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Differentiation of cognitive abilities as a function of neuroticism level: A measurement equivalence/invariance analysis

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Abstract

This paper investigates the differentiation of cognitive abilities as a function of neuroticism. Specifically, we examine Eysenck and White's [Eysenck, H.J., and White, P.O. (1964). Personality and the measurement of intelligence. British Journal of Educational Psychology, 24, 197–201.] hypothesis that cognitive abilities are less differentiated at high levels of neuroticism than they are at low levels of neuroticism. In spite of its potential importance, this hypothesis has only received limited research attention. Although a recent series of papers has found some initial support for the neuroticism-differentiation hypothesis, these studies have relied on correlational techniques. The current paper uses a more rigorous structural equation modeling technique to explicitly test for measurement invariance to determine whether the structure of cognitive abilities differs between high and low neuroticism levels, as measured by two self-report scales. Results from two datasets provide convincing evidence for complete measurement invariance across different levels of neuroticism, thus disconfirming the neuroticism-differentiation hypothesis.

Keywords: Cognitive abilities; Differentiation hypothesis; Intelligence; Intelligence–personality associations; Personality; Neuroticism; Measurement equivalence/invariance

The recent trend to study individual differences as constellations rather than as separate and distinct constructs has renewed researchers' interest in the relationship between personality and intelligence. In fact, a large number of recent empirical studies (e.g., Bates & Shieles, 2003; Gignac, Stough, & Loukotomis, 2004; Harris, 2004), theoretical models (e.g., Chamorro-Premuzic & Furnham, 2004), and a seminal meta-analysis (Ackerman & Heggestad, 1997) have focused on the relationship between these two core individual difference domains. The main theme behind these treatments is to investigate the magnitude of linear relations between specific cognitive abilities and specific personality traits.

However, in the early 1960s, researchers (e.g., Eysenck & White, 1964; Lienert, 1963) proposed a different type of intelligence–personality association, namely differentiation. That is, it was suggested that the structure of cognitive abilities may change across levels of a personality trait. Specifically, the neuroticism-differentiation hypothesis posits that the structure of cognitive abilities may change as a function of neuroticism. Despite having been introduced in the literature over four decades ago, researchers have only recently begun to once again empirically investigate this question (e.g., Austin, Deary, & Gibson, 1997). As such, the differentiation of abilities as a function of

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neuroticism is an old question, but one with a short research history. The purpose of this paper is to extend the brief literature testing this hypothesis by employing a more rigorous analytical strategy than has been used previously; specifically, we use structural equation modeling techniques to test for measurement invariance.

1. Structure of cognitive abilities

Although research on cognitive abilities has a long and complex history, there is general agreement among differential researchers on the structure of abilities. Following Carroll (1993), cognitive abilities are best represented as a three-tier hierarchy. The general factor (*g*), typically defined as the "eduction of relations and correlates" (Spearman, 1927) or "neogenesis with abstractness" (Jensen, 1998), is located at the top of the hierarchy in the third stratum. *g* subsumes a group of eight to ten narrow[1] abilities in the second stratum, which is composed of "very general abilities that lie in broad domains of behavior" (Carroll, 1993, p.633–634). Compared to the general factor, these second stratum abilities are moderately specialized. In turn, these subsume a group of approximately 70 even more specific abilities located in the first stratum.

McGrew (1997) further refined Carroll's (1993) model by integrating it with the Horn–Cattell G_f–G_c model. There are many similarities between the Horn–Cattell and the Carroll models, especially in terms of the overlap in the narrow abilities included in the model. However, an important difference between the models is that the Horn–Cattell model does not include the general factor, whereas Carroll's model does. McGrew's (1997) synthesized Carrol–Horn–Cattell representation of cognitive abilities is arguably the most accurate and current representation of the construct space of cognitive abilities. In addition to the broad *g* factor, McGrew's model includes the following narrow abilities: fluid intelligence (G_f), crystallized intelligence (G_c), quantitative reasoning (G_q), short-term memory (G_{sm}), visual intelligence/processing (G_v), auditory intelligence/processing (G_a), long-term associative storage and retrieval (G_{lr}), cognitive processing speed (G_s), decision reaction-time (G_t), and reading and writing (G_{rw}).

[1] Numerous terms exist to refer to narrower, non-*g* cognitive abilities (e.g., group factors, specific abilities, narrow abilities). The term "narrow abilities" is used throughout this paper to refer to the group of non-*g* ability factors.

2. Differentiation of abilities as a function of neuroticism

In general, research on the differentiation of cognitive abilities concerns changes in the structure of cognitive abilities as a function of another construct. Two of the more well-known differentiation hypotheses are the cognitive-differentiation hypothesis and the age-differentiation hypothesis. The cognitive-differentiation hypothesis posits that abilities become increasingly distinct at higher levels of general intelligence (e.g., Carlstedt, 2000; Detterman & Daniel, 1989, see also Spearman, 1927). For example, Abdad, Colom, Juan-Espinosa, and García, (2003) recently demonstrated that the *g* factor accounts for more variance among less able individuals than it does among more able individuals, and that the average correlation among ability tests is greater for low ability individuals than it is for high ability individuals. Similarly, Detterman and Daniel (1989) showed that the positive manifold (that is, the positive correlations) among cognitive ability tests is stronger for lower IQ subjects than it is for their higher IQ counterparts. The age-differentiation hypothesis posits that abilities become more differentiated from early childhood until full maturity (e.g., Garrett, 1946), and then become increasingly dedifferentiated for the remainder of the life-span (e.g., Balinsky, 1941). Although research has tended to support the cognitive-differentiation hypothesis, evidence for the age-differentiation hypothesis has been mixed (e.g., Juan-Espinoza et al., 2002).

The neuroticism-differentiation hypothesis suggests that cognitive abilities are *less* differentiated at *increased* levels of neuroticism, and conversely *more* differentiated at *decreased* levels of neuroticism. In other words, *g* should account for more of the total observed variance in a battery of ability tests at high levels of neuroticism than it should at low levels (while the opposite pattern is expected for the narrow abilities). The idea that the structure of cognitive abilities could vary as a function of neuroticism was first proposed by Lienert (1963) and by Eysenck and White's (1964) reanalysis of his data.

In an early study linking intelligence to neuroticism, Lienert (1963) analyzed the factor structure of cognitive ability tests for high and low neuroticism children separately. While appropriately cautioning against accepting evidence before replicating it, Eysenck and White (1964) concluded that in Lienert's data "the [emotionally] stable group has a more clearly marked structure in the cognitive test field that has the labile group" (p.201). In fact, both Lienert's original and Eysenck and White's re-analysis demonstrated that more factors could be extracted from the "stable" (i.e., low neuroticism) group