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Personality and Individual Differences xxx (2006) xxx–xxx
PERSONALITY AND INDIVIDUAL DIFFERENCES
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Personality predictors of intelligence: Differences between young and cognitively healthy older adults

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Received 30 August 2005; accepted 6 February 2006

Abstract

Previous investigations of personality–intelligence relationships have sampled mainly young adults. The present study compared young and older groups in identifying personality predictors of cognitive abilities. A sample of 381 adults was administered the Woodcock–Johnson III Tests of Cognitive Abilities and the Big Five Inventory-44. Participants were separated into three groups: young adults (aged 19–60), older adults that were cognitively comparable to the young, and cognitively superior older adults. Results indicated that Openness and Extraversion predicted cognitive abilities in the young and cognitively comparable old, but the specific abilities predicted were different for the two groups. In the cognitively superior older group, Agreeableness was a negative predictor of Gc ($\beta = -.28$), and Conscientiousness and Openness were predictors of short-term memory and visual and auditory processing.

Keywords: Personality; Cognitive ability; Aging; Intelligence; Openness; Extraversion; Agreeableness; Conscientiousness

1. Introduction

Previous research has found relations of varying strength between personality factors and specific cognitive abilities, mainly fluid ability (Gf) and crystallized ability (Gc). However,

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doi:10.1016/j.paid.2006.02.017

personality–intelligence relations have been examined primarily in samples of young adults using a limited array of cognitive ability measures. This study examined personality–intelligence relationships in younger and cognitively healthy older adults. It also examined how a group of cognitively superior older adults are characterized in terms of these relationships.

1.1. Past research

The cognitive abilities most often studied in investigations of personality predictors have been Horn–Cattell's first-order factors, Gf and Gc. See Table 1 for a description of Horn–Cattell cognitive abilities (Gf–Gc Theory; Horn, 1985). In addition, the personality factors most often studied have been those derived from the Five-Factor Model (FFM): Extraversion, Agreeableness, Conscientiousness, Neuroticism, and Openness to experience (Digman & Inouye, 1986; Goldberg, 1993; John, Donahue, & Kentle, 1991; McCrae & Costa, 1987). Agreeableness is the only personality factor not to have been found in previous research to relate to intelligence measures.

A number of studies have found that Openness is a strong personality predictor of Gc but not Gf (see Ackerman & Heggestad, 1997, for a meta-analysis; Ashton, Lee, Vernon, & Jang, 2000; Bates & Shieles, 2003). Other studies have reported that Gc and Gf abilities do not differ in their relation to Openness (Austin, Deary, & Gibson, 1997; Holland, Dollinger, Holland, & MacDonald, 1995). In addition, one recent study found a significant correlation between Openness and Gf in the absence of measuring Gc (Chamorro-Premuzic, Moutafi, & Furnham, 2005).

Although Openness has been the most common personality factor found to correlate with intelligence measures in young adults, evidence also suggests that Conscientiousness is negatively correlated with Gf, but has no association with Gc (Moutafi, Furnham, & Paltiel, 2004). Other studies have found significant negative correlations between Conscientiousness and other specific measures of intelligence (Moutafi, Furnham, & Crump, 2003; Moutafi, Furnham, & Paltiel, 2005).

Studies investigating the relationship between Neuroticism and cognition have reported conflicting results. Pearson (1993) reported a positive correlation between Neuroticism and a measure of Gc in an older sample of women diagnosed with anxiety and depression. Jorm et al. (1993), on the other hand, found negative correlations between Neuroticism and cognitive abilities in older adults. Specific associations differed by gender: Neuroticism was negatively related to measures of Gf and Glr in males, whereas negative relations between Neuroticism and Gs measures were found in women. However, Jelicic et al. (2003) found no relationship (and no gender interaction)

Table 1
Description of cognitive abilities tested in the WJ-III battery (based on descriptions given in the WJ-III examiner's manual; Mather & Woodcock, 2001)

Ability	Description
Fluid reasoning (Gf)	Ability to draw inferences, solve problems
Comprehension-knowledge (Gc)	Crystallized ability; breadth and depth of knowledge
Visual-spatial thinking (Gv)	Comprehension of visual and spatial configurations
Auditory processing (Ga)	Comprehension/discrimination of auditory stimuli
Processing speed (Gs)	Ability to perform automatic cognitive tasks quickly
Short-term memory (Gsm)	Ability to store and retrieve information within a few seconds
Long-term retrieval (Glr)	Ability to retrieve information stored earlier

between Neuroticism and a number of cognitive abilities in an older sample, including measures of Gc, Gs, and Glr. Researchers attempting to clarify the nature of the relation between Neuroticism and cognition have found it may depend on the facet of Neuroticism measured. Specifically, Furnham, Forde, and Cotter (1998) found that irresponsibility correlated negatively with Gf, whereas impulsivity correlated positively. In addition, Neuroticism's reported negative relationship with certain cognitive abilities has been hypothesized to be due to the anxiety associated with its measure (Jorm et al., 1993; Zeidner, 1995), and anxiety has been found to interfere with higher cognitive processing by reducing efficiency (e.g., Eysenck, 1985; Eysenck & Calvo, 1992; Miller & Bichsel, 2004). Recent data indicates that once test anxiety is partialled out, the relationship between Neuroticism and intelligence disappears (Moutafi, Furnham, & Tsaousis, 2006).

Past research examining associations between Extraversion and cognition have also produced mixed results. Furnham et al. (1998) found that Extraversion was positively correlated with a multiple abilities test but was not related to a test of Gf. In other studies examining categorical levels of Extraversion, extraverts outperformed introverts on speeded measures (Rawlings & Carnie, 1989), individuals with moderate levels of Extraversion performed better on measures of Gf and Gc than both introverts and high-level extraverts (Stough et al., 1996), and introverts outperformed both moderate and high-level extraverts on a test of Gc (Roberts, 2002). A recent meta-analysis provided two explanations for these conflicting results: (a) recent studies tend to use FFM measures of Extraversion, which differ from Extraversion measures used in the past; and (b) recent studies tend to use older samples (meaning older adolescents as opposed to younger adolescents), and this age difference may moderate the relation between Extraversion and intelligence, at least in young samples (Wolf & Ackerman, 2005).

1.2. The present study

Previous studies of intelligence–personality relations have one or more underlying limitations: (a) the sample is restricted to young adults, (b) a limited range of cognitive abilities and/or personality is measured, (c) a small sample size is utilized, and (d) reliability estimates are not reported, so null effects cannot be interpreted. This study seeks to address these limitations by utilizing a large sample of older and younger adults, measuring multiple cognitive abilities and all FFM personality constructs, and reporting reliability estimates for personality and cognition measures.

Moreover, this study delineates personality–intelligence relationships in a group of older adults who are cognitively comparable to younger adults and a group of older adults who are cognitively superior to both groups. Despite the predominance of research that focuses on cognitive decline in old age, cognitive decline is not absolute (Deary, Whalley, Lemmon, Crawford, & Starr, 2000; Horn, 1985; Horn & Cattell, 1966; Kaufman & Horn, 1996). The principal finding of Gf–Gc theory regarding development is that Gf declines with age, whereas Gc remains relatively stable (Horn & Noll, 1997). Since the present study focuses on groups of individuals who do not show cognitive decline with age, the most compelling results may be in regard to Gc. Since Gc is expected to remain stable, one might predict that the personality predictors of Gc will be the same in older adults as in younger adults. However, it could also be the case that the personality factors that are important for helping to acquire the knowledge inherent in Gc in youth are not the same ones that serve to maintain it in old age. By examining personality–intelligence relationships in

older adults who have maintained cognitive vitality, we may gain a better understanding of how these relationships characterize healthy aging.

2. Method

2.1. Measures

The Big Five Inventory. The Big Five Personality Inventory-Version 44 (BFI-44; John et al., 1991) is a 44-item self-administered test of personality measuring Openness, Conscientiousness, Extraversion, Agreeableness, and Neuroticism. The test is made up of 44 statements, each of which is rated on a 5-point Likert scale as to the subjects' degree of agreement with how well it describes them. The five scores obtained from the BFI-44 are averages of the group of statements that measure each factor.

The Woodcock–Johnson III Tests of Cognitive Abilities. The WJ-III (Woodcock, McGrew, & Mather, 2001) measures Gf, Gc, and five other abilities that are derived from the Gf–Gc theory of intelligence (Cattell, 1963; Horn, 1985; Horn & Cattell, 1966). The standard and extended batteries of the WJ-III were used to obtain two measures of each ability. Table 1 describes the cognitive abilities tested in further detail. More information on each test can be found in the WJ-III Examiner's Manual (Mather & Woodcock, 2001). Standard scores were obtained for each test, and scores on the two tests for each ability were averaged to obtain a single score for each of the seven abilities. Education level was then regressed onto these ability scores, and the standardized residuals were used for analysis, providing a control for education level.

2.2. Participants

Subjects consisted of 381 adults (239 females, 142 males) aged 19–89 ($M = 56.97$, SE = 1.01). Education ranged from some high school to graduate degree completion. The participants were solicited through newspaper ads, radio ads, and by word of mouth. Financial compensation of $40.00 was provided for participation.

Individuals over the age of 60 were classified as "older". Data for any older subjects reporting hearing problems or dementia was not included in the study. The older group was further subdivided using a median split of the average standardized residual score (controlling for education) across all tests administered on the WJ-III. Hence, subjects were separated into three groups for analysis: (a) younger adults, (b) older adults who were cognitively comparable to the younger adults as a whole, and (c) older adults who were cognitively superior to both the first and second groups. The younger group consisted of 135 adults (78 females, 57 males) aged 19–60 ($M = 33.85$, SE = 1.22), the cognitively comparable older group consisted of 123 adults (76 females, 47 males) aged 61–89 ($M = 69.20$, SE = .54), and the cognitively superior older group consisted of 123 adults (85 females, 38 males) aged 61–89 ($M = 70.11$, SE = .57).

2.3. Procedure

Each participant was tested individually. Subjects first completed a demographic questionnaire that included questions about age, gender, and level of education. The administration of the

WJ-III and the BFI-44 were then counterbalanced. Subjects were administered Tests 1–7 and Tests 11–17 of the WJ-III in accordance with the examiner's manual (Mather & Woodcock, 2001). Subjects were instructed to complete the BFI-44 on their own, marking the most accurate descriptions for their personality.

3. Results

Descriptive statistics (Cronbach's alpha, mean, sample size, standard error, and range of standardized scores) for each cognitive ability are listed in Table 2 for each of the three groups. The young adults did not outperform either of the older adult groups on any of the cognitive ability measures. This result contradicts many of the findings in previous studies that have shown young adults to be superior on many cognitive ability tests due to age-related declines, particularly tests of Gf, Gs, and Gsm (e.g., Craik, Morris, & Gick, 1990; Horn & Noll, 1997; Park, 2000; Salthouse, 1996). A MANOVA revealed significant differences between groups on all of the ability measures,

Table 2
Descriptive statistics for the WJ-III

Ability	Reliability (α)	Mean	Residual mean[a]	SE
Young (a)				
Gf	.92	108.10	$-.31_{c}$	.08
Gc	.91	105.09	$-.59_{bc}$	.08
Gv	.79	108.24	$-.35_{c}$	.09
Ga	.86	104.47	$-.16_{c}$	.07
Gs	.93	107.55	$-.32_{c}$	.09
Gsm	.86	103.40	$-.21_{c}$	.09
Glr	.86	104.11	$-.39_{c}$	.07
Cognitively comparable old (b)				
Gf	.95	106.89	$-.46_{c}$	.07
Gc	.88	109.67	$-.21_{ac}$	.06
Gv	.73	109.61	$-.20_{c}$	.07
Ga	.90	102.22	$-.41_{c}$	.09
Gs	.94	108.08	$-.31_{c}$	.08
Gsm	.75	101.72	$-.38_{c}$	.06
Glr	.88	103.47	$-.46_{c}$	.06
Cognitively superior old (c)				
Gf	.90	120.47	$.79_{ab}$	.07
Gc	.82	120.06	$.85_{ab}$	.06
Gv	.72	115.76	$.59_{ab}$	.08
Ga	.91	111.61	$.58_{ab}$	.08
Gs	.91	119.90	$.66_{ab}$	.07
Gsm	.76	112.40	$.62_{ab}$	.08
Glr	.76	118.17	$.79_{ab}$	.08

Note. Lettered subscripts denote a significant difference from the designated group on the mean for that factor at $p < .001$ in the Tukey honestly significant difference comparisons.

[a] Standardized residual mean after controlling for education.

and posthoc comparisons revealed which differences were significant (Table 2). The cognitively superior older adults outperformed both the cognitively comparable older adults and the younger adults on every ability tested (Table 2).

The posthoc comparison revealed that the young and the cognitively comparable old had similar mean scores on six of the seven abilities (Table 2). These two groups differed significantly on only one ability, Gc, where the older group outperformed the younger group. Given that Gc measures breadth and depth of knowledge, and that this knowledge is generally enhanced through life experience and learning, it is not surprising that a group of older individuals who are comparable on other cognitive ability measures would outperform the younger group on Gc.

The three groups were remarkably similar in terms of their mean scores on each of the personality factors measured by the BFI-44. A MANOVA was found to be significant for the Agreeableness factor only, $F(2,378) = 8.96$, $p < .001$. A Tukey HSD test indicated that the cognitively comparable older group ($M = 4.18$, SE = .05) was significantly more agreeable than the younger group ($M = 3.87$, SE = .03), $p < .001$. At least one other study (Hrebickva, Cermak, & Osecka, 2000) has found older adults to be more agreeable than younger adults. However, our results suggest that high cognitive ability may moderate this apparent age effect, as there were no differences in Agreeableness between the young and the cognitively superior old. No other significant differences were found between the groups on any of the personality factors. Cronbach's alpha for the five personality factors ranged from .71 to .85.

3.1. Prediction of Gc and Gf

Standard regression analyses were performed on each of the seven cognitive ability measures using the five personality factors as predictors. The coefficients for personality factors that were significant are presented in Table 3 for each of the three groups. In regard to the first-order abil-

Table 3
Summary of standard regression analysis coefficients for significant personality factors predicting cognitive abilities

Personality factor	Ability	*B*	SE *B*	*β*
Young				
Openness	Gc	.40	.13	.27**
	Gsm	.31	.15	.19*
Extraversion	Gc	−.23	.10	−.19*
	Gs	.25	.11	.20*
Cognitively comparable old				
Openness	Ga	.34	.16	.21*
Extraversion	Glr	.19	.08	.24*
Cognitively superior old				
Agreeableness	Gc	−.31	.11	−.28**
Openness	Gv	.27	.12	.21*
Conscientiousness	Ga	.35	.13	.24*
	Gsm	.28	.13	.19*

* $p < .05$.
** $p < .01$.

ities Gc and Gf, only Gc was reliably predicted by personality. In the young group, Openness was a positive predictor of Gc, and Extraversion was a negative predictor. These results support previous research on young adults finding Openness to be a stronger predictor of Gc than Gf (Ackerman & Heggestad, 1997; Ashton et al., 2000; Bates & Shieles, 2003). In addition, these results help to clarify, using multiple ability measures and a large sample size, the conflicting results of previous studies exploring Extraversion and Gc. To test Stough et al.'s (1996) theory that Extraversion has an inverted *u*-shaped association with Gc, with moderate scorers on Extraversion outperforming both low and high scorers, we recoded Extraversion into three approximately equal-*n* categories: low (scores up to 2.88), medium (scores from 2.89 to 3.63), and high (scores over 3.64). Fig. 1 depicts scores on Gc plotted as a function of categorical Extraversion in the young group. The graph clearly depicts a negative linear relation between Extraversion and Gc, supporting Roberts' (2002) results and contradicting Stough et al.'s nonlinear finding.

Personality–Gc relations were different for the older groups. In the case of the cognitively comparable old, Gc was not predicted by any of the personality factors. In the cognitively superior old, Agreeableness was a negative (and the sole) predictor of Gc.

Our results do not support a personality–Gf relation for any of the groups. Although a relationship between Openness and Gf has been found in a few prior studies (Ashton et al., 2000; Holland et al., 1995), these studies did not include "pure" tests of novel problem solving (Gf) abilities. The Gf tests in the WJ-III are strict measures of novel problem solving and do not tap any crystallized abilities, unlike the Performance scales of the WAIS-R (Wechsler, 1981) and the MAB (Jackson, 1984) used in some studies (Ashton et al., 2000; Holland et al., 1995). For example, the test of Picture Completion from the WAIS-R asks what feature will make the picture whole again. While this may appear to be problem solving on the surface, the participant is also using preexisting knowledge (Gc) to complete the picture. However, our results conflict more directly with Cham-

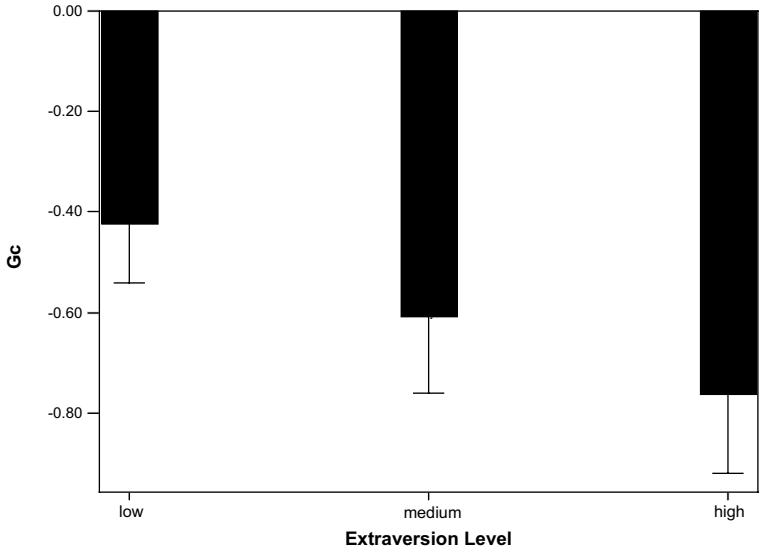

Fig. 1. Mean standardized Gc scores as a function of extraversion level in young adults. Error bars represent standard error.

orro-Premuzic et al.'s (2005) recent study of young adults in which they found that Openness was a significant predictor of what is considered to be a pure measure of Gf, the Raven.

3.2. Comparisons of the younger group and their cognitively comparable older counterparts

Comparisons between the young group and a cognitively comparable group of older adults allow us some speculation as to how personality–intelligence relationships may change with age in the context of maintaining cognitive vitality, as these older adults, on average, do not appear to have experienced the cognitive decline normally associated with aging. For the young group, Openness and Extraversion, in addition to being predictors for Gc, were also predictors of lower order cognitive abilities. Openness predicted short-term memory (Gsm), and Extraversion predicted processing speed (Gs). The latter finding supports previous research (Rawlings & Carnie, 1989). For the older group that was cognitively comparable to the younger group, personality appeared less important in explaining overall variance in cognitive abilities, most notably because of the lack of any relation with Gc. However, like the young group, Openness and Extraversion were also the only significant personality predictors of lower order cognitive abilities in the cognitively comparable old, although these were different abilities. Openness predicted auditory processing (Ga) in this group, and Extraversion predicted long-term retrieval (Glr).

3.3. Personality–intelligence relationships in the cognitively superior old

Although much research attempts to delineate factors underlying cognitive decline in older adults (e.g., Park, 2000; Salthouse, 1996), relatively few studies have explored factors that may relate to cognitive excellence in the old. Table 3 illustrates that there are considerable differences in personality predictors of cognitive ability for the cognitively comparable old and the cognitively superior old. Whereas there were no personality predictors for Gc in the cognitively comparable old, Agreeableness was a significant negative predictor for Gc in the cognitively superior old. These results suggest that superior crystallized ability is relatively strongly associated with low Agreeableness scores, meaning that older individuals who have a tendency toward being unfriendly and uncooperative maintain higher levels of breadth and depth of general knowledge. In addition to the first-order factor of Gc, personality factors predicted a number of lower order abilities in the cognitively superior group (Table 3). Conscientiousness predicted both auditory processing (Ga) and short-term memory (Gsm) in cognitively superior older adults.

3.4. Neuroticism

Neuroticism was the only personality factor not found to relate to any of the cognitive abilities in the three groups studied. Previous research has suggested there may be an interaction between gender and Neuroticism in predicting cognition (Jorm et al., 1993). We tested this interaction in each of the three groups by regressing each of the seven cognitive abilities onto Neuroticism, gender, and a "Neuroticism × gender" term in standard regression analyses. In none of the analyses was there a significant interaction between Neuroticism and gender in predicting any of the ability scores. These results support Jelicic et al.'s (2003) finding of no relationship between Neuroticism and cognition. It is important to note, however, that the BFI-44 measure of Neuroticism does not

contain subscales for the measure of anxiety, irresponsibility, or impulsivity, and these aspects of Neuroticism have been found to relate to cognition in previous research (e.g., Furnham et al., 1998; Miller & Bichsel, 2004).

4. Discussion

This cross-sectional comparison suggests that personality–intelligence relationships change from younger to older adulthood. The results also suggests that there are differences in personality–intelligence relationships between those who retain a normal level of overall cognitive ability in old age and those older adults who are cognitively superior. Perhaps most importantly, personality predictors of Gc differed among the three groups studied. Openness and Extraversion were important predictors of Gc in young adults, presumably the time of life when Gc undergoes more development, with those higher in Openness and lower in Extraversion scoring higher on Gc. These factors were not important predictors of Gc in the older groups. Given the robustness of the Openness–Gc relation in prior studies of young adults, the absence of this relation in both of the older groups in the present study suggests that Openness to experience is no longer necessary for the sustenance of crystallized ability in old age. Perhaps Openness is only important for Gc's development in young adulthood.

Instead of Openness, Agreeableness negatively predicted Gc in the cognitively superior old, suggesting that a disagreeable nature goes hand in hand with advanced vocabulary and general knowledge in old age. This result is in accordance with previous research that suggests that those who are highly intelligent are more independent (Harris, Vernon, & Jang, 2005); non-reliance on others means Agreeableness is less necessary. Furthermore, a negative relationship between Agreeableness and intelligence has been previously reported among highly intelligent young adults (ages 17–39) (Allik & Realo, 1997), which suggests that a disagreeable nature may foster intellectual achievement that in turn leads to cognitive vitality in old age.

Interestingly, Conscientiousness positively predicted Ga and Gsm, which contradicts previous findings that Conscientiousness has a negative relationship with intelligence (Moutafi et al., 2004; Moutafi et al., 2005). Moutafi et al. (2004) suggested there is an inverse relationship between Conscientiousness and intelligence because less intelligent people make up for their shortcomings by being more steadfast, and those with higher intellectual abilities do not need to be conscientious. Our results contradict this suggestion as our Conscientiousness–intelligence relationship was found only among the intellectually superior older adults. It may be that in old age Conscientiousness does not necessarily make one "smarter"; rather, this trait enables older individuals to perform better on tests of cognition. This explanation makes more sense when considering the abilities that relate to Conscientiousness in this group. The tasks that make up Ga and Gsm appeared to elicit the most frustration in our older subjects, according to anecdotal reports from the research assistants. In addition, both Ga and Gsm, as measured by the WJ-III, tap attentional capacity (Mather & Woodcock, 2001). Previous research also suggests that Conscientiousness, at least in part, reflects attentiveness (Digman & Inouye, 1986). It makes sense then that high scorers on Conscientiousness were also the best performers in terms of Ga and Gsm. This line of reasoning would benefit from a longitudinal study investigating personality and intelligence to determine the nature of the Conscientiousness–intelligence relationship over the lifespan. In par-

ticular, such a study could help determine whether Conscientiousness serves to help deter cognitive decline and, if so, suggest possible mechanisms by which this deterrence is accomplished.

Acknowledgements

We would like to thank Mary Beth Greenhalgh and Genevieve Bink for aiding in data collection.

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