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Testing the differentiation of intelligence by neuroticism hypothesis

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ABSTRACT

The prediction that neuroticism (or emotional instability) will change the definition of an intelligence factor, or g, was tested in a large sample (N = 2,716) of British managers who completed both personality and intelligence measures. Specifically, we examine if the structure of mental abilities changes across levels of personality (with a focus on the neuroticism/adjustment dimension). The results demonstrate that, similar to a recent report, there is some evidence supporting the suggestion that intelligence scales inter-correlate higher for less adjusted individuals, but that the effect is not strong enough to impact intelligence and personality research.

Background

Differentiation of intelligence by personality

The research question of whether or not personality influences the relationship between intelligence measures originated from a report by Eysenck and White (1964) who re-examined a German data set from G. A. Lienert which included test responses from 1003 adolescent students between the ages of 15 and 16 years who had completed a measure of neuroticism and 13 intelligence (mental ability) scales. In their re-analysis, Eysenck and White examined the factor structure of the intelligence scales for students scoring at the highest 25% on the neuroticism scale and compared the factor structure of the intelligence scales to that extracted from the students with the lowest 25% neuroticism scores. In their results, Eysenck and White reported that the structure of intelligence differed between those scoring higher versus lower in neuroticism. Specifically, individuals scoring higher in stability (had low neuroticism scores) had three intelligence factors (because of greater variability in the intelligence scores) and those scoring higher in neuroticism (labile) had two intelligence factors and had less variable scores for the intelligence scales. In their explanation of the results, Eysenck and White (1964) suggest that personality and intelligence are related and that those who are emotionally stable (have lower neuroticism personality scores) have a "greater organization of abilities" (p. 189) than those who are less stable and therefore score higher on neuroticism scales. Having a greater understanding of how personality may influence intelligence test responses and, following, the structure of intelligence is of importance for further understanding the structure of individual differences. If, for example, personality influences the number and structure of intelligence/ability factors, then the possible universality of these factors may be questioned.

Following, Austin et al. (1997) examined the influence of neuroticism on intelligence with a sample of Scottish farmers, who had completed two intelligence measures, and reported that the correlation between the two intelligence measures was higher for those individuals scoring higher in neuroticism compared to those who scored lower in neuroticism. In a follow-up study with two large samples of police applicants and felons, Austin et al. (2000) replicated the findings and suggested that there was a greater differentiation in ability for the individuals who scored lower in the measure of neuroticism. Austin et al. (2002) further examined the differentiation of intelligence by neuroticism levels in four data sets. For two of the data sets, the intercorrelations between intelligence scales were found to increase (become less differentiated) with higher neuroticism scores, but this effect was not present in the other two data sets examined, nor for the other Big Five traits.

In contrast to the findings reported by Austin et al. (1997; 2000; 2002), Bonaccio and Reeve (2006) tested the Differentiation of Intelligence by Neuroticism Hypothesis and found no evidence to support the hypothesis in two different data sets of students. Escorial et al. (2006) also concluded that personality, based on the Big Five factors, did not influence the structure of intelligence or the variability of cognitive ability tests when low, medium, and high personality scorers were compared. Recently, Schermer and Goffin (2021) examined the general intelligence factor loadings and inter-scale correlations for an ability measure separately for individuals scoring higher versus lower on each of the Big Five personality scales in a large sample of managers. The results demonstrated that although there was a slight increase in the average inter-scale correlation for the ability measure for

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those scoring higher, versus lower, in neuroticism, the difference was not significant. For each of the Big Five dimensions, the inter-scale correlations for the ability measure were found to not differ significantly between those scoring higher versus lower on the personality scale. Similarly, the general intelligence factor loadings did not change when the lower and upper personality scoring groups were compared. In addition, the results remained consistent when the variance due to social desirability was removed from the personality scale scores.

Objective

In the present study, the inter-scale correlations of an ability measure are examined between those scoring higher, versus lower, on each of six personality scales measured to assess if these personality dimensions may have an influence on the variability of intelligence. Also tested will be the general intelligence factor loadings of the ability scales onto a single factor for the upper, versus lower, scoring individuals for each personality dimension.

Method

Sample and procedure

Managers (N = 2716, 63.6% men) with a mean age of 40.72 years (SD = 10.64), were participants in an assessment centre sponsored by the individual's host organization. Almost all of the participants (99.4%) were British, with one or two individuals each from Brazil, Egypt, Kuwait, Luxembourg, Saudi Arabia, Spain, the Ukraine, and the United Arab Emirates.

Measures

Personality

Six dimensions of personality was assessed using the High Potential Trait Inventory (HPTI; MacRae and Furnham, 2014). This omnibus personality measure consists of 78 items and provides scores for adjustment (described as the bipolar end of neuroticism), risk approach or courage (indicative of an individual who does not let fear detract from their problem-solving skills), conscientiousness, competitiveness (described as a drive for achievement and success), ambiguity acceptance (described as able to succeed in uncertain environments), and curiosity or openness to experiences. MacRae and Furnham (2020) report that the scale has sound measurement properties, fitting a six-factor model, and with internal consistency estimates ranging from 0.72 for risk approach/courage to 0.80 for curiosity. In the present study, the coefficient alpha values were 0.79 for adjustment, 0.72 for risk approach, 0.73 for conscientiousness, 0.77 for competitiveness, 0.69 for ambiguity acceptance, and 0.71 for curiosity.

Intelligence

Intelligence was assessed using the General Intelligence Assessment (GIA; Dann, 2015). The GMA assesses mental ability with five timed sub-tests. Verbal reasoning is assessed with a five minute test requiring individuals to read a statement and then deduce the correct response. Perceptual speed is assessed with a four and a half minute test requiring individuals to match lowercase letters with the correct uppercase letter located in a different row. Numerical speed is assessed with a two minute test in which individuals are presented with an array of numbers and they must correctly determine which number is least like the other numbers given. Word meaning is assessed with a two and a half minute scale in which individuals are presented with a list of words and they are required to correctly determine which word does not fit with the other words. Spatial visualization is assessed in a two minute test asking individuals to correctly identify which objects are the same when they have been rotated or are the mirror image of the object. The GIA can be examined for each scale separately or as a general intelligence composite. In the present study, the inter-scale correlations averaged 0.41.

Table 1
Descriptive statistics for the GIA scales for the present sample and the normative values.

GIA Scale	Present Sample		Normative Scores*	
	M	SD	M	SD
Perceptual Speed	43.24	6.06	42.48	6.46
Number Speed	15.11	5.68	13.92	5.53
Spatial Visualization	10.78	4.98	9.52	4.89
Word Meaning	30.43	5.48	29.12	5.51
Reasoning	40.30	8.76	38.68	8.55

* based on responses from 8786 employed British adults (Dann, 2015).

Statistical analyses

To test the Differentiation of Intelligence by Personality Hypothesis, the mean inter-scale correlations between the ability scales are computed for individuals scoring below and above each personality scale's median, replicating the methodology commonly used in previous studies, as well as examining the 90th and 10th percentile groups (representing extreme groups). Because the present data set includes five intelligence scales, the first unrotated factor following Maximum Likelihood extraction, or g-factor, is examined for the median splits and 10th and 90th percentiles for each personality scale.

Results

Ability scores

The overall GIA scores were found to have a normal distribution. The scale descriptive statistic values were slightly higher than the normative values reported in the test manual with respect to average scores, with differences ranging from 0.12 SD for perceptual speed to 0.26 SD for spatial visualization. The standard deviation values between the present sample and the normative sample were very similar (see Table. 1).

Differentiation of intelligence by personality hypothesis

As described above, the Differentiation of Intelligence by Personality Hypothesis suggests that the mean inter-scale correlations for the intelligence measure will differ based on personality scale scores. Each of the six HPTI scales were found to have a normal distribution. For each of the personality scales, median splits were generated and the average intelligence inter-scale correlations were computed for the upper and lower personality halves. For the personality scale adjustment, the mean intelligence inter-scale correlation was 0.425 (range = 0.317–0.559) for the lower scoring half (n = 1338) and 0.398 (range = 0.277–0.512) for the upper scoring half (n = 1378). As a low score on adjustment is regarded as akin to a higher score on neuroticism, the slightly higher average inter-scale correlation for the intelligence scales in the lower scoring adjustment half, provides some support for the hypothesis.

For completeness, the inter-scale intelligence correlations were examined for each of the remaining personality scales. The average intelligence inter-scale correlation for the lower risk approach scoring half (n = 1338) was 0.407 (range = 0.280–0.546) and 0.416 (range = 0.312–0.526) for the upper scoring half (n = 1378). For conscientiousness, the lower scoring half (n = 1248) had an average intelligence inter-scale correlation of 0.405 (range = 0.297–0.547) and 0.417 (range = 0.279–0.526) for the upper scoring half (n = 1468). The average intelligence inter-scale correlation for the lower scoring competitiveness half

Table 2
Intelligence scale loadings onto the first factor after Maximum Likelihood extraction for the lower and upper scoring personality scale responses.Loadings.

HPTI Scale	Reason	PerS	NumS	Word	Spatial	% var	χ^2
Adjustment							
Lower Half	.770	.689	.621	.685	.497	54.28	45.50*
Upper Half	.728	.668	.641	.639	.481	52.07	65.91*
Risk Approach							
Lower Half	.775	.679	.620	.668	.447	52.92	49.55*
Upper Half	.727	.679	.639	.655	.527	53.45	56.93*
Conscientious							
Lower Half	.729	.656	.621	.686	.490	52.64	69.91*
Upper Half	.768	.693	.640	.645	.488	53.68	47.96*
Competitiveness							
Lower Half	.731	.690	.619	.674	.521	53.69	79.84*
Upper Half	.767	.661	.643	.668	.454	52.92	37.79*
Ambiguity Acceptance							
Lower Half	.763	.675	.605	.648	.489	52.56	25.89*
Upper Half	.732	.685	.641	.662	.474	52.87	86.04*
Curiosity							
Lower Half	.723	.692	.650	.637	.496	52.87	28.15*
Upper Half	.776	.666	.614	.685	.476	53.47	85.42*

Reason = Reasoning; PerS = Perceptual Speed; NumS = Number Speed; Word = Word Meaning; Spatial = Spatial Visualization;% var = Percentage of Variance accounted;.
* $p<.01$.

($n = 1325$) was 0.419 (range = 0.312–0.534) and 0.407 (range = 0.261–0.546) for the upper scoring half (n = 1391). For ambiguity acceptance, the average intelligence inter-scale correlation for the lower half ($n = 1287$) was 0.404 (range = 0.297–0.524) and 0.407 (range = 0.276–0.535) for the upper scoring half (n = 1429). The average intelligence inter-scale correlation for the lower scoring curiosity half (n = 1297) was 0.408 (range = 0.306–0.509) and 0.415 (range = 0.287–0.571) for the upper scoring half (n = 1419).

In addition to the median splits for each personality scale, the 10th and 90th percentile groups were computed and the average intelligence inter-scale correlations were calculated such that the bottom 10% and top 10% were compared. For the bottom 10% adjustment scoring group (or most neurotic, n = 334), the average intelligence inter-scale correlation was 0.432 (range = 0.29–0.561) and 0.429 (range = 0.257–0.579) for the top 10% group (n = 305), similar to the findings with the median split for adjustment scale scores.

For the remaining personality scales, the average intelligence inter-scale correlation for the 10% lower risk approach scoring group (n = 274) was 0.410 (range = 0.297–0.566) and 0.450 (range = 0.289–0.581) for the upper scoring 10% (n = 311). For conscientiousness, the lower scoring 10% (n = 286) had an average intelligence inter-scale correlation of 0.412 (range = 0.258–0.522) which was the same value as for the upper 10% (n = 318) average of 0.412 (range = 0.258–0.559). The average intelligence inter-scale correlation for the lower 10% scoring competitiveness group (n = 300) was 0.401 (range = 0.273–0.497) and 0.466 (range = 0.313–0.598) for the upper scoring 10% (n = 310). For ambiguity acceptance, the average intelligence inter-scale correlation for the lower scoring 10% group (n = 287) was 0.421 (range = 0.304–0.557) and 0.440 (range = 0.277– 0.537) for the upper scoring 10% group (n = 309). The average intelligence inter-scale correlation for the lower 10% scoring curiosity group (n = 311) was 0.409 (range = 0.314–0.511) and 0.421 (range = 0.291–0.600) for the upper 10% scoring group (n = 328). As with the median split groups, these results fail to show a consistent difference in the average inter-scale correlations for the intelligence measure when the bottom and top ten-percent groups are compared for each personality scale.

As stated above, the GIA includes five intelligence scales which can be combined to generate an overall intelligence score. To further examine how personality may influence the intelligence scores, the first unrotated factor, using Maximum Likelihood extraction, of the GIA scores for the lower and upper halves for each personality scale, based on the median split, and between the 10th and 90th percentiles for each personality scale, was examined. Table. 2 lists the GIA loadings for the general intelligence factor loadings for the lower and upper scoring halves for each of the personality scales. As is evident in the values, the factor loadings for the intelligence scales remain fairly consistent between the lower and upper personality scoring halves. In addition, the percentage of variance accounted for by the general intelligence factor remained consistent for each of the personality groups. To further test the hypothesis, those scoring in the lower 10% were compared to those scoring in the highest 10% for each of the personality scales. Table. 3 lists the general intelligence factor loadings for the lower 10% and upper 10% groups by personality scale and replicate the results reported in Table. 2 with the personality groups created by conducting median splits. These results suggest that the structure of the general intelligence factor did not change for those individuals scoring lower, versus higher, on each personality scale.

Discussion

Differentiation of intelligence by personality hypothesis

The present study examined the Differentiation of Intelligence by Personality Hypothesis which suggests that personality may influence the inter-scale correlations for intelligence scales. As stated above, this hypothesis was based on the suggestion put forth by Eysenck and White (1964) who demonstrated a stronger intelligence structure in children scoring lower on neuroticism compared to those scoring higher in neuroticism. In the first test with adults, Austin et al. (1997) compared the inter-scale correlations between two intelligence measures for those scoring higher versus lower on neuroticism and found that the correlation between the two intelligence scales was lower for those scoring lower in neuroticism compared to those scoring higher in neuroticism. The present sample had scale scores for the five intelligence scales which make up the GIA (Dann, 2015). In addition to examining the inter-scale correlations for the intelligence scales for those scoring higher versus lower on adjustment, defined as low neuroticism, median splits for each of the personality sale scores were used to create upper and lower scoring halves. Only for the adjustment scale was the results reported by Austin et al. (1997) partially supported in the present sample. Specifically, for those scoring lower in adjustment, reflecting higher neuroticism, the average inter-scale correlation for the intelligence scales was

Table 3
Intelligence scale loadings onto the first factor after Maximum Likelihood extraction for the lower and upper 10% scoring personality scale responses.Loadings.

HPTI Scale	Reason	PerS	NumS	Word	Spatial	% var	$\chi^2(5)$
Adjustment							
Lower 10%	.730	.743	.588	.742	.483	54.93	15.33*
Upper 10%	.722	.737	.638	.725	.456	54.74	20.48*
Risk Approach							
Lower 10%	.778	.707	.676	.591	.456	53.24	8.54
Upper 10%	.761	.691	.655	.717	.527	56.18	28.60*
Conscientious							
Lower 10%	.707	.690	.645	.694	.474	53.23	21.96*
Upper 10%	.820	.675	.617	.650	.451	53.40	13.94
Competitiveness							
Lower 10%	.711	.668	.561	.613	.617	52.20	24.05*
Upper 10%	.797	.679	.710	.686	.547	57.51	19.76*
Ambiguity Acceptance							
Lower 10%	.772	.687	.601	.691	.497	53.97	5.55
Upper 10%	.726	.713	.672	.686	.524	55.44	25.62*
Curiosity							
Lower 10%	.707	.705	.583	.645	.561	52.89	12.00
Upper 10%	.793	.649	.596	.686	.510	53.84	33.78*

Reason = Reasoning; PerS = Perceptual Speed; NumS = Number Speed; Word = Word Meaning; Spatial = Spatial Visualization;% var = Percentage of Variance accounted;.
* $p<.01$.

higher when compared to the average correlation for the lower adjustment scoring half. All other average inter-scale intelligence correlations did not differ in a consistent pattern when the upper and lower scoring groups, for each of the other personality scales, were compared.

Also examined in the present data was the structure of g, or general intelligence, between the upper and lower scoring individuals for each of the personality scales. For both median splits and upper and lower 10% scoring groups, the factor loadings of the first factor for the five intelligence sub-scales remained consistent. In addition, the percentage of variance accounted for in the intelligence scales remained consistent between the upper and lower scoring groups for each of the personality scales, suggesting that, for this data, personality did not influence the structure of the intelligence measure. These results are similar to those recently reported by Schermer and Goffin (2021) who found that the influence of neuroticism was not large enough to influence the factor structure of g, or a general intelligence, factor. Similarly, Bonaccio and Reeve (2006) report that cognitive ability measures maintained their measurement invariance across levels of neuroticism in two datasets. Following, how personality, and in particular neuroticism, influences the structure of intelligence is clearly an area requiring further research.

Limitations

The present study was limited in that the personality responses were self-report without behavioural data from external observers, such as peers. This study also does not directly test Eysenck and White (1964) findings, as they examined data from adolescents, and the present sample, similar to those used by Austin et al. (1997) and Schermer and Goffin (2021) assessed adults. Future studies may want to investigate the hypothesis with children or adolescents. In addition, the present study's sample, and the samples used in past studies, were drawn from non-clinical populations. How the personality characteristics of clinical samples might influence intelligence test responses is an area which is unexplored with respect to the Differentiation of Intelligence by Personality Hypothesis. A further limitation was the cross-sectional nature of the data. Future research may want to examine how personality influences the development of intelligence as well as how intelligence influences the development of personality over time.

Conclusions

The present study utilized a large sample of managers and followed the procedures used by previous research and fails to demonstrate a strong effect of neuroticism/adjustment on the structure of the general intelligence (g) factor. This finding is consistent with some of the recent research published with adult samples. As there is no consistent finding of an effect, it is suggested that future research on the topic be conducted with samples of various ages and possibly clinical samples.

Data is available by contacting the third author

The authors declare no conflict of interest.

Declaration of Competing Interest

The authors declare no conflict of interest.

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