The Differentiation of Personality by Intelligence Hypothesis in a Sample of British

Managers

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Abstract

In this study, we test the hypothesis that personality is more differentiated (variable) in individuals scoring higher in intelligence in a large sample ($N = 16,258$) of managers. In addition to a measure of the Big Five personality factors, participants completed 11 "dark" personality scales in self-report format. Intelligence was measured using a reasoning test, including verbal, numerical, and abstract scales, aggregated to create a general mental ability or intelligence score. The intelligence scores had a normal distribution and were used to generate tertile splits. Following, the higher and lower tertile group's standard deviations were compared. The higher ability tertile had significantly greater scale variances for most of the Big Five scales (with the exception of agreeableness) but the differences tended to be small. Only three of the "dark" personality scales had significantly larger standard deviations in the higher tertile group, but also these differences were small. The inter-scale correlations and exploratory factor analyses suggested less covariance among the upper intelligence group but not for single Big Five factor facets. These results demonstrate some, but not definitive, support for the differentiation of personality by intelligence hypothesis and expand on the test of the theory by suggesting that some of the darker personality scale responses may also differ depending on individual differences in intelligence.

Introduction

Brand, Egan, and Deary (1994) suggested that personality may be more variable, or differentiated, for individuals who are more intelligent. The theory followed Spearman's (1927) findings of greater variability in mental ability scales for individuals scoring higher in intelligence, or `*g*', (Spearman, 1904). As described below, tests of the "Differentiation of Personality by Intelligence Hypothesis" has had mixed results. The present study is an attempt at replicating the results with the Big Five personality dimensions and is an additional test of the hypothesis by using a multi-scale measure of "darker" personality characteristics from self-report responses from a large sample of managers.

Investigating how personality may be more variable for individuals higher in intelligence typically starts by first generating groups of individuals based on their intelligence scores. Commonly used are median splits, tertile splits, and quartile splits (depending on the sample size). Following, the higher and lower intelligence groups are compared on their self-report responses to personality measures. Comparisons can be straightforward tests of variance (such as Levene's *F*-test), or may include comparisons of reliability values, factor structures, inter-scale correlations, and measurement invariance.

Of the studies that have tested the hypothesis, the most common personality scales have been measures of the Big Five (openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism). Austin et al. (1997) reported that in their sample of adult farmers, there was no support for the differentiation hypothesis as intelligence did not change the correlations between pairs of personality scales. Similarly, Waiyavutti et al. (2012) found that personality items measuring the Big Five were invariant when higher and lower intelligence groups were compared. In contrast, Mõttus et al. (2007) reported lower correlations between personality dimensions in a higher ability group but that the differences

were non-significant when compared to a lower ability group. Harris et al. (2006) found that there was greater personality variability for a higher intelligence group but only for adults and not late adolescent students. Schermer et al. (2020a) recently reported greater variability and scale ranges in a higher ability tertile compared to a lower ability tertile in a sample of students. De Fruyt et al. (2006) reported that openness, neuroticism, and extraversion were more variable for those higher in intelligence, but that the latter two only showed greater variability at higher intelligence scores (greater than an IQ of 115). Also reported was that the structure of the Big Five measure remained across levels of intelligence. In contrast, Escorial et al. (2019) reported that the factor structure of the Big Five changed across intelligence levels and that more factors were present in the higher intelligence group. In general, the results testing the hypothesis with Big Five measures result in mixed results.

The second most popular personality measure used to test the differentiation of personality by intelligence hypothesis has been Cattell's 16PF. Austin et al. (2000) tested police applicants and felons and reported that intelligence did not alter the factor structure and that the variance of a "depression component" decreased when individuals higher in general mental ability were examined. Murray et al. (2016) reported mixed results using the American standardization data of the 16PF. The scales of anxiety and tough-mindedness supported the differentiation hypothesis but the results for extraversion, self-control, and independence did not support the hypothesis (although it should be noted that they used the reasoning scale from the 16PF as their measure of ability, as opposed to a standardized intelligence test). Schermer et al. (2020c) also failed to find support for the differentiation hypothesis using the 16PF in a sample of forestry manager applicants. Both variance tests and the factor structure comparisons between the upper and lower intelligence halves failed to reach significant differences. Based on these three studies, the differentiation of personality by intelligence hypothesis is not supported using the 16PF.

Also examined has been a six-factor model of personality that included four of the Big Five scales, but split conscientiousness into two dimensions: industriousness and methodicalness (McLaron & Carswell, 2013). Specifically, McLaron and Carswell (2013) demonstrated that the six-factor solution was not invariant across ability levels. Jackson's Personality Research Form (PRF) has also been used to assess the differentiation hypothesis (Harris et al., 2005; Schermer et al., 2020b) as well as select PRF scales including achievement, affiliation, dominance, nurturance, and social recognition (Harris et al., 2006). In general, the results from the PRF scales has shown little support for the differentiation hypothesis with variance being slightly higher in higher intelligence groups for only some of the scales and resulting factors. DuVernet et al.'s (2014) investigation of the differentiation hypothesis included four facets: empathy, optimism, emotional control, and responsibility. In their study, DuVernet et al. (2014) reported that the psychometric properties of personality items changed by mental ability and the authors suggested that mental ability may impact how people process personality items. Shure and Rogers (1963) reported that the factor structure of the California Psychological Inventory scales differed for individuals who differed in terms of intelligence but not the number of factors. Although the study was conducted before Brand et al.'s (1994) reference of the differentiation hypothesis, the results reported by Shure and Rogers (1963) demonstrated that the definition of personality factors could change (even if the same battery of personality scales is used) if individual groups are from different levels of mental ability. For example, a "personal integrity and mental health" factor was better defined and accounted for more variance in a higher intelligence group than in a lower intelligence group.

What has been less studied with the differentiation of personality by intelligence hypothesis has been "darker" personality dimensions. Although scales such as the PRF and the 16PF have less positive personality dimensions, such as aggression, less is known about

how these types of scales behave in groups differing in intelligence. Navarro-González et al. (2018) tested the hypothesis with scales measuring indirect aggression, impulsiveness, psychological maturity, and callous unemotionality. Of interest, they report that the higher intelligence group were more consistent in their responses but that the standard deviations of the scales did not differ by intelligence groups, suggesting that further research is required. Following, the present study tests the differentiation of personality by intelligence hypothesis also using the Big Five personality dimensions but also with the "darker" scales from Hogan and Hogan's (2001) Hogan Development Survey (HDS). Specifically, if the differentiation hypothesis is supported for both sets of measures, then the higher intelligent group should have greater scale variance compared to individuals lower in intelligence. In addition, because the greater scale variance may translate to more factors in an exploratory factor analysis, the results of maximum likelihood factor analyses for the upper and lower intelligence groups were compared.

Method

Sample and Procedure

The sample consists of 16,258 managers (76.1% men) with a mean age of 40.75 (*SD* = 7.49) and ranging in age from 20 to 66 years. These individuals took park in an assessment centre of which only scale totals were available for research purposes. Participation was sponsored by the individual's host organization. On average, seven years (*SD* = 4.64) had lapsed from when the individual started their career to becoming a manager. Participants were employed in a wide variety of business positions, such as engineering/technical (21%), operations (14.6%), finance (11.8%), managing director (10.4%), legal (6.1%), and human resources (5.5%). The majority of the sample were British nationals (82.8%), followed by North Americans (6%) and Europeans not from the United Kingdom (5.3%). The remaining

individuals were from Africa, Asia, South America, the Middle East, and the Caribbean (each representing less than 2%).

Measures

<u>Personality</u>

The Big Five personality facets (six for each of the five dimensions) and factors were measured using the NEO Personality Inventory Form S (NEO-PI; Costa & McCrae, 1992). The NEO-PI is a standard measure of the Big Five personality dimensions. Also completed was the HDS (Hogan & Hogan, 2001) which consists of 154 items with 14 items for each of the 11 scales (see Table 2 for scale titles). The scales have been reported to be reliable, with respect to both internal consistency and test-retest over three months. Each scale was designed to capture "derailment" dimensions and contain no "medical or psychiatric content, sexual preferences, religious beliefs, illegal behavior, or racial/ethnic attitudes" (Hogan & Hogan, 2001, p.41).

<u>Intelligence</u>

Intelligence was assessed using the Graduate Management Assessment (GMA; see Furnham et al., 2007). The GMA assesses mental ability by testing high levels of abstract reasoning. Although full-scale scores reflect an individual's performance on verbal, numerical, and abstract sub-scales, only full-scale values were made available by the assessment centre.

Results

Ability Splits

The GMA scores fit a normal distribution, which allowed for the generation of tertile splits of the sample. For men, 31.6% were in the lower tertile and 31.2% were in the upper

tertile. For women, 24.0% were in the lower tertile and 30.3% were in the upper tertile. These percentages suggest a slightly lower representation of women in the lower intelligence tertile. The standard deviations and Levene's *F*-test of homogeneity of variance for the facets and Big Five scales, comparing the lower and upper intelligence tertile groups, are presented in Table 1 and Table 2 provides the results of the 11 scales from the HDS. For completeness, the means for each tertile group are also presented in the two tables.

Insert Tables 1 and 2 here

As reported in Table 1, thirteen facets and two personality factor scores from the Big Five had significant *F*-tests of variances. Specifically, the neuroticism facet of impulsiveness, the extraversion facets of warmth, gregariousness, assertiveness, and activity, the openness facets of aesthetics, feelings, and actions, and the conscientiousness facets of order, achievement striving, self-discipline, deliberation, and the conscientiousness factor score fit the pattern of greater scale variability in the higher tertile group, although the magnitude of the differences is small. Interestingly, the agreeableness factor score and the agreeableness facets of trust and compliance demonstrated the reverse pattern and the more variable group was the the lower intelligence tertile.

As stated above, only scale totals were available for analyses, limiting possible examinations of the hypothesis at the item level. As facet scale scores were available and because each facet is designed to assess a common personality factor (Costa & McCrae, 1992), another test of the differentiation of personality by intelligence hypothesis was conducted by comparing the average inter-facet correlations (between the upper and lower intelligence tertile groups) for each of the Big Five scales. If the differentiation hypothesis is supported, then there should be lower inter-facet correlations in the higher intelligence tertile.

Although none of the comparisons reached statistical significance based on independent group z-tests (following r to z transformations), the average inter-facet correlations were consistently lower in the upper tertile group. For neuroticism, the mean inter-facet correlation was .469 in the lower tertile and .454 in the upper tertile. For extraversion, the mean inter-facet correlations were .392 and .383 for the lower and upper intelligence groups, respectively. For openness, the average inter-facet correlation was .322 for the lower intelligence tertile and .317 for the higher intelligence tertile. For agreeableness, although some of the facets had greater variance in the lower intelligence group, the lower intelligence tertile's mean inter-facet correlation was .323, higher than the .299 value for the higher tertile group. For conscientiousness, the average inter-facet correlation was also higher in the lower intelligence tertile (.452) compared to the higher intelligence tertile (.450). This pattern of results does support the differentiation of personality by intelligence hypothesis.

Table 2 lists the F-tests of variance for the 11 scales from the HDS (Hogan & Hogan, 2001). Three of the scales, cautious, reserved, and diligent, significantly fit the predicted pattern of higher variability in the higher intelligence group. In contrast, the scales skeptical and imaginative had significant tests of variance but in the opposite direction such that the lower intelligence tertile was the most variable. These results therefore provide mixed results for the differentiation of personality by intelligence hypothesis.

Exploratory factor analyses with maximum likelihood extraction was used to examine the factor results of the NEO-PI facets and the Hogan Dark scales separately for the upper and lower tertile groups. The Kaiser-Meyer-Olkin (KMO) values for the NEO facets were .895 for the lower tertile group and .883 for the upper tertile group, suggesting lower inter-scale correlations for the upper tertile group. The mean inter-scale correlation for the NEO facets for the upper tertile group was .059, which was lower than the mean inter-scale

correlation of .067 for the lower tertile group. When five factors were extracted from both groups, the factors accounted for 57.70% of the variance in the lower tertile group versus 48.68% of the variance in the upper tertile group. The goodness-of-fit test suggested a worse fit for the upper tertile group (χ^2(295) = 5702.82, p<.001) than the lower tertile group (χ^2(295) = 4960.30, p<.001; Montanelli, 1974). Although the model fit was poor for both groups, the inter-scale correlations, KMO, percentage variance accounted, and model fit values suggest that the upper tertile group was more variable.

The factor structure of the darker scales has not been established. Using an Eigen value greater than unity and the scree plot, the upper tertile group (Eigen values = 2.893, 1.960, 1.139, 1.003, .777, .681, .656, .597, .494, .429, .370) suggested the presence of four factors and the lower tertile group (Eigen values = 2.744, 2.272, 1.194, .957, .741, .622, .607, .568, .491, .436, .369) suggested three factors. Both groups were set to three factors for comparisons. The average inter-scale correlation was .098 for the lower tertile group and .071 for the upper tertile group. The KMO was .745 for the lower tertile group and .742 for the upper tertile group. For the lower tertile, the three factors accounted for 40.39% of the variance. In contrast, the three factors accounted for 38.06% of the variance for the upper tertile group. Similar to the results with the NEO, the goodness-of-fit test suggested a worse fit for the upper tertile group (χ^2(25) = 504.79, p<.001) than the lower tertile group (χ^2(25) = 494.98, p<.001). Also similar to the results from the NEO, the inter-scale correlations, KMO, and percentage variance accounted suggest that the upper tertile group was more variable with the HDS.

Discussion

The differentiation of personality by intelligence hypothesis (Brand et al., 1994) suggests that there is greater individual difference variance in personality for individuals

higher in intelligence. This hypothesis was tested by examining the scale variances for the

facets and scale scores of the Big Five personality scales and the 11 scales from the HDS

(Hogan & Hogan, 2001) separately for higher and lower intelligence tertile groups of a large

sample of British managers. Also examined was the mean inter-facet correlations for the Big

Five personality dimensions for each intelligence tertile, the mean inter-scale correlations for

the Big Five factor scores and the HDS scales, as well as exploratory factor analyses. As

stated in the introduction, if the differentiation hypothesis is supported, then the higher

intelligent group should have greater scale variance values (Austin et al., 2000; Brand et al.,

1994). The results of this study provide some support for the differentiation hypothesis. The

tests of variance found greater variability in scale scores for the higher ability group for many

of the facet scores of the Big Five dimensions, with the exception of agreeableness, which

demonstrated a reverse pattern. Why agreeableness was in the opposite direction is an area

requiring further research as both Schermer et al. (2020a) and Harris et al. (2006) reported

greater variability in agreeableness scores in higher ability groups. Possibly the difference

could be due to the assessment centre condition of the managers assessed in the present study

as De Fruyt et al. (2006) demonstrated that agreeableness did not show a significant increase

in variance for a higher intelligence scoring group and that the structure of the Big Five

remained consistent across intelligence levels in a selection context. Possibly the managers

who were more intelligent in this sample responded consistently to the agreeableness items as

they perceived agreeableness as an attractive dimension for their careers. How the

differentiation of personality by intelligence hypothesis behaves in high stakes situations,

such as job selection situations are under analyzed and less understood (DuVernet et al.,

2014; McLarnon & Carswell, 2013; Schermer et al., 2020b, 2020c).

As an additional test of scale variances, the "darker" personality scales from the HDS

(Hogan & Hogan, 2001) provided mixed results. Only three of the scales supported the

pattern at the statistically significant level but two scales demonstrated the reverse pattern. These results both partially support and are partially in contrast to those found by Navarro-González et al. (2018) who reported that their more "darker" dimensions, such as indirect aggression, did not have significantly different standard deviations when comparing lower and higher intelligence groups. How the differentiation of personality by intelligence hypothesis is reflected in "darker" personality dimensions, such as the Dark Triad, is an area requiring further research.

When the Big Five facets were inter-correlated, the mean values were lower in the higher intelligence tertile than in the lower intelligence tertile. These results, although not statistically significant, do support the differentiation hypothesis as they suggest that there is greater *dis*similarity among individuals in the higher intelligence tertile and replicate the results reported by Mõttus et al. (2007). Exploratory factor analyses of both the Big Five and dark scales separately did suggest greater variability in the higher tertile group with lower KMO values, lower inter-scale correlations, and less variance accounted for with the same number of factors. This pattern of results was similar to the factor results reported by Schermer et al. (2020b) in their sample of forestry manager applicants and the PRF and do suggest that the factor structure of personality measures should be examined for possible effects of general mental ability (McLarnon & Carswell, 2013; Shure & Rogers, 1963).

Limitations of the present study include the lack of item-level data. Understanding how the reliability values of the scales may differ for individuals differing in intelligence is an area requiring further research as researchers such as Austin et al. (2000) suggest that individuals higher in intelligence should have higher reliability values. Similarly, Navarro-González et al. (2018) demonstrated that "person reliability" is positively related to general mental ability. Recently Schermer et al. (2020a) also provided some support for the suggestion that those higher in intelligence would also have higher scale reliability values.

Another possible limitation of the present study was the lack of peer reports (see for example, Mõttus et al., 2007) or behavioural data indicative of personality for the managers. Of future interest would be to assess if those higher in intelligence are also more variable in their behaviours compared to those lower in intelligence.

In conclusion, the results of this study provide some, but not definitive, support for the differentiation of personality by intelligence hypothesis, especially for four of the five Big Five personality dimensions. Less is still known about how intelligence may impact the variability of personality scale responses in "darker" dimensions as the present study provided mixed and limited results.

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Table 1. Means (*M*), Standard deviations (*SD*), and Levene's *F*-test of variance homogeneity

of variance for the lower and upper tertile ability groups for the NEO-PI facets and scales.

NEO Facets and Scale	Lower Tertile *M* (*SD*)	Upper Tertile *M* (*SD*)	Levene's *F* test of variance
NEO-PI-R N1: Anxiety	11.93 (5.11)	11.79 (5.18)	1.30
NEO-PI-R N2: Angry Hostility	9.90 (4.56)	9.66 (4.51)	.69
NEO-PI-R N3: Depression	9.03 (4.63)	9.06 (4.64)	.45
NEO-PI-R N4: Self-Consciousness	11.24 (4.18)	11.54 (4.29)	3.00
NEO-PI-R N5: Impulsiveness	14.22 (4.32)	14.63 (4.49)	12.28**
NEO-PI-R N6: Vulnerability	6.09 (3.45)	6.35 (3.52)	.18
Neuroticism	62.37 (19.63)	63.00 (19.70)	.00
NEO-PI-R E1: Warmth	24.02 (3.94)	23.66 (4.09)	14.57**
NEO-PI-R E2: Gregariousness	20.44 (4.62)	19.96 (4.78)	6.23*
NEO-PI-R E3: Assertiveness	21.45 (4.26)	21.10 (4.37)	1.27
NEO-PI-R E4: Activity	22.12 (3.95)	21.88 (4.09)	10.97**
NEO-PI-R E5: Excitement-Seeking	18.95 (4.42)	19.09 (4.44)	.48
NEO-PI-R E6: Positive Emotions	22.68 (4.57)	22.65 (4.70)	3.13
Extraversion	129.59 (18.31)	128.34 (18.52)	3.50
NEO-PI-R O1: Fantasy	16.59 (4.81)	17.11 (4.93)	2.43
NEO-PI-R O2: Aesthetics	17.54 (5.82)	17.42 (6.07)	10.25**
NEO-PI-R O3: Feelings	21.91 (4.10)	21.77 (4.27)	7.07*
NEO-PI-R O4: Actions	19.60 (4.32)	20.10 (4.16)	8.12*
NEO-PI-R O5: Ideas	20.22 (5.21)	21.73 (5.15)	.71
NEO-PI-R O6: Values	23.37 (3.46)	23.92 (3.41)	2.20
Openness	119.26 (18.56)	122.03 (18.74)	.30
NEO-PI-R A1: Trust	22.16 (4.18)	22.52 (3.97)	9.50*
NEO-PI-R A2: Straightforwardness	19.10 (4.55)	18.99 (4.41)	3.71
NEO-PI-R A3: Altruism	24.13 (3.54)	23.92 (3.42)	1.98
NEO-PI-R A4: Compliance	17.96 (4.09)	18.19 (3.92)	5.00*
NEO-PI-R A5: Modesty	17.86 (4.63)	17.53 (4.63)	.08
NEO-PI-R A6: Tender-Mindedness	19.75 (3.52)	19.46 (3.40)	2.92
Agreeableness	120.95 (16.24)	120.62 (15.40)	6.27*
NEO-PI-R C1: Competence	24.77 (3.22)	24.49 (3.22)	.61
NEO-PI-R C2: Order	19.60 (4.37)	18.77 (4.55)	9.56*
NEO-PI-R C3: Dutifulness	25.43 (3.43)	25.06 (3.55)	2.78
NEO-PI-R C4: Achievement Striving	24.06 (3.81)	23.34 (3.98)	12.71**
NEO-PI-R C5: Self-discipline	24.51 (3.84)	23.77 (4.16)	21.13**
NEO-PI-R C6: Deliberation	19.07 (4.31)	18.54 (4.44)	7.93*
Conscientiousness	137.43 (16.86)	133.96 (17.52)	8.06*

*$p<.01$; **$p<.001$, two-tailed

Table 2. Means (*M*), Standard deviations (SD), and Levene's *F*-test of variance homogeneity of variance for the lower and upper tertile ability groups for the HDS scales.

Hogan Development Survey Scale	Lower Tertile *M* (*SD*)	Upper Tertile *M* (*SD*)	Levene's *F* test of variance
Excitable	2.98 (2.47)	2.92(2.44)	.26
Skeptical	4.69 (2.42)	4.32 (2.27)	9.90*
Cautious	2.93 (2.45)	3.28 (2.61)	19.51**
Reserved	4.22 (2.16)	4.62 (2.26)	12.01**
Leisurely	4.73 (2.21)	4.87 (2.16)	2.92
Bold	7.51 (2.65)	7.34 (2.90)	.44
Mischievous	6.92 (2.48)	6.90 (2.49)	.04
Colorful	8.00 (2.83)	7.85 (2.93)	6.28
Imaginative	5.60 (2.42)	5.48 (2.28)	8.42*
Diligent	9.19 (2.36)	8.69 (2.50)	17.95**
Dutiful	7.06 (2.07)	7.01 (2.03)	3.10

*$p < .01$; **$p < .001$, two-tailed