ABILITY AND EXPERTISE

It's Time To Replace the Current Model of Intelligence

BY ROBERT J. STERNBERG

BILLY HAS an IQ of 121 on a standardized individual intelligence test, and Jimmy has an IQ of 94 on the same test. What do these scores, and the difference between them, mean? The conventional answer to this question is that they represent a kind of intellectual predestination: The two children possess inborn gifts that are relatively fixed and will, to a large extent, predict their future achievement. So no one will be surprised if Billy goes on to do well in high school and gets into a good college—or if Jimmy barely gets through school and ends up with a minimum-wage job—because that's what this familiar and widely accepted model of human intelligence would lead us to expect.

But a scientific model is just a way of fitting together pieces of information and things we have observed into a pattern that makes sense. It does not represent the certain or only way of arranging the pieces, and models can be and often are modified or even discarded when we make new discoveries or look at what we know in new ways. This happened, for example, in the early seventeenth century, when the Ptolemaic model of the solar system, in which all the heavenly bodies were said to revolve around the earth, was replaced by the Copernican, sun-centered, model of the solar system.

Many psychologists now question the simple identification of IQ with ability, which the old model of human intelligence posits. They believe that abilities are too broad and too complex to be measured by the kind of IQ test that Billy and Jimmy took. They also believe that environment and genetics play a part and, furthermore, that abilities are not a fixed quantity: They can be modified by education and experience. I'd like to propose a further, and important, building block for this new model of human intelligence—namely that the difference in Billy's and Jimmy's IQ scores simply means that the two children are at a different stage in developing the expertise measured by the IQ test. Furthermore, I suggest that people who study abilities and those who study expertise are really talking about the same thing. What we are measuring when we administer a Wechsler Intelligence Scale for Children (WISC) or an Iowa Test of Basic Skills (ITBS) or an SAT are the same. They are not different in kind but only in the point at which we are measuring them.

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In the Eye of the Beholder

When we give an achievement test, we accept the idea that we are testing a form of expertise, but this is equally true when we administer an IQ test. What differs is the level of expertise we measure and, probably more important, the way we perceive what we are measuring. The familiar IQ/ability model creates a certain expectation: that one kind of accomplishment (IQ test scores) will predict—and, in fact, lead to—another kind of accomplishment (grades or scores on achievement tests). And of course we also use different words to describe the two kinds of accomplishment.

But this way of looking at the two kinds of test scores is a familiar convenience rather than a psychological reality. Solving problems on a verbal-analogies test or a test of mathematical problem solving, which are supposed to test a child's abilities, calls for expertise just the way so-called achievement tests do: You can't do well on these so-called tests of ability without knowing the vocabulary or having some familiarity with problem-solving techniques. The chief difference between ability and achievement tests is not what they measure but the point at which they measure it. IQ and other tests of ability are, typically, administered early in a child's school career, whereas various indications about school performance, such as grades or achievement test scores, are collected later. However, all of the various kinds of assessments are of the same kind, psychologically. They all test—to some extent—what you know and how well you can use it. What distinguishes ability tests from the other kinds of assessments is how the ability tests are used (usually, predictively), rather than what they measure. There is no qualitative distinction.

But if the distinction between what these tests measure does not exist, how do we come to make it? The

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answer is a complicated story, but the principal reason is historical accident. Briefly, the two kinds of testing were developed separately and used on different groups of people. IQ/ability testing, which originated in Alfred Binet's testing of young children, focused on exceptionally low levels of performance and came to be viewed primarily as predictive. Early studies of expertise were done with adults. They focused on exceptionally high levels of performance and came to be viewed as measures of achievement.

The Traditional Model

According to the traditional model of fixed individual differences, the capabilities that a child inherits interact with the child's environment to produce, at an early age, a relatively fixed potential for achievement. Children fulfill this potential to a greater or lesser degree. Thus, if a child who scores well on ability tests does well in school, we say he is living up to his potential. If, as sometimes happens, his achievement does not match his test scores, we call him an *underachiever*—or if the kid confounds expectations by working hard and doing well, he gets the label of *overachiever.* Ironically, ability test scores are considered a better indicator of what a child can achieve (or should achieve) than what the child actually does. A test of verbal analogies, in this view, might actually tell us more about a person's verbal abilities than the person's comprehension of the reading he or she does in everyday life; or a test of mathematical problem-solving skills might be viewed as more informative than the mathematical problem solving the person does on the job.

According to this model, the more intelligent students (that is, the ones with higher IQs) do better in school. As a result, they are likely to attend selective colleges, go on to professional schools, and eventually get well-paying jobs and enjoy other forms of success. The less intelligent do worse in school and may drop out. At best, they probably have to be satisfied with low-status credentials that reflect hard work rather than ability, and their role in the labor market is to fill the jobs that the more intelligent people don't want to do.

This is the view Richard Herrnstein and Charles Murray present in *The Bell Curve* (1994), and as people who have read the book will remember, it assigns African Americans as a group to the status of an underclass, based on the average "potential" of group members displayed in IQ and other ability tests. Herrnstein and Murray's use of the traditional model has occasioned a great deal of controversy. However, the view of IQ as fixed and determinant is, unfortunately, consistent with many current educational practices and common views about intellectual competence.

Developing Expertise

The idea that abilities are a form of developing expertise offers a more flexible and optimistic view of human capabilities, and one that is more in line with what we are discovering about human intelligence. Children become experts in the skills needed for success on ability tests in much the same ways that they become experts in doing anything else—through a combination of genetic endowment and experience (Ericsson, 1996). To do well on a test, a child needs to acquire, store, and learn how to use at least two kinds of knowledge: explicit knowledge of a domain and implicit or tacit knowledge of a field. Knowledge of a domain is subject-matter knowledge: In American history, for example, it would be the facts, trends, and major ideas about the political, economic, and social development of our country. Implicit knowledge is the kind of knowledge one needs to be successful in a field but which is not part of the subject matter and often is not even talked about. For example, in American history, the role of the Federalist Papers in the shaping of the U.S. Constitution would be explicit knowledge; how to use the library or Internet to research an essay about the Federalist Papers and how to take and organize notes and carry the paper through successive drafts to completion would be implicit knowledge.

Tests measure both explicit and implicit knowledge: knowledge of the subject matter and knowledge about how to take a test. This is as true of ability tests as it is of achievement tests. A verbal-analogies test, for example, measures explicit knowledge of vocabulary and a student's ability to reason with this knowledge, but the test also measures implicit knowledge of how to take a test. Thus, the student has to work within certain time limits and choose the best answer from a list of answers no one of which is exactly right.

To translate the gaining of expertise on test-taking into procedural terms, students need

- direct instruction in how to solve test-like problems—usually this takes place in school;
- practice in solving such problems, again usually in academic contexts;
- an opportunity to watch others, such as teachers or other students, solve test-like problems;
- practice thinking about such problems, sometimes mentally simulating what to do when confronting them;
- rewards for successful solutions (good grades, praise from teachers, other kinds of recognition), thereby reinforcing such behavior.

The difference between Billy's score of 121 and Jimmy's 94 also reflects a number of personal and cultural factors, and they do not all pertain to what we usually consider expertise. For example, the two boys may possess different degrees of "test-wiseness," that is, understanding the tricks of taking tests (Millman, Bishop, and Ebel, 1965; Bond and Harman, 1994). They may feel differing levels of anxiety and/or alertness on the day they are tested, and this would probably show itself in their scores. Cultural differences between them may lead to different attitudes about the importance of doing well on a test, particularly one that clearly does not "count." Most important of all, the boys may be at different levels of developing expertise in the skills that the test measures.

Individual Differences

But saying that IQ tests and other assessments of ability are testing the same thing as achievement tests and

that the expertise revealed is not fixed should not be taken to mean that everybody has the same intellectual capacity. The difference in expertise that Billy and Jimmy reveal on their IQ tests may indicate an underlying difference in their capacities. However, IQ tests do not directly measure these differences and neither do any of the other ways in which we currently seek to measure ability (see, for example, Vygotsky, 1978). Individual differences in developing expertise result in much the same way as in most kinds of learning: from (a) the rate of learning (which can be caused by the amount of direct instruction received, the amount of problem solving done, the amount of time and effort spent in thinking about problems, and so on); and from (b) the asymptote of learning—that is, the limit set by ability to what a student can ultimately achieve, given unlimited training. This limit, or asymptote, can be caused by differences in numbers of schemas—the networks of information on various subjects stored in our memories—the organization of schemas, efficiency in using schemas, and so on (see Atkinson, Bower, and Crothers, 1965). For example, children can learn how to solve the various kinds of mathematical problems found in tests of mathematical abilities, whether through regular schooling, a special course, or through assimilation of everyday experience. When they learn, they will learn at different rates, and reach different asymptotes. Ultimately the differences represent genetic and environmental factors that are interacting in ways that we cannot now measure.

Various Kinds of Expertise

As I've already noted, the so-called ability tests typically come earlier in a student's school career than the various types of achievement tests, but what IQ tests measure is not psychologically prior. Achievement tests might just as well be used to predict scores on ability tests—and sometimes they are, as for instance, when school officials try to predict a student's college admissions test scores on the basis of the student's grades. When we look at the test of abilities as though they are psychologically prior, we are confusing the order in which students usually take these tests with some kind of psychological ordering. But in fact, our temporal ordering implies no psychological ordering at all. The recent change in the meaning of the acronym *SAT* (from Scholastic Aptitude Test to Scholastic Assessment Test) reflects the recognition that what was called an aptitude test measures more than just "aptitude"—indeed, it hints at the interchangeability of the two kinds of tests. Nevertheless, the SAT is still widely used as an ability test, and the SAT-II, which more directly measures subject-matter knowledge, as a set of achievement tests.

Tests that claim to measure ability through questions employing vocabulary, reading comprehension, verbal analogies, arithmetic problem solving, and the like are all, in part, tests of achievement. Even abstract-reasoning tests measure achievement in dealing with geometric symbols, which is a skill taught in Western schools (Laboratory of Comparative Human Cognition, 1982). Indeed, if we examine the content of ability tests, it is clear that they measure achievement that the students taking the test should have accomplished several years back. We could just as well use academic performance to predict ability-test scores. The problem with the traditional model is not that it proposes a correlation between ability tests and other forms of achievement. That undoubtedly exists. It is rather the traditional model's proposing that the capacities measured by the tests *cause* later success—or failure—instead of merely preceding it.

An Illusion of Causality

The notion that success on ability tests predicts success in many other areas gains credibility from the fact that some of the skills or qualities that make people more expert at taking tests are also likely to make them successful in other aspects of life in our culture. Taking a test, say, of verbal or figural analogies, or of mathematical problem solving, typically requires skills such as (a) puzzling out what someone else wants (here, the person who wrote the test), (b) command of English vocabulary, (c) reading comprehension, (d) allocation of limited time, (e) sustained concentration, (f) abstract reasoning, (g) quick thinking, (h) symbol manipulation, and (i) suppression of anxiety and other emotions that can interfere with test performance. These skills are also part of what is required for successful performance in school and in many kinds of job performance. Thus, an expert test-taker is likely also to have skills that will be involved in other kinds of expertise as well, such as expertise in getting high grades in school.

To the extent that the expertise required for one kind of performance overlaps with the expertise required for another kind of performance, there will be a correlation between performances. However, the expertise that ability tests measure is not the cause of school or job expertise; it is itself an expertise that overlaps with school or job expertise. Differences in test scores, academic performance, and job performance are all effects of different levels of expertise.

The New Model

The notion of *developing* expertise means that people are constantly in the process of developing expertise when they work within a given domain. Individuals can differ in rate and asymptote of development. However, the main constraint in achieving expertise is not some fixed prior level of capacity, of the kind measured by IQ tests. It is the degree to which students are purposefully engaged in working and teachers in helping them. This involves direct instruction, active participation, role modeling, and reward.

The model of developing expertise has five key elements: metacognitive skills, learning skills, thinking skills, knowledge, and motivation. The elements all influence one another, both directly and indirectly. For example, learning leads to knowledge, but knowledge facilitates further learning.

1. *Metacognitive skills.* Metacognitive skills refer to students' understanding and control of their own learning. These skills would include what a student

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