BIOLOGY OF HUMAN INTELLIGENCE

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The article presents a brief review of the genetic aspects of intelligence as measured by IQ tests. The results from family and twin investigations seem to agree in as much as high heritabilities for IQ can be calculated. There are, however, a large number of insecurities and sources of error which invite to criticism. Although, at present, it is justified to assume that genetic factors contribute substantially to variations in IQs, it would be premature to claim that genetic and other causes of variation could be expressed in precise figures. It seems doubtful if this situation could be further improved by continued use of IQs in genetic investigations. It should be more profitable to use other entities, such as well-defined special abilities, which could be designed directly for genetic analyses.

There is no doubt that the variations of the individual genetic blueprints, in as much as they control the development of the brain, have ramifications which contribute to the variation of mental phenol types. It is often asked how much, and it is only when we try to quantify that we run into difficulties. Intelligence tests have been designed to describe the normal variation in a specified population and the mean is arbitrarily defined as 100 IQ points. Most tests were worked out on ordinary classes of school children. When applied to unselected samples of individuals from the general population the test values are still almost normally distributed but not quite because of a certain surplus of individuals in the lowest IQ classes, a phenomenon to which I shall return shortly.

Within populations there are considerable individual differences in respect of intelligence. For example, in Western White populations the standard deviation averages 15 IQ points. Broadly speaking, there are two main causes of variation, i.e., genetic and environmental. At this juncture, the only reasonable hypothesis is that the genetic background of intelligence as defined by response to standard tests is multifactorial.

The theory of evolution which is largely based on modern genetics assumes — with ample documentation — that present day man has evolved from lower, perhaps apelike forms through a process of selection combined with mutations, migrations and genetic drift as the main ingredients. Selection is inefficient unless it works on phenotypical traits which are closely connected with the genotype. Present day man is certainly different from his ancestors of some millions of years ago and along this line the structure and the function of his central nervous system has changed. Moreover, this evolution has taken place in a number of different and relatively isolated subpopulations, living under vastly different environmental conditions and spread over the entire world. It is clear that if one wants to postulate that human intelligence has evolved exclusively through changes in the environment, it would be necessary to include some rather improbable assumptions.

If the influence of genetic factors on differences in intelligence is negligible one would expect to find a very strong correlation between environment and IQ. A number of investigations have shown significant differences between the mean IQs when different groups in the population were compared, e.g., when the population was divided into traditional social classes. However, the variations within the groups are often larger than between them. Moreover, because the variation in environment is larger between families than within, one would expect the differences in IQs within families to be

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consistently smaller than between families also when families belonging to similar environments or social groups are examined.

This argument can be put to a test by using an unselected sample of probands with low IQs derived from a population with no apparent differences in environmental conditions between families. This was made in an epidemiological investigation of mental defect in Northern Sweden (Böök 1953). The data were derived from three remote communities, sparsely populated with 9,000 people and with small farming and forestry as the important means of livelihood.

All individuals with a mental retardation correspondig to an IQ of 70 or below were registered as probands. Through clinical and genetic examinations the probands were divided into groups of known etiology, such as firstly birth injuries, infections of the central nervous system and other purely environmental causation and secondly simple gene and chromosomal differences. A remaining group of 49 probands did not display any significant clinical signs or symptoms and no specific etiologies were discosed.

Returning to the IQ distribution in the population, the mentally retarded probands with a known etiology can be regarded as the cause of the distortion of the normal curve, i.e., of the surplus of individuals in the lower IQ classes. If we remove these, the approximation to a normal distribution improves considerably. Consequently, as we have a complete ascertainment in this investigation, the remaining 49 probands should represent the extreme minus variates of the normal distribution of intelligence in this population. On the environmental hypothesis these 49 probands should be concentrated to a few families subjected to environmental disadvantage and they should have siblings with similar IQs. On the other hand, because no significant environmental differences were observed in respect of this population, one might argue that the whole population were subjected to some environmental disadvantage.

If this latter assumption were true, the incidence of mental retardation should be higher than in other more developed parts of the country. Some such estimates are available and they show an incidence of 10-18 per thousand (cf. Åkesson 1961). The corresponding incidence for this population was 11.4 ± 1.4 per thousand. It should be safe to conclude that the investigated population is not characterized by an abnormally high incidence of mental retardation.

The 49 probands were distributed over 43 different families and they had a total of 237 siblings. The incidence of the same type of unspecific mental retardation among those siblings was estimated at 97 ± 19 per thousand which was 10 times higher than the incidence in the population (9.6 ± 1.2 per thousand) from which they were drawn.

Assuming that genetic differences have nothing to do with these distributions it is perhaps not surprising that 43 families have produced 73 children with IQs below 70 but it is rather surprising that they have also produced 164 children with IQs fairly well distributed over the normal range.

FAMILIAL DISTRIBUTION OF IQ VALUES

Well over 50 investigations over the past 60 years have yielded family data which are relevant to this discussion (cf. reviews by Erlenmeyer-Kimling and Jarvik 1963, and Vandenberg 1971). These studies show a close correspondence between the median correlation of IQ values and the genetic relationship between individuals. On the whole, the observations are in good agreement with a multifactorial model of inheritance but without supporting evidence this may be only superficially so. It could be argued that the correlations reflect nothing but familial similarities of environment. There are, however, two observations backed up by sufficient data which put such an explanation into difficulties. When full siblings are separated early and reared in different families the correlation between their IQs remains close to the expected 0.5. It is reduced by some 15% only. The correlation between unrelated children reared apart is practically zero. On the other hand, if unrelated children are reared together the correlation increases to about 0.25 which is considerably less than what could be expected on an environmental hypothesis.

While these observations provide strong evidence for a significant participation of genetic factors

in IQ variability they do not allow quantitative estimates of what percentages of the variation are due to genetic factors and environment, respectively. The main difficulty is that environmental factors are often not easy to identify or define and in the reviewed material they are never randomized.

IQ OBSERVATIONS OF TWINS

Twins were once thought of as easy material for the study of the interaction between heredity and environment. With the years, however, quite a number of complications have been observed. While these complications do not disqualify the twin method as a research tool, they certainly invite a more critical appraisal. MZ twinning is an anomaly by which one zygote develops into two embryos instead of one.

In this process the chromosomes may or may not be distributed so that both individuals obtain exact copies of the original genetic blueprint of the zygote. Moreover, the process may result in differences of extra nuclear material, or so called cytoplasmatic differences, the effect of which cannot be anticipated presently. Such "intrinsic" differences between MZ twins are likely to be extremely rare and therefore should not seriously distort the results.

More serious is the competition between the twins in utero. For MZ twins this competittion is greater when they share the same placenta as this is likely to result in differences in nutrition. The effect of such prenatal factors are reflected in differences in birth weight and these differences are greater between partners of MZ than of DZ twins. This becomes particularily interesting here because it is known that there is a positive correlation between birth weight and later IQ (Scarr 1969). In fact when one twin is less than 2,500 the later IQ difference may amount to as much as 13 IQ points. It is also well known that a special environment is created for MZ twin pairs, partly because they receive more similar attention than DZ pairs or ordinary siblings and partly because their genetic similarities are likely to contain a mechanism through which they are influenced to seek similar environments.

When the twin method is applied in the traditional way the first two of these groups of factors will lead to an overestimate of post natal environmental influence and the third to an overestimate of genetic factors.

Most interesting are the differences between partners of MZ pairs who have been separated early and reared apart. The existing published data on such pairs have been reviewed and reanalysed by Jensen (1970). The conclusions are based on four sets of data comprising a total of 122 pairs of MZ twins, the partners of which had been reared apart.

The analysis showed that the mean IQ of these MZ twins was slightly below the population mean which is best explained as an effect of prenatal factors. Otherwise, the IQs of the total sample of 244 individuals were typical of the distribution of intelligence in the general population. The intraclass IQ correlation, corrected for attenuation, was 0.86. The socioeconomic status of the homes in which the twins were brought up was divided into six different categories. The correlation between home conditions of the separated twin partners was 0.03 so that apparently none of the correlation between the IQs of the twins could be explained by similarities in their home environments as defined.

Through a statistical analysis based on the absolute differences between the twin partners which represent nongenetic effects and measurement errors, it could be shown that in this material the environmental effects on IQ were normally distributed. Since the IQs, i.e., the phenotypes were normally distributed, it follows that also the genotypes for IQ must be normally distributed. Based on observations on the IQ distribution in populations similar to those from which the twin samples were drawn the population standard deviation can be estimated at 15 IQ points. From this the variances of heredity, environment and test error were calculated. The result shows that 85% of the variance in IQs should be caused by genetic differences, 10% by environmental differences and 5% by test error.

Jensen's analysis does not leave much room for environmental effects on intelligence. In fact, it could be interpreted as leaving practically no room at all for what is commonly thought of as environ-

mental effects, namely socioeconomic and psychological environment. A major part of the differences in IQ between the twin partners could be explained as prenatal effects, particularily in birth weight. The analysis is formally correct but the material cannot be freed of some of the insecurities which have been mentioned previously. In particular, twins do not constitute random samples from the general population so that, e.g., the frequency of influence of birth weight on later IQ is lower in the general population than in a twin sample. Morover, it is presently not possible to decide whether or not it is justified to pool together twin data from several different countries even if no mathematical objections can be raised.

Nevertheless, Jensen's analysis represents a serious attempt to throw some light on the problem heredity, environment and IQ and it must be accepted as an informed pilot study. It is highly desirable that further comprehensive investigations on separated MZ twins be undertaken so that the results can be put to new tests.

Circumstantial evidence which was discussed earlier certainly is in favor of major genetic effects on human intelligence but it does not seem very likely that the IQ tests by some fluke unintentionally were measuring such a great deal of innate intelligence. On the other hand it must be added that those who advocate a major or exclusive psychosocial determination of intelligence have produced far less convincing evidence.

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