# Childhood Intelligence Predicts Adult Trait Openness

## Psychological and Demographic Indicators

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**Abstract.** This study used a longitudinal data set of 5,672 adults followed for 50 years to determine the factors that influence adult trait Openness-to-Experience. In a large, nationally representative sample in the UK (the National Child Development Study), data were collected at birth, in childhood (age 11), adolescence (age 16), and adulthood (ages 33, 42, and 50) to examine the effects of family social background, childhood intelligence, school motivation during adolescence, education, and occupation on the personality trait Openness assessed at age 50 years. Structural equation modeling showed that parental social status, childhood intelligence, school motivation, education, and occupation all had modest, but direct, effects on trait Openness, among which childhood intelligence was the strongest predictor. Gender was not significantly associated with trait Openness. Limitations and implications of the study are discussed.

**Keywords:** intelligence, gender, education, social class, openness

Of all the Big Five personality traits, Openness-to-Experience is often shown as the strongest correlate of ability, particularly creativity and intelligence. In the Big Five personality system trait Openness is associated with having a vivid imagination and an active fantasy life; a deep appreciation for art and beauty; a receptivity to one's own and other's emotions; a willingness to try new experiences; intellectual curiosity and a readiness to examine political, social, and religious values. People high in Openness have been shown to be unconventional, questioning, and emotionally literate (McCrae & Costa, 2010).

Other personality theories and systems have described Openness as Intellect or Culture and had different ideas about the facets of the super-factor or domain. Thus in the Hogan Personality Inventory (HPI) system it is described as Inquisitiveness with subscales (HICS) labeled: Science Ability, Curiosity, Thrill Seeking, Intellectual Games, Generates ideas, and Culture (Hogan, Hogan, & Warrenfeltz, 2007). The HEXACO model has four Openness facets labeled Aesthetic Appreciation, Inquisitiveness, Creativity, and Unconventionality (Ashton & Lee, 2007). While there is confusion and disagreement about facets of Openness there seems agreement that it is a stable trait that reflects intellectual curiosity, imaginativeness, and inquisitiveness.

Those interested in personality correlates of educational, health, and occupational outcomes have tended to show that of the Big Five traits Neuroticism and Conscientiousness account for most of the variance, with Openness being related to very specific issues like aesthetic preferences or leisure pursuits (Furnham, 2008). In most individual difference studies personality traits are the predictor variables and some salient beliefs or behaviors the criterion variable but in this study trait Openness is the criterion or outcome variable. One relevant theory is Cattell's (1971) investment theory which suggests personality and fluid intelligence contribute to the development of crystallized intelligence. Our research question is what are the early determinants, including intelligence of Openness in adulthood? Few studies have done this because of the difficulty of obtaining longitudinal data, though there are some recent exceptions (Furnham & Cheng, 2015).

There is considerable debate about the stability of personality over time. Furnham and Cheng (in press) have noted that the debate about the equivocal nature of both findings and conclusions regarding continuity versus change revolves around a number of issues: the reliability and validity of personality tests used (to account in part for measurement error); the moderator variables considered (like sex, education, and ethnicity); the age at which people are measured (i.e., adolescents, adults, old age); the time span that shows most change and stability; how change is measured (such as mean level change, rank order, ipsative change); the stability of the environments of people and what, if anything, leads to change.

There inevitably remain many disagreements however all agree that there is evidence of *both* stability *and* change. Personality seems most stable between the ages of 30 and

60 years, particularly using established big five measures to assess it and there are modest increases in emotional ability and agreeableness over this period with Extraversion and Neuroticism showing least change (both with a slight decline) and Conscientiousness showing most change (an increase).

Various studies have been reported using longitudinal data and cross-lagged correlation coefficients, path analysis, and structural equation modeling where the causal ordering in the analysis has not matched the time at which data was gathered (Cheng & Furnham, 2012; McManus, Keeling, & Price, 2004). That is, because it is generally accepted that some factors are generally stable over adulthood (like height) it is assumed that when they are measured is relatively unimportant (i.e., people remain very similar in height from 20 to 60 years). It is however generally accepted it is desirable to measure variables according to the causal modeling pattern.

There is an extensive literature on Openness. Many studies are concerned with the extent to which Openness is related to cognitive ability. Studies have used different measures of both Openness and intelligence and have all tended to show a significant positive correlation (Chamorro-Premuzic, Moutafi, & Furnham, 2005; DeYoung, Quilty, Peterson, & Gray, 2014). One study (Ziegler, Danay, Heene, Asendorpf, & Buhner, 2012) was developmental and measured parent-rated Openness in 172 adolescents at 17 years, and both Openness and Fluid and Crystallized intelligence at 23 years. The correlation between the two measures of Openness was .49 and those between Openness and Intelligence between .23 and .49. In another study, Schretlen and colleagues tested 335 healthy adults and found that Openness was more strongly with verbal/crystallized intelligence ($r = .44$) than with executive functioning ($r = .16$) and fluency ($r = .26$). Other studies have shown that Openness is related to a Deep Learning Approach which is correlated to educational success (Chamorro-Premuzic & Furnham, 2009). There are also a number of studies that have demonstrated the relationship between Openness and work success (Woo, Chernyshenko, Stark, & Conz, 2014).

In a relevant study Gow, Whiteman, Pattie, and Deary (2005) analyzed longitudinal data on 500 people tested at 11 and 79 years. They found that intelligence measured in childhood and late adulthood was significantly correlated with Intellect (Openness) but that when the association in old age was controlled for childhood intelligence it fell to almost zero. Their conclusion was that the relationship between intelligence and Openness in adulthood is related through the lifelong stable trait of intelligence. However, showing that childhood variables predict adult variables does not unambiguously show environmental effects (regardless of what the childhood variables are) because there could be genetic forces that influence both predictor and criterion variables (i.e., the third-variable problem).

It is however not clear what the physiological or biological bases are for trait Openness. In an attempt to explore the sources of Openness/Intellect, DeYoung, Peterson, and Higgins (2005) develop a neuropsychological model relating it to dopaminergic function and to the functions of the prefrontal cortex (PFC) ($n = 175$). They found that dorsolateral PFC function, as well as both fluid and crystallized cognitive ability, was positively related to Openness/Intellect but no other personality trait. Furthermore, facet level analysis supported the characterization of Openness/Intellect as a primarily cognitive trait. They thus defined Openness/Intellect as motivated cognitive flexibility (DeYoung et al., 2005). DeYoung and colleagues have used fMRI and molecular genetics to explore the similarity and distinction between Intellect and Openness (DeYoung, Shamosh, Green, Braver, & Gray, 2009; DeYoung et al., 2011). He has also summarized what we know about Openness and the processes and mechanism underlying it (DeYoung, 2014)

Von Stumm and Ackerman (2013) have noted that cognitive or intellectual investment theories propose that the development of intelligence is partially influenced by personality traits, in particular by so-called investment traits that determine when, where, and how people invest their time and effort in their intellect. Thus to some extent personality factors influence intelligence, which in turn may influence personality functioning. However, others argue that intelligence is largely inherited and that there is comparatively little change over time, and that if anything intelligence affects personality (rather than the other way around) it is because the former is more heritable than the latter (Lynn & Mikk, 2007)

This study has data to explore the latter association, namely the relationship between childhood intelligence and adult personality. This study examines the relationship between an individual's gender, social class, childhood intelligence, education, and occupation on adulthood trait Openness in a longitudinal data set. Unfortunately personality was not measured until participants were 50 years old. However, there is sufficient evidence to suggest that personality is relatively stable over time and that adult Openness would be modestly correlated with childhood Openness (Lucas & Donnellan, 2011).

Previous studies have well established the significant associations between parental social class, intelligence, education, and occupation (Deary et al., 2005; Duncan & Brooks-Gunn, 1997; Duncan, Featherman, & Duncan, 1972; Heath, 1981). The role of school motivation in enhancing educational achievement and promoting successful career development has been demonstrated in a number of studies across different cultural contexts (Eccles, 2004; Fredricks, Blumenfield, & Paris, 2004; Wang & Holcombe, 2010). There are however few studies examining the associations between school motivation and outcomes other than education and occupation. In a study using a life course model with data of two large British cohorts, Schoon and Cheng (2011) demonstrated that school motivation not only significantly associated with educational and occupational outcomes, but also significantly associated with childhood intelligence and adult political trust. The current study is able to examine whether school motivation is associated with trait Openness.

## Hypotheses

There are various studies in this area which serve to help formulate hypotheses for this study. First, nearly all studies

in the area show a significant relationship between intelligence and Openness. We therefore predict a significant positive correlation between intelligence measured at age 11 and Openness aged 50 years (H1). Second, since studies show that intelligence is significantly associated with educational and occupational outcomes, we predict a significant correlation between these variables and trait Openness (H2). Third, as many studies show that parental social class is significantly associated with intelligence, education, and occupation, we predict a significant correlation between parental social class and trait Openness (H3). Fourth, as studies show that school motivation is significantly associated with intelligence, education, and occupation, we predict a significant correlation between this variable and trait Openness (H4). The model tested is similar to that of Furnham and Cheng (2015).

## Method

### Participants

The National Child Development Study 1958 is a large-scale longitudinal study of the 17,415 individuals who were born in Great Britain in a week in March 1958 (Ferri, Bynner, & Wadsworth, 2003). At age 11 years 14,134 children completed tests of cognitive ability (response = 87%). Testing took place in school, and written, informed consent was given by the parents. At age 16 years, 11,562 (86%) cohort members completed a measure on school motivation. At 33 years, 11,142 participants provided information on their educational qualifications obtained (response = 72%), and at 42 years 9,592 participants provided information on their occupational levels (response = 62%). At 50 years, 8,532 participants completed a questionnaire on personality trait Openness (response = 69%). The analytic sample comprises 5,672 cohort members (52% females) for whom complete data were collected at birth, at 11 years, and the outcome measure at 50 years. Bias due to attrition of the sample during childhood has been shown to be minimal (Davie, Butler, & Goldstein, 1972; Fogelman, 1976).

### Measures

Family social background includes information on parental social class and parental education. Parental social class at birth was measured by the Registrar General's measure of social class (RGSC). RGSC is defined according to occupational status (Marsh, 1986). Where the father was absent, the social class (RGSC) of the mother's father was used. RGSC was coded on a 6-point scale: I professional; II managerial/technical; IIIN skilled nonmanual; IIIM skilled manual; IV semiskilled; and V unskilled occupations (Leete & Fox, 1977). This is an ordinal variable but treated as a continuous variable in most research. Scores were reversed in the following analyses. Parental education is measured by the age parents had left their full-time education.

Childhood intelligence was assessed at age 11 in school using a general ability test (Douglas, 1964) consisting of 40 verbal and 40 nonverbal items. School motivation was measured at age 16 years on a 5-point Likert scale. It is comprised of five items (e.g., "School is largely a waste of time"; "Homework is a bore"). At 33 years, participants were asked about their highest academic or vocational qualifications. Responses are coded to the 6-point scale of National Vocational Qualification (NVQ) levels ranging from "none" to "university degree or equivalent." Again this is strictly speaking an ordinal variable but treated as continuous in this and other studies. At 42 years participants provided information on their occupational levels which are coded according to the RGSC described above, using a 6-point classification. Personality trait Openness was assessed at 50 years, from the International Personality Item Pool (IPIP; Goldberg, 1999).

## Results

### Correlational Analysis

Table 1 shows the means, SDs, and correlations between the observed variables in the study. Trait Openness was significantly ($p < .001$) associated with all social variables and childhood intelligence (in boldness) except sex, which was not significant. Cohort members from higher social class who had higher scores on childhood intelligence, school motivation, education, and occupation tended to have higher scores on trait Openness in adulthood. School motivation was also significantly associated with parental social class, education, and occupation, as well as gender ($p < .05$ to $p < .001$). Hypotheses 1–4 thus were supported. The four personality traits: Extraversion, Emotional Stability, Agreeableness, and Conscientiousness were less substantially correlated with intelligence ($r = .01$ to $r = .13$) than trait Openness ($r = .29$ with verbal scores, $r = .25$ with nonverbal scores). Therefore, only Openness was further investigated in the SEM.

To further investigate the correlates of trait Openness, a Principal Component Analysis on the 10 items of trait Openness was conducted, and three subscales of Openness were extracted with eigenvalues greater than 1 accounting for 57.6% of variance. The three subscales were Abstract (4-item), Ideas (3-item), and Imagination (3-item). IBM SPSS Statistics version 22 was used for correlation and factor analyses.

### Structural Equation Modeling

Structural Equation Modeling was used to assess the links between gender, family social status, childhood intelligence, school motivation, education, occupation, and personality trait Openness. Paths in the models are designed to correspond with the time sequence in which the variables occurred. The SEM model testing was carried out using the

*Table 1.* Pearson's correlations among variables used in the study

| Variables | Mean (SD) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Openness | 32.57 (5.17) | – | | | | | | | | | | | | | |
| 2. Extraversion | 29.49 (6.61) | **.391** | – | | | | | | | | | | | | |
| 3. Emotional stability | 28.86 (7.03) | **.093** | .198 | – | | | | | | | | | | | |
| 4. Agreeableness | 32.57 (5.32) | **.333** | .367 | .056 | – | | | | | | | | | | |
| 5. Conscientiousness | 33.98 (5.29) | **.222** | .135 | .197 | .271 | – | | | | | | | | | |
| 6. Gender | 0.49 (0.50) | **−.017** | .078 | −.133 | .407 | .101 | – | | | | | | | | |
| 7. Parental social class at birth | 3.31 (1.23) | **.139** | .028 | .019 | .043 | .030 | −.003 | – | | | | | | | |
| 8. Paternal education at birth | 15.53 (1.98) | **.155** | .048 | .017 | .065 | .015 | .022 | .469 | – | | | | | | |
| 9. Maternal education at birth | 15.50 (1.54) | **.132** | .042 | .009 | .055 | .031 | .038 | .343 | .511 | – | | | | | |
| 10. Verbal scores at age 11 | 24.42 (8.58) | **.288** | .042 | .065 | .130 | .053 | .121 | .254 | .232 | .204 | – | | | | |
| 11. Nonverbal scores at age 11 | 22.86 (6.91) | **.247** | .011 | .103 | .063 | .037 | .017 | .258 | .226 | .189 | .777 | – | | | |
| 12. School motivation at age 16, α = .77 | 18.07 (4.51) | **.178** | .045 | .092 | .139 | .171 | .078 | .168 | .144 | .126 | .249 | .231 | – | | |
| 13. Education at age 33, α = .78 | 2.72 (1.44) | **.313** | .065 | .084 | .073 | .061 | −.079 | .309 | .303 | .261 | .458 | .443 | .393 | – | |
| 14. Occupation at age 42 | 4.05 (1.21) | **.254** | .105 | .081 | .088 | .111 | −.040 | .221 | .199 | .184 | .343 | .320 | .272 | .489 | – |

*Notes.* Variables were scored such that a higher score indicated being female, higher scores on traits Openness, Extraversion, Emotional Stability, Agreeableness, and Conscientiousness, a more professional occupation for the parent and higher age parents left school, higher verbal and nonverbal cognitive ability scores, higher scores on school motivation, highest educational qualification, and more professional occupation. The *N* in this analysis was 5,672.

*Table 2.* Measurement of the latent variables and SEM of trait Openness

| Variables | Unstandardized estimate | Standard error | Standardized estimate |
|---|---|---|---|
| **Parental social class** | | | |
| RGSC | 1.000 | | .609 |
| Father's education | 2.075 | .066*** | .779 |
| Mother's education | 1.303 | .043*** | .631 |
| **Childhood intelligence** | | | |
| Verbal | 1.000 | .013*** | .914 |
| Nonverbal | 0.727 | | .838 |
| **Openness subscales** | | | |
| Abstract | 1.000 | | .855 |
| Ideas | 0.448 | .014*** | .571 |
| Imagination | 0.393 | .014*** | .468 |
| **Predicting Openness** | | | |
| Gender | −0.235 | .131 | −.023 |
| Parental social class (latent) | 0.318 | .127* | .046 |
| Childhood intelligence (latent) | 0.111 | .011*** | .171 |
| School motivation | 0.065 | .018* | .049 |
| Education | 0.052 | .067*** | .145 |
| Occupation | 0.399 | .067*** | .093 |

*Notes.* *p < .05. ***p < .001. (all two-tailed)

structural equation modeling program AMOS 22 (Arbuckle, 2013) with the maximum likelihood estimation in AMOS (Arbuckle, 1996).

The loadings of the three latent variables of family social status and childhood intelligence are shown in Table 2. For family social status, the loading ranged from .61 to .78. For childhood intelligence, they were .91 for verbal tests and .84 for nonverbal tests. For trait Openness, they were .86 for Abstract, .57 for Ideas, and .47 for Imagination.

Figure 1 shows the standardized path coefficients of the structural equation model. Measurement errors for each observable variable were included in the model (not shown in the diagram).

The $\chi^2$ statistic is overly sensitive when sample sizes are large or the observed variables are non-normally distributed. The root mean square error of approximation (RMSEA) gives a measure of the discrepancy in fit per degrees of freedom (values less than .05 indicate a good fit and values > .10 are considered as a poor fit; Bentler, 1990). The indices of choices are the Comparative Fit Index (CFI) and the Tucker Lewis Index (or Non-normed Fit Index) where values above .95 indicate a very good fit and values > .90 are interpreted as "good" (Bentler, 1990).
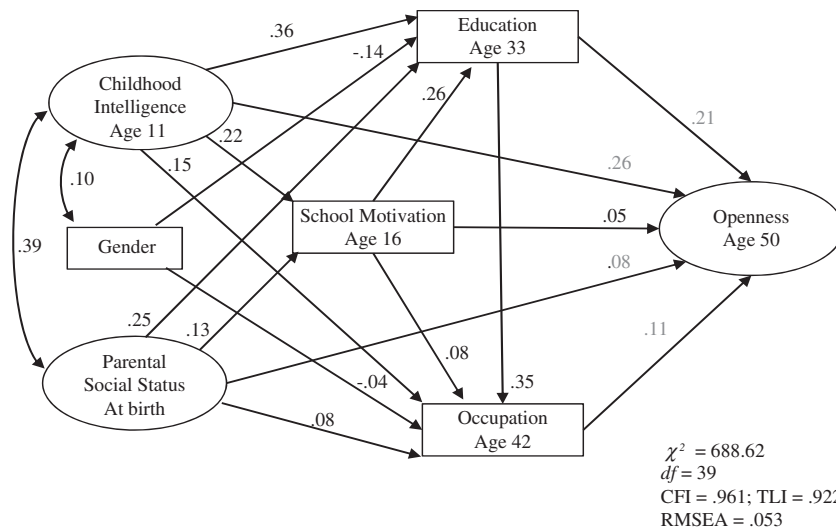
*Figure 1.* Path model: Predicting Openness (*N* = 5,672).

$\chi^2$ = 688.62
*df* = 39
CFI = .961; TLI = .922
RMSEA = .053

The model showed a good fit. Chi-square was 688.7 (*df* = 39, *p* < .001), the CFI was .961, the TLI was .922, and the RMSEA was .053, accounting for 29% of total variance. Figure 1 shows that family social status, childhood intelligence, school motivation, education, and occupation were all significant and direct predictors of adult trait Openness. Gender was not significantly associated with the outcome variable.

As childhood intelligence was the strongest predictor of Openness, we further tested the direct effect of childhood intelligence on the outcome variable. Results showed that the direct path coefficient was .39 between childhood intelligence and adult Openness, $R^2$ = .22, Chi-square was 581.1 (*df* = 23, *p* < .001), the CFI was .955, the TLI was .921, and the RMSEA was .065.

## Discussion

The findings of the current study confirm the significant associations between family social status, intelligence, educational achievement, and occupational attainment as established in the previous studies (Deary et al., 2005; Duncan & Brooks-Gunn, 1997; Duncan et al., 1972; Heath, 1981). It also replicates positive associations between childhood intelligence, educational and occupational achievement, and school motivation (Schoon & Cheng, 2011). It further confirms the positive associations between education and occupation and Openness (Furnham, 2008). Moreover, the current study extends the previous studies in the area by showing evidence that school motivation measured at age 16 is a significant predictor of adult trait Openness measured 34 years later.

The current study demonstrates that childhood intelligence is indeed positively associated with adult trait Openness, even when it was assessed almost four decades earlier when participants were at 11 years. This suggests the

opposite of Investment Theory of Curiosity reviewed by Von Stumm and Ackerman (2013). They argued that intellectual investment theories propose that the development of intelligence is partially influenced by personality traits (i.e., Curiosity, a facet of Openness) that determine when, where, and how people invest their time and effort in their intellect. Thus investment contributes to individual differences in cognitive growth and the accumulation of knowledge across the life span. This study suggests that intelligence may influence the development of personality in that intelligent people develop habits to satisfy their curiosity and "cognitive hunger" which are an essential ingredient of Openness.

There are no doubt genetic and environmental factors that contribute to adult Openness. The pattern of findings shown in Figure 1 suggests a possible mechanism: Parents of higher socioeconomic status may foster children's trait Openness by providing better resources such as choosing good schools and cultural environment (theaters, museums, traveling abroad, etc.); intelligent children tend to use more mental activities (such as abstract ideas, learning new vocabularies, or math formulas) than those who are less intelligent; school settings (quality of teaching, good facilities) may enhance pupils to engage more in school learning. All these three factors may influence educational and occupational achievement, which in turn, may increase the scores on Openness.

Indeed, these results support the twin study on personality and intelligence reported by Bartels et al. (2012). They found phenotypical correlations between IQ and Openness on the 646 adolescent twins of *r* = .32 and argued that high scores on Openness contribute to higher IQ scores. This study showed that high scores on intelligence, in early adolescents are significantly related to IQ scores almost 40 years later. While investment theory suggests that personality can significantly modify intelligence it is also possible that intelligence shapes personality particularly in the former is more "hard-wired" and stable than the latter. There has been a longstanding debate called the plaster

versus plasticity debate where the former advocates argue that personality is "set like plaster" early in life (usually by adolescents), while those who support the plasticity model stress how much and how often personality changes over time (Roberts, Walton, & Viechtbauer, 2006).

The current study has various significant limitations. It would have been most desirable that Openness was measured earlier so that changes could be monitored, and seeing it as an independent as well as a dependent variable. Thus, it is difficult to infer causation as opposed to correlations on the findings from the current study. It would also be most desirable to have had a measure of Openness with different facets as many studies have shown they operate rather differently on various social outcomes like employment (Kern et al., 2013). Besides, all the path weights leading to Openness were modest accounting for only 14% of total variance, suggesting that perhaps many other important factors were important determinants of this trait in adulthood. Further studies are required to explore those factors.

## Acknowledgments

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