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Openness to experience, general intelligence and crystallized intelligence: A methodological extension

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Abstract

Using a semi-partial correlation approach, Gignac, Stough, and Loukomitis [Gignac, G. E., Stough, C., & Loukomitis, S. (2004). Openness, intelligence, and self-report intelligence. *Intelligence*, 32, 133–143] examined the relationship between Openness and '*g*' and residualized scores from Vocabulary and Information as estimates of crystallized intelligence. To help overcome any ambiguity in the interpretation of the results, a more sophisticated analysis based on nested factor modeling (SEM) is demonstrated to support the findings reported in Gignac et al. Researchers are encouraged to make use of the nested factor modeling approach, rather than the procedure endorsed in Gignac et al., because of advantages relevant to modeling superior estimates of intelligence factors, as well the means of evaluating model fit afforded by SEM.

Keywords: Openness; Crystallized intelligence; Nested factor modelling

1. Introduction

In a recent investigation, Gignac, Stough, and Loukomitis (2004) argued that past research which tested hypotheses pertaining to Openness relationship with intelligence were confounded by the fact that subtests such as Vocabulary and Information are imbued with high levels of general intelligence, as indicated by their large factor loadings on a general factor of intelligence. In contrast, subtests such as Digit Symbol are weak measures of general intelligence (Gignac & Vernon, 2002).

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To test hypotheses relevant to crystallized intelligence and Openness less ambiguously, Gignac et al. (2004) partialed out the general factor from each subtest and then correlated Openness with the residuals of each subtest. More specifically, Gignac et al. estimated '*g*' component scores and then regressed each intelligence subtest onto the '*g*' component scores. The residuals from each regression were saved as new variables, which were considered representations of crystallized intelligence for subtests such as Vocabulary and Information. Note well that each general component did not include the respective subtest that was partialed. Thus, at each step, a somewhat different general component was estimated for the purpose of partialling out general intelligence from each subtest. Based on these semi-partial correlations, Gignac et al. found that objective Openness component scores correlated positively with '*g*' but not with any of the verbal subtest residuals (i.e., crystallized intelligence).

A limitation to the procedure endorsed by Gignac et al. (2004) is that the first component/factor extracted from the Wechsler sales has been argued to be biased toward verbal intelligence subtests, because of the disproportionate amount of inter-subtest covariation between subtests such as Vocabulary, Information, Comprehension, and Similarities (Ashton, Lee, & Vernon, 2001; Gustafsson, 1992; Jensen, 1987). Thus, the effect of partialling out a biased '*g*' component/factor from individual subtests may extract a non-negligible amount of group-level variance (i.e., Gc) from the verbal subtests. Another limitation of the Gignac et al. procedure is that the residual variance from each subtest was examined only individually. It could be argued to be advantageous to examine the unique variance (i.e., Gc) derived from subtests such as Vocabulary, Information, Comprehension, and Similarities, collectively as a factor. Finally, the procedure endorsed by Gignac et al. could probably be argued to be cumbersome and time consuming, given that a separate estimate of '*g*' component/factor scores has to be estimated for each subtest.

Gustafsson and Balke (1993) demonstrated an SEM procedure for the purpose of examining the relationship between educational achievement and crystallized intelligence, as distinguished from general intelligence. Gustafsson and Balke referred to the SEM procedure as 'nested factor modeling', because the group-level factors (e.g., crystallized intelligence, perceptual organization, etc.) were nested within the general factor. Mulaik and Quartetti (1997) noted the close similarities between the Gustafsson and Balke nested factor modeling approach and Holzinger's bi-factor model (Holzinger & Swineford, 1937).

In contrast to the procedure used by Gignac et al. (2004), nested factor modeling does not suffer from the limitations noted above. Specifically, the primary advantage of modeling intelligence as a nested factor model is that latent variables can be modeled both simultaneously (which controls for potential bias in the general factor) and orthogonally to each other (which increases the clarity of relationships between intelligence factors and a criterion). Thus, a latent variable estimate of crystallized intelligence (Gc) can be obtained, which is independent of the latent general intelligence variable, and any other group-level factor that may be of interest, allowing for less ambiguous interpretations of relationships between factors and a criterion. Further to the above two advantages, because nested factor modeling is an SEM procedure, estimates of model fit can be obtained to evaluate the plausibility of the model. All three of these advantages can be contrasted with the procedure employed by Gignac et al., which may have estimated biased '*g*' component scores, did not model Gc as a factor (individual residualized subtest scores were calculated), and nor was any method of evaluating model fit available.

Consequently, to examine further the relationship between Openness and intelligence, the data from Gignac et al. (2004) were re-analyzed, using a nested factor modeling approach. Although it was