning; ± = standard deviation. Data are presented as frequency (%) for categorical, and mean ± SD for continuous variables unless indicated otherwise.

Table 4
Association of personality facets on cognition.

N = 79911	Hit rate		Speed	
	Model I	Model II	Model I	Model II
Hostility	**−0.04** *** [-0.04, −0.03]	**−0.04**** [-0.04, −0.03]	**−0.05** *** [-0.05, −0.04]	**−0.05** *** [-0.05, −0.04]
Self-Consciousness	−0.01 [-0.01, 0.00]	0.00 [-0.01, 0.00]	**−0.03** *** [-0.04, −0.02]	**−0.03** *** [-0.03, −0.02]
Impulsiveness	0.00 [-0.01, 0.01]	0.00 [-0.01, 0.00]	0.00 [-0.00, 0.01]	0.00 [-0.00, 0.01]
Vulnerability	**−0.02** *** [-0.03, −0.02]	**−0.02** *** [-0.03, −0.02]	**−0.05** *** [-0.06, −0.05]	**−0.05** *** [-0.06, −0.05]
Excitement Seeking	**0.01** *** [0.00, 0.01]	0.00 [-0.00, 0.01]	**0.03** *** [0.02, 0.03]	**0.02** *** [0.02, 0.03]
Competence	**0.02** *** [0.01, 0.02]	**0.02** *** [0.01, 0.02]	**0.03** *** [0.02, 0.03]	**0.03** *** [0.02, 0.03]
Self-Discipline	**−0.01** *** [-0.02, −0.01]	**−0.01** *** [-0.02, −0.00]	0.00 [-0.00, 0.01]	0.00 [-0.00, 0.01]
Deliberation	0.00 [-0.01, 0.00]	0.01 [-0.01, 0.00]	**−0.01** *** [-0.02, −0.01]	**−0.01** *** [-0.02, −0.00]

Note. Regression coefficient estimates [95 % confidence intervals] are reported. ***p < 0.001. Models I were corrected for age, age squared, education level, sex, and time interval. Models II were corrected for age, age squared, education level, sex, smoking, glasses of alcohol per month, and moderate intensity physical activity. For both cognitive outcomes a higher score is indicative of better cognition. The first four facets belong to the domain neuroticism, the fifth to the domain extraversion, and the last three to the domain conscientiousness.

unchanged when correcting for multiple comparisons, setting a false discovery rate at 5% using the Benjamini-Hochberg method and considering a corrected p < 0.05 as significant.

Results of models I and II on cognition using the four cognitive outcomes instead of composite scores are reported in Supplementary Table S1. In Supplementary Table S2 we report results additionally correcting for an averaged (moderate and vigorous) physical activity measure.

3.2. Interaction of age

The interaction between facets and age was tested in separate models to examine whether the associations found varied by age. Of the sixteen interactions tested, six were significant ($p < 0.05$). Age interacted with impulsiveness, excitement seeking, self-discipline, and deliberation in predicting hit rate. Also, age interacted with hostility and vulnerability in predicting speed. The associations with cognition were stronger in older people for impulsiveness, deliberation, and hostility, while stronger in younger people for excitement seeking, self-discipline, and vulnerability (Fig. 1, displaying the sample split in age tertiles).

4. Discussion

This study investigated the relationship between personality facets and cognitive functioning in a large population-based cohort study. Hostility, vulnerability, excitement seeking, and competence were related to both processing speed and visual attention, as well as working and visual memory. Impulsivity-related facets had weak and differential associations, with self-discipline having a negative association with measures of accuracy and deliberation having a negative effect on speed. The associations remained unchanged when accounting for lifestyle factors of smoking, alcohol drinking, and physical activity. Additionally, age seemed to moderate only some of the relationships between facets and cognition, namely, the associations with cognition were stronger in older people for impulsiveness, deliberation, and hostility, while stronger in younger people for excitement seeking, self-discipline, and vulnerability.

Hostility, regarded as a type of emotionally charged aggressive behavior; vulnerability, the inability to withstand unfavorable and stressful situations; less excitement seeking, the wish for strong thrills and stimulations; and less competence, namely a set of skills that provide successful outcomes (Bartram, 2005), were related to worse

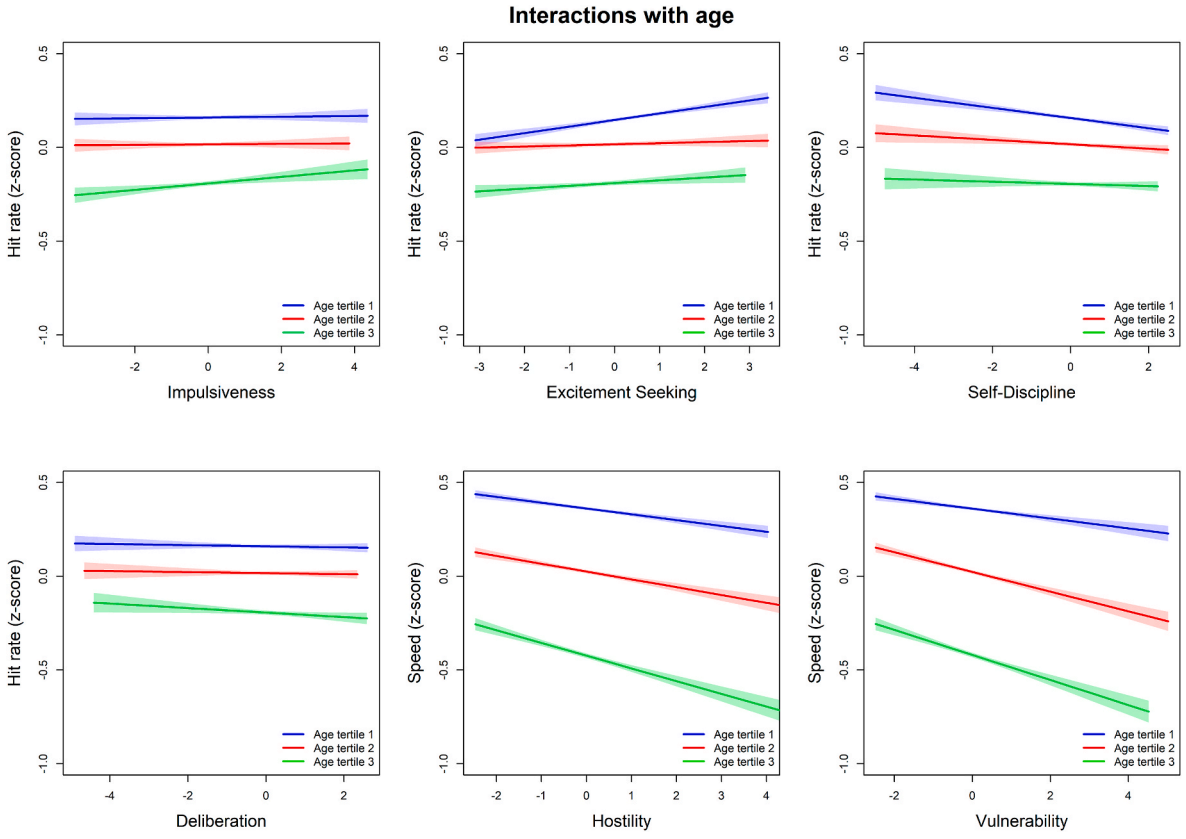

Fig. 1. Interaction models of age and personality facets on cognition.
Note. The interactions displayed are those with $p < 0.001$; all models were corrected for age, age squared, education level, sex, and time interval. Age tertile 1 included participants of age 18–39, tertile 2 participants of age 39.06–48, and tertile 3 participants of age 48.01–76.
The regression slopes are reported here, for impulsiveness: age tertile 1 β = 0.002, age tertile 2 β = 0.001, age tertile 3 β = 0.017; for excitement seeking: age tertile 1 β = 0.035, age tertile 2 β = 0.006, age tertile 3 β = 0.014; for self-discipline: age tertile 1 β = −0.027, age tertile 2 β = -0.012, age tertile 3 β = -0.006; for deliberation: age tertile 1 β = −0.003, age tertile 2 β = −0.003, age tertile 3 β = −0.012; for hostility: age tertile 1 β = −0.031, age tertile 2 β = −0.042, age tertile 3 β = −0.070; and for vulnerability: age tertile 1 β = −0.027, age tertile 2 β = −0.052, age tertile 3 β = −0.067.

processing speed, visual attention, working and visual memory. These results follow our hypothesis and indicate that these tendencies, related to engagement in more aversive behavior, are not favorable for effective cognitive functioning. Self-consciousness, namely the sense of awareness of oneself, and deliberation, namely the tendency to carefully consider the consequences and take extensive time in making decisions, were unrelated to accuracy but related to worse speed in psychomotor and visual attention tasks. As found in a previous study, individuals that are very cautious and deliberate before acting tend to have slower performances (Sutin et al., 2011). Interestingly, these significant relationships are only seen with the outcome measuring the speed of response. On the contrary, self-discipline was related to worse working and visual memory, but not to measures of speed. This result was unexpected, although self-discipline, namely the ability to continue with a task despite distractions, might increase one's cognitive effort and consequently could have a negative impact on performance. A previous study has found that students with high self-control showed stronger decrement in performance in subsequent unrelated tasks (Lindner et al., 2017). They suggest that individuals with high self-control traits tend to avoid situations in daily life requiring self-control more often and therefore we might speculate that they have less strategies to optimally perform in working and visual memory tasks. In the introduction, we report some literature on the association between personality factors and cognition. While the association with facets might not be much larger than with personality factors, our results support the idea that facets within the same factor can have different associations.

Generally, several mechanisms are thought to play a role in the relationship between personality and cognition and might explain these associations. The findings of this study suggest that smoking, alcohol, and physical activity are likely to have only a modest effect, given that the inclusion of these variables had a minor impact on the associations. Other potential mechanisms should be considered. For instance, individuals with a nervous personality had the highest risk of developing myocardial infarction, while diligent and sociable personalities had the lowest risk (Dahlén et al., 2022). The association of personality traits with cardiovascular disease is important in the context of dementia, considering that cardiovascular risk factors are also increasingly recognized risk factors for dementia (Liang et al., 2021; Wu et al., 2023), and some personality traits even seem to be cardioprotective (Dahlén et al., 2022). Thus, vascular mechanisms might contribute to these relationships between personality and cognition, especially with advancing age (Giannakopoulos et al., 2022). In a recent paper we find that neuroticism is related to cognition in part through white matter hyperintensities, a marker of cerebral small vessel disease, in brain scans of older adults (Terracciano et al., 2023a). Strong negative affect and social inhibition can manifest enhanced cortisol spikes in response to acute stress, as well as disrupted hypothalamic-pituitary-adrenal (HPA) axis and increased presence of coronary artery plaques (Kupper and Denollet, 2018). However, there is little evidence that personality traits are related to cortisol levels (Steptoe et al., 2017; Waldstein et al., 2010). Additionally, personality traits have also been related to different markers of Alzheimer's disease neuropathology, namely plasma markers of astrogliosis and neurodegeneration (Terracciano et al., 2023b), as well as amyloid and tau accumulation assessed using cerebrospinal fluid or Positron Emission Tomography (Baena et al., 2021; Terracciano et al., 2022a).

Interestingly, in our study, the associations between facets and cognition remained mostly unchanged when accounting for some lifestyle factors, namely smoking, alcohol, and physical activity. This suggests that in the Lifelines population of middle-aged and older adults, personality facets are related to one's cognition independently of these behaviors. Future studies should examine whether other lifestyle factors (e.g., sleep, diet, social engagement) might account for these relationships.

Age moderates some of the relationships between facets and cognition contrary to some previous studies (Simon et al., 2020; Soubelet, 2011; Terracciano et al., 2022b). In line with our findings, two other studies focusing on facets, found age to moderate some of the relationships with cognition (Graham and Lachman, 2014; A. R. Sutin et al., 2023). A hypothesis might be that certain traits might be less favorable for optimal cognitive performance during certain age periods, such as excitement seeking during younger age, and impulsiveness in older age, as found in our study.

Strengths of our study include the large cohort size, which provides high statistical power and should generate robust estimates. Additionally, by measuring the associations with cognition at the facet level, greater specificity is provided than at the higher-order factor level. Our study also has some limitations; only a few cognitive domains were used as outcomes, calling for future studies using a broader neuropsychological battery, although not feasible for such a large cohort. Additionally, our sample mostly included white individuals of European descent, limiting the generalizability of findings. Finally, Lifelines used an abbreviated version of the NEO questionnaire that assessed only eight facets. Specifically, no facets from the openness and agreeableness domains were available, while previous literature has shown a relationship especially between openness and cognitive decline.

Overall our results show that the associations between cognition and facets differ among facets belonging to the same domain, highlighting the importance of analyzing facets separately. This is also the case when looking at the moderating effect of age on the relationship between facets and cognition. This study suggests that in developing strategies aimed at dementia prevention, differences in personality facets should be taken into account and could be a relevant target. For example, there have been efforts to develop interventions to change maladaptive personality traits (Stieger et al., 2021). Interventions for personality intended to improve cognitive outcomes could be more effective if they target hostility or vulnerability instead of impulsiveness, given the results of the present study. Facets could also help in designing targeted interventions (Kolanowski et al., 2011) or moderate the effectiveness of common interventions (Kekäläinen et al., 2023). Additionally, for targeting interventions to the individuals at greater risk, our findings suggest that those who score high on hostility and vulnerability may be at higher risk compared to those who score high on impulsiveness.

Author statement

Sofia Marcolini: Conceptualization; Methodology; Data curation; Formal analysis; Writing- Original draft preparation; Resources; Project administration; Visualization.

Ingeborg Frentz: Conceptualization; Methodology; Data curation; Writing- Reviewing and Editing; Visualization.

Antonio Terracciano: Conceptualization; Methodology; Data curation; Writing- Reviewing and Editing; Supervision.

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Declaration of competing interest

None.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jpsychires.2023.10.034.

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