How is personality related to intelligence and achievement? A replication and extension of Borghans et al. and Salkever

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Abstract

In two equally enlightening contributions on identification problems in personality psychology, Borghans, Golsteijn, Heckman, and Humphries (2011) and Salkever (2015) discussed two questions with potentially far-reaching implications for studies on the effects of cognitive ability on important life outcomes: (1) whether measures of "achievement" and "intelligence" are distinct; (2) and to what extent achievement measures are confounded with personality traits. In the present article, we revisit this controversy, identify unresolved issues, and provide a fresh look at the key questions. Our independent replication and extension using a large representative sample of German ninth-grade students (N = 13,648) demonstrates that achievement and intelligence tests are highly but not perfectly correlated. Personality accounts for a substantial share of the variance in achievement but only a small share of that in intelligence. Importantly, personality incrementally explains variance in achievement above and beyond intelligence. Whereas standardized achievement measures are a good (but not "pure") indicator of cognitive ability, this problem of confounding is particularly pressing for school grades, which are only modestly correlated with intelligence and highly laden with personality. We discuss theoretical implications and recommend that studies aiming to identify the effects of cognitive ability on life outcomes routinely control for personality.

1. Introduction

How are cognitive ability1 and personality2 related? This question is important in its own right and has recently attracted renewed attention (Chamorro-Premuzic & Furnham, 2005; Rammstedt, Danner, & Lechner, 2017). Yet it is also at the core of a more specific debate (Borghans et al., 2011; Salkever, 2015) revolving around the question to what extent measures of learned skills, such as standardized achievement tests or school grades, reflect basic cognitive skills—often termed "intelligence" or "IQ"—or, instead, personality traits such as the Big Five. The present study provides a fresh look at this question, using a large and representative sample of ninth-graders from the German National Educational Panel Study (NEPS).

1.1. The original argument

In an instructive article, Borghans et al. (2011) delineated what they called a "fundamental identification problem in personality psychology" (p. 319) that arises from the practice of equating measures of traits with the traits themselves. The authors criticized this practice as unwarranted because measures of traits arise from multiple sources other than the traits they intend to measure. As a case in point, Borghans et al. discussed standardized achievement tests and school grades. They argued that such achievement measures, often taken to measure intelligence, reflect more than cognitive ability—namely, also personality traits. In their view, achievement measures cannot be used to identify effects of intelligence on outcomes of interest.

The authors corroborated their arguments with empirical analyses in two samples: a representative sample of American youth (the National Longitudinal Survey of Youth, NLSY79, N = 12,686) and a smaller Dutch high school sample (Stella Maris, N = 374). In both samples, achievement test scores and school grades showed far-from-perfect
correlations with psychometric intelligence. In the NLSY79, the Armed Forces Qualifications Test (AFTQ) correlated only at \( r = 0.64 \) with IQ percentile scores, casting doubt on its suitability as an indicator of cognitive skills. Even more important, the authors found that, “substantial portions of the variance in achievement test scores and grades, which are often used as measures of cognition, can be explained by personality variables” (p. 315)—even after adjusting for IQ percentile scores. Even the “relatively weak measures of personality” (p. 318) in the NLSY79 (self-esteem and locus of control) explained about one-third of the variance in achievement test scores and grades, amounting to an \( R^2 \) increment over IQ of 5% for achievement tests scores and 3% for school grades. In Stella Maris, offering better personality measures (notably the Big Five) but suffering from range restriction as no lower-track students were included, personality effects were even more pronounced. Here, personality alone explained as much variance in school grades as they did after adjusting for IQ (7%), with IQ alone explaining only 1% of the variance in grades.

These findings have important implications for studies relating measures of achievement (e.g., SAT scores or GPA) to important life outcomes such as earnings or health. Stated briefly, they imply that, unless personality is adequately controlled for, achievement measures cannot identify the effect of cognitive ability on these outcomes; rather, achievement measures reflect the combined effect of cognitive and non-cognitive traits. Indeed, as Borghans et al. ventured to claim, studies purportedly revealing effects of cognition that fail to control for personality traits, including the famous ‘bell curve’ (Herrnstein & Murray, 1994), “are also demonstrations of the power of personality” (p. 317).

1.2. The critique

Recently, Salkever (2015) has challenged these conclusions on conceptual and empirical grounds. Citing authoritative educational testing literature, he maintained that the distinction between ‘achievement’ and ‘intelligence’ tests was less sharp than Borghans et al. suggested. His view is that all tests reflect “developed abilities” (p. 67), or acquired knowledge. Salkever did acknowledge possible distinctions between tests—in particular, the well-established distinction between crystallized and fluid intelligence (\( g_c \) and \( g_f \); see Nisbett et al., 2012, for a review), with achievement tests falling into the first (\( g_c \)) and more pure measures of basic cognitive ability, such as Raven’s progressive matrices, falling into the latter (\( g_f \)) category. Yet he maintained that most of the seven different intelligence tests in the NLSY79 from which Borghans et al. constructed IQ percentile scores were not primarily measures of \( g_f \), thus failing to qualify as ‘intelligence’ tests.

Salkever also identified problems in Borghans et al.’s analyses with the NLSY79 dataset that may attenuate the correlation between IQ and achievement test scores. First, for many respondents, a substantial amount of time (between 5 and 15 years) elapsed between the assessment of intelligence on the one hand and those of achievement/grades and personality on the other. Second, the decision to re-construct IQ percentile scores for the roughly two-thirds of respondents for whom only raw test scores were available might introduce measurement error. In a re-analysis attempting to remove these sources of bias, Salkever restricted the sample to respondents for whom at least one actual percentile score on at least one of the seven intelligence tests was available, and for whom the time between taking the IQ and the achievement test was below certain thresholds (3.1 years on average in the strictest specification). With these restrictions, the correlation between the AFQT test score and IQ increased to up to \( r = 0.84 \). Concomitantly, the \( R^2 \) increment of personality in predicting achievement over intelligence decreased substantially to just around 1%.

In the light of his re-analysis, Salkever cautioned that Borghans et al.’s distinction between the AFTQ as an achievement test and the various intelligence tests in the NLSY79 was a “murky one” (p. 64). He called for further research using intelligence tests that are “more heavily weighted toward fluid intelligence to demonstrate clear empirical distinctions between these other types of tests vs. the AFQT or vs. other 'IQ' test scores.” (p. 64).

1.3. A critique of the critique

Though enlightening, Salkever’s re-analysis is subject to limitations of its own. First, the necessary sample restrictions in his re-analysis of the NLSY79 decreased sample size to as little as \( N = 401 \) in some specifications, potentially introducing selectivity. Second, his re-analysis used manifest variables (principal components scores for the AFTQ and sum scores for personality), a feature shared with Borghans et al.’s analysis. As recent simulation studies (Westfall & Yarkoni, 2016) demonstrate, even small amounts of measurement error in manifest variables entail high type-I error rates in multiple regressions testing the incremental validity of a predictor over another. Latent-variable models explicitly modeling measurement error are required lest researchers fall prey to spurious support for incremental validity (Westfall & Yarkoni, 2016, p. 19), such as whether personality predicts achievement over intelligence. Third, as Borghans et al. had remarked themselves, the NLSY79 personality measures are rather weak. Yet Salkever did not comment on the fact that Borghans et al. reported a similar pattern of results in the small Stella Maris sample, where better measures of personality (the Big Five) and intelligence (Raven’s matrices, which can be considered the best single measure of \( g_f \)) were available. Fourth, Salkever did not examine another of Borghans et al.’s presumptions: that achievement tests are more heavily laden with personality than more pure measures of intelligence are; or put differently, that personality is more strongly related to markers of \( g_f \) than markers of \( g_c \).

2. The present contribution

The limitations of Borghans et al.’s original analysis and Salkever’s re-analysis call for an independent replication. Here we conduct such replication using data from the German National Educational Panel Study (NEPS). These rich and recent data allow us to overcome most limitations of the previous two contributions. The NEPS comprises a representative sample of ninth-grade students in Germany, covering an age bracket similar to the samples used by Borghans et al. The dataset contains (a) a short measure of the Big Five, the most well-validated and widely used personality inventory; (b) standardized achievement tests and report-card grades; as well as (c) two relatively pure intelligence measures, namely a figural reasoning matrix test (the single best measure of \( g_f \); Nisbett et al., 2012) and a digit symbol test measuring perceptual and processing speed. Importantly, all tests and questionnaires were administered within the same school year (9th grade), eliminating any bias that may arise from time lags between measures.

We mimic Borghans et al.’s and Salkever’s analyses as closely as possible to address two core issues of their controversy: first, whether achievement and intelligence tests are empirically distinct; second, how much variance in achievement measures is accounted for by intelligence vs. by personality, whereby \( R^2 \) increments of personality after adjusting for intelligence are the primary interest. Moreover, we extend their analyses in several regards: In addition to how much variance personality explain in achievement measures, we also examine how much variance they explain in intelligence measures. This allows us to test Borghans et al.’s proposition that the confounding of cognitive skill measures with personality traits “applies with greater force to achievement tests and grades [than to intelligence measures]” (p. 317). We also report in detail which specific Big Five dimensions relate to which cognitive abilities. We use latent variable models so as to limit type-I errors when assessing incremental validity (Westfall & Yarkoni, 2016).
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