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# Big Five personality relationships with general intelligence and specific Cattell-Horn-Carroll factors of intelligence

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ABSTRACT

*Objective:* Though relationships among Big Five personality traits and general intelligence have been found consistently, less is known of how personality traits relate to specific factors of intelligence. The present study examined relationships between Big Five personality traits on the NEO Personality Inventory-Revised (NEO-PI-R; Costa & McCrae, 1992) and *g*-residualized scores of the seven factors of the Cattell-Horn-Carroll (CHC) model on the Woodcock-Johnson-III (WJ-III; Mather & Woodcock, 2001).

*Method:* College students referred to a learning disorders clinic were assessed with a comprehensive neuropsychological battery that involved cognitive, achievement, and personality testing. The sample was culled for failure on a sensitive effort measure (Word Memory Test; Green, 2003), leaving 140 participants.

*Results:* Openness (O) accounted for significant variance in all seven WJ-III IQ factors with the O-crystallized intelligence (Gc) relationship being strongest and all other personality-IQ relationships being small. However, using residualized scores to remove common intellectual variance showed that Openness related only to Gc while Extraversion related to both processing speed and Gc.

*Conclusions:* The role that personality plays in the specific aspects of CHC factors of intellectual test performance is discussed in the context of learning difficulties in college students.

Substantial relationships between the Big Five factors of personality and intelligence have been found (e.g., Ashton, Lee, Vernon, & Jang, 2000; Bartels et al., 2012; Bates & Shieles, 2003; Holland, Dollinger, Holland, & MacDonald, 1995; McRae & John, 1992; Moutafi, Furnham, & Crump, 2003; von Stumm, Chamorro-Premuzic, Quiroga, & Colom, 2009; Wolf & Ackerman, 2005). Although much of this work has focused on the relation between personality traits with broad constructs of intelligence, relatively little is known of how personality traits relate to more specific factors of intelligence. The purpose of the present study was to refine our understanding of personality-IQ relationships by examining the Big Five traits of personality alongside the Cattell-Horn-Carroll (CHC) seven-factor model. Furthermore, the present study addressed various criticisms of the extant literature. Specifically, to identify the relationship of personality traits to factors of intelligence, those factors must be independent of *g*, general intelligence factor (Reeve, Meyer, & Bonaccio, 2006). Additionally, a sample referred for clinical evaluation of learning difficulties and psychiatric diagnoses was used that provided a broader range of intellectual performance to avoid attenuated correlations between personality and intelligence that might otherwise be due to range restriction in both the personality and intelligence measures. Finally, the sample was culled for participants providing insufficient effort in testing in order to dampen experimental error associated with mismeasurement of personality and intelligence.

It is still unclear whether personality traits relate just to overall intelligence or to factors of intelligence, or to both overall and specific factors of intelligence. As noted by Reeve et al. (2006), various factors of intelligence have shown different relationships with the Big Five traits across studies (e.g., -N: Austin, Hofer, Deary, & Eber, 2000; +E: Wolf & Ackerman, 2005; A: Krebs & Sturrup, 1982; –C: Furnham & Chamorro-Premuzic, 2005). Nevertheless, it might be argued that the most consistent personality-IQ relationships holds for Openness (Moutafi et al., 2003; Zeidner & Matthews, 2000). Specifically, Ashton et al. (2000) found Openness to correlate better with crystallized intelligence (Gc) than fluid intelligence (Gf), which is consistent with previous studies (e.g., Ackerman & Goff, 1994; Goff & Ackerman, 1992). Similarly, a meta-analysis confirmed the relationship of Openness to Gc over other factors of intelligence (Ackerman & Heggestad, 1997, although see Reeve et al., 2006 and von Stumm et al., 2009 for a

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divergent opinion). Despite the weight of evidence favoring the Openness-G*c* relationship, criticisms of existing evidence need to be addressed. First, a systematic analysis using a CHC model of intelligence is lacking in present literature, and it can therefore not be ruled out that additional Big Five personality traits may differentially relate to the various factors of intelligence. Such a model (crystallized intelligence [G*c*], long-term retrieval [G*lr*], visual-spatial thinking [G*v*], auditory processing [G*a*], short-term memory [G*sm*], fluid reasoning [G*f*], and processing speed [G*s*]) represents the synthesis of a comprehensive account of intelligence and, when measured in a single battery, can provide a more comprehensive study of the personality-intelligence relationship. Second, consistent with Reeve et al. (2006) specific factors of intelligence that are not substantially correlated with *g* must be examined for their association to personality variables. Only in this way can personality be related to specific intellectual variance apart from overall intelligence.

Another confounding variable that may be clouding the intelligence-personality relationship is insufficient effort in test performance. Poor effort is a nuisance variable that confounds assessment literature results (Green, 2007). Thus, ensuring adequate effort in the participant sample can lessen experimental error, yielding a better examination of the personality relationship with intelligence. For example, college student samples show a 5–12% failure rate on sensitive measures of effort (Ross et al., 2015; Santos, Kazakov, Reamer, Park, & Osmon, 2014; Silk-Eglit et al., 2014). Likewise, poor participant effort and/or feigning/malingering have been found to explain sizeable amounts of variance in neuropsychological performance, especially when incentive to falsify performance is present (e.g., to obtain Attention-Deficit/Hyperactivity Disorder (ADHD) medication; Constantinou, Bauer, Ashendorf, Fisher, & McCaffrey, 2005; Green, 2007; Green, Rohling, Lees-Haley, & Allen, 2001; Williamson et al., 2004). Furthermore, poor participant effort has been found to operate even when no discernable incentive to appear deficient has been found. For example, An, Zakzanis, and Joordens (2012) found that almost half of college participants in a study of neuropsychological test performance failed a common performance validity measure. While this finding is probably not a good estimate of college student effort in general (see Ross et al., 2015; Santos et al., 2014; Silk-Eglit et al., 2014), it does suggest that under some circumstances effort problems can grossly affect experimental findings. Therefore, well-designed assessment studies must ensure internal validity by at least excluding participants for failure on a sensitive measure of performance validity, such as Green's Word Memory Test (WMT) or Medical Symptom Validity Test (MSVT).

The present study used a sample of participants that excluded for insufficient effort in order to minimize experimental error in evaluating the relationship between personality and overall intelligence and its various components. Because there may be a differential relationship between each personality trait and the different factors of intelligence, the Woodcock-Johnson-III (WJ-III; Mather & Woodcock, 2001) instrument was used to assess seven CHC factors of intelligence as well as a full-scale score (GIA). While the WJ-III provides an aggregate intelligence score (GIA) as well as specific intelligence scores (G*c*, G*f*, G*lr*, G*sm*, G*a*, G*v*, G*s*; see Materials below for description), each of these specific scores correlate substantially with the aggregate score and, therefore, do not purely represent specific intelligence factors. In order to mitigate the concern about the overestimation of personality relationships with specific factors of intelligence (see Reeve et al., 2006, for a discussion), residualized scores for the CHC factor scores were obtained by removing common intelligence variance (GIA) and then were subjected to additional regression analyses for comparison to non-residualized CHC factor scores.

## 1. Methods

### 1.1. Participants

Participants initially included a total of 240 individuals referred to the university Learning Disability Clinic for academic concerns. Sixty-two of those participants were excluded for failing the Word Memory Test (any of the IR, DR, CNS, MC, PA scales (Green, 2003); see the following paragraph for details) leaving 178 participants of which 145 had an available primary diagnosis/no diagnosis: ADHD (38), Psychiatric (28), Cognitive Disorder-NOS (10), Learning Disorder (LD)-NOS (8), Math LD (8), No Warranted Diagnosis (17), Reading LD (35), Writing LD (1). Thirty-six percent of the sample had co-morbid diagnoses and 28 of the participants were found to have only psychiatric diagnoses but were included to fairly represent a sample referred for academic problems. The sample had an average age of 26.71 (SD = 9.66) and were college students who were given a multitude of psychoeducational measures for clinical purposes, which included the Woodcock-Johnson cognitive and achievement tests (WJ-III), standalone specific reading measures (e.g., Test of Word Reading Efficiency), neuropsychological measures (e.g., memory, attention, executive function tests), broad-based personality (i.e., NEO-PI-R) and college adjustment measures (e.g., Achievement Motivation Profile, Career Decisions Inventory, SACQ, etc.). Because this battery required on average 11.5 h to complete, participants were tested over two different sessions on consecutive days. Participants who were fluent in English and who completed the majority of measures including the complete WJ-III cognitive and NEO-PI-R were included in the analyses. Five participants had incomplete data on the WJ-III cognitive and/or NEO-PI-R, thus all analyses were conducted on the remaining 140 participants.

Sixty-two (26%) of the 240 total participants were removed from final analyses due to inadequate effort defined by performance cutoff scores below threshold for any of the five symptom validity scales of the Word Memory Test (IR, DR, CNS, MC, PA (Green, 2003)). Fig. 1 shows the entire distribution of participants on the WJ-III GIA compared to the distribution with participants removed for poor effort. Both distributions were fitted adequately by a normal distribution with delta Akaike's Information Criterion-corrected (AICc) values within < 2 of the best fitting distributions (Johnson Su and Gamma, respectively). Likewise, distributions for the two NEO-PI-R variables were also modeled by multiple distributions. Openness fit a normal distribution both before and after culling participants. Conscientiousness fit a Normal 2 Mixture distribution according to delta AICc values. Nevertheless, the distribution was normal looking except for a slight overrepresentation at the low end of the distribution. Additionally, removing participants for poor effort nearly eliminated outliers in the GIA distribution, as evident in the box plot. Since culling participants improved the distribution of the retained sample, further analyses were completed with the retained sample. Additionally, parametric statistics appear to be warranted for these distributions, even for Conscientiousness because the statistics are robust in near-normal distributions.

### 1.2. Materials

The NEO Personality Inventory-Revised (NEO-PI-R; Costa & McCrae, 1992) is a 240-item questionnaire that measures the Big Five personality traits: Neuroticism, Extraversion, Openness to Experience, Agreeableness, and Conscientiousness, each of which is comprised of six facets. NEO-PI-R measures used in the study included composites (mean of 50; standard deviation of 10) of the Big Five variables. Neuroticism (N) is the predisposition to experience psychological stress as manifested by anxiety, anger, depression or other negative affect. Extroversion (E) includes sociability, liveliness, and cheerfulness. Openness (O) comprises aesthetic sensitivity, intellectual curiosity, need for variety, and non-dogmatic attitudes. Agreeableness (A) consists of trust,