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Personality-Cognition Associations across the Adult Lifespan and Potential Moderators: Results from Two Cohorts

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Abstract

Objective: Personality and cognitive abilities have been previously linked. However, there are inconsistencies regarding whether this relationship varies as a function of age, and a lack of evidence on whether gender contributes to this relation, particularly across the adulthood. Therefore, this study investigated the association between personality and cognition across adult lifespan, accounting for age and gender.

Methods: We examined the association between personality and cognition in two large samples (Sample 1: N = 422; Sample 2: N = 549) including young, middle aged and older adults. Participants completed personality scales and several cognitive measures related to reasoning, language, memory and speed of processing. Structural equation modelling was applied in order to investigate associations between personality and cognition, and moderation of age and gender within this relationship. We also conducted a mini-metanalysis procedure in order to examine personality-cognition associations, combining results from the two samples.

Results: Openness was the main trait associated with cognitive performance; however, extraversion, conscientiousness and neuroticism were also independently associated with cognition. Age and gender did not consistently moderate personality-cognition across the samples.

Conclusions: We provided robust evidence of personality-cognition associations across the adult lifespan, but these associations were not consistently moderated by age and gender.

Keywords

Personality; Cognition; Lifespan; Aging; Gender

Introduction

There has been a growing interest in the extent to which personality characteristics are related to cognitive functioning and cognitive aging. The examination of personality implications for health and cognition has a long history in the behavioral and biomedical

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sciences (Ackerman & Heggestad, 1997; Bogg & Roberts, 2013; DeYoung, Peterson, & Higgins, 2005a; Moutafi, Furnham, & Crump, 2003; Smith & Spiro, 2002; Sutin, Stephan, & Terracciano, 2018). Nevertheless, in the last decade there has been an increasing interest in investigating how personality is associated with cognitive performance across adult lifespan (including older population), and possible moderators of this association (Curtis, Windsur, & Soubelet, 2014; Graham & Lachman, 2012, 2014; Rammstedt, Danner, & Martin, 2016; Soubelet & Salthouse, 2011). Personality traits describe individual differences in behavior, cognition, and emotion, and may affect the development of cognitive abilities and the risk of age-related cognitive changes through response to stress, engagement in health behaviors, and cognitively stimulating activities. Investigating the relationship between personality and cognition across the lifespan can provide valuable information on the role of personality as a protective resource or a source of vulnerability to age-related cognitive decline.

Personality and Cognitive Performance

In the current study, we are considering the taxonomy of personality traits organized around five broad dimensions from Big-Five/Five Factor Model (FFM), which includes openness, conscientiousness, extraversion, agreeableness and neuroticism (McCrae & John., 1992; McCrae, 2010). Personality traits are considered to be relatively enduring patterns of thoughts, feelings and behaviors that distinguish individuals from one another (Roberts & Mroczek, 2008). Both personality and cognitive ability are core aspects of adult behavior and functioning, and previous research has found relations between these two major constructs, despite some inconsistencies.

For instance, extraversion has been positively (Ackerman & Heggestad, 1997; Austin et al., 2002; Schaie, Willis, & Caskie, 2004) and negatively related to intelligence, reasoning and verbal ability (Baker & Bichsel, 2006; Graham & Lachman, 2014; Mccrae, 1987; Moutafi et al., 2003; Moutafi, Furnham, & Paltiel, 2005; Soubelet & Salthouse, 2011; Wolf & Ackerman, 2005). Meta-analysis indicates, however, that regardless of whether the association is positive or negative, it is very weak (Wolf & Ackerman, 2005). Some researchers have suggested that the association between cognition and extraversion is domain-specific, such that individuals high in extraversion perform better on speed-based tasks, but worse on tasks that require effortful processing and reasoning (Luchetti, Terracciano, Stephan, & Sutin, 2016).

Conscientiousness has shown bi-directional associations with cognitive performance. Some studies found positive associations with speed of processing (Graham & Lachman, 2014; Soubelet & Salthouse, 2011; Stock & Beste, 2015), and short-term memory (Baker & Bichsel, 2006; Maldonato et al., 2017). However, conscientiousness is frequently negatively associated with abstract reasoning or fluid intelligence (Allik & Realo, 1997; Chamorro-Premuzic & Fumham, 2006; Chamorro-Premuzic & Furnham, 2008; Moutafi et al., 2003; Moutafi, Furnham, & Paitiel, 2004; Moutafi et al., 2005). Agreeableness is not typically associated with cognition (Ackerman & Heggestad, 1997; Austin et al., 2002; Baker & Bichsel, 2006; Chapman et al., 2012; Curtis et al., 2014; Furnham, Moutafi, & Chamorro-Premuzic, 2005; Graham & Lachman, 2014; Moutafi et al., 2005; Soubelet & Salthouse, 2011), although some reports found negative associations (e.g., measures of intelligence, spatial orientation, verbal fluency and reaction time) (Baker & Bichsel, 2006; Graham & Lachman, 2012; Maldonato et al., 2017; Schaie et al., 2004).

The strongest and most consistent finding is that openness is positively associated with cognitive abilities, followed by neuroticism being negatively linked to cognitive performance, as shown in a previous metanalysis (Ackerman & Heggestad, 1997), and several subsequent studies (Ashton, Lee, Vernon, & Jang, 2000; Baker & Bichsel, 2006; Chamorro-Premuzic, Furnham, & Petrides, 2006; Chamorro-Premuzic, Moutafi, & Furnham, 2005; Graham & Lachman, 2012, 2014; Maldonato et al., 2017; Mccrae, 1987; Moutafi et al., 2003; Moutafi et al., 2005; Schaie et al., 2004; Sharp, Reynolds, Pedersen, & Gatz, 2010; Soubelet & Salthouse, 2011).

Openness-Fluid-Crystallized-Intelligence (OFCI) is a developmental model integrating openness, fluid (Gf) and crystallized (Gc) intelligence (Ziegler, Danay, Heene, Asendorpf, & Bühner, 2012), and has been tested in younger and older adults (Ziegler, Cengia, Mussel, & Gerstorf, 2015; Ziegler et al., 2012). The OFCI combines four main components from previous research: environmental enrichment, environmental success, mediation hypotheses, and investment theory. The environmental enrichment hypothesis (Raine, Reynolds, Venables, & Mednick, 2002) assumes that openness has a positive longitudinal influence on Gf because individuals scoring higher on openness are more likely to encounter new learning opportunities. The environmental success hypothesis assumes that Gf positively affects the development of openness. Individuals with high Gf would have a higher probability of successfully managing new problems, increasing the likelihood that they would continue seeking new situations and thereby increasing their openness to experience. In addition, the mediation hypothesis suggests that openness also influences the development of Gc via the effect on the development of Gf. Therefore, in order to learn, it does not suffice to experience new and stimulating situations, but it is also critical that the new information be actively processed using higher cognitive abilities. Lastly, the OFCI model considers investment theory (Cattel, 1987), which states that Gf positively affects the development of Gc. In the case of older adults, the OFCI model was adapted to accommodate the decline of cognitive abilities with increasing age, and the authors suggest that openness acts as a buffer, slowing down cognitive decline (Ziegler et al., 2015).

Age, Cognition and Personality

The existence of age-related changes in cognition across the adult lifespan is well established, with a decrease of performance in several abilities, such as fluid reasoning, memory and speed of processing, but an increase in language (i.e.,vocabulary) (Salthouse, 2004, 2009; Salthouse & Ferrer-Caja, 2003; Stern et al., 2014). Regarding personality, despite its relative stability and the previous idea that personality becomes “set like plaster” by age 30 (i.e., the plaster hypothesis) (Costa & McCrae, 1994; Costa, Metter, & Mccrae, 1994; Costa & McCrae, 1997; Roberts & DelVecchio, 2000; Srivastava, John, Gosling, & Potter, 2003), there is compelling evidence of changes in personality across adulthood, including in old age.

Cross-sectional and longitudinal studies involving both young and older individuals indicated that an increase in age is associated with higher levels of agreeableness and conscientiousness, and lower levels of neuroticism and, less consistently, openness and extraversion (Allemand, Zimprich, & Hendriks, 2008; Caspi, Roberts, & Shiner, 2005; Costa & McCrae, 1997; Helson, Jones, & Kwan, 2002; McCrae, Martin, & Costa, 2005; Roberts & Mroczek, 2008; Roberts, Walton, & Viechtbauer, 2006; Soubelet & Salthouse, 2011; Srivastava et al., 2003; Terracciano, McCrae, Brant, & Costa, 2005; Weiss et al., 2005). Despite this observed age effect, it is relevant to consider that major life events can have an impact on personality traits, and are therefore confounded with age, since they occur in different phases of life. For instance, a study analyzed approximately 14.700 adults and found specific effects of some major life events (e.g., first job, marriage, childbirth, separation, divorce and retirement) on different personality traits (Specht et al., 2011). In addition, a framework to better understand personality development across adulthood (TESSERA) has been recently proposed. The framework posits that long-term personality development occurs due to repeated short-term, situational processes. For instance, on a "micro-level", there are triggering situations (T), expectancies (E), states and state expressions (SS), and reactions (RA) that lead to development of the respective traits on a "macro-level" (for a review, see Wrzuz & Roberts, 2017).

Little research has examined age effects on personality-cognition relations, and it is an area of debate. A study involving individuals from 19 to 96 years old found that personality-cognition relations were very similar among young, middle aged, and older adults (Soubelet & Salthouse, 2011). In contrast, a study involving adults from 22 to 84 years old found that age moderated the relationship between neuroticism and cognition (e.g., reasoning and reaction time) (Graham & Lachman, 2014). The same authors also reported that the relationship between personality change (over 10 years) and cognition varied by age, such that older adults whose neuroticism increased had significantly worse reaction times than those who remained stable or decreased in neuroticism (Graham & Lachman, 2012). Furthermore, it has been shown that cognition (i.e., fluid reasoning and working memory) can mediate the age-conscientiousness association, suggesting that conscientiousness may help to compensate for age differences in cognition (Soubelet, 2011).

Gender, Cognition and Personality

Gender differences in cognitive performance are well documented, typically finding that women outperform men on episodic memory and verbal production tasks, whereas men outperform women on tasks assessing visuospatial ability (De Frias, Nilsson, & Herlitz, 2006; Halpern & LaMay, 2000; Herlitz, Nilsson, & Backman, 1997; Voyer, Voyer, & Bryden, 1995). In the field of personality research, women have consistently scored higher than men on neuroticism and agreeableness (Costa, Terracciano, & McCrae, 2001; Feingold, 1994; Schmitt, Realo, Voracek, & Allik, 2008), and to some extent, extraversion (Donnellan & Lucas, 2008; Feingold, 1994; Weisberg, DeYoung, & Hirsh, 2011). There are inconsistent findings regarding extraversion differences across gender: men scored higher than women on some facets of extraversion (e.g., assertiveness, dominance), but lower on others (sociability, warmth, positive emotionality) (Costa et al., 2001; Feingold, 1994; Schmitt et al., 2008). Gender differences in conscientiousness and openness/intellect are less consistent. Some evidence suggests higher conscientiousness in women (Goodwin & Gotlib, 2004; Marsh, Nagengast, & Morin, 2013; Schmitt et al., 2008), and findings are contradictory regarding openness (Goodwin & Gotlib, 2004; Marsh et al., 2013; Schmitt et al., 2008). In addition, others found no gender differences regarding openness and conscientiousness at the trait-level, only in the facets of these traits (Costa et al., 2001; Feingold, 1994; Weisberg et al., 2011). For example, within the openness trait, men scored higher in intellect and ideas, while women scored higher in aesthetics and feelings, as well as in orderliness (a conscientiousness's facet).

In addition, gender differences in personality have been described as consistent between younger (Feingold, 1994) and older samples (Chapman, Duberstein, Sorensen, & Lyness, 2007), suggesting that gender does not moderate age differences in personality (Donnellan & Lucas, 2008; Marsh et al., 2013; Roberts et al., 2006). However, others have found that gender moderates age differences in neuroticism, openness and agreeableness. For example, a positive association was found for age and agreeableness in women, and a negative association was found for age and neuroticism in men, and age and openness in women (McCrae, Terracciano, & Personality Profiles of Cultures, 2005; Weisberg et al., 2011). Therefore, there is still a debate regarding whether gender is a moderator of age-related changes in personality. Importantly, to the best of our knowledge, there have been no studies on the effect of gender on personality-cognition relations, particularly across the lifespan.

The present study

Previous studies found associations between personality and age, and personality and gender; however, these demographic variables are rarely considered relevant when examining the relationship between personality and cognition, indicating a gap in the literature that should be more systematically investigated, particularly considering large datasets across the adult lifespan. The few studies including large datasets across lifespan (Graham & Lachman, 2014; Soubelet & Salthouse, 2011) found conflicting evidence when examining age as moderator of personality-cognition relations (Graham & Lachman, 2014; Soubelet & Salthouse, 2011). Furthermore, these studies failed to investigate gender as a moderator, which could be relevant because it can impact on both cognitive (De Frias et al., 2006) and personality scores (Schmitt et al., 2008). Furthermore, if age and gender can influence personality-cognition relations, we cannot rule out the possibility that these demographics could also interact and together affect these relations.

Additionally, it is critical to consider methodological limitations when estimating personality-cognition relations. For instance, using one single test score as a proxy for a cognitive ability can be problematic, which can both over- and under-estimate these correlations, confounding the results in the literature (Reeve, Meyer & Bonaccio., 2006). For instance, general and narrow cognitive abilities can present different associations with personality measures, which may not be psychometrically optimal or comprehensive. This measurement limitations could be overcome by assessing several cognitive domains using multiple well-stablished cognitive measures.

In order to address the gaps in the literature, the current study has two aims: 1) investigate personality-cognition associations across the adult lifespan; and 2) test whether age and gender moderate personality-cognition relations. These aims were investigated taking into account methodological advantages: a) different populations (i.e, two cohorts), b) relatively large sample sizes (> 400), c) wide age range (young, middle age and older adults), and d) cognitive domains based on multiple measures.

Methods

Samples and recruitment

The current report is based on two samples. Sample 1 was derived from our ongoing studies at Columbia University Medical Center: the Reference Ability Neural Network (RANN) study and the Cognitive Reserve (CR) study (Habeck et al., 2016; Stern, 2009; Stern et al., 2014). Sample 2 was derived from the Nathan Kline Institute-Rockland Sample Initiative (NKI-RSI), a community-ascertained lifespan sample (Nooner et al., 2012). Participants were recruited using established random market mailing procedures, as well as posting of materials in local shops, community centers and meeting places for NKI-RSI. Written informed consent was obtained from all participants prior to any study participation.

Sample 1—In the initial telephone screening, participants who met basic inclusion criteria (i.e., right handed, English speaking, no psychiatric or neurological disorders, and normal or corrected-to-normal vision) were further screened in person with structured medical and neuropsychological evaluations to ensure that they had no neurological or psychiatric conditions, cognitive impairment or contraindication for MRI scanning. Global cognitive functioning was assessed with the Mattis Dementia Rating Scale (Lucas et al., 1998); on which a minimum score of 135 was required for retention in the study. In addition, any performance on the cognitive test battery that was indicative of mild cognitive impairment was grounds for exclusion. The studies were approved by the Internal Review Board of the College of Physicians and Surgeons of Columbia University. Additional details about procedures can be found in previous reports (Habeck et al., 2016; Stern, 2009; Stern et al., 2014) (Salthouse et al., 2015).

Sample 2—The study included residents of Rockland, Bergen, Orange and Westchester counties, aged 6–85, who were fluent in English. General NKI-RSI exclusions were assessed over a screening phone call or determined at the time of study participation by the research team, and included chronic or significant medical illness, serious neurological or metabolic disorders, contraindication for MRI scanning, or inability to ambulate independently. Other exclusionary criteria included any psychiatric condition, which were determined through self-report at screening or at study visit via diagnostic interview (SCID-I/NP) (First, Spitzer, Gibbon, & Williams, 2002).

In addition, individuals with an estimated full score IQ below 70 in the Wechsler Abbreviated Scale of Intelligence 2nd Edition (WASI-II) (Wechsler, 2011) were excluded from the study. This study is in compliance with the Columbia University Institutional Review Board. A more detailed description about this study can be found in (Nooner et al., 2012 and Colvin et al., 2018). Besides the initial screening, we only included participants with available data on personality and a minimum of cognitive tests enough to calculate one cognitive domain (e.g., reasoning, language, memory or speed of processing).

Measures

Personality

In Sample 1, personality was measured using the 50-item Big-Five scale from the International Personality Item Pool (IPIP), to evaluate five major dimensions of personality: Openness to Experience, Conscientiousness, Extraversion, Agreeableness, and Neuroticism (reversed Emotional Stability) (Goldberg, 1999). Participants rated themselves on a 5-point scale ranging from “Strongly Agree” to “Strongly Disagree” with respect to how well each statement described them. In the sample included for analysis, we identified 0.03% of item-level missing data in the questionnaire. We computed prorated values by averaging the available items in each personality dimension subscale that had missing values (Schafer & Graham, 2002). We allowed the maximum of two items missing in each personality dimension subscale for each participant.

In Sample 2, personality was measured through the NEO Five Factor Inventory (NEO-FFI-3), which included the 60item scale to assess the same five major dimensions of personality mentioned above. Similarly to the IPIP, participants were asked to select the response that best represents their opinion on a 5-point scale ranging from “Strongly Agree” to “Strongly Disagree” (McCrae & Costa, 2010).

Cognition

Each participant underwent an extended cognitive evaluation. Based on previous factor analysis (Salthouse et al., 2015; Soubelet & Salthouse, 2011) we created four cognitive domains in Sample 1: reasoning, language, memory and speed of processing. In order to create similar cognitive domains, we applied the Principal Axis Factor (PAF) analysis to Sample 2, in which the items loaded onto the same cognitive factors (Figure 1S, Supplemental Material). First, we performed a parallel analysis to determine the number of factors within our neuropsychological tasks. We then examined the structure, loadings and statistical fit parameters of the three- and five-factor models. Lastly, to examine the robustness of the extracted factor structure independent of any age effects, we performed the same PAF analysis after residualizing all neuropsychological task performances with regards to age. The analysis was performed in R using the psych (Revelle, 2010) and lavaan (Rosseel, 2012) packages.

In Sample 1, the cognitive domains included the following tests: *Reasoning*: Wechsler Adult Intelligence Scale (WAIS-III) Matrix Reasoning, Letter-number Sequencing, and Block Design test\ (Wechsler, 1997); *Language:* WAIS-III Vocabulary test, the Wechsler Test of Adult Reading (WTAR) (Wechsler, 2001), and the American National Adult Reading Test (AMNART) (Grober, Sliwinski, & Korey, 1991); *Memory*: Selective Reminding Test (SRT); last trial, continuous long-term retrieval and last retrieval (Buschke & Fuld, 1974); *Speed of Processing*: WAIS-III Digit-symbol (digit coding test), Stroop Color Naming test (Golden, 1975), and Trail Making Test (TMT)-A (time) (Reitan, 1978).

Based on the PAF analysis and the measures available in Sample 2, efforts were made to include the most similar tests in each cognitive domain, as following: *Reasoning*: WASI-II Matrix Reasoning and Block Design tests (Wechsler, 2011), and the TMT Number-Letter Switching ('TMT-B like' from Delis-Kaplan Executive Functioning System (D-KEFS) (Delis, Kaplan & Framer, 2001); *Language*: WASI-II Vocabulary test, and the Wechsler Individual Achievement Test - 2nd Edition Abbreviated (WIAT-IIA) Word Reading and Spelling tests (Wechsler, 2005); *Memory*: Rey Auditory Verbal Learning Test (RAVLT) (Schmidt, 1996), sum of the five learning trials, list B and delayed recall (Schmidt, 1996); *Speed of Processing*: D-KEFS 'Stroop' like task, the Color Naming (time) and Inhibition (time) tests (Delis, Kaplan & Kramer, 2001).

Statistical Analysis

Data description and regression models

Demographics characteristics and IQ scores of the participants were present with means, standard deviation or percentage; and differences across the age groups were tested using analyses of variance (ANOVA), or Pearson chi-squared test (Table 1). In order to assess the relationship between personality and cognition for each sample, we used structural equation model (SEM) as depicted in Figure 1. In defining cognition, four cognitive abilities were formed from apriori selected variables, and general cognitive ability was defined as the second order latent variable of the four cognitive abilities. In addition, we fitted additional models (Figure 1 Supplemental Material) in which personality predicted general cognitive ability (instead each of the cognitive abilities separated), in order to investigate associations between the general cognitive factor and personality. We had to create a separate model to fit general cognitive ability predictions since the models would not converge if these predictions were included in the same model with the predictions of each of the cognitive abilities. Regarding the estimation method, full information maximum likelihood (FIML) was used to allow missing values in the models. In addition, all of the predictor variables in the models (i.e., personality, age and gender) were allowed to correlate.

In order to examine associations between personality, cognition, age and gender, separate SEMs were conducted for each of the personality measures, with age and gender as predictors and cognition as an outcome (Table 2). Unadjusted standardized regression coefficients from the second order hierarchical model represent marginal association of cognitive abilities with personality, age and gender. In addition, the associations between personality and age were described with Pearson correlation coefficients, and the association between personality and gender were presented with standardized regression coefficients. In Model 1 of Figure 1, we investigated the association between personality and cognitive performance by controlling for relevant demographics that can influence personality and cognition (i.e., age and gender), and all the personality variables, in order to control for the other personality traits, and therefore assess the unique relationship between each personality trait and cognitive ability. In Model 2, we added two-way interaction terms to the previous model in order to examine the potential moderator effect of age or gender in personality-cognition associations. Lastly, in Model 3, we added the three-way interaction term (age, gender, personality) to investigate possible moderation of age and gender (in combination) in the personality-cognition associations. The variables were centered when using the interaction terms. Model fit indices were calculated for each model, including Generalized Least Squares (GLS), Root Mean Square Error of Approximation (RMSEA), Chis-squared, and p-values. In addition, since Models 2 and 3 included multiple testing, we applied FDR correction for multiple comparison in the results (Benjamini & Hochberg, 1995).

In addition, we conducted a mini-metanalysis procedure (Goh, Haal, & Rosenthal, 2016) in order to examine personality-cognition associations combining results from the two samples. We computed the combined effect size for the weighted means correlations as follows. First, the partial eta-squared of the effects of interests were converted to r by taking the square root, reserving the signs of the beta estimates. The r values from two studies were transformed via Fisher's z transformation, and the weighted z scores were computed as $\overline{z}_{combined} = \frac{(N_1 - 3)z_1 + (N_2 - 3)z_1}{(N_1 - 3) + (N_2 - 3)}$. For easier interpretation, the weighted z scores were converted to $\overline{r}_c$ via inverse Fisher's z transformation. To summarize p-values for the two studies, the Stouffer's Z test was conducted as described previously (Goh et al., 2016) and the p-values are reported ($\overline{p}_c$). The analysis was performed in R using lavaan (Rosseel, 2012) package. Finally, we state that we reported our samples size selection, and criteria for data exclusion. In addition, we reported all measures considered relevant for the current study from a larger set of measures administrated in the CR and RANN studies.

Results

A general description of the two samples is provided in Table 1. It included 422 participants in Sample 1, and 549 in Sample 2. The mean age of the participants in Sample 1 was 54 years, slightly higher than the mean age in Sample 2 (49.5 years). Furthermore, Sample 2 displayed a higher percentage of women, and lower mean education and IQ than Sample 1. When analyzing demographics by age groups, we observed that Sample 2 showed age differences in percentage of women, education, and IQ scores, while Sample 1 only showed differences in IQ scores.

Table 2 provides correlations between cognitive performance, personality scores, age and gender, considering the hierarchical model. All cognitive domains were associated with openness, which was observed for general cognitive ability, language and memory in both samples, but for speed only in Sample 1, and for reasoning only in Sample 2. In addition, there were negative associations between language and personality, such that in Sample 1 language was associated with neuroticism, and in Sample 2 language was correlated to extraversion. Age was negatively correlated with neuroticism in both cohorts, but correlations with extraversion and agreeableness occurred only in Sample 2. There was no association between gender and any personality trait in Sample 1, while in Sample 2 women presented higher scores of conscientiousness and agreeableness. Regarding cognitive measures, age effects were similar in the two datasets, indicating a decline of performance as a function of age in general cognitive ability, reasoning, memory and speed, but an increase of language scores. Lastly, gender was only associated with general cognitive ability in Sample, indicating a better performance in men.

In addition, model fit indices were calculated for each of the models, and all models were considered as good fit. We calculated Generalized least squares (GLS), Root Mean Square Erroor of Approximation (RMSEA) and Chis-squares

Model 1: personality-cognition relations

Model 1 results are presented in Table 3, reflecting the pattern of personality-cognition associations in each sample. Openness was positively associated with most cognitive measures, indicating that higher openness is linked to better general cognitive ability, reasoning, language, and memory. Extraversion was negatively associated with general cognitive ability, reasoning and language in both samples. In addition, we found specific results for each sample, such as the positive association between conscientiousness and speed in Sample 1, and the negative association between neuroticism and both general cognitive ability, and reasoning, in Sample 2.

Moderation effects: Models 2 and 3

Table 4 describes the moderators of cognition-personality relations. Regarding Model 2, we observed gender moderations only in Sample 2. Gender moderated the association between conscientiousness and reasoning, conscientiousness and general cognitive ability, openness and memory, and openness and general cognitive ability. In Model 3, both age and gender moderated the relationship between conscientiousness and language in Sample 1. Despite these initial findings, none of these moderations survived FDR correction.

Metanalysis Summary

After combining the two samples using the mini-metanalysis procedure (see Table 3 and Table 4), we found that openness was associated with general cognitive ability and all four cognitive abilities in Model 1. In addition, extraversion was negatively associated with general cognitive ability, reasoning and language; neuroticism was negatively associated with general cognitive ability and reasoning; and conscientiousness was positively associated with speed. In Model 2, gender moderated the association between conscientiousness and reasoning, and conscientiousness and general cognitive ability, indicating that higher levels of conscientiousness were associated with better reasoning in women, but not in men (Figure 2).

Discussion

The present study investigated the relations between the FFM of personality and cognitive domains across adult lifespan in two independent samples, and whether these relations can be moderated by age and gender. We report two major findings. First, aspects of personality are associated with specific cognitive abilities, and these relations are consistent across the two samples. Openness was positively associated with all cognitive abilities, conscientiousness was positively associated with speed, extraversion was negatively associated with general cognitive ability, reasoning and language, and neuroticism was negatively linked to general cognitive ability and reasoning. Second, age and gender moderation was weak and not consistent across samples. Although none of the moderation survived FDR correction, the gender moderations on the association between conscientiousness and cognitive ability (i.e., reasoning and general cognition) remained significant after applying a metanalytical procedure across the two samples.

The strongest relation between personality and cognition occurred between openness and intelligence measures: both fluid (reasoning factor), crystallized (language factor). This observation has been reported by others, and is not surprising since some of the adjectives used to measure openness have an intellectual connotation, leading researchers to call it the "Intellect factor" (Ackerman & Heggestad, 1997; Ashton et al., 2000; Baker & Bichsel, 2006; DeYoung, Peterson, & Higgins, 2005b; Schaie et al., 2004; Soubelet & Salthouse, 2011). We also found that openness predicted memory performance, similar to previous research (Schaie et al., 2004; Soubelet & Salthouse, 2011; Terry, Puente, Brown, Faraco, & Miller, 2013), which remained significant when applying a metanalysis to both samples. Although we did not find that openness was associated with speed in either sample, this relationship was significant after applying the metanalytical procedure, in line with previous reports (Sharp et al., 2010; Soubelet & Salthouse, 2011), but not others (Graham & Lachman, 2014; Wettstein, Tauber, Kuzma, & Wahl, 2017). These findings are consistent with the OFCI model (Ziegler et al., 2012), suggesting that individuals with higher levels of openness may be more likely to spend time exploring intellectual pursuits, which can influence cognitive performance.

Associations between extraversion and cognition have been inconsistently noted. Previous metanalysis indicates that the extraversion-intelligence relationship varies in magnitude and direction as a function of study, depending on the instruments used (Wolf & Ackerman, 2005). In the current study, extraversion was negatively associated with language, reasoning and general cognitive ability in both samples. These results are in line with previous studies focused on FFM that also included young, middle and older individuals (Graham & Lachman, 2014; Soubelet & Salthouse, 2011), but are inconsistent with another report (Schaie et al., 2004). In addition, Baker and colleagues found negative associations between extraversion and crystallized knowledge only for young adults, but not for older individuals (Baker & Bichsel, 2006). Furthermore, others have suggested that introverted individuals may display slower performance, because they are more likely to take time to think thoroughly about a task (Baker & Bichsel, 2006; Wolf & Ackerman, 2005). We hypothesize that the association between extraversion and cognition may differ based on the extent to which better scores are related to accuracy, effortful processing or speed (Chamorro-Premuzic & Fumham, 2006; Luchetti et al., 2016).

In addition, we only found a positive association between conscientiousness and speed of processing in one sample, in line with previous reports (Graham & Lachman, 2014; Soubelet & Salthouse, 2011; Stock & Beste, 2015), which remained significant in the metanalysis considering the two samples. This finding may be related to the observation that highly conscientious people tend to be more organized, goal-directed and present self-discipline, with evidence of a more efficient step-by-step processing strategy to achieve a goal, which may contribute to a faster performance (Stock & Beste, 2015).

Our study supports the claim that higher levels of neuroticism is associated with poorer cognitive performance in healthy adults, in line with several cross-sectional studies (Graham & Lachman, 2014; Soubelet & Salthouse, 2011; Saylik, Szamentat, Cheeta, 2018), and longitudinal findings that indicate higher neuroticism is associated with greater cognitive decline in older adults (Luchetti et al., 2016; Waggel et al., 2015), major depression, and incident Alzheimer’s disease (for a review see Terracicano & Sutin, 2019). These findings are consistent with the “mental noise hypothesis”, which suggests that individuals with higher neuroticism experience more mental noise due to higher levels of anxiety, stress, worry-related thoughts, aspects that contribute to distractions and can impair cognitive performance (Curtis, Windsor, & Soubelet, 2015; Robinson & Tamir, 2005; Robison, Gath, & Unsworth, 2017). Another hypothesis, particularly for older individuals, is that the prolonged arousal experienced by individuals with higher neuroticism causes neural damage over time (Curtis et al., 2015).

We did not find any associations between agreeableness and cognition in any sample, consistent with other reports (Ackerman & Heggestad, 1997; Austin et al., 2002; Baker & Bichsel, 2006; Chapman et al., 2012; Curtis et al., 2014; Furnham et al., 2005; Graham & Lachman, 2014; Moutafi et al., 2005; Soubelet & Salthouse, 2011). However, others have described negative associations (Baker & Bichsel, 2006; Graham & Lachman, 2012; Maldonato et al., 2017; Schaie et al., 2004), suggesting that better cognitive abilities decrease the need for pleasing others and are thus related to lower levels of agreeableness (Baker & Bichsel, 2006; Segel-Karpas & Lachman, 2016). In addition, highly agreeable people may rely on their social skills, rather than on cognitive performance as a main avenue for achievements, which possibly contributes to the lack of association between agreeableness and cognition (Segel-Karpas & Lachman, 2016).

We found that age and gender moderated personality-cognition relations differently in each sample; however, none of these moderations remained significant after FDR correction for multiple comparisons. Our findings are in line with the report of no age moderation on personality-cognition relations across adulthood (Soubelet & Salthouse, 2011), but are not consistent with another study that found that age moderates personality-cognition associations (Graham & Lachman, 2014), although this study did not apply correction for multiple comparisons. Despite that, the metanalysis results showed a significant moderation indicating that gender may moderate reasoning-conscientiousness. Therefore, the pattern observed in Sample 2 was extended when considering the two samples together, indicating that higher levels of conscientiousness are associated with better reasoning in women, but not in men.

The present study had several strengths. First, we analyzed personality-cognition relations across adult lifespan using two different cohorts, including large sample sizes and wide age range. Second, each cognitive domain was created based on multiple cognitive tests, which minimizes the bias of a specific task. In each sample, the cognitive tests were grouped based on a statistical method (i.e., factor analysis), in order to reassure the tasks were measuring the same cognitive domain. Third, the personality scales across cohorts (IPIP vs NEO-FFI) are both based on the Five-Factor Model and have been demonstrated to be highly correlated (Gow, Whiteman, Pattie & Deary, 2005). Fourth, we conducted a mini-metanalysis procedure that allowed us to examine personality-cognition relations combining data from the two samples, thus optimizing the power of our analysis. Lastly, we were able to examine the unique association of each trait to each cognitive factor, since our models controlled for the other personality traits, age and gender, which are critical demographics that can interfere in cognitive performance and personality.

Despite its contributions, our study does have important limitations. We used a cross-sectional design to investigate personality-cognition relations, which does not allow us to make directional conclusions, infer causality, and exclude cohort effects. Future work involving longitudinal data will allow for testing causal models to further understand the associations identified. Personality data was examined only at the trait-level, and not sub-factor level (e.g., facets), which limits the interpretation of the results, and may account for some variability in the findings. Future work should include facets more systematically, and not only traits in order to better understand personality-cognition relations (Graham & Lachman, 2014). In addition, both samples were highly educated, which limits the external validity of the study. Additional research on personality-cognition relations involving wider educational range is relevant, especially because educational attainment can moderate personality-cognition relations (Rammstedt et al., 2016). Finally, it is possible that the differences between samples may reflect the different cognitive and personality instruments used in each sample. Previous research has shown two major subfactors within each of the Big Five factors (De Young, Quilty & Peterson., 2007), however the two factors are better represented in the NEO-FFI than in the IPIP-50. For instance, in the IPIP-50, the openness scale is tilted more toward intellect than openness to experience, and the conscientiousness scale is strongly biased to orderliness rather than industriousness. This difference across instruments suggests that the IPIP-50 presents a narrower personality assessment than the NEO-FFI, which may influence associations with cognitive ability. Last, we do not rule out that the interactions observed may reflect random findings, although results were corrected for multiple comparisons.

In conclusion, this study extends previous findings and provides novel information on personality-cognition relations. First, we observed in two independent samples that personality was associated with cognitive performance, particularly openness, and extraversion, and to some extent conscientiousness and neuroticism. We found that crystallized and fluid intelligence (i.e., language and reasoning, respectively) were the cognitive abilities most consistently linked with personality; however, memory and speed were also associated. In addition, our findings suggest that age and gender do not consistently moderate personality-cognition relations, however we found that gender may moderate conscientiousness-reasoning associations, indicating that these relations may be more complex that previous research has suggested. Investigating the complexity of personality-cognition relations can help to elucidate patterns of behavior throughout the lifespan that might be a protective resource or a source of vulnerability to cognitive functioning, especially later in life.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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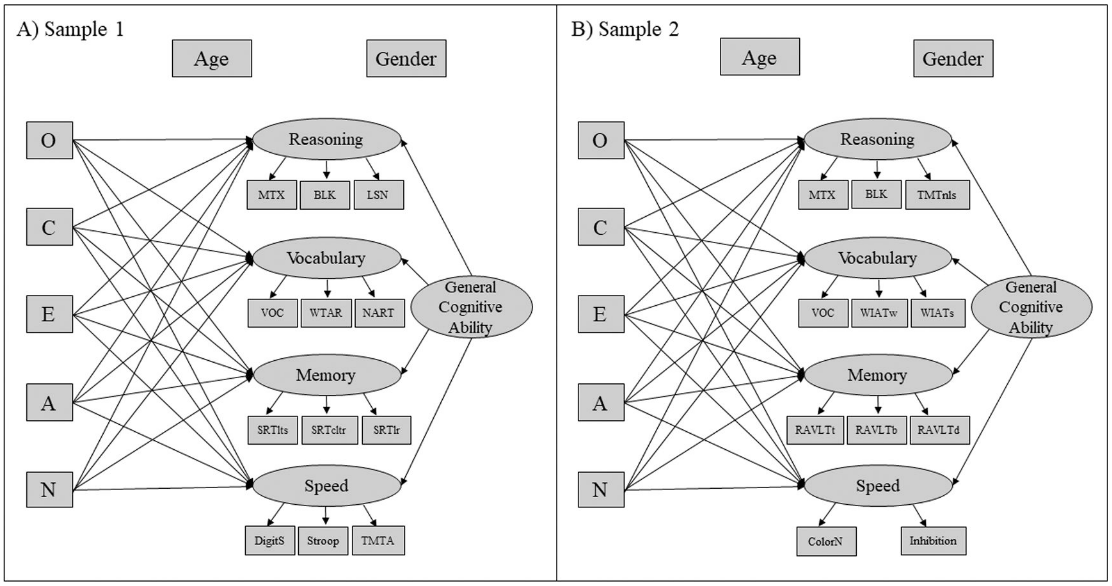

Figure 1. Structural Equation Models for each Sample.

In the models, age and gender are linked (through regression paths) to all cognitive abilities. All predictors (age, gender and personality) were allowed to correlate. BLK = Block Design; ColorN = Color Naming; DigitS = Digit-Symbol; LSN = Letter-number Sequencing; NART = National Adult Reading Test; MTX = Matrix Reasoning; RAVLT = Rey Auditory Verbal Learning Test (t=total five learning trials; b = list B; d = delayed recall); SRT = Selective Reminding Test; TMTA = Trail Making Test part A; TMT-nls = Trail Making Test Number-Letter Switching; VOC = Vocabulary; WIAT = Wechsler Individual Achievement Test (w = word reading; s = spelling); WTAR = Wechsler Test of Adult Reading.

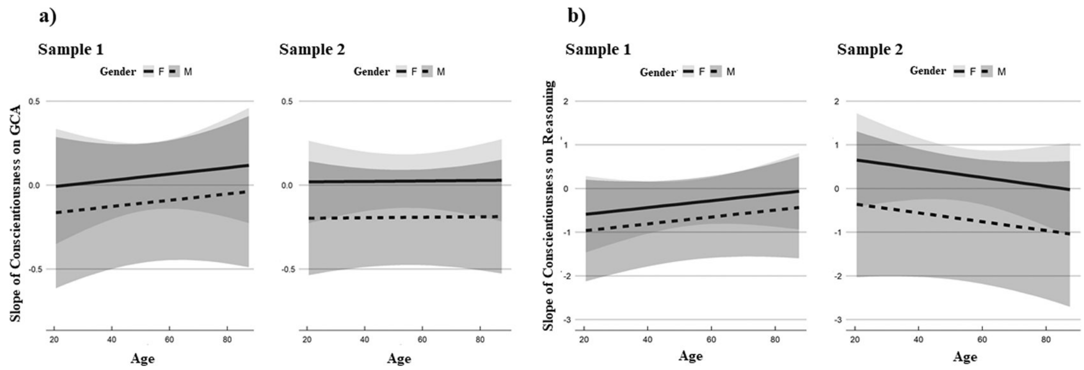

Figure 2. Gender Moderation on Conscientiousness-cognition Association.

a)mRefers to gender moderation on Conscientiousness and Global Cognitive Ability (GCA); b) Refers to gender moderation on Conscientiousness and Reasoning. F = Female; M = Male.

Table 1.

General description of the samples

	All	Young	Middle Age	Older Adults	p-value
Sample 1	**19–80 years**	**19–39 years**	**40–59 years**	**60–80 years**	
Number of subjects	422	106	100	216	
Age, M (SD), years	54.0 (16.7)	29.3 (4.9)	50.5 (5.3)	67.7 (5.2)	<.001
Sex, % of Women	54.6 %	50.9 %	58.6 %	54.6 %	.54
Education, M(SD), years	16.2 (2.3)	15.8 (2.3)	16.2 (2.3)	16.4 (2.3)	.15
IQ Scores	117.0 (8.5)[2]	113.4 (8.2)	116.1 (8.2)	119.1 (8.1)	<.001
Sample 2	**18–85 years**	**18–39 years**	**40–59 years**	**60–85 years**	
Number of subjects	549	168	181	200	
Age, M (SD), years	49.5 (18.8)	25.6 (6.1)	49.8 (5.7)	69.5 (6.1)	<.001
Sex, % of Women	67.9 %	57.7%	80.1%	65.5%	<.001
Education, M(SD), years	15.7 (2.2)	15.0 (2.0)	16.0 (2.1)	16.2 (2.3)	<.001
IQ Scores	101.4 (13.1)[1]	99.3 (11.9)	99.2 (12.1)	105.2 (14.0)	<.001

[1] *Note:* IQ scores based on American National Reading Test (AMNART);

[2] IQ scores based on Wechsler Abbreviated Scale of Intelligence (WASI);

M = Mean; SD = Standard Deviation. P-value refers to the comparison (one-way ANOVA) between young, middle age and older adults.

Table 2.

Associations between cognitive abilities, personality, age and gender

	O	C	E	A	N	Age	Gender
SAMPLE 1							
General Cognitive Ability	**.23 (.001)**	−.07 (.20)	−.07 (.20)	−.01 (.80)	.03 (.54)	**−.67 (<.001)**	**−.12 (.01)**
Reasoning	.21 (.65)	−.11 (.71)	−.09 (.83)	−.02 (.87)	.03 (.83)	**−.47 (.03)**	−.01 (.71)
Language	**.26 (<.001)**	−.01 (.84)	−.02 (.62)	.08 (.13)	**−.10 (.04)**	**.25 (<.001)**	−.009 (.56)
Memory	**.13 (.01)**	−.06 (.20)	−.02 (.67)	.004 (.94)	.02 (.65)	**−.47 (<.001)**	.002 (.89)
Speed	**.14 (.01)**	.10 (.10)	.01 (.86)	− .01 (.74)	.09 (.08)	**−.63 (<.001)**	−.003 (.88)
Age	−.08 (.08)	.05 (.22)	.01 (.82)	.05 (.29)	**−.13 (.004)**	- -	- -
Gender	.06 (.16)	.03 (.42)	.09 (.05)	.08 (.07)	.02 (.66)	- -	- -
SAMPLE 2							
General Cognitive Ability	**.22 (<.001)**	−.03 (.57)	−.009 (.86)	−.06 (.25)	−.03 (.50)	**−.46 (<.001)**	−.03 (.65)
Reasoning	**.19 (.005)**	−.03 (.50)	.002 (.96)	−.09 (.08)	−.04 (.37)	**−.43 (<.001)**	.01 (.56)
Language	**.21 (<.001)**	−.04 (.43)	**−.11 (.01)**	−.01 (.84)	−.02 (.64)	**.15 (<.001)**	−.009 (.55)
Memory	**.11 (.02)**	−.06 (.20)	.03 (.56)	.01 (.82)	.02 (.55)	**−.38 (<.001)**	−.02 (.09)
Speed	.08 (.10)	.04 (.39)	.07 (.14)	−.007 (.88)	−.01 (.70)	**−.38 (<.001)**	.01 (.54)
Age	−.06 (.16)	.04 (.27)	**−.13 (.002)**	**.15 (<.001)**	**−.15 (<.001)**	-	-
Gender	.03 (.45)	**.10 (.01)**	.04 (.29)	**.30 (<.001)**	.01 (.79)	-	-

Note: Associations between cognition, personality, age and gender represent standardized regression coefficient from unadjusted models. Age and personality associations are presented with Pearson correlations; and personality and gender associations are described with standardized regression coefficients. Reference values for gender: 1 - women; 0 - men. Values for General Cognitive Ability are based on a separate model. Higher speed values reflect better performance. P-values are presented in the parentheses, and significant results are highlighted in bold.

Table 3.

Personality-cognition relations in each sample and meta-analyzed (Model 1)

		Sample 1 (n=422)			Sample 2 (n=549)			Metanalysis[a]	
Cognitive Ability	**Personality Trait**	**Estimates**	**95% CI**	***p***	**Estimates**	**95% CI**	***p***	***r***	***p***
General Cognitive Ability	Openness	.30	[.12, .48]	**001**	.25	[.14, .36]	**<.001**	.21	**<001**
	Conscientiousness	−.007	[−.17, .16]	.93	−.05	[−.17, .107]	.40	−.02	.52
	Extraversion	−.15	[−.30, −.008]	**.03**	−.13	[−.25, −.01]	**.02**	−.11	**.002**
	Agreeableness	−.02	[−.17, .11]	.72	−.04	[−.16 .07]	.45	−.03	.43
	Neuroticism	−.04	[−.18, .10]	.57	−.19	[−.32, −.106]	**.003**	−.10	**.01**
Reasoning	Openness	.82	[.16, 1.4]	**.01**	.42	[.18, .66]	**.005**	.22	**<001**
	Conscientiousness	−.40	[−.84, .03]	.07	−.10	[−.32, .11]	.34	−.08	.05
	Extraversion	−.09	[−1.07, −.04]	**.03**	−.23	[−.44, −.03]	**.02**	−.14	**.002**
	Agreeableness	−.04	[−.40, .31]	.81	−.24	[−.35 .05]	.16	−.04	.24
	Neuroticism	−.23	[−.59, .12]	.19	−.37	[−.62, −.12]	**.003**	−.13	**.002**
Language	Openness	.55	[.39, .71]	**<.001**	.38	[.25, .52]	**<.001**	.29	**<001**
	Conscientiousness	−.13	[−.30, .02]	.09	−.04	[−.18, .09]	.54	−.05	.10
	Extraversion	−.25	[−.41, −.09]	**.002**	−.20	[−.34, −.06]	**.004**	−.14	**<001**
	Agreeableness	.02	[−.14, .19]	.78	−.08	[−.22, .05]	.24	−.02	.53
	Neuroticism	−.11	[−.27, .04]	.14	−.07	[−.22, .06]	.29	−.06	.07
Memory	Openness	.16	[.03, .28]	**.01**	.14	[−.02, .26]	**.02**	.11	**<001**
	Conscientiousness	−.08	[−.19, .02]	.11	−.10	[−.24, .03]	.15	−.07	**.03**
	Extraversion	−.08	[−.120 .02]	.13	−.04	[−.17, .09]	.52	−.05	.13
	Agreeableness	.01	[−.09, .13]	.75	.08	[−.04, .21]	.19	.04	.25
	Neuroticism	−.07	[−.18, .04]	.22	−.09	[−.23, .04]	.19	−.06	.07
Speed	Openness	.15	[−.01, .33]	.08	.08	[−0.05,0.21]	.22	.07	**0.03**
	Conscientiousness	.24	[05, .43]	**.01**	.04	[−.09, .17]	.53	.07	**0.02**
	Extraversion	−.02	[−.19, .14]	.76	−.03	[−.18, .11]	.64	−.02	0.58
	Agreeableness	−.05	[−.23, .14]	.51	.03	[−.08, .16]	.54	.00	0.97
	Neuroticism	.08	[−.07 .24]	.28	−.10	[−.25 .04]	.16	−.01	0.82

Note. Models included all personality factors, and are adjusted for age and gender. CI = confidence interval, DV = dependent variable, IV = independent variable. Significant p-values (< .05) are in bold. Analysis for General Cognitive Ability were run in a separate model.

[a]Results referred to the both samples meta-analyzed.

Table 4.

Moderators of personality-cognition relations in each sample

			Sample 1*			Sample 2*			Metanalysis[1]	
Model	**Cognitive Factor (DV)**	**Interaction term**	**Estimates**	**95% CI**	***p***	**Estimates**	**95% CI**	***p***	***r***	***p***
2										
	Reasoning	Gender*Conscien	−.22	[−.87, .42]	.49	−.55	[−.98,−.12]	**.01**	−.10	**.02**
	GCA	Gender*Conscien	−.15	[−.44, .13]	.29	−.22	[−.45, .009]	.06	−.09	**.03**
	Memory	Gender*Openness	−.12	[−.35, .11]	.35	.32	[−.04, .59]	**.02**	.04	.37
	GCA	Gender*Openness	−.26	[−.54, .01]	.06	.25	[.02, .49]	**.03**	.01	.83
3	Language	Age*Gender*Conscien	.02	[.01, .04]	**.001**	−.006	[−.02, .007]	.34	.05	.11

Note: Models are adjusted by age, gender, and the other personality traits. Model 2 included two-way interaction terms in the absent of the 3-way interaction terms, which were included only in the Model 3. Only significant results are displayed in the table.

CI = confidence interval. Abbreviations: Conscien. = Conscientiousness; GCA: General Cognitive Ability. Significant p-values (< .05) are in bold.

*No interactions survived after multiple comparison correction (FDR).

[1] Results referred to the both samples meta-analyzed