What Do We Know When We Know an IQ Score?
Ability-by-Personality Interactions Predict Intelligence Test Performance and Item Response Styles

Ashley Brown, David Condon, & William Revelle

Northwestern University—Evanston, IL

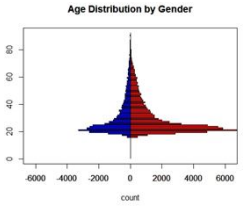
INTRODUCTION

- Researchers often assume that intelligence test scores are pure, albeit unreliable measures of latent ability. This assumption presupposes another; that is, that the takers of intelligence tests engage completely and dispassionately in the tasks that comprise the tests. Thus, motivation, emotion, and other non-cognitive variables should not affect performance on ability tests, yielding an untainted estimate of latent intelligence. Whether this assumption is correct is itself an empirical question, the answer to which previous research suggests is a resounding 'no'.
- Ever since Tolman & Honzik (1930), researchers have known that performance and competence differ. By analogy, cognitive competence may predict, but does not capture all the variability we observe in intelligence test performance and, importantly, in its correlates, which tend to reflect life success.
- Recent inquiries have sought the factors that supplement cognitive competence in predicting performance, demonstrating, for instance, that a small but significant portion of the variance in performance on ability tests is attributable to other sources, most notably to personality traits (Ackerman & Heggestad, 1997; Reeve, Meyer, & Bonaccio, 2005).
- Chamorro-Premuzic and Furhnam (2006) have developed the 'Intellectual Competence' model, which uses measures of personality traits and self-assessed intelligence as well as of psychometric intelligence to predict performance in a number of achievement-related domains. They note that the same personality traits may enhance performance in some situations or on some tasks, and impair it in others. They encourage other researchers to embark on systematic studies of such differential trait profiles; the current poster describes the results of one such study.
- Intelligence and personality may interact in several different ways, on either their "latent" or "observable" levels. Evidence for such interactions strongly supports the contention that non-cognitive variables affect test-taking style and other predictors of performance on intelligence tests.
- The present study utilized the Synthetic Aperture Personality Assessment (SAPA) Project's personality and ability data to investigate the manner in which personality trait estimates interact with ability estimates and gender to predict four relevant dependent variables; namely, personality traits, scores on the full SAPA ability battery, scores on subsets of ability items exhibiting a range of difficulties, and a specific item response style (namely, willingness to endorse an 'I don't know' response option to a set of particularly difficult items).

METHODS

Participants

- **Demographics** : Data were analyzed for 96,947 participants who had taken the SAPA battery between August 2010 and May 2013.
- Gender: 66% female
- Age: med = 22 years; range = 14 to 90 years
- Country of Origin: U.S.: 78%; others from 1 of 234 other countries.
- Ethnicity: White: 53%; African American: 30%; 18 others.
- Marital Status: Never Married: 73%; Married: 17%; the rest were widowed or divorced, single or remarried.
- Education: Currently enrolled in college or university: 51%. Only 20% of participants had had no university education.
- Standardized test scores: SATV: M = 611 (SD = 128), SATQ: M = 610 (SD = 128), SATW: M = 606 (SD = 133), ACT: M = 26 (SD = 5.2).



Procedure

- SAPA is a web-based assessment technique that explores the structure of a sampling of personality and ability items. These items are 'massively missing at random'; that is, although no one person takes all the ability or all the personality items, data on each item are collected for approximately 10,000 subjects.
- The procedure begins by requesting test-takers to provide consent and demographic information.
- Next, 60 personality items are administered. Fifty items assess the open-source International Personality Item Pool (IPIP) Big Five domains of Conscientiousness (C), Agreeableness (A), Neuroticism (N), Extraversion (E), and Intellect/Openness to Experience (I/O) (Digman, 1990; Goldberg, 1980); of these, 10 items apiece are randomly selected from each of the IPIP Big Five domains (Goldberg et al., 2006). The item pool from which the latter are taken contains 100 items, with 20 items in each domain. Ten items are randomly selected from a set of 'exploratory' items; these assess such constructs as interests and attitudes.
- Finally, each participant receives a set of between 12 and 16 ability items (the exact number varied by administration period). Ability items are also randomly drawn from a pool of either 80 , 65, or 60 items. The 60-item pool currently being administered was constructed by eliminating from the original 80 items those 20 that possessed the worst psychometric properties.
- Participants who complete the survey receive feedback regarding their performance on the ability test (e.g., number incorrect) and on their personality, with text adapted from Johnson (2005).

Measures

- **The SAPA ability test** consists of a random set of matrix reasoning items (drawn from an 11 item pool), letter and number series items (9 item pool), three-dimensional rotation items (24 item pool), and verbal reasoning items (21 item pool). All SAPA's ability items have been designed in-house to create a `Google-resistant power test' (Condon & Revelle, 2012); that is, an untimed online ability test that is largely immune to the attempts of participants to find answers using Internet search engines.
- **Psychometric Properties**
  - **General:** Two-parameter item response theory (IRT) analyses of each IQ subtest showed that, in general, the psychometric properties of the SAPA item set seemed sound. The reliability results for both the personality and the ability items are similar to earlier SAPA reliabilities reported for other samples (Revelle, Wilt, and Rosenthal, 2010).
  - **SAPA Personality:** Reliability analyses based on item information indicated that the alpha reliabilities of SAPA's Big Five scales were good, ranging from 0.71 (Intellect/Openness to Experience) to 0.81 (Stability/Neuroticism). These reliabilities are similar to those of Big Five scales computed from paper-and-pencil data.
  - **SAPA Ability:** Both items and item types (e.g. alphanumeric sequences, spatial rotations, etc.) differed substantially in difficulty. Reliability and information analyses of the ability items suggested that the range of reliabilities at different levels of participant ability was quite good, falling between alphas of 0.75 and 0.95.

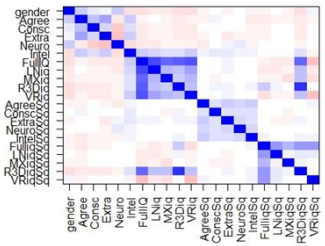
RESULTS

- Descriptive Statistics for Personality and Ability Domains

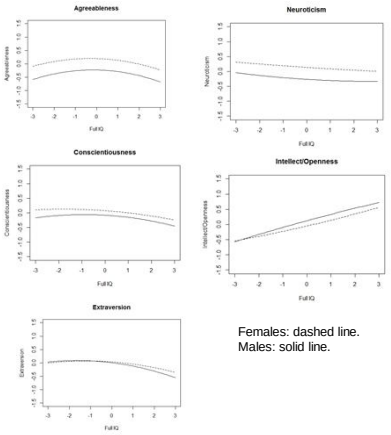
	N	Mean	SD	Skew	Kurtosis
Agree	96,334	0.78	1.41	-0.04	-0.09
Consc	96,616	0.36	1.30	-0.01	-0.01
Extra	96,359	-0.15	1.36	-0.09	-0.08
Neur	96,260	-0.13	1.37	0.12	0.01
Intel	96,428	0.90	1.32	0.05	-0.12
FullIQ	95,221	0.24	1.80	-0.03	-0.51
LNiq	94,688	0.41	2.42	-0.08	-1.13
MXiq	92,566	0.28	2.49	-0.11	-1.23
R3Diq	61,493	-1.56	2.79	0.74	-1.12
VRiq	94,476	0.72	2.20	-0.22	-0.97

Note. All statistics are in z-score form. Agree = agreeableness; Consc = conscientiousness; Extra = extraversion; Neur = neuroticism; Intel = Openness/Intellect; FullIQ = full set of ability items.; LNiq = letter and number series items; MXiq = matrix reasoning items; R3Diq = spatial rotation items; VRiq = verbal reasoning items.

- Correlations Among Raw and Squared Measures of Ability, Personality, and Gender

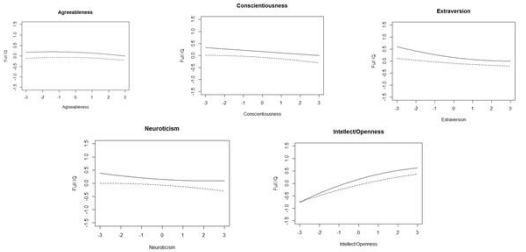


- Predicting each of five personality traits from gender and linear and quadratic effects of full IQ score



Females: dashed line.
Males: solid line.

- Predicting full ability score from gender and linear and quadratic effects of personality
  - Females: dashed line. Males: solid line.



- Regression Coefficients for SAPA Ability Item Types Regressed on IQ, Gender, and Each of Five Personality Traits; IDKs Ignored

Three-Dimensional Rotation

	Main Effects			Interactions			
	Trait	IQ	Gender	Trait*IQ	Trait*Gender	IQ*Gender	Trait*IQ*Gender
Agree	-0.05	0.28	-0.07	-0.02	0.00	-0.04	-0.01
Consc	-0.04	0.28	-0.07	-0.03	0.00	-0.04	0.00
Extra	-0.05	0.28	-0.07	-0.04	0.01	-0.04	0.00
Neuro	0.00	0.28	-0.08	0.00	0.00	-0.04	0.00
Intel	0.09	0.27	-0.07	0.05	-0.01	-0.03	-0.01

Verbal Reasoning

	Main Effects			Interactions			
	Trait	IQ	Gender	Trait*IQ	Trait*Gender	IQ*Gender	Trait*IQ*Gender
Agree	-0.01	0.37	-0.07	-0.02	-0.01	0.00	0.01
Consc	-0.05	0.37	-0.07	-0.01	-0.01	-0.01	0.00
Extra	-0.04	0.37	-0.07	-0.02	0.00	-0.01	0.00
Neuro	-0.01	0.38	-0.07	0.00	0.00	-0.01	0.00
Intel	0.13	0.36	-0.07	0.01	0.01	-0.01	0.01

Matrix Reasoning

	Main Effects			Interactions			
	Trait	IQ	Gender	Trait*IQ	Trait*Gender	IQ*Gender	Trait*IQ*Gender
Agree	-0.01	0.34	-0.02	-0.01	0.00	-0.03	0.00
Consc	-0.01	0.34	-0.03	-0.01	0.00	-0.03	0.00
Extra	-0.03	0.34	-0.03	-0.02	0.01	-0.03	0.00
Neuro	-0.03	0.34	-0.02	0.00	0.00	-0.03	0.00
Intel	0.05	0.34	-0.02	0.02	-0.01	-0.03	0.00

Letter and Number Series

	Main Effects			Interactions			
	Trait	IQ	Gender	Trait*IQ	Trait*Gender	IQ*Gender	Trait*IQ*Gender
Agree	0.01	0.38	-0.03	-0.02	0.00	-0.02	0.00
Consc	0.01	0.38	-0.03	-0.01	0.00	-0.02	0.00
Extra	-0.02	0.37	-0.03	-0.02	0.00	-0.02	0.00
Neuro	-0.03	0.37	-0.02	0.00	0.00	-0.02	0.00
Intel	0.09	0.36	-0.02	0.02	0.00	-0.02	0.00

Note. Color indicates that regression weight is significant at p < .001. Agree = agreeableness; Consc = conscientiousness; Extra = extraversion; Neuro = neuroticism; Intel = openness/intellect; IQ = SAPA ability composite; IDKs = "I don't know" responses to three-dimensional rotation items.

- Number of 'I don't know' responses to three-dimensional rotation items regressed on composite IQ, gender, and personality

IDKs ignored

	Main Effects			Interactions			
	Trait	Comp IQ	Gender	Trait*IQ	Trait*Gender	IQ*Gender	Triple
Agree	0.01	-0.11	0.07	-0.01	-0.01	-0.02	0.00
Consc	-0.02	-0.11	0.07	0.01	-0.01	-0.02	0.00
Extra	-0.01	-0.11	0.07	0.01	-0.01	-0.02	0.00
Neuro	0.04	-0.11	0.07	-0.01	0.00	-0.02	0.00
Intel	-0.06	-0.10	0.07	-0.01	-0.01	-0.02	0.00

IDKs incorrect

	Main Effects			Interactions			
	Trait	Comp IQ	Gender	Trait*IQ	Trait*Gender	IQ*Gender	Triple
Agree	0.01	-0.11	0.07	-0.01	-0.01	-0.01	0.00
Consc	-0.02	-0.11	0.07	0.01	-0.01	-0.02	0.00
Extra	-0.01	-0.11	0.07	0.01	-0.01	-0.02	0.00
Neuro	0.04	-0.11	0.07	-0.01	0.00	-0.01	0.00
Intel	-0.06	-0.10	0.07	-0.01	-0.01	-0.02	0.00

Note. Color indicates that regression weight is significant at p < .001. Agree = agreeableness; Consc = conscientiousness; Extra = extraversion; Neuro = neuroticism; Intel = openness/intellect; IQ = SAPA ability composite; IDKs = "I don't know" responses to three-dimensional rotation items; Triple = IQ x Trait x Gender.

FUTURE DIRECTIONS AND CONCLUSIONS

- Non-cognitive as well as cognitive variables have small but reliable influences on intelligence test scores; recurrent themes involving personality, gender, and ability variables are easily observed in the data presented here.
- Limitations of the current study included the self-selected SAPA participant sample, which rendered certain analyses (e.g. of items skipped across the test battery) low in power to detect effects. Future research will be aimed at improving the SAPA battery in its entirety, and the ability battery in particular.

NORTHWESTERN UNIVERSITY