

Intelligence and individual differences

Ian J. Deary and John Maltby on psychology's return to its practical roots

Currently, individual differences researchers in Britain are still making key contributions and developing bodies of work to advance our understanding of intelligence's structure, origins and outcomes. Far from being a niche area of study, British researchers have applied the principles and theories around the psychology of intelligence to provide insights into key topics of interest in modern day science, including (1) ageing, cognitive decline, and health, (2) academic achievement and competence and (3) intelligent ways of using and managing emotions.

Intelligence is arguably psychology's best-attested and most important variable. Britain has made notable contributions to intelligence since the late 19th century (Deary, 2001), and researchers continue to apply the principles and theories in areas of vital importance to society.

These modern-day psychologists stand on the shoulders of giants: the currently-accepted psychometric structure of intelligence differences, with *g* at the pinnacle, cognitive domains below that, and specific abilities lower still – is a monument to British psychologists. Sir Francis Galton correctly conceived the idea of general intelligence (and also the ideas that it might be largely heritable and correlated with simpler psychological functions); Spearman discovered *g* empirically and developed intelligence theory; Cattell and Vernon suggested the major group factors; and Burt and Vernon suggested long ago the hierarchical structure that is accepted today. Thomson offered a theoretically different interpretation of the correlations among intelligence tests; he was also behind a monumental amount of work applying intelligence to educational selection and was responsible for the only population-wide intelligence surveys ever conducted (in Scotland). Hans Eysenck deserves special mention for keeping the wreckers away from intelligence's structure, origins and outcomes, when (largely) ignorance and faddishness made intelligence unpopular among some psychologists.

Productive British researchers in differential psychology in recent years

have been Ian Deary (your first author), Adrian Furnham and Robert Plomin, all of whom have studied intelligence. Deary and his colleagues in Edinburgh (Elizabeth Austin, Tim Bates, Wendy Johnson, Michelle Luciano, Lars Penke and Alex Weiss) form an unusually large group of permanent differential psychology staff in a single department. Deary leads his own large research group, following up the Scottish Mental Surveys of 1932 and 1947 (in the form of the Lothian birth cohorts of 1921 and 1936). In addition, he directs the MRC-administered Centre for Cognitive Ageing and Cognitive Epidemiology, which brings together a large and diverse group of researchers, focusing on the reciprocal influences of intelligence and health across the human lifecourse. Much of this research arises from the follow-up to the population-wide surveys of intelligence that took place in the Scottish Mental Surveys of 1932 and 1947. The first 10 years of work on these surveys is summarised in the book, *A Lifetime of Intelligence* (Deary et al., 2009). To date, peer-reviewed papers based solely on the Scottish Mental Surveys' data amount to over 100, so the following are just a few examples of the research outputs.

Intelligence and ageing

In ageing research, using their follow-up samples from the Scottish Mental Surveys, the Deary group were the first to show that, when the same mental test is given at age 11 and approximately at age 80, half of the variance is stable (Deary et al., 2000). Since this, the team has published many papers on the possible determinants of a change in intelligence across the lifecourse, exploring causes from a wide range of domains. From genetics, they showed that possessing the *e4* allele of the gene for apolipoprotein E (APOE) is associated with intelligence at age 80 (approx.), but not at 11 (Deary et al., 2002). These sorts of studies, using the intelligence and other cognitive ability data from the follow-up samples of the

question

Why do more intelligent people live longer?

resources

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Scottish Mental Surveys, have produced many other candidate gene studies. The group has now progressed to genome-wide association studies, for example looking at mental speed (Luciano et al., 2011), and perform these in collaboration with other large databases worldwide. Another area of the determinants of cognitive change that has been looked at is brain structure; the group have shown that brain white-matter lesions and white-matter integrity are associated with intelligence in old age, after adjustment for intelligence in childhood.

One novel contribution was to show that the integrity of the brain's principal white-matter tracts are positively correlated, producing a general white-matter integrity factor that is correlated with processing speed (Penke et al., 2010). The group have also shown that men with more symmetrical faces have more successful cognitive ageing (Penke et al., 2009).

There are many other examples of genetic, biomedical, lifestyle and social-demographic contributions to cognitive ageing (some are summarised in Deary et al., 2009). However, we conclude this section with an unusual contribution by the team, due to the fact that their samples include intelligence data in both childhood and old age. In several cases they have been able to demonstrate so-called reverse causation: this is where a variable is assumed to contribute to intelligence in old age but, in fact, the opposite is the case. One example is C-reactive protein, a blood-borne indicator of the amount of systemic inflammation. Some studies had shown that this was associated with intelligence in old age, and made the assumption that inflammation is a determinant of cognitive ageing. Using data from the Lothian birth cohort 1936 sample, it was shown that there was an association, but that it attenuated to almost zero when childhood intelligence was covaried. The conclusion? That children with higher intelligence tend to be less inflamed in old age, and not that inflammation is a determinant of cognitive

ageing. This association between intelligence in youth and later health is called cognitive epidemiology, and we turn to it next.

Intelligence and health

Health is a new outcome of intelligence. It has been shown that intelligence at age 11 could predict mortality in men and women up to the age of 76 (Whalley & Deary, 2001), and it is now well established that intelligence in youth is as strong a predictor of mortality as any of the traditional medical risk factors (Deary et al., 2010). Much of the aforementioned group's work has been in exploring the many possible causes of this association.

Reaction time can account for the majority of the association between intelligence and mortality (Deary & Der, 2005). That is, in a sample where intelligence was measured at age 55 and where follow-up for mortality was carried out for 15 years, measures of reaction time were also available. Higher intelligence at baseline was associated with lower risk of mortality. Reaction time correlated moderately strongly with intelligence scores at baseline. When reaction time was included as a covariate in the intelligence–mortality association, the association was attenuated by about two thirds. This lent support to the idea that intelligence is an indicator of bodily system integrity, and appeared to offer less support for the idea that intelligence was largely an indicator of social class, which is also associated with differential mortality.

It is also known that the personality

traits of neuroticism (Weiss et al., 2009) and conscientiousness (Deary et al., 2008) are associated with mortality – the former is a risk factor, the latter protective – and that intelligence and neuroticism interact in their influence on mortality. The neuroticism–intelligence work was carried out using the USA's Vietnam Experience Study (Batty et al., 2008). Other large samples that have been used include the

Swedish Conscripts Study, which provided the team with its largest ever confirmation of the intelligence–mortality association, through a sample of over one million men (Batty et al., 2009). Another large sample – Generation Scotland's Scottish Family Health Study – provided the data with which the team have shown that many so-called 'environmental' determinants of health actually have substantial genetic causes, and that they are often shared with intelligence's genetic background

(Luciano et al., 2010). These include education, smoking, and eating fruit and vegetables.

Beyond the work on the Scottish Mental Survey follow-ups, and the work on cognitive epidemiology, there is a great deal more basic and applied intelligence research being carried out in Edinburgh. For example, there is the research on the structure of intelligence, in which a tweak to the three-level hierarchy has been to add a third factor (image rotation) in addition to the verbal and perceptual domains (Johnson & Bouchard, 2005). Then there is the work on the constancy of *g* across different test batteries, as demonstrated in various large datasets (Johnson, te Nijenhuis et al., 2008). There is also a



Men with more symmetrical faces have more successful cognitive ageing

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individual differences

substantial body of work on sex differences – especially the greater variation in male as compared with female intelligence (Johnson, Carothers et al., 2008) – and on intelligence's place in social mobility (Johnson et al., 2010).

Academic competence

One key development in this resurgence in the study of intelligence is the thinking about the role of intelligence within a number of models in creative ways. One excellent example is the identification of intellectual competence (IC). This idea was forwarded and has been led by Tomas Chamorro-Premuzic and Adrian Furnham (University College London) to elaborate on the conventional notion of intelligence by including other determinants of future academic achievement. Chamorro-

Premuzic and Furnham (2006) define IC as an individual's capacity to obtain and consolidate knowledge throughout their lifespan. Thus, they present a model that unites traditional estimates of abilities (e.g. intelligence), personality traits (e.g. the five-factor model of personality) and self-assessed intelligence (SAI: self-estimates of mathematical, spatial, verbal, and logical and general knowledge abilities).

Research has focused on how this model can be used to elucidate the relationship between intelligence and personality in terms of predicting real-life achievements, such as academic performance. For example, Chamorro-Premuzic and Arteche (2008) have found some interesting interactions and mediational effects among ability and personality predictors of academic

performance among university students. One such finding was that those higher in fluid intelligence (who show a greater capacity to think logically and solve problems in novel situations) were lower in levels of conscientiousness (i.e. they had lower levels of self-discipline, carefulness, and thoroughness traits) and this contributed to lower academic performance. The authors found that those higher in fluid intelligence do better in their academic performance partly because such performance is linked to higher self-estimates of intelligence and higher crystallised intelligence (the ability to use acquired skills, knowledge, and experience). These findings open up and extend discussions of how we might understand how intelligence interacts with personality and self-estimates of ability in a person's academic performance.

This consideration of the dynamics that surround the model of IC has extended to the longitudinal consideration of children's academic achievement. Among a sample of 3220 girls and 2737 boys from the UK Twins Early Development Study, examined at two time points (age 9 and 12), Chamorro-Premuzic et al. (2010) found that the effects of prior academic achievement on subsequent self-estimates of intelligence were of a similar size to the effects of previous self-estimates of intelligence on later academic achievement, independent of intelligence. These findings present interesting accounts of the relationship between perceptions of intelligence and academic achievement, and show that children's beliefs about their previous performance and self-efficacy (resulting from their beliefs about their own ability) have an important effect on later academic achievement.

Emotional intelligence

A natural extension of the work on intelligence is to explore the nature of emotional intelligence (EI). One of the most notable contributions to this literature is the work of K.V. Petrides and



Longitudinal twin research has examined the impact of children's beliefs on their later academic achievement

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colleagues on trait EI. Trait EI is different from Salovey and Mayer's 'ability' and Goleman's mixed-models of EI. Instead, it conceptualises EI as comprising 'emotional self-perceptions' (Petrides & Furnham, 2001). Consequently, it centres around self-perceived emotional abilities and is investigated within a personality framework and has alternatively been labelled 'emotional self-efficacy'.

Research supports the efficacy of the trait EI concept. Bivariate behavioural genetic analyses have revealed that, for trait emotional intelligence, phenotypic correlations are attributable to common genetic and common non-shared environmental factors (Veselka et al., 2010). The concept shows some value in predicting a number of outcomes (e.g. life satisfaction, rumination, coping) after controlling for personality factors (Petrides et al., 2007) and has been shown to correlate positively with teacher-rated positive behaviour and negatively with negative behaviour (e.g. emotional symptoms, problems with conduct, peer problems, and hyperactivity) among schoolchildren (Mavroveli et al., 2008).

An intriguing aspect of EI that has been considered by British researchers is

its possible dark side, within the Dark Triad of Personality comprising narcissism, Machiavellianism, and psychopathy traits (Paulhus & Williams, 2002). University of Edinburgh psychologist Elizabeth Austin first posited the relationship between Machiavellianism and EI (Austin et al., 2007) in terms of Machiavellianism comprising deceptive traits in everyday behaviour and interactions with others (particular in terms of trying to gain advantage for oneself), and EI comprising traits that enable the individual to manage the emotions of others, suggesting a possible dark side. Austin et al. concluded that, although people high in Machiavellianism endorse emotionally manipulative behaviour, the evidence did not support the view that people high in Machiavellianism were successful at emotionally manipulating people, due to

a negative relationship between Machiavellianism and EI. Nonetheless, some support has been found for the conceptualisation of a dark side to EI, by finding that Trait EI is correlated positively with narcissism, albeit negatively with the other two traits (Petrides et al., 2011).

Summary

Today, investigation into intelligence from the point of view of psychology has returned to its practical roots. Like Binet, whose first aim was to help identify children requiring special education, intelligence theory and research are being applied in a number of contexts today, whether in terms of cognitive decline, promoting health, academic achievement or how to successfully promote oneself intra- or interpersonally.



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