We have come to the end of the first series of columns on the "Development of the Cerebral Cortex." We now begin the second series, which will explore the "Genetics of Childhood Disorders." We start with 3 articles on the genetics of intelligence from 3 groups with different perspectives on the topic. It is hoped that this will make for an interesting contrast of opinions that perhaps underscores how little we truly understand in this complicated field. Subsequent columns will expand on different topics in molecular biology and, in particular, will discuss the underlying basis for a number of childhood disorders for which the molecular basis is now known. These columns will introduce the genes that are mutated and will discuss the normal function of these proteins.

P.J.L.

Genetics of Childhood Disorders: I. Genetics and Intelligence

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In 1905, Alfred Binet and Theodore Simon succeeded in creating a test that would distinguish children with behavior problems from children who were mentally retarded. The idea was to prevent children in France who had behavior problems from being consigned to the dust heap that in those days constituted the classrooms for the mentally retarded. The test proved successful in predicting academic performance beyond that of just those children at the lower end of the ability spectrum, and a variant of Binet's test, the Stanford-Binet, soon came to figure prominently in the landscape of American schooling. Eventually, the Stanford-Binet was joined by other tests, including individual measures such as the Wechsler series, and group measures such as the Otis tests.

So successful were these tests that Edward Boring, a Harvard psychologist in the 1920s, proposed that intelligence is nothing more than what tests of intelligence measure. Some might dismiss Boring's definition as trivial or circular, but it reflects a major issue here in the United States and abroad

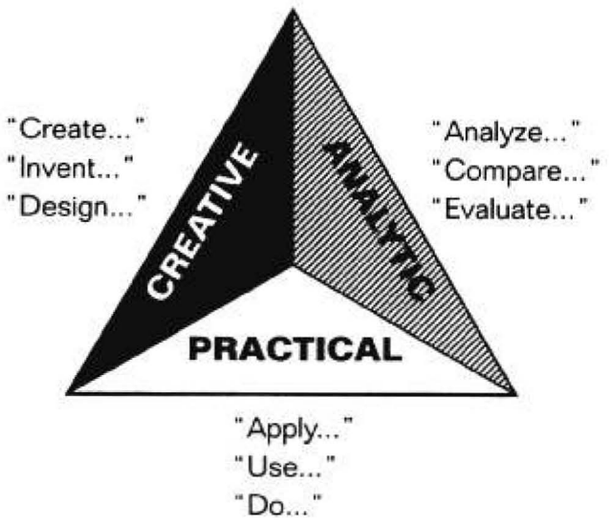

Fig. 1 The triarchic theory of intelligence. Intelligence is composed of analytic, creative, and practical abilities. In analytic thinking, we try to solve familiar problems by using strategies that manipulate the elements of a problem or the relationships among the elements. In creative thinking, we try to solve new kinds of problems that require us to think about the problem and its elements in a new way. In practical thinking, we try to solve problems by applying what we know to everyday contexts. Figure adapted from *In Search of the Human Mind*, 2nd ed, Sternberg Robert J, copyright © 1998 by Harcourt Brace & Company, reproduced by permission of the publisher.

about the nature and measurement of intelligence. To this day, many psychiatrists as well as psychologists view intelligence as essentially what the tests measure.

Increasingly solid evidence is emerging that what psychological tests measure is only a part of the entire portrait of what intelligence is. Over the next several months, aspects of the nature of intelligence and the contribution of genetic factors to intelligence will be reviewed in this column.

Investigators have studied implicit, or folk, theories of intelligence around the world. People's intuitive concepts of intelligence are much broader than the conceptions represented by the tests. A number of studies have asked lay people what they understand intelligence to be. Their responses have included factors such as practical problem-solving ability, verbal ability, and social competence. Although verbal ability is carefully measured by existing tests, social competence is generally not measured at all.

Conceptualizations of intelligence vary by ethnic group. In a study of various groups in California, for example, Latino parents emphasized social competence skills in their definitions of intelligence whereas Asian and Anglo parents emphasized cognitive competence skills. Teachers' conceptions of intelligence corresponded more to that of the Asian and Anglo parents. Not surprisingly, children in these groups did better in school, perhaps in part because of the match between their socialization and the expectations of the school.

Outside the United States, the departures from the test-based notion are even greater. In a study conducted in Taiwan, intelligence embraced not only conventional cognitive abilities, but also interpersonal competence (understanding of others), intrapersonal competence (understanding of self), intellectual self-assertion (knowing when to show one's intelligence), and intellectual self-effacement (knowing when not to show one's intelligence).

But implicit theories do not tell the whole story. Performance-based definitions of intelligence exist as well. At least 2 kinds of abilities appear to be relatively distinct from the kinds of abilities measured by conventional intelligence tests: creative abilities and practical abilities. In one series of studies on creative intellectual abilities, individuals were asked to write stories with unusual titles such as "2985," to draw artistic compositions on unusual topics such as "The earth from an insect's point of view," to create advertisements for boring products such as a brand of "bow ties," or to suggest solutions to problems such as that of how we would recognize extraterrestrial aliens among us seeking to escape detection. Performance on tasks such as these proved to be only weakly to moderately correlated with scores on conventional tests of intelligence.

There is even more evidence for the relative independence of practical intellectual abilities from IQ and related measures. Practical intellectual abilities reflect the ability to solve commonsense problems a person encounters in the world of work. In multiple studies of business managers, academic psychologists, sales people, teachers, and military leaders, scores on tests of practical intelligence do not correlate well with IQ. Nonetheless, practical intelligence predicts job performance as well as or better than IQ. In a study of children in Kenya, a test of practical intelligence involved children's using knowledge they had acquired on how to use natural herbal medicines to fight infections. In Kenya, this knowledge is highly adaptive. Significant negative correlations were found with conventional kinds of ability measures.

In another set of studies, a test for high school students was developed that measured traditional analytical abilities of the kinds found on conventional intelligence tests, but also tests of creative and practical abilities. This battery used both multiple-choice items and essay questions in the verbal, quantitative, and figural domains. Analytical, creative, and practical abilities were found to be relatively uncorrelated. The general ("g") factor so prevalent in conventional tests accounted for little of the variance in the results. Apparently, this factor appears only when the tests measure a fairly narrow range of abilities.

In summary, the evidence suggests there is more to intelligence than IQ. Creative and practical abilities matter as well as the more conventional analytical abilities. These abilities are relatively independent of analytical abilities, but they are measured minimally or not at all by conventional tests. We need to develop new, expanded tests to assess a broader range of intellectual abilities. Indeed, lack of adequate psychometric tools assessing other than g-related intellectual abilities is one of the main reasons why the conventional view of intelligence dominates the field.

The field of behavioral genetics of intelligence uses the old, g-related view of IQ. Virtually none of the new developments in the general theory of intelligence have penetrated the field. The argument here is that any instrument used in behavioral-genetic studies needs to be psychometrically solid, and there is nothing in the field that even approaches the psychometric properties of g-based tests. Correspondingly, behavioral geneticists still conceptualize the domain of cognitive abilities only as a g-championed hierarchy of abilities.

Given the absolute power of the psychometric theory of intelligence in behavioral-genetic studies of intelligence, it is not surprising that such studies support the g view of intelligence. It is remarkable, however, that since the consensus was reached a number of years ago that genetic variability explains about 50% of observed individual differences in general cognitive ability (with an upper boundary of about 80% obtained through direct estimates of heritability using relatives reared apart and a lower boundary of about 40% obtained through

indirect estimates of heritability using relatives reared together), behavioral-genetic models have not changed to accommodate the new evidence accumulated in psychological theories of intelligence.

Even though the importance of genes in the development of individual differences in IQ has been unequivocally established, these influences account for only half of the variability. Moreover, much debate was generated by the publication of *The Bell Curve,* which unequivocally supported the g view and the argument that g is subject to substantial genetic impact. It is clear that the issues of the definition of intelligence, genetic influences, and validity and reliability of modern intelligence tests remain to be discussed.

To date, behavioral-genetic research addresses exclusively the etiology of g-based abilities. Whereas other areas of psychology have appreciated the diversity of human abilities, the field of behavioral genetics remains a dedicated soldier in the g-empire. Although the findings about the heritability of g-based abilities are reliable and conclusive, g appears to be only one of the letters of the alphabet of human abilities.

WEB SITES OF INTEREST

http://www.leaderu.com/ftissues/ft9502/nathanson.html
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