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.

![Triarchic Theory of Intelligence](image_url)

*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 intelli-
gence as essentially what the tests measure.

Increasingly solid evidence is emerging that what psy-
chological 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 fac-
tors 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 repre-
sented 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, ver-
bal ability, and social competence. Although verbal ability is
carefully measured by existing tests, social competence is gen-
ernally 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 def-
initions 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 teachers.

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 abili-
ties, but also interpersonal competence (understanding of oth-
ers), intrapersonal competence (understanding of self), intel-
lectual self-assertion (knowing when to show one's intelli-
gence), 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 abil-
ities measured by conventional intelligence tests: creative abil-
ities 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 composi-
tions 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 prob-
lems 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 cor-
related with scores on conventional tests of intelligence.

There is even more evidence for the relative independence
of practical intellectual abilities from IQ and related mea-
sures. 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 per-
formance 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 knowl-
edge 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") fac-
tor 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 intelli-
gence 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 mea-
sured minimally or not at all by conventional tests. We need to
develop new, expanded tests to assess a broader range of intel-
lectual 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 domi-
nates 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 intelli-
gence. 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 cog-
nitive 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/ftissue/69/02/nathanson.html
http://serendip.brynmawr.edu/LetternYtimes.html

ADDITIONAL READINGS
Sternberg RJ (1997), Successful Intelligence. New York: Plume

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