

Commentary: Francis Galton, twins and intelligence

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Well before the rediscovery of Mendel's principles in 1900, Francis Galton in 1875 was clever enough to recognize the potential that twins had for determining whether a character was inherited or not.¹ Although he did not use the terms, he recognized that identical or monozygotic (MZ) twins arose from the same ovum whereas non-identical twins or dizygotic (DZ) twins were produced from separate ova. This distinction was critical for Galton because, although the environment was constant for each pair of twins, MZ twins were identical genetically whereas DZ twins were no more alike than sisters and brothers.

Galton then made use of a psychological questionnaire he had devised to query different pairs of twins, classified them into groups (e.g. 'girls alike, girls unlike, girls partially alike') and eventually networked his way to 94 sets of twins. In his *Fraser's Magazine* paper, Galton analysed 35 pairs of identical twins. Just as psychologists have done ever since, he collected anecdotes about behavioural quirks shared by individual pairs of twins and recounted the more remarkable of these. Galton, of course, did not have the IQ test available to him since Alfred Binet and Theodore Simon would not invent the test until the early 20th century.

It was not until 1937 that twins were used again to try to assess the relative contributions of nature and nurture to intelligence.² Frank N Freeman and Karl J Holzinger, two University of Chicago psychologists, collaborated with Horatio H Newman, a biologist, to report on the IQs of 19 pairs of MZ twins reared apart as compared with a similar number reared together.³ The correlation of 0.67 for twins reared apart implied a marked hereditary component. However, as Freeman and his colleagues were careful to note, the greatest IQ differences were seen between MZ twins that had been reared in the most strikingly different environments. Subsequently, Sir Cyril Burt, the famous British psychologist, reported his intelligence test correlations of approximately 0.771 on increasingly large numbers of twins reared apart, in papers published in 1943, 1955 and 1966.⁴ Thus, it appeared that intelligence had a substantial hereditary component.

Arthur Jensen, a Berkeley psychologist, used Burt's numbers to argue in a 1969 *Harvard Educational Review* article that nature was far more important than nurture in determining one's ability to learn.⁵ Jensen's article was long and scholarly, but he got into trouble in one short section where he compared the IQs of Blacks and Whites, observing that the average IQ of Blacks was about 15 points below Whites. After correcting for socio-economic differences, this number dropped to 11 points. Jensen averred that this was about the same as siblings in the same family, but then he went on to conclude that these differences were probably largely genetic, a claim that was hotly contested in the press and elsewhere. Furthermore, there were scientists who seriously doubted the hereditarian view of IQ, now defined in the dictionary as 'Jensenism'. One was psychologist Leon Kamin of Princeton who recognized that Burt's twin studies were the foundation upon which the hereditarian thesis rested.⁶ Kamin discovered that Burt's correlations were constant in different papers even though the number of twins tested varied. This led Kamin to suspect that Burt's data were faked, especially when Kamin discovered that other twin studies gave variable correlations.^{7,8} Hereditarian premises were also attacked in books by Harvard paleontologist Stephen Jay Gould (*The Mismeasure of Man*, 1981⁹), and by Kamin in collaboration with Harvard population geneticist Richard Lewontin, and British biologist Steven Rose (*Not In Our Genes*, 1984¹⁰).

Nevertheless, the hereditarian thesis rebounded with a vengeance upon the publication of *The Bell Curve* in 1994 by Richard Herrnstein and Charles Murray.¹¹ Furthermore, the 15-point average IQ differential between Blacks and Whites was graphically illustrated in an accompanying *New Republic* article titled 'I.Q.—An Apologia'.¹² Once again IQ studies of MZ twins reared apart formed the major evidence for the heritability of intelligence. By now, there were other studies with the most comprehensive being that of Thomas Bouchard, Director of the Minnesota Center for Twin and Adoption Research, and his colleagues at the University of Minnesota.¹³ Burt's papers being suspect, they were no longer cited.

The Bell Curve came in for withering criticism in articles and entire books, most notably that of Claude S. Fischer and colleagues of his in the Department of Sociology at the University of California, Berkeley.¹⁴ Not only did they discover technical flaws in the analysis done by Herrnstein and Murray, but also they highlighted numerous instances where the authors claimed that intelligence was more important than socio-economic status whereas the reverse was true.

Other problems with the hereditarian thesis of intelligence were also beginning to surface. One was a phenomenon dubbed by Herrnstein and Murray 'The Flynn Effect', named for James R Flynn, a professor of political science at the University of Otago, New Zealand. Flynn had discovered that during the 20th century, there had been massive gains in intelligence from generation to generation, an observation that could not be explained by heredity.¹⁵ Then Nicholas J Mackintosh, a distinguished animal-learning theorist at the University of Cambridge, took a careful look at the contributions of nature and nurture to intelligence.¹⁶ He came away sceptical of the literal interpretation of the IQ heritability data for several reasons. For one thing, including the most recent studies of Bouchard, only 162 pairs of identical twins reared apart were tested in the five studies he examined. Perhaps even more important, he discovered that the environments the twins were reared in were often not wholly uncorrelated. He estimated the overall heritability of IQ as ranging between 0.30 and 0.75. Richard Nisbett, a social psychologist and distinguished professor at the University of Michigan, echoed many of the concerns raised by Mackintosh and added to them.¹⁷ He pointed out that for MZ twins reared apart 'a tacit assumption that is surely false' is that 'the twins were placed into environments at random'. Nisbett went on to cite by way of example, the work of Uri Bronfenbrenner who found that when twins reared apart were reared in similar environments their IQ score correlations ranged from 0.83 to 0.91, but when the environments differed markedly correlations ranged from 0.26 to 0.67. Furthermore, Eric Turkheimer of the University of Virginia had studied over 600 pairs of twins reared together, most of whom were below the poverty level.¹⁸ He 'found that for the poorest twins, IQ seemed to be determined also exclusively by their socioeconomic status, which is to say their impoverished environment. Yet for the best-off families, genes were the most important factor in determining IQ, with the environment playing a much less important role'. Thus, Turkheimer's results suggested that in upper-middle class families, the environment for the development of intelligence was much better than in impoverished families. Furthermore, these environments may not differ greatly between families. Since studies of twins reared apart often involve families that are middle class or upper-middle class who are relatively easy

to contact, heritability will be biased towards the high end because environments are not uncorrelated.

What is clear is that many different genes affect intelligence either directly or indirectly. As of September 2003, 282 genes had been identified as having mutations which led to mental retardation.¹⁹ This is consistent with the normal distribution of IQ that is seen for polygenic traits, that is, traits such as height affected incrementally by many genes. The environment can also have a marked effect on the parameters of these distributions. For example, malnutrition leads to stunted growth and reduced IQ (this relationship has been the subject of many studies either separately or in combination. For example, see ref.²⁰). Therefore, although studies of twins reared apart strongly suggest that nature contributes to intelligence, nurture is clearly important too and determining the precise balance between forces is a question for the future. Progress in understanding this balance is going to require a new approach. This may come from collaborative investigations like those of the Genes to Cognition Project.²¹ These scientists are studying a complicated structure made up of over 100 proteins called the *N*-methyl-D-aspartate receptor that appears to be involved in memory function. These receptors sit at the junctions (synapses) between nerve cells and modulate the strength of signals sent between neurons. The functions of the different proteins in this complex can be examined through the use of a mouse model where the gene encoding each protein can be knocked out one at a time. For instance, mice that lack a protein called Postsynaptic density protein 95 (PSD-95) have severe learning disabilities.

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