Personality-Cognition Relations across Adulthood

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Abstract

Although an increasing number of studies have investigated relations between dimensions of personality and level of cognitive functioning, the research results have been somewhat inconsistent. Furthermore, relatively little is known about whether the personality-cognition relations vary as a function of age in adulthood. The current project examined these issues with data from a sample of 2,317 adults between 18 and 96 years of age who each completed a personality inventory and performed a broad battery of cognitive tests. The results revealed strong relations of the personality trait of Openness with several distinct cognitive abilities, and smaller relations of other personality traits with specific cognitive abilities. Comparisons across different age groups indicated that the personality-cognition relations were both qualitatively and quantitatively similar across the adult years.
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There has been considerable research on the relations of age to personality (e.g., McCrae, Martin & Costa, 2005; Roberts & Mroczek, 2008; Srivastava, John, Gosling & Potter, 2003; Terracciano, McCrae, Brant & Costa, 2005), on the relations of age to cognition (e.g., Salthouse, 2004; Salthouse & Ferrer-Caja, 2003; see Craik & Salthouse, 2008 for a review), and some research on the relations of personality to cognition (e.g., Ackerman & Heggestad, 1997; Moutafi, Furnham & Crump, 2006; Schaie, Willis & Caskie, 2004). However, results of studies investigating personality-cognition relations have not always been consistent. For example, reported correlations between both Extraversion and Conscientiousness have sometimes been positive and sometimes negative (for contradictory results on Extraversion: e.g., Ackerman & Heggestad, 1997; Austin et al. 2002; Meier, Perrig-Chiello, & Pierrig, 2002; Moutafi, Furnham, & Paltiel, 2005; Moutafi, et al., 2006; see also Wolf & Ackerman, 2005; for contradictory results on Conscientiousness: e.g., Allik & Realo, 1997; Booth, Schinka, Brown, Mortimer, & Borenstein, 2006; Furnham & Chamorro-Premuzic, 2006; Moutafi et al., 2006; Moutafi, Furnham & Crump, 2003; Moutafi, Furnham & Paltiel, 2004). In addition, although the relations of Neuroticism to cognitive measures tend to be negative in nature (e.g., Crowe, Andel, Pedersen, Fratiglioni, & Gatz, 2006; Judge, Higgins, Thoresen, & Barrick, 1999; Wilson, Schneider, Boyle, Arnold, Tang & Bennett, 2007), they have not always been significant (e.g., Arbuckle, Gold, Andres, Schartzman, Chaikelson, 1992; Hultsch, Hertzog, Small & Dixon, 1999; Jelicic, Bosma, Ponds, Van Boxtel, Houx, & Jolles, 2003; Schaie et al., 2004; Wheterell, Reynolds, Gatz & Petersen, 2002). The most consistent finding regarding the relations between personality and cognition may be that higher levels of Openness are associated with better performance on several cognitive
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tasks (e.g., Ackerman & Heggestad, 1997; DeYoung, Peterson, & Higgins, 2005; Judge et al., 1999; for relations between creativity and typical measures of intelligence, see DeYoung, Flanders, & Peterson, 2008).

One potential reason for the inconsistent results is that relatively little research has examined the possibility that personality-cognition relations might vary as a function of age (but see Hultsch et al., 1999). This omission is unfortunate because in addition to determining whether the relations generalize to other segments of the population, examination of age relations could be informative about the nature of age differences in both personality and cognition. For example, an increase in the strength of the personality-cognition relation with increased age might suggest that the two aspects are becoming more closely integrated, or less differentiated, with increased age. Alternatively, a nearly constant relation between aspects of personality and aspects of cognition across the adult years would be consistent with the preservation of the distinction between the two dimensions of functioning across the adult years.

There were two major goals of the current project. The first was to determine which dimensions of personality are related to which aspects of cognitive functioning. The second goal was to investigate whether the personality-cognition relations differed across adulthood. Among the desirable conditions for providing meaningful answers to these questions are a moderately large sample of participants across a wide age range, reliable assessment of major dimensions of personality, broad and sensitive coverage of cognition, and evidence that the relevant aspects of both personality and cognition are measured in a similar fashion at different ages.
The current project attempted to incorporate these characteristics by examining data from a sample of 2,317 adults between 18 and 96 years of age who each completed the International Personality Item Pool personality questionnaire (IPIP; Goldberg, 1999) which assesses the “Big 5” personality traits, and also performed a broad variety of cognitive tests. The cognitive tests were selected to represent the four cognitive abilities indicated in Figure 1, and prior research (e.g., Salthouse, 2004; Salthouse & Ferrer-Caja, 2003; Salthouse, Pink & Tucker-Drob, 2008) has established that all of the variables have good reliability (i.e., coefficient alphas greater than .7) and validity (i.e., factor loadings greater than .7).

There were four major phases to our analyses. Because we were interested in age relations, we first divided our sample into three age groups which approximately corresponded to the periods of young adulthood (18-39), middle adulthood (40-59), and older adulthood (60-96). Confirmatory factor analyses were then conducted to investigate the structure of the cognitive abilities and the personality traits and determine whether it is reasonable to assume that they were invariant across age groups. Next we converted the composite scores for the cognitive abilities and the scores for the personality traits into z-scores, and examined the age trends in the four cognitive ability variables and the five personality traits. Finally, we used the model in Figure 1 to investigate the relations between the personality traits and the cognitive abilities in each age group. It is important to emphasize that although Figure 1 portrays the personality-cognition relations as though personality was a cause of cognition, we are interested in the associations between the two domains, and we do not assume that either personality or cognition is necessarily more primitive or fundamental in the relationship between the
two. The relations were examined in terms of regression coefficients rather than covariances because we were interested in identifying unique relations among the variables. However, it is worth noting that nearly identical patterns, with congruence coefficients greater than .99, were found when the analyses were repeated with the personality-cognition relations represented by covariances instead of regressions.¹

Method

Participants

Participants were recruited through newspaper advertisements, flyers, and referrals from other participants over a period of several years. Descriptive characteristics of the sample are provided in Table 1. All of the participants had Mini Mental Status Exam (Folstein, Folstein & McHugh, 1975) scores of 27 or greater, and thus were unlikely to be demented. The mean age of the participants was 50.5 (SD=18.6) and 64.5% of them were female. The self-identified ethnicity of the participants was primarily white (81%) with about 10% black and the remainder split among different groups including mixed ethnicity. Most of the participants were highly educated, with a mean of nearly 16 years of formal education, and healthy, with a mean of about 2 on a self-report scale ranging from 1 (for excellent) to 5 (for poor). As a means of evaluating the representativeness of the sample, age-adjusted scaled scores are provided for four tests from the Wechsler Adult Intelligence Scale III (Wechsler, 1997a) and the Wechsler Memory Scale III (Wechsler, 1997b). These age-adjusted scores have means of 10 and standard deviations of 3 in the nationally representative normative samples, and therefore it can be inferred that the current sample is functioning about 2/3 to 1 standard deviation

¹ Congruence coefficients reflect the correspondence between factor configurations, see Jensen (1998, p. 99).
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above the national norms. Importantly for the age comparisons, however, is that there were relatively small relations of age to the number of years of education, or to the age-adjusted scaled scores for four cognitive variables.

Materials and Procedure

A total of 16 cognitive tests were performed in the laboratory, and a series of questionnaires, including the personality inventory, were completed at home.

Cognitive tests. The cognitive tests were designed to assess Fluid Intelligence (Gf) with tests of reasoning and spatial visualization, Crystallized intelligence (Gc) with tests of vocabulary, Episodic Memory with verbal memory tests, and Perceptual Speed with substitution and comparison tests. Descriptions of the tests, and their sources, are contained in other articles (e.g., Salthouse, 2004; Salthouse et al., 2008).

Personality. Personality was evaluated with the International Personality Item Pool questionnaire (Goldberg, 1999; 50-item version). The five factors identified from this questionnaire were neuroticism (reverse coded from emotional stability), extraversion, openness, agreeableness, and conscientiousness.

Results

The initial analyses examined, factor invariance for the cognitive abilities and personality traits across the three age groups with multi-group analyses and nested comparisons with different sets of constraints. Neither constraining the factor loadings to be equal across the three age groups ($\chi^2_{\text{diff}} = 12.3, \text{df}_{\text{diff}} = 24$), nor constraining the factor correlations to be equal across the three age groups ($\chi^2_{\text{diff}} = 5.8, \text{df}_{\text{diff}} = 12$), nor constraining the variances to be equal across the three age groups ($\chi^2_{\text{diff}} = 7.7, \text{df}_{\text{diff}} = 32$) resulted in a significant change in fit for the cognitive ability structure. Similar
analyses with the personality data also revealed no significant loss of fit when the factor loadings were constrained ($\chi^2_{\text{diff}} = 1.6$, $df_{\text{diff}} = 90$), when the factor correlations were constrained ($\chi^2_{\text{diff}} = 1.6$, $df_{\text{diff}} = 20$) and when the variances were constrained to be equal across the three age groups ($\chi^2_{\text{diff}} = 2.7$, $df_{\text{diff}} = 110$). These results indicate that there was no evidence that the structure of either the cognitive abilities or the personality traits differed as a function of age.

Results were also similar when the 60-96 age group was divided into two groups age 60-69 ($n= 388$) and age 70-96 ($n = 396$), and thus this wide age range was considered justified. Neither constraining the factor loadings to be equal across the four age groups ($\chi^2_{\text{diff}} = 7.7$, $df_{\text{diff}} = 36$), nor constraining the factor correlations to be equal across the four age groups ($\chi^2_{\text{diff}} = 3.1$, $df_{\text{diff}} = 18$), nor constraining the variances to be equal across the four age groups ($\chi^2_{\text{diff}} = 11.8$, $df_{\text{diff}} = 40$) resulted in a significant change in fit for the cognitive ability structure. Analyses with the personality data revealed no significant loss of fit when the factor loadings were constrained ($\chi^2_{\text{diff}} = 1.7$, $df_{\text{diff}} = 90$), when the factor correlations were constrained ($\chi^2_{\text{diff}} = 2.3$, $df_{\text{diff}} = 20$), and when the variances were constrained to be equal across the three age groups ($\chi^2_{\text{diff}} = 2.3$, $df_{\text{diff}} = 110$).

The cognitive variables and the personality scales were next converted into z-scores based on the complete sample. Composite cognitive scores were created by averaging z-scores of cognitive variables assumed to measure the same ability. The left panel of Figure 2 contains the means and standard errors of the four cognitive composites in the three age groups, and the right panel contains the corresponding information for the Big Five personality dimensions. The simple age correlations were .31 for Gc, -.51 for
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Gf, -.43 for Memory, -.63 for Speed, -.19 for Neuroticism, .00 for Extraversion, -.06 for Openness, .13 for Agreeableness, and .22 for Conscientiousness. Quadratic and cubic relations of age to both cognitive abilities and personality traits were also examined. Very few of them were significantly different from zero, and because they were all associated with less than 1% of the variance, these nonlinear age trends were not retained in subsequent analyses. Although all of the age relations except that with Extraversion were significantly different from zero (p<.01), it can be seen that the age relations were much larger for the cognitive variables than for the personality variables.

Finally, the structural equation model portrayed in Figure 1 was applied to the data in each age group. In order to remove potentially spurious influences associated with stronger relations of age to the cognitive variables at older ages, the influence of age was statistically controlled in the analysis within each age group. This has the effect of comparing the personality-cognition relations at the average age in each group, and therefore it allows the groups to be compared without distortion of the relations by differential age relations within groups. The standardized coefficients representing the relations of the personality scales to each cognitive ability are portrayed in Figure 3 for the three age groups. Coefficients with absolute values greater than .12 were significantly different from 0 at p <.01. The unstandardized coefficients along with standard errors and confidence intervals of these estimates are reported in Table 2. The unique relations of each personality trait to cognitive abilities were expressed in $R^2$ changes by regressing cognitive abilities on each personality trait after controlling for the four other personality traits. $R^2$ values are reported in Table 2.
The first point to note in Figure 3 is that the results are quite similar in each age group. The possibility that the personality-cognition relations varied as a function of age was investigated with tests of interactions of age and the personality trait in the prediction of the latent cognitive ability construct. These analyses revealed that only the relation between Conscientiousness and the Memory construct differed significantly as a function of age. However, the lower right panel of Figure 3 reveals that the pattern was unsystematic, and therefore could be attributable to chance fluctuation. Furthermore, when the age group differences in the personality-cognition relations were expressed in $d$ units, all of the absolute values were less than .12, with a median of .04, which suggests that the personality-cognition relations were quite similar in the three age groups.

The strongest personality-cognition relations were apparent for the personality dimension of Openness as higher levels of Openness were associated with higher levels on all four cognitive ability factors. Moreover, all of the relations were in the moderate to strong range as the standardized regression coefficients were between .2 and .6. There were also consistent relations involving Extraversion as higher levels of Extraversion were associated with lower levels on the Gc and Gf.

The relations between the three other personality traits and cognitive abilities were smaller, and less systematic across age groups. People with higher levels of Agreeableness tended to have lower levels on Gf, and people with higher levels of Conscientiousness tended to have slightly higher levels on the perceptual speed factor. The relations with Neuroticism were limited to a slight negative association with Gf.

Because there is considerable evidence for hierarchical structure of cognitive abilities, with cognitive variables organized in terms of 1st-order abilities, which are in
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turn related to one another through a higher-order factor (e.g., Carroll, 1993; Salthouse, 2004; Salthouse & Ferrer-Caja, 2003), the analyses were repeated with the personality variables allowed to be related to different levels within the hierarchical structure. All of the personality traits except Conscientiousness were significantly (p<.01) related to the 2nd-order factor representing the variance shared by all 1st-order cognitive abilities. In addition, after controlling for the influence on the 2nd-order factor, there were also moderate relations of Openness on Gc and of Agreeableness on Memory, and a smaller relation of Conscientiousness on Speed.

Discussion

The current project capitalized on the availability of extensive cognitive assessment in a moderately large sample of adults across a wide age range to investigate personality-cognition relations across adulthood. A unique feature of the project was that cognition was examined not at the level of individual cognitive variables, which include test-specific influences and measurement error, but at the latent factor level which represent what different variables have in common. Moreover, the availability of four latent cognitive ability constructs provides a relatively comprehensive assessment of cognitive functioning.

Although there were early speculations that cognitive abilities become more differentiated, and less strongly correlated with one another, with increased age (e.g., Balinsky, 1941), the recent literature has failed to support the de-differentiation hypothesis of cognitive abilities (e.g., Facon, 2008; Juan-Espinosa, García, Escorial, Rebollo, Colom, & Abad, 2002; Salthouse & Saklofske, in press; Salthouse, 2010; Tucker-Drob & Salthouse, 2008; Zelinski & Lewis, 2003). The analyses conducted in
the current study also found that the cognitive ability structure was similar at different periods in adulthood. In addition, the structure of the personality traits was also invariant across age.

The relations between age and the personality factors were similar to those reported in the literature as increased age was associated with lower levels of Neuroticism (Roberts & Mroczek, 2008; Schaie et al., 2004; McCrae et al., 2005) and Openness (McCrae et al., 2005; Terracciano et al., 2005), and with somewhat higher levels of Agreeableness (McCrae et al., 2005; Roberts & Mroczek, 2008; Terracciano et al., 2005) and Conscientiousness (McCrae et al., 2005; Roberts & Mroczek, 2008; Terracciano et al., 2005). One exception was for the personality trait of Extraversion. Indeed, while there have been previous reports of age variations in this personality trait (e.g., McCrae, Costa, Ostendorf, Angleitner, Hrebícková, Avia, et al., 2000; Roberts & Mroczek, 2008), there were no significant age differences in the level of Extraversion in the current study. However, previous reports refer to studies that used NEO scales (e.g., Costa & McCrae, 1992), which contain two distinguishable dimensions of Extraversion, social dominance and social vitality. It is possible that we did not find significant age-related variation in Extraversion because these two dimensions are not adequately represented in Goldberg’s IPIB scale which we used.

The structure of cognitive abilities was also replicated, with four factors corresponding to four domains of crystallized intelligence (Gc), fluid intelligence (Gf), memory and perceptual speed (e.g., Salthouse, 2004; Salthouse & Ferrer-Caja, 2003).

One of the major findings of the project was that the personality-cognition relations were very similar among young, middle-aged, and older adults. The distinction
between aspects of typical functioning reflected in personality assessments, and aspects of maximal functioning reflected in cognitive assessments (Cronbach, 1949), therefore appears to be maintained, both qualitatively and quantitatively, across the adult years.

The strongest relations between personality and cognition were found for the personality dimension of Openness. This relation is not surprising because the Openness trait is sometimes considered to represent “intellect” (e.g., Goldberg, 1993). However, it is noteworthy that there was an independent influence of Openness on Gc even after controlling influence on what all 1st-order abilities have in common. These results suggest that Openness may have two distinct relations with cognition – one on the effectiveness of processing different types of information, as evident in the 2nd-order common factor and the relations with all 1st-order constructs, and another on the tendency to acquire information, as reflected in the unique relations on Gc.

The negative relations between Extraversion and Gf and Gc may reflect a tendency for people who are more introverted (or conversely, lower in Extraversion) to be more oriented towards abstract intellectual endeavors, and less oriented towards social and emotional dimensions of life. It is noteworthy that the negative relations between Extraversion and these aspects of cognitive functioning are consistent with recent reports but contrary to older reports. Furthermore, in their meta-analysis, Wolf and Ackerman (2005) provided evidence for changes over time in both magnitude and direction of the correlation between Extraversion and cognition.

The relations between the other personality dimensions and the cognitive factors were generally small, although they were consistent across the three independent groups of participants. It is possible that the influences of Neuroticism may be related to either
impulsiveness or anxiety, and those with Agreeableness may be related to a complaisant and possibly unanalytical style, but we are not aware of any evidence relevant to these speculations.

To summarize, the current project had two major goals. The first was to determine which dimensions of personality are related to which aspects of cognitive functioning. Our results confirm and extend earlier results in terms of strong relations of Openness to several distinct cognitive abilities, and smaller relations of other personality traits with specific cognitive abilities. The second goal was to examine whether the personality-cognition relations differed across adulthood. The patterns apparent in Figure 3, together with the general lack of significant interactions of age and personality in the prediction of the cognitive composites, indicate that the associations between personality and cognition are both qualitatively and quantitatively similar in healthy adults between at least 20 and 90 years of age.
References


Costa, P. T., Jr., & McCrae, R. R. (1992a). *Revised NEO Personality Inventory (NEO-PI-R) and NEO Five-Factor Inventory (NEOFFI) professional manual*. Odessa, FL: Psychological Assessment Resources.
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Goldberg, L. R. (1999). A broad-bandwidth, public domain, personality inventory measuring the lower-level facets of several five-factor models. In I. Mervielde, I.
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Andrea Soubelet is now at University of Provence, Laboratory of Cognitive Psychology – CNRS & University of Provence - UMR 6146
Table 1

*Description characteristics of the sample*

<table>
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<tr>
<th></th>
<th>18-39</th>
<th>40-59</th>
<th>60-96</th>
<th>Age Correlation</th>
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<tr>
<td>Number</td>
<td>663</td>
<td>870</td>
<td>784</td>
<td>NA</td>
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<tr>
<td>Age</td>
<td>26.3 (6.0)</td>
<td>50.8 (5.5)</td>
<td>70.5 (7.6)</td>
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<td>Proportion Female</td>
<td>.60</td>
<td>.71</td>
<td>.61</td>
<td>.01</td>
</tr>
<tr>
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<td>2.2 (0.9)</td>
<td>2.3 (0.9)</td>
<td>.13*</td>
</tr>
<tr>
<td>Years of Education</td>
<td>15.1 (2.3)</td>
<td>15.8 (2.6)</td>
<td>16.3 (2.9)</td>
<td>.22*</td>
</tr>
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</table>

Age-Adjusted Scaled Scores

<p>| | | | | |</p>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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</thead>
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<td>Vocabulary</td>
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<td>12.3 (2.8)</td>
<td>13.4 (2.5)</td>
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</tr>
<tr>
<td>Digit Symbol</td>
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<td>11.2 (2.9)</td>
<td>11.7 (2.7)</td>
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<tr>
<td>Logical Memory</td>
<td>11.8 (2.7)</td>
<td>11.8 (2.7)</td>
<td>12.6 (2.7)</td>
<td></td>
</tr>
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<td>12.2 (3.3)</td>
<td>12.6 (3.3)</td>
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</tr>
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</table>

*p<.01

Note: Self-rated health is on a 5-point scale ranging from 1 for excellent to 5 for poor.
The age-adjusted scaled scores are based on the nationally representative normative samples from the WAIS III (Wechsler, 1997a) and WMS III (Wechsler, 1997b) in which the means are 10 and the standard deviations are 3.
Table 2

*Relations of personality factors to cognitive factors – Unstandardized estimates, standard errors, confidence intervals, \( R^2 \) values and \( d \) values for contrasts between groups.*

<table>
<thead>
<tr>
<th></th>
<th>Age 18-39</th>
<th>Age 40-59</th>
<th>Age 60-96</th>
<th>( d_1 )</th>
<th>( d_2 )</th>
<th>( d_3 )</th>
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<td>CMIN/df</td>
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<td>3.3</td>
<td>2.8</td>
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<tr>
<td>CFI</td>
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<td>.80</td>
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<tr>
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<td>.05</td>
<td>.05</td>
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<tr>
<td>Est.</td>
<td>S.E.</td>
<td>C.I.</td>
<td>( R^2 )</td>
<td>Est.</td>
<td>S.E.</td>
<td>C.I.</td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td>-</td>
<td>+</td>
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</tr>
<tr>
<td>Gf</td>
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<td>.05</td>
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<td>.00</td>
<td>.01</td>
<td>-.06</td>
</tr>
<tr>
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<td>.06</td>
<td>-.20</td>
<td>.09</td>
<td>.00</td>
<td>.00</td>
</tr>
<tr>
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<td>.05</td>
<td>-.06</td>
<td>.18</td>
<td>.00</td>
<td>.00</td>
</tr>
<tr>
<td>Speed</td>
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<td>.06</td>
<td>.01</td>
<td>.04</td>
</tr>
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<tr>
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<td>-.33</td>
<td>-.07</td>
<td>.02*</td>
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<table>
<thead>
<tr>
<th></th>
<th>Memory</th>
<th>Speed</th>
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<th>Gc</th>
<th>Memory</th>
<th>Speed</th>
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<tr>
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<td>-0.05</td>
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<td>-0.14</td>
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<tr>
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<td>0.07</td>
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<tr>
<td>O Gf</td>
<td>-0.08</td>
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<td>Speed</td>
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<tr>
<td>Gc</td>
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<td>0.10</td>
<td>-0.47</td>
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<td>.27</td>
<td>.00</td>
</tr>
</tbody>
</table>

$R^2$ values represent $R^2$ changes explained by each personality trait after controlling for variance associated with the four other personality traits in cognitive abilities.

d$_1$ column displays $d$ values for the differences between the age group 18-39 and the age group 40-59

d$_2$ column displays $d$ values for the differences between the age group 18-39 and the age group 60-96

d$_3$ column displays $d$ values for the differences between the age group 40-50 and the age group 60-96
Figure Captions

Figure 1 – Schematic illustration of the possible relations of the Big 5 personality traits on four latent constructs representing different cognitive abilities.

Figure 2 – Means (and standard errors) of cognitive composite scores (left panel) or personality traits (right panel) in z-score units of the entire sample for adults in three age groups.

Figure 3 – Standardized regression coefficients for the relations of personality traits on four cognitive abilities in three age groups.
Figure 1 -
Figure 2 -
Figure 3 -

Neuroticism

Extraversion

Openness

Agreeableness

Conscientiousness

<table>
<thead>
<tr>
<th>Age 18-39</th>
<th>Age 40-59</th>
<th>Age 60-96</th>
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</thead>
<tbody>
<tr>
<td>Standardized Regression Coefficient</td>
<td></td>
<td></td>
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<tr>
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<td>0.0</td>
<td>0.2</td>
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</tbody>
</table>

Age 18-39
Age 40-59
Age 60-96

Gc  Gf  Memory  Speed