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The power of cognitive ability in explaining educational test performance, relative to other ostensible contenders

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ABSTRACT

The paper examines the relationship between cognitive ability at thirteen years of age and children's academic performance assessments at aged nine. Alongside cognitive ability, other variables considered predictive of academic success were assessed including personality measures, birthweight, handedness, socio-economic background, parental education, home language, and child-rearing practices such as breast-feeding and access to video-games. The final sample comprised 7525 children who participated in both wave 1 and wave 2 of the Growing Up in Ireland (GUI) longitudinal study. Participants in the study were selected through the state school system using a 2-stage sampling method producing a large sample representative of the national population of nine-year-old children. Linear multiple regression identified five variables which significantly explained both reading and mathematics test scores: two cognitive ability measures, birthweight, wealthier households, and high attendance at parent-teacher meetings. Gender, parental education, and home language also made a contribution to reading test scores, while a general factor of personality was significant for mathematics. Overall the cognitive ability measures accounted for almost all of the explained variance, and other factors, while sometimes statistically significant, were of relatively minor importance.

In meritocratic knowledge-based economies, academic attainment is the key determinant for how and where individuals enter the employment market, and how their work is likely to be rewarded (Strauss & de la Maisonneuve, 2009). Identifying the substantive predictors of academic attainment is therefore of considerable importance. A number of domains have been highlighted by different traditions of research. One raises the importance of intelligence or cognitive ability in influencing academic performance and/or attainment. Another focuses on ostensibly environmental factors, particularly parental or household socio-economic status (SES), but also parental practices, as well as the quality of schools and teachers. A more recent approach has raised interest in personality factors and self-control. This paper compares the explanatory power of the different domains through data from the Growing Up In Ireland (GUI) longitudinal study.

1. Introduction

1.1. Cognitive ability

Intelligence or general cognitive ability has been defined as “the ability to reason, plan, solve problems, think abstractly, comprehend

complex ideas, learn quickly and learn from experience” (Gottfredson et al., 1997, p. 13). Thus, it is not surprising that it should be expected to influence academic performance and attainment. The well-known estimate for range of correlational association between cognitive ability and educational achievement provided by Jencks et al. (1979) was between 0.40 and 0.63. Mackintosh (1998) reported a correlational range of between 0.4 and 0.7 between IQ and school performance grades, and gave a single figure of 0.5 for the prospective prediction of the grades of 16 year olds from their IQs measured at aged 11. While Sternberg, Grigorenko, and Bundy (2001) caution that IQ is culturally a ‘Western’ concept, they acknowledge that in the specific, and important, domain of academic attainment in Western educational systems, measured cognitive ability in childhood is a strong predictor of school grades. Deary, Strand, Smith, and Fernandes (2007) examined the relationship among a very large sample of British children between their score on an intelligence test aged 11, and their grades in the public examination, the GCSE, aged 15/16. In most subjects, like mathematics, science and geography, the correlations were high, while in a smaller number such as Art and Design, they were lower. Overall, “general intelligence contributed to success on all 25 subjects” (Deary et al., 2007, p. 13). More recently, a meta-analysis by Roth, Becker, Romeyke,

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and Schäfer, S.m, Domnick, F., and Spinath, S. (2015), involving 240 independent samples and 105,185 participants, reported a population correlation between school grades and intelligence tests at 0.54.

1.2. Parental SES and other environmental factors

The attribution of school grades primarily to intelligence was questioned by other researchers who claimed that both might be causally influenced by a third variable – parental SES. Blanden and Gregg (2004), examining UK household data, reported that in households with an income more than one third below the national average, children were 3–4% more likely to leave school with no basic educational grades in standard state exams. Generally, they report, “children from low-income households go on to leave full-time education much earlier, and with fewer formal qualifications than their more affluent counterparts” (2004, p. 1). Alongside economic factors are background educational ones; Dubow, Boxer, and Huesmann (2009), interrogating the Columbia County Longitudinal Study dataset, found that parental educational level, when the child was 8 years old, “significantly predicted educational and occupational success for the child 40 years later.” (Dubow et al., 2009, p. 224). Alongside the advantages of formal educational knowledge bestowed on children by better educated parents, the authors also point to indirect advantages for children such as a more stimulating environment in the home, and greater knowledge of and involvement in the child's role in school. Specific child-rearing practices might also be linked to parental SES. Breastfeeding for example has been linked to gains in cognition and educational attainment. However, this may arise either directly through improved nutrition for infants, or might be an indirect indicator of parental social class, see McCrory & Murray, 2013. Strenze (2007) in a meta-analysis of longitudinal studies, concluded that while intelligence was an important predictor of people's socio-economic success, parental SES was almost as important.

There are wider environmental factors potentially at play also in determining children's attainment in school beyond parental SES. (Of course, given that intelligence is partly a heritable trait, the argument that parental SES can be compartmentalised as a purely environmental factor is not sustainable. Parental SES is influenced by *their* cognitive ability, and children's cognitive ability will resemble their parents; this relationship is intensified by assortative mating for intelligence, see Plomin & Deary, 2015). Sociologists in the tradition of Robert Merton have pointed to community and sub-cultural factors in influencing children's perceptions of the value of schooling, and the idea that in times of widespread economic difficulty, communities and their institutions such as schools may come under “strain”, with a vicious cycle of self-reinforcing failure and social stress ensuing. See for example, Sampson and Wilson's (1995) restatement of the theory of social disorganization.

1.3. Personality variables

A popular domain of investigation in recent years with regard to academic attainment has been around the related concepts of self-discipline, self-control, and ability to delay gratification. For example, Duckworth and Seligman (2006) argued that girls outperformed boys in elementary, middle and high school grades despite equivalent levels of cognitive ability because typically girls had better self-discipline and ability to delay gratification than their male counterparts. Overlapping with this argument is a focus on personality, and the idea that certain stable personality traits can either benefit or hinder people's expression of their academic strengths; for example, considering the Big-Five personality measures, high levels of neuroticism and extraversion might be unhelpful for an individual, while conscientiousness, openness and perhaps agreeableness could make a positive contribution to an individual's ability to learn in school. In this regard, Nofle and Robins (2007) found that Conscientiousness and Openness were strong predictors of SAT verbal scores and college GPA.

1.4. The rationale of this paper

The purpose of this paper is to report on the relationships between assessed cognitive ability and academic performance in a longitudinal assessment of a large and representative sample of Irish children. These data are from the Growing Up In Ireland (GUI) study; the second wave of the child cohort was made available to researchers relatively recently. Unlike the analysis of Deary et al. (2007) cited above, where the prospective explanatory power of the cognitive ability test was examined on later academic grades, this analysis looks at the retrospective power of cognitive ability tests undertaken at age 13 in sweep 2 of the survey, in explaining the variance in standardised educational tests (reading and mathematics) when the children were aged nine in sweep 1 of the survey. Along with measures of cognitive ability, the contribution of personality measures (aged 13), and background economic, family, educational and personal factors (gathered aged 9) are also assessed. The purpose of the paper is to report on the relationship between measured cognitive ability and standardised educational tests in a representative Irish sample of children, and more broadly to add to the important debate of the relative contribution of other factors that have been considered important in influencing educational outcomes, such as parental SES, personality and school resources.

2. Methodology

2.1. The growing up in Ireland (GUI) longitudinal study

The data reported here are drawn from participants in Growing Up in Ireland (GUI), the first Irish longitudinal child cohort study. It was commissioned by the Irish Government, and funded by the Department of Health and Children in association with the Department of Family and Social Affairs and the Central Statistics Office. It is intended that the GUI (Murray, McCrory, Thornton, Williams, & Quail, 2011), will follow the same children from the age of nine to adulthood. The data available to date are wave 1 (from the cohort at aged 9), and wave 2 (collected from the same cohort aged 13). Responses to the first wave of the survey were collected from 8568 children (child self-assessment, child-on-parent responses), their parents (parent self-assessment, parent-on-child responses), their teachers (teacher-on-child responses) and school principals. Data collection for wave 1 took place between August 2007 and May 2008. A total of 7525 children, or 87.9% of the original group, participated in the second wave of data collection that took place between August 2011 and March 2012. The sampling strategy involved contacting more than a thousand randomly selected schools in the Republic of Ireland, and then, via schools, contacting children and their families. Parents and children could request the questionnaire in their native language. Letters of invitations were sent in English and in the native language of the primary caregiver (usually the mother). Of all schools contacted, 82% participated, and 57% of age-eligible children took part. The study coordinators estimated that wave 1 of the GUI sample represented 14% of all nine-year olds in the country, or roughly 1 in 7 of nine-year old children living in Ireland (Murray et al., 2011). Thus the study provides information on a large and population-representative group of children at different points of time in their lives. Furthermore, it collects data in relation to standardised educational tests, measures of cognitive ability, personality, other personal information, detailed measures of family background including in relation to economic status and parenting, as well as information about the child, and child's school, from school principals and teachers.

2.2. The dependent measures

Two academic assessments were completed by the child in wave 1 of the data collection. These were the Vocabulary section of the Drumcondra Primary Reading Test - Revised (DPRTR), and Part 1 of the

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