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The five factor model of personality and intelligence: A twin study on the relationship between the two constructs

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ABSTRACT

We assessed the association and underlying genetic and environmental influences among intelligence (IQ) and personality in adolescent and young adult twins. Data on intelligence were obtained from psychometric IQ tests and personality was assessed with the short form of the NEO five factor inventory (NEO-FFI).

IQ and personality data were available for 646 twins. There were an additional 1307 twins with NEO-FFI data, and 535 with IQ data. Multivariate genetic structural equation modeling was carried out.

Significant positive phenotypic correlations with IQ were seen for agreeableness ($r = 0.21$) and openness to experience ($r = 0.32$). A negative correlation emerged for neuroticism and IQ ($r = -0.10$). Genetic factors explained (nearly) all of the covariance between personality traits and IQ. Genetic correlations were 0.3–0.4 between IQ and agreeableness and openness. The genetic correlation between IQ and neuroticism was around −0.18. Thus, personality and IQ did not appear to be independent dimensions, and low neuroticism, high agreeableness and high scores on openness all contributed to higher IQ scores.

1. Introduction

Intelligence and personality are enduring and stable traits across situations and over time. They show substantial contributions of genetic factors to individual differences. Personality and intelligence are considered separate constructs (Maltby, Day, & Macaskill, 2007). The few studies that attempted to link them reported modest correlations. There are interesting hypotheses about how the two domains are conceptually and empirically related (Furnham, Moutafi, & Chamorro-Premuzic, 2005; Goff & Ackerman, 1992). Intelligence has been viewed as the cognitive part of the construct of personality (Brody, 1992; Cattell, 1941; Eysenck, 1997). Wechsler (1950) considered intelligence to be a manifestation of personality as a whole and argued that certain affective and motivational factors are integral parts of the construct of intelligence.

Several dimensional models have been suggested for personality. The five factor model (FFM) distinguishes five domains of personality: neuroticism, extraversion, openness to experience, agreeableness and conscientiousness (Costa & McCrae, 1992a). These traits show heritabilities from 30% to 60%, with openness to experience and extraversion commonly being the most heritable (Bouchard & Loehlin, 2001; Distel et al., 2009; Rettew, Rebollo-Mesa, Hudziak, Willemsen, & Boomsma, 2008).

Openness to experience tends to correlate highest with intelligence (Ackerman & Heggestad, 1997; Aitken Harris, 2004; Chamorro-Premuzic, Moutafi, & Furnham, 2005; Moutafi, Furnham, & Crump, 2006) and is associated with a wide class of intellectually oriented traits, such as curiosity, creativity, and willingness to explore new ideas (Goldberg, 1993). Results for other personality traits are less clear. Some studies reported negative associations between IQ and neuroticism (Austin, Hofer, Deary, & Eber, 2000; Kyllonen, 1997). Occasionally, extraversion has been reported to correlate (positively and negatively) with intelligence (Wolf & Ackerman, 2005), and this relation has been moderated by the nature of the test and the context (Bates & Rock, 2004; Matthews, 1997; Rawlings & Carnie, 1989; Robinson, 1985). Correlations of intelligence with conscientiousness have been small and negative (Furnham et al., 2005). Moutafi et al. (2006) hypothesized that conscientiousness is a trait that less intelligent individuals can possess to compensate in a competitive environment. Conscientiousness, in contrast, has been positively associated with academic performance (Chamorro-Premuzic & Furnham, 2003; Lievens et al., 2002). Agreeable people tend to be pleasant and accommodating in social situations and this trait is rarely associated with

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intelligence. However, one study found a small positive relation with scholastic achievement in adolescent males (Peterson, Pihl, Higgins, Seguin, & Tremblay, 2003). Altruistic behavior, which is a small aspect of the construct of agreeableness, was associated with higher IQ scores in younger children (Kohlberg, 1964; Krebs & Sturrup, 1982).

A few studies have focused on the question of common genetic and environmental influences on the association between personality and IQ. Aitken Harris, Vernon, and Jang (1998) reported moderate to large phenotypic and genotypic correlations, with especially large correlations for curiosity and achievement, using full-scale IQ and the personality research form E (PRF-E; Jackson, Procidanom, & Cohen, 1989). Pincombe, Luciano, Martin, and Wright (2007) found a genetic association between extraversion and IQ. However, a significant phenotypic correlation between the extraversion domain score and IQ was absent. Luciano, Wainwright, Wright, and Martin (2006) reported genetically mediated correlations for competence and dutifulness aspects of conscientiousness with IQ.

The present study investigates the association of psychometric IQ and the NEO-FFI personality scales in adolescent and young adult twins and examines genetic and environmental correlations between IQ and personality. Additional analyses explored differences between associations of verbal and performance intelligence with personality features.

2. Materials and methods

2.1. Participants and procedures

The data were obtained from the Netherlands twin register (NTR) (Bartels et al., 2007; Boomsma, Geus, et al., 2006). Data on intelligence and personality were collected in 3 laboratory studies (see Table 1). Additional personality data were collected by mailed surveys (Distel et al., 2009). The first sample (I) came from a longitudinal twin study on the genetic architecture of cognition (Bartels, Rietveld, Baal, & Boomsma, 2002; Boomsma & Van Baal, 1998; Hoekstra, Bartels, & Boomsma, 2007). A second sample (II) participated in a study on attention and cognition (Polderman et al., 2006) and a third sample (III) participated in an EEG study (Van Beijsterveldt, Molenaar, de Geus, & Boomsma, 1996). In each of these studies full-scale intelligence tests (FS-IQ) were administered. In addition, in samples II and III, the Raven standard progressive matrices (SPM) and the Raven advanced progressive matrices (APM) were administered. If twins participated at multiple ages, FS-IQ scores obtained at age 18 were analyzed. When data at 18 years were absent FS-IQ scores at age 12 were analyzed.

There were 646 twins with FS-IQ and NEO-FFI data; an additional 535 twins with full-scale IQ data and 1307 twins with NEO-FFI data. A total of 426 twins completed the Raven SPM at age 16 and 227 twins completed the Raven APM at ages 16–23 (see Table 1).

The 2488 twins came from 1289 families. There were 1143 MZ twins and 1345 DZ twins. For 1128 twins zygosity was based on DNA polymorphisms; 39 twins with unknown zygosity were excluded from the analyses; 424 twins were part of an opposite-sex twin pair. For the remaining twins, resemblance is based on survey information. Questions were completed by the twins or by their parents. Zygosity determination using these questionnaires is 93% (Rietveld et al., 2000).

2.2. Measures

At age 12 the Wechsler intelligence test for children (Wechsler et al., 2002) and at age 18, 11 subtests (6 verbal and 5 performance) of the Wechsler adult intelligence scale (Wechsler, 1997) were administered. From all these tests full-scale IQ scores and verbal and performance IQ scores were obtained (Hoekstra, Bartels, van, & Boomsma, 2009). At ages 15–17 the Raven advanced or standard progressive matrices test was part of the protocol. Raven is a non-verbal test that uses only figurative multiple-choice questions. The Raven test is a reliable measure of overall cognitive abilities, especially performance IQ and is less prone to cultural influences (Raven, 1960, 2000).

Personality traits were measured by the short version of the NEO (NEO-FFI: Costa & McCrae, 1992b). The NEO-FFI consists of 60 items that are rated on a five point scale (1–5: totally disagree, disagree, neutral, agree and totally agree) and gives a score for the

Table 1
Number of participants in the three IQ studies and the NEO-FFI survey study.

	Age 12	Age 16	Age 18	% Female			Age at NEO		
				12	16	18	12	16	18
Study I	–	–	WAIS: 370			54%			20.7
Study II	WISC: 353	–	APM: 227	53%		62%	17.7		18.0
Study III	–	SPM: 426	WAIS: 388		54%	54%		29.0	29.0
NEO-FFI	–	–	1307			65%			19.7

Note: SPM = Raven standard progressive matrices; APM = Raven advanced progressive matrices; WISC = Wechsler intelligence scale for children; WAIS = Wechsler adult intelligence scale.

Table 2
Means, standard deviations and twin correlations (95% CI) for the FFM personality traits and for IQ scores.

	Open	Agr	Neu	Cons	Ext	IQ	PIQ	VIQ	SPM	APM
Mean	36.12	43.80	30.51	43.96	43.35	106.08	107.61	104.18	49.37	19.75
SD	5.55	4.86	7.71	5.91	5.78	15.47	17.67	15.70	6.11	6.32
MZ	0.51 (0.44–0.57)	0.38 (0.29–0.45)	0.51 (0.44–0.57)	0.46 (0.38–0.53)	0.48 (0.41–0.54)	0.84 (0.81–0.87)	0.75 (0.69–0.79)	0.83 (0.80–0.86)	0.57 (0.44–0.68)	0.67 (0.54–0.76)
DZ	0.28 (0.19–0.35)	0.12 (0.03–0.20)	0.19 (0.11–0.28)	0.21 (0.13–0.29)	0.16 (0.07–0.25)	0.50 (0.42–0.58)	0.52 (0.44–0.60)	0.41 (0.32–0.50)	0.48 (0.32–0.60)	0.18 (−0.05–0.38)

Note: Open = openness; Agr = agreeableness; Neu = neuroticism; Cons = conscientiousness; Ext = extraversion; IQ = full-scale IQ; SPM = Raven standard progressive matrices; APM = Raven advanced progressive matrices; PIQ = performance IQ; VIQ = verbal IQ; MZ = monozygotic; DZ = dizygotic.