Multiple Intelligences in the New Age of Thinking

16

Robert J. Sternberg

In this chapter, I describe two theories that involve the idea of "multiple intelligences." The first is the theory of multiple intelligence (MI theory—Gardner 1983, 1993, 2006). The second is the theory of successful intelligence (Sternberg 1997, 2003, 2005, 2009, 2010).

Multiple Intelligences Theory

Howard Gardner (1983, 1993, 2006) has proposed a theory of multiple intelligences, according to which intelligence comprises multiple independent constructs, not just a single, unitary construct. However, instead of speaking of multiple abilities that together constitute intelligence (e.g., Thurstone 1938), this theory distinguishes eight distinct intelligences that are relatively independent of each other.

The multiple intelligences are linguistic intelligence, used to read, write, speak, and listen to speech; logical-mathematical intelligence, used to solve mathematical and logical problems; spatial intelligence, used to imagine how objects would look if they were rotated or otherwise displaced in space; musical intelligence, used to compose, play, and appreciate music; bodily-kinesthetic intelligence, used to coordinate oneself and to participate successfully in athletics; interpersonal intelligence, used to understand other people; intrapersonal intelligence, used to understand oneself; and naturalist intelligence, used to understand the natural world.

Each intelligence is a separate system of functioning, although these systems can interact to produce what we see as intelligent performance. Looking at Gardner's list of intelligences, you might want to evaluate your own intelligences, perhaps rank ordering your strengths in each.

In some respects, Gardner's theory sounds like a factorial one. It specifies several abilities that are construed to reflect intelligence of some sort. However, Gardner views each ability as a separate intelligence, not just as a part of a single whole. Moreover, a crucial difference between Gardner's theory and factorial ones is in the sources of evidence Gardner used for identifying the eight intelligences. Gardner used converging operations, gathering evidence from multiple sources and types of data.

In particular, the theory uses eight "signs" as criteria for detecting the existence of a discrete kind of intelligence (Gardner 1983, pp. 63–67):

1. Potential isolation by brain damage. The destruction or sparing of a discrete area of the brain (e.g., areas linked to verbal aphasia) may destroy or spare a particular kind of intelligent behavior.

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2. The existence of exceptional individuals (e.g., musical or mathematical prodigies). They demonstrate extraordinary ability (or deficit) in a particular kind of intelligent behavior.
3. An identifiable core operation or set of operations (e.g., detection of relationships among musical tones). It is essential to performance of a particular kind of intelligent behavior.
4. A distinctive developmental history leading from novice to master. It is accompanied by disparate levels of expert performance (i.e., varying degrees of expressing this type of intelligence).
5. A distinctive evolutionary history. Increases in intelligence plausibly may be associated with enhanced adaptation to the environment.
6. Supportive evidence from cognitive-experimental research. An example would be task-specific performance differences across discrete kinds of intelligence (e.g., visuospatial tasks versus verbal tasks). They would need to be accompanied by cross-task performance similarities within discrete kinds of intelligence (e.g., mental rotation of visuospatial imagery and recall memory of visuospatial images).
7. Supportive evidence from psychometric tests indicating discrete intelligences (e.g., differing performance on tests of visuospatial abilities versus on tests of linguistic abilities).
8. Susceptibility to encoding in a symbol system (e.g., language, math, musical notation) or in a culturally devised arena (e.g., dance, athletics, theater, engineering, or surgery as culturally devised expressions of bodily-kinesthetic intelligence).

Gardner does not dismiss entirely the use of psychometric tests. But the base of evidence used by Gardner does not rely on the factor analysis of various psychometric tests alone. In thinking about your own intelligences, how fully integrated do you believe them to be? How much do you perceive each type of intelligence as depending on any of the others?

Gardner's view of the mind is modular. Modularity theorists believe that different abilities—such as Gardner's intelligences—can be isolated as emanating from distinct portions or modules of the brain. Thus, a major task of existing and future research on intelligence is to isolate the portions of the brain responsible for each of the intelligences. Gardner has speculated as to at least some of these locales. But hard evidence for the existence of these separate intelligences has yet to be produced. Furthermore, there is no real evidence for the strict modularity of Gardner's theory. Consider the phenomenon of preserved specific cognitive functioning in autistic savants. Savants are people with severe social and cognitive deficits but with corresponding high ability in a narrow domain. They suggest that such preservation fails as evidence for modular intelligences. The narrow long-term memory and specific aptitudes of savants may not really be intelligent. Thus, there may be reason to question the intelligence of inflexible modules.

I do not detail this theory further because there has been no empirical evidence collected since MI theory was proposed that validates the theory as a whole and the one extensive study that has been done yielded results inconsistent with it (Visser et al. 2006).

The Triarchic Theory of Successful Intelligence

The Nature of Intelligence

There are many definitions of intelligence, although intelligence is typically defined in terms of a person's ability to adapt to the environment and to learn from experience (Inteligence and its Measurement: A Symposium, 1921; Sternberg and Detterman 1986). The definition of intelligence here is somewhat more elaborate and is based on my (Sternberg 1984, 1997, 1998, 1999b, 2000, 2003) theory of successful intelligence. According to this definition, (successful) intelligence is (1) the ability to achieve one's goals in life, given one's sociocultural context; (2) by capitalizing on strengths and correcting or compensating for weaknesses; (3) in order to adapt to, shape, and select environments; (4) through a combination of analytical, creative, and practical abilities. In recent years, I have emphasized that intelligence best serves individuals and societies when it is augmented by wisdom (Sternberg 2003, 2008).

According to the proposed theory of human intelligence and its development (Sternberg 1997, 1999a, 2003, 2004, 2009), a common set

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According to the proposed theory of human intelligence and its development (Sternberg 1997, 1999a, 2003, 2004, 2009), a common set of processes underlies all aspects of intelligence. These processes are hypothesized to be universal. For example, although the solutions to problems that are considered intelligent in one culture may be different from the solutions considered to be intelligent in another culture, the need to define problems and translate strategies to solve these problems exists in any culture. Even within cultures, there may be differences in what different groups mean by intelligence (Okagaki and Sternberg 1993; Sternberg 1985b).

Metacomponents, or executive processes, plan what to do, monitor things as they are being done, and evaluate things after they are done. Examples of metacomponents are recognizing the existence of a problem, defining the nature of the problem, deciding on a strategy for solving the problem, monitoring the solution of the problem, and evaluating the solution after the problem is solved.

Performance components execute the instructions of the metacomponents. For example, inference is used to decide how two stimuli are related and application is used to apply what one has inferred (Sternberg 1977). Other examples of performance components are comparison of stimuli, justification of a given response as adequate although not ideal, and actually making the response.

Knowledge-acquisition components are used to learn how to solve problems or simply to acquire declarative knowledge in the first place (Sternberg 1985a). Selective encoding is used to decide what information is relevant in the context of one's learning. Selective comparison is used to bring old information to bear on new problems. And selective combination is used to put together the selectively encoded and compared information into a single and sometimes insightful solution to a problem.

Although the same processes are used for all three aspects of intelligence universally, these processes are applied to different kinds of tasks and situations depending on whether a given problem requires analytical thinking, creative thinking, practical thinking, or a combination of these kinds of thinking. In particular, analytical thinking is invoked when components are applied to fairly familiar kinds of problems abstracted from everyday life. Creative thinking is invoked when the components are applied to relatively novel kinds of tasks or situations. Practical thinking is invoked when the components are applied to experience to adapt to, shape, and select environments. One needs creative skills and dispositions to generate ideas, analytical skills and dispositions to decide if they are good ideas, and practical skills and dispositions to implement one's ideas and to convince others of their worth.

Because the theory of successful intelligence comprises three subtheories—a componential subtheory dealing with the components of intelligence, an experiential subtheory dealing with the importance of coping with relative novelty and of automatization of information processing, and a contextual subtheory dealing with processes of adaptation, shaping, and selection—the theory has been referred to from time to time as *triarchic*.

Intelligence is not, as Edwin Boring (1923) once suggested, merely what intelligence tests test. Intelligence tests and other tests of cognitive and academic skills measure part of the range of intellectual skills. They do not measure the whole range. One should not conclude that a person who does not test well is not smart. Rather, one should merely look at test scores as one indicator among many of a person's intellectual skills. Moreover, the kinds of skills posited by hierarchical theories (e.g., Carroll 1993; Cattell 1971; Vernon 1971) are viewed only as a subset of the skills important in a broader conception of intelligence.

The Assessment of Successful Intelligence

Our assessments of intelligence have been organized around the analytical, creative, and practical aspects of it. We discuss those assessments here, singly and collectively.

Analytical Intelligence

Analytical intelligence is involved when the information-processing components of intelligence are applied to analyze, evaluate, judge, or compare and contrast. It typically is involved when components are applied to relatively familiar kinds of problems where the judgments to be made are of a fairly abstract nature.

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In some early work, it was shown how analytical kinds of problems, such as analogies or syllogisms, can be analyzed componentially (Guyote and Sternberg 1981; Sternberg 1977, 1980b, 1983; Sternberg and Gardner 1983), with response times or error rates decomposed to yield their underlying information-processing components. The goal of this research was to understand the information-processing origins of individual differences in (the analytical aspect of) human intelligence. With componential analysis, one could specify sources of individual differences underlying a factor score such as that for "inductive reasoning." For example, response times on analogies (Sternberg 1977) and linear syllogisms (Sternberg 1980a) were decomposed into their elementary performance components. The general strategy of such research is to (a) specify an information-processing model of task performance; (b) propose a parameterization of this model, so that each information-processing component is assigned a mathematical parameter corresponding to its latency (and another corresponding to its error rate); and (c) construct cognitive tasks administered in such a way that it is possible through mathematical modeling to isolate the parameters of the mathematical model. In this way, it is possible to specify, in the solving of various kinds of problems, several sources of important individual or developmental differences: (1) What performance components are used? (2) How long does it take to execute each component? (3) How susceptible is each component to error? (4) How are the components combined into strategies? (5) What are the mental representations upon which the components act?

Research on the components of human intelligence yielded some interesting results. Consider some examples. First, execution of early components (e.g., inference and mapping) tends exhaustively to consider the attributes of the stimuli, whereas execution of later components (e.g., application) tends to consider the attributes of the stimuli in self-terminating fashion, with only those attributes processed that are essential for reaching a solution (Sternberg 1977). Second, in a study of the development of figural analogical reasoning, it was found that although children generally became quicker in information processing with age, not all components were executed more rapidly with age (Sternberg and Rifkin 1979). The encoding component first showed a decrease in component time with age and then an increase. Apparently, older children realized that their best strategy was to spend more time in encoding the terms of a problem so that they later would be able to spend less time in operating on these encodings. A related, third finding was that better reasoners tend to spend relatively more time than do poorer reasoners in global, up-front metacomponential planning, when they solve difficult reasoning problems. Poorer reasoners, on the other hand, tend to spend relatively more time in local planning (Sternberg 1981). Presumably, the better reasoners recognize that it is better to invest more time up front so as to be able to process a problem more efficiently later on. Fourth, it also was found in verbal analogical reasoning that as children grew older, their strategies shifted so that they relied on word association less and abstract relations more (Sternberg and Nigro 1980).

In the componential analysis work described above, correlations were computed between component scores of individuals and scores on tests of different kinds of psychometric abilities. First, in the studies of inductive reasoning (Sternberg 1977; Sternberg and Gardner 1983), it was found that although inference, mapping, application, comparison, and justification tended to correlate with such tests, the highest correlation typically was with the preparation-response component. This result was puzzling at first, because this component was estimated as the regression constant in the predictive regression equation. This result ended up giving birth to the concept of the metacomponents: higher-order processes used to plan, monitor, and evaluate task performance. Second, it was also found that the correlations obtained for all the components showed convergent-discriminant validation: They tended to be significant with psychometric tests of reasoning but not with psychometric tests of perceptual speed (Sternberg 1977; Sternberg and Gardner 1983). Third, significant correlations with vocabulary tended to be obtained only for encoding of verbal stimuli (Sternberg 1977; Sternberg and Gardner 1983). Fourth, it was found in studies of linear-syllogistic reasoning (e.g., *John is taller than Mary; Mary is taller than Susan; who is tallest?*) that components of the proposed (mixed linguistic-spatial) model that were supposed to correlate with verbal ability did so and did not correlate with spatial ability; components that were supposed to correlate with spatial ability did so and did not correlate with verbal ability. In other words, it was possible successfully to validate the proposed model of linear-syllogistic reasoning not only in terms of the fit of response-time or error data to the predictions of the alternative models but also in terms of the correlations of component scores with psychometric tests of verbal and spatial abilities (Sternberg 1980a). Fifth and finally, it was found that there were individual differences in strategies in solving linear syllogisms, whereby some people used a largely linguistic model, others a largely spatial model, and most the proposed linguistic-spatial mixed model. Thus, sometimes, less than perfect fit of a proposed model to group data may reflect individual differences in strategies among participants.

Creative Intelligence

Intelligence tests contain a range of problems, some of them more novel than others. In some of the componential work, we have shown that when one goes beyond the range of unconventionality of the conventional tests of intelligence, one starts to tap sources of individual differences measured little or not at all by the tests. According to the theory of successful intelligence, (creative) intelligence is particularly well measured by problems assessing how well an individual can cope with relative novelty (see Sternberg et al. 2002).

We presented 80 individuals with novel kinds of reasoning problems that had a single best answer. For example, they might be told that some objects are green and others blue; but still other objects might be grue, meaning green until the year 2000 and blue thereafter, or bleen, meaning blue until the year 2000 and green thereafter. Or they might be told of four kinds of people on the planet Kyron, blens, who are born young and die young; kwefs, who are born old and die old; balts, who are born young and die old; and prosses, who are born old and die young (Sternberg 1982; Tetewsky and Sternberg 1986). Their task was to predict future states from past states, given incomplete information. In another set of studies, 60 people were given more conventional kinds of inductive reasoning problems, such as analogies, series completions, and classifications, but were told to solve them. But the problems had premises preceding them that were either conventional (dancers wear shoes) or novel (dancers eat shoes). The participants had to solve the problems as though the counterfactuals were true (Sternberg and Gastel 1989a, b).

In these studies, we found that correlations with conventional kinds of tests depended on how novel or non-entrenched the conventional tests were. The more novel are the items, the higher are the correlations of our tests with scores on successively more novel conventional tests. Thus, the components isolated for relatively novel items would tend to correlate more highly with more unusual tests of fluid abilities (e.g., that of Cattell and Cattell 1973) than with tests of crystallized abilities. We also found that when response times on the relatively novel problems were componentially analyzed, some components better measured the creative aspect of intelligence than did others. For example, in the "grue-bleen" task mentioned above, the information-processing component requiring people to switch from conventional green-blue thinking to grue-bleen thinking and then back to green-blue thinking again was a particularly good measure of the ability to cope with novelty.

In our original work with divergent reasoning problems having no one best answer, we asked 63 people to create various kinds of products (Lubart and Sternberg 1995; Sternberg and Lubart 1991, 1995, 1996) where an infinite variety of responses were possible. Individuals were asked to create products in the realms of writing, art, advertising, and science. In writing, they were asked to write very short stories for which we would give them a choice of titles, such as "Beyond the Edge" or

"The Octopus's Sneakers." In art, the participants were asked to produce art compositions with titles such as "The Beginning of Time" or "Earth from an Insect's Point of View." In advertising, they were asked to produce advertisements for products such as a brand of bow tie or a brand of doorknob. In science, they were asked to solve problems such as one asking them how people might detect extraterrestrial aliens among us who are seeking to escape detection. Participants created two products in each domain.

First, we found that creativity comprises the components proposed by their investment model of creativity: intelligence, knowledge, thinking styles, personality, and motivation. Second, we found that creativity is relatively although not wholly domain-specific. Correlations of ratings of the creative quality of the products across domains were lower than correlations of ratings and generally were at about the .4 level. Thus, there was some degree of relation across domains at the same time that there was plenty of room for someone to be strong in one or more domains but not in others. Third, we found a range of correlations of measures of creative performance with conventional tests of abilities. As was the case for the correlations obtained with convergent problems, correlations were higher to the extent that problems on the conventional tests were nonentrenched. For example, correlations were higher with fluid than with crystallized ability tests, and correlations were higher, the more novel the fluid test was. These results suggest that tests of creative intelligence have some overlap with conventional tests (e.g., in requiring verbal skills or the ability to analyze one's own ideas—Sternberg and Lubart 1995) but also tap skills beyond those measured even by relatively novel kinds of items on the conventional tests of intelligence.

Practical Intelligence

Practical intelligence involves individuals applying their abilities to the kinds of problems that confront them in daily life, such as on the job or in the home. Practical intelligence involves applying the components of intelligence to experience so as to (a) adapt to, (b) shape, and (c) select environments. People differ in their balance of adaptation, shaping, and selection and in the competence with which they balance among the three possible courses of action.

Much of our work on practical intelligence has centered on the concept of tacit knowledge. We have defined this construct as what one needs to know in order to work effectively in an environment that one is not explicitly taught and that often is not even verbalized (Sternberg et al. 2000; Sternberg and Hedlund 2002; Sternberg and Wagner 1993; Sternberg et al. 1993; Sternberg et al. 1995; Wagner 1987; Wagner and Sternberg 1986; Williams et al. 2002). We represent tacit knowledge in the form of production systems or sequences of "if-then" statements that describe procedures one follows in various kinds of everyday situations.

We typically have measured tacit knowledge using work-related problems that present problems one might encounter on the job. We have measured tacit knowledge for both children and adults, and among adults, for people in over two-dozen occupations, such as management, sales, academia, teaching, school administration, secretarial work, and the military. In a typical tacit-knowledge problem, people are asked to read a story about a problem someone faces and to rate, for each statement in a set of statements, how adequate a solution the statement represents.

In the tacit-knowledge studies, first we have found that practical intelligence as embodied in tacit knowledge increases with experience, but it is profiting from experience, rather than experience per se, that results in increases in scores. Some people could have been in a job for years and still have acquired relatively little tacit knowledge. Second, we also have found that subscores on tests of tacit knowledge—such as for managing oneself, managing others, and managing tasks—correlate significantly with each other. Third, scores on various tests of tacit knowledge, such as for academics and managers, are also correlated fairly substantially (at about the .5 level) with each other. Thus, fourth, tests of tacit knowledge may yield a general factor across these tests.

However, fifth, scores on tacit-knowledge tests do not correlate with scores on conventional tests of intelligence, whether the measures used are single-score measures of multiple-ability batteries. Thus, any general factor from the tacit-knowledge tests is not the same as any general factor from tests of academic abilities (suggesting that neither kind of *g* factor is truly general but rather general only across a limited range of measuring instruments). Sixth, despite the lack of correlation of practical-intellectual with conventional measures, the scores on tacit-knowledge tests predict performance on the job as well as or better than do conventional psychometric intelligence tests. Seventh, in one study done at the Center for Creative Leadership, we further found that scores on our tests of tacit knowledge for management were the best single predictor of performance on a managerial simulation. In a hierarchical regression, scores on conventional tests of intelligence, personality, styles, and interpersonal orientation were entered first and scores on the test of tacit knowledge were entered last. Scores on the test of tacit knowledge were the single best predictor of managerial simulation score. Moreover, these scores also contributed significantly to the prediction even after everything else was entered first into the equation.

Eighth, in work on military leadership (Hedlund et al. 2003; Sternberg and Hedlund 2002; Sternberg et al. 2000), it was found that scores of 562 participants on tests of tacit knowledge for military leadership predicted ratings of leadership effectiveness, whereas scores on a conventional test of intelligence and on a tacit-knowledge test for managers did not significantly predict the ratings of effectiveness. In work with Eskimos (Grigorenko et al. 2004), it was found that low achievers in school can have exceptionally high practical adaptive skills at home.

Even stronger results have been obtained overseas. In a study in Usenge, Kenya, near the town of Kisumu, we were interested in school-age children's ability to adapt to their indigenous environment. We devised a test of practical intelligence for adaptation to the environment (see Sternberg and Grigorenko 1997; Sternberg, Nokes et al. 2001b; and Sternberg 2004, 2007 for more examples of cultural work relevant to the theory). The test of practical intelligence measured children's informal tacit knowledge for natural herbal medicines that the villagers believe can be used to fight various types of infections.

We found no correlation between the test of indigenous tacit knowledge and scores on the fluid-ability tests. But to our surprise, we found statistically significant correlations of the tacit-knowledge tests with the tests of crystallized abilities. The correlations, however, were *negative.* In other words, the higher the children scored on the test of tacit knowledge, the lower they scored, on average, on the tests of crystallized abilities.

We have considered each of the aspects of intelligence separately. How do they fare when they are assessed together?

All Three Aspects of Intelligence Together

Internal Validity Studies Several separate factor-analytic studies support the internal validity of the theory of successful intelligence.

In one study (Sternberg et al. 1999), we used the so-called Sternberg Triarchic Abilities Test (STAT—Sternberg 1993) to investigate the internal validity of the theory. Three hundred twenty-six high-school students, primarily from diverse parts of the United States, took the test, which comprised 12 subtests in all. There were four subtests each measuring analytical, creative, and practical abilities. For each type of ability, there were three multiple-choice tests and one essay test. The multiple-choice tests, in turn, involved, respectively, verbal, quantitative, and figural content.

Confirmatory factor analysis on the data was supportive of the triarchic theory of human intelligence, yielding separate and uncorrelated analytical, creative, and practical factors. The lack of correlation was due to the inclusion of essay as well as multiple-choice subtests. Although multiple-choice tests tended to correlate substantially with multiple-choice tests, their correlations with essay tests were much weaker. The multiple-choice analytical subtest loaded most highly on the analytical factor, but the essay creative and practical subtests loaded most highly on their respective factors. Thus, measurement of creative and practical abilities probably ideally should be accomplished with other kinds of testing instruments that complement multiple-choice instruments.

External Validity Studies We have also looked at the external validity of tests assessing successful intelligence.

The Rainbow Project In a study supported by the College Board (Sternberg and the Rainbow Project Collaborators 2006), we used an expanded set of tests on 1,015 students at 15 different institutions (13 colleges and 2 high schools). Our goal was not to replace the SAT but to devise tests that would supplement the SAT, measuring skills that this test does not measure. In addition to the multiple-choice STAT tests described earlier, we used 3 additional measures of creative skills and 3 of practical skills:

Creative Skills The three additional tests were captioning cartoons, writing creative short stories using two of a number of suggested titles, and orally telling creative stories based on a picture.

Practical Skills The three additional tests were everyday situational judgments based on movie scenarios, a common-sense questionnaire based on problems found in work life, and a common-sense questionnaire based on problems confronted in school.

We found that our tests significantly and substantially improved upon the validity of the SAT for predicting first-year college grades (Sternberg and the Rainbow Project Collaborators 2006). The test also improved equity: using the test to admit a class would result in greater ethnic diversity than would using just the SAT or just the SAT and grade-point average.

The Kaleidoscope Project The Kaleidoscope Project (Sternberg 2005, 2010; Sternberg et al. 2012) has been used over the past 5 years to admit undergraduate students to Tufts University. Each year, all 15,000+ applicants are given a selection of essays assessing analytical, creative, practical, and also wisdom-based skills. The applicants have the option of completing one of the essays, and then the analytical, creative, practical, and wisdom-based skills demonstrated through these essays and other aspects of the application are rated.

The exact Kaleidoscope prompts vary from year to year (see Sternberg 2010 for a complete list through 2009). The questions differ in the skills they emphasize. No question is a "pure" measure of any single component of successful intelligence. Scoring of the exercises is holistic and is completed by admissions officers using rubrics with which they were provided by the Center for the Psychology of Abilities, Competencies, and Expertise at Tufts (PACE Center). We have found that with training, admissions officers can achieve good inter-rater reliability (consistency) in their evaluations.

The results at Tufts illustrated that a highly selective college can introduce an "unconventional" exercise into its undergraduate admissions process without disrupting the quality of the entering class. It is important to underscore the point that academic achievement has always been and remains the most important dimension of Tufts' undergraduate admissions process. Since we introduced the Kaleidoscope pilot in 2006, applications have remained roughly steady or increased slightly, and the mean SAT scores of accepted and enrolling students increased to new highs. In addition, we have not detected statistically meaningful ethnic group differences on the Kaleidoscope measures. Controlling for the academic rating given to applicants by admissions officers (which combines information from the transcript and standardized tests), students rated for Kaleidoscope achieved significantly higher academic averages in their undergraduate work than students who were not so rated by the admissions staff. In addition, research found that students with higher Kaleidoscope ratings were more involved in, and reported getting more out of, extracurricular, active-citizenship and leadership activities in their first year at Tufts.

In sum, as Tufts seeks to identify and develop new leaders for a changing world, Kaleidoscope provides a vehicle to help identify the potential leaders who may be best positioned to make a positive and meaningful difference to the world in the future. In the fast-paced, data-driven atmosphere of highly competitive college admissions, Kaleidoscope validates the role of qualitative measures of student ability and excellence.

Instruction for Successful Intelligence

Instructional studies are a further means of testing the theory (Sternberg & Grigorenko 2007; Sternberg et al. 2001a, 2008, 2009).

Several sets of studies investigated instruction for academic skills. Four sets are briefly described here.

In a first set of studies, researchers explored the question of whether conventional education in school systematically discriminates against children with creative and practical strengths (Sternberg and Clinkenbeard 1995; Sternberg et al. 1996, 1999). Motivating this work was the belief that the systems in most schools strongly tend to favor children with strengths in memory and analytical abilities.

The investigators used the Sternberg Triarchic Abilities Test in some of their instructional work. The test was administered to 326 children around the United States and in some other countries who were identified by their schools as gifted by any standard whatsoever. Children were selected for a summer program in (college-level) psychology if they fell into one of five ability groupings: high analytical, high creative, high practical, high balanced (high in all three abilities), or low balanced (low in all three abilities). Students who came to Yale were then divided into four instructional groups. Students in all four instructional groups used the same introductory-psychology textbook (a preliminary version of Sternberg (1995)) and listened to the same psychology lectures. What differed among them was the type of afternoon discussion section to which they were assigned. They were assigned to an instructional condition that emphasized either memory, analytical, creative, or practical instruction. For example, in the memory condition, they might be asked to describe the main tenets of a major theory of depression. In the analytical condition, they might be asked to compare and contrast two theories of depression. In the creative condition, they might be asked to formulate their own theory of depression. In the practical condition, they might be asked how they could use what they had learned about depression to help a friend who was depressed.

Students in all four instructional conditions were evaluated in terms of their performance on homework, a midterm exam, a final exam, and an independent project. Each type of work was evaluated for memory, analytical, creative, and practical quality. Thus, all students were evaluated in exactly the same way.

Our results suggested the utility of the theory of successful intelligence. This utility showed itself in several ways.

First, we observed when the students arrived at Yale that the students in the high creative and high practical groups were much more diverse in terms of racial, ethnic, socioeconomic, and educational backgrounds than were the students in the high-analytical group, suggesting that correlations of measured intelligence with status variables such as these may be reduced by using a broader conception of intelligence. Thus, the kinds of students identified as strong differed in terms of populations from which they were drawn in comparison with students identified as strong solely by analytical measures. More importantly, just by expanding the range of abilities measured, the investigators discovered intellectual strengths that might not have been apparent through a conventional test.

Second, we found that all three ability tests—analytical, creative, and practical—significantly predicted course performance. When multiple-regression analysis was used, at least two of these ability measures contributed significantly to the prediction of each of the measures of achievement. Perhaps as a reflection of the difficulty of deemphasizing the analytical way of teaching, one of the significant predictors was always the analytical score. (However, in a replication of our study with low-income African-American students from New York, Deborah Coates of the City University of New York found a different pattern of results. Her data indicated that the practical tests were better predictors of course performance than were the analytical measures, suggesting that what ability test predicts what criterion depends on population as well as mode of teaching.)

Third and most importantly, there was an aptitude-treatment interaction whereby students who were placed in instructional conditions that better matched their pattern of abilities outperformed students who were mismatched. In other words, when students are taught in a way that fits how they think, they do better in school. Children with creative and practical abilities, who are almost never taught or assessed in a way that matches their pattern of abilities, may be at a disadvantage in course after course, year after year.

A follow-up study (Sternberg et al. 1998) examined learning of social studies and science by third graders and eighth graders. The 225 third graders were students in a very low-income neighborhood in Raleigh, North Carolina. The 142 eighth graders were students who were largely middle to upper-middle class studying in Baltimore, Maryland, and Fresno, California. In this study, students were assigned to one of three instructional conditions. In the first condition, they were taught the course that basically they would have learned had there been no intervention. The emphasis in the course was on memory. In the second condition, students were taught in a way that emphasized critical (analytical) thinking. In the third condition, they were taught in a way that emphasized analytical, creative, and practical thinking. All students' performance was assessed for memory learning (through multiple-choice assessments) as well as for analytical, creative, and practical learning (through performance assessments).

As expected, students in the successful-intelligence (analytical, creative, practical) condition outperformed the other students in terms of the performance assessments. One could argue that this result merely reflected the way they were taught. Nevertheless, the result suggested that teaching for these kinds of thinking succeeded. More important, however, was the result that children in the successful-intelligence condition outperformed the other children even on the multiple-choice memory tests. In other words, to the extent that one's goal is just to maximize children's memory for information, teaching for successful intelligence is still superior. It enables children to capitalize on their strengths and to correct or to compensate for their weaknesses, and it allows children to encode material in a variety of interesting ways.

We extended these results to reading curricula at the middle-school and the high-school level. In a study of 871 middle-school students and 432 high-school students, we taught reading either triarchically or through the regular curriculum. At the middle-school level, reading was taught explicitly. At the high-school level, reading was infused into instruction in mathematics, physical sciences, social sciences, English, history, foreign languages, and the arts. In all settings, students who were taught triarchically substantially outperformed students who were taught in standard ways (Grigorenko et al. 2002).

The largest-scale study, described in Sternberg et al. (2008), was conducted with 196 teachers and 7,702 students. The study spanned 4 years, 9 states, 14 school districts, and 110 schools. It showed that with many thousands of fourth graders, it was possible to obtain gains in fourth-grade reading and mathematics that were greater for triarchic instruction for critical thinking or memory. This study suggested that triarchic instruction can be "scaled up" to reach children across a wide variety of geographic areas as well as subject matter areas.

Thus, the results of these sets of studies suggest that the theory of successful intelligence is valid as a whole. Moreover, the results suggest that the theory can make a difference not only in laboratory tests but in school classrooms and even the everyday life of adults as well.

Conclusions

This chapter has presented the theory of successful intelligence. Some psychologists believe the theory departs too much from the conventional theory of general intelligence (i.e., the theory of Spearman 1904, 1927). Some disagree with the theory (Gottfredson 2003a, b; Jensen 1998). Others believe the theory does not depart from conventional *g* theory enough (Gardner 1983, 2006). Still others have theories that are more compatible, in spirit, with that proposed here, at least for intelligence (Ceci 1996). The theory is rather newer than that of, say, Spearman (1904) and has much less work to support it as well as a lesser range of empirical support. I doubt the theory is wholly correct—scientific theories so far have not been—but I hope at the same time it serves as a broader basis for future theories than, say, Spearman's theory of general intelligence. No doubt, there will be those who wish to preserve this and related older theories, and those who will continue to do research that replicates hundreds and thousands of time that so-called general intelligence does indeed matter for success in many aspects of life. I agree. At the same time, I suspect it is not sufficient and also that those who keep replicating endlessly the findings of the past are unlikely to serve as the positive intellectual leaders of the future. But only time will tell. As noted earlier, there is typically some value to replication in science, although after a point is established, it seems more to continue to produce papers than to produce new scientific breakthroughs.

The educational system in the United States, as in many other countries, places great emphasis on instruction and assessments that tap into two important skills: memory and analysis. Students who are adept at these two skills tend to profit from the educational system, because the ability tests, instruction, and achievement tests we use all largely measure products and processes emanating from these two kinds of skills. There is a problem, however, namely, that children whose strengths are in other kinds of skills may be shortchanged by this system. These children might learn and test well, if only they were given an opportunity to play to their strengths rather than their weaknesses.

As a society, we can create a closed system that advantages only certain types of children and that disadvantages other types. Children who excel in memory and analytical abilities may end up doing well on ability tests and achievement tests and hence find the doors of opportunity open to them. Children who excel in other abilities may end up doing poorly on the tests and find the doors shut. By treating children with alternative patterns of abilities as losers, we may end up creating harmful self-fulfilling prophecies.

Institutions should consider pooling their resources and developing a common model and common methods of assessment. By working separately, they fail to leverage their strengths and to share information regarding the best ways to make decisions. In essence, each institution "reinvents the wheel." A consortium would be far more powerful than each institution working on its own. Successful intelligence is one model such a consortium might use. Doubtless there are many others. The important thing is to work together toward a common good—toward devising the best ways to select students so as to maximize their positive future impact. We all wish our intellectual leaders to show wisdom. We ourselves need to do the same.

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