Available online at www.sciencedirect.com
SCIENCE DIRECT®
Intelligence 31 (2003) 399–413
INTELLIGENCE

Discussion

Our research program validating the triarchic theory of successful intelligence: reply to Gottfredson

Robert J. Sternberg*

Department of Psychology, Yale University, PACE Center, P.O. Box 208358, New Haven, CT 06520-8358, USA

Received 6 February 2002; received in revised form 23 July 2002; accepted 23 July 2002

Abstract

This article discusses our research program construct-validating the triarchic theory of successful intelligence, and also discusses some objections that have been raised to the triarchic theory. The article is divided into five parts. First, it discusses what our positive program is for using converging operations to construct-validate the theory of successful intelligence. Second, it describes the theory of successful intelligence. Third, it indicates what kinds of data have been collected to test the theory and what they have shown. Fourth, it discusses substantive objections against the theory and responses to those objections. Finally, it draws some brief conclusions.

This article constitutes a reply to Gottfredson (2002). Because I found Gottfredson's article pervasively to misrepresent the theory of successful intelligence as well as the data collected to test it, I decided that the best form of reply would be to make clear (a) what our positive program is for using converging operations to construct-validate the theory of successful intelligence, (b) what the theory of successful intelligence actually does state, (c) what kinds of data have been collected to test the theory and what they have shown, and (d) what *substantive* objections have been raised by Gottfredson and others, and how I would respond to those objections. Obviously, this article can represent only a brief account of the theory, data, and responses to objections.

* Tel.: +1-203-432-4633; fax: +1-203-432-8317.
E-mail address: robert.sternberg@yale.edu (R.J. Sternberg).

0160-2896/02/$ – see front matter
doi:10.1016/S0160-2896(02)00143-5

1. A positive program of converging operations

How does one know what intelligence really is, how it is structured, or what effects it has on various kinds of everyday performance? There is no "magic bullet" that will answer questions such as these. So, the approach we use in our research is that of converging operations, attempting to show in a number of different ways the validity of our claims. Our research program is a *positive* one: That is, we are not interested in "trashing" so-called *g* or, for that matter, *g* theorists or anyone else. We believe that the psychological construct or set of constructs called *g* constitutes an important aspect of intelligence, and that aspects of many research programs elucidating properties of *g* are very useful. Rather, we are interested in showing that there is more to intelligence than *g* and in showing through converging operations what this "more" might be. Thus, we believe we are building on the work of Spearman (1904), rather than tearing it down. After close to 100 years, it perhaps makes more sense to expand Spearman's theory rather than to accept it in close to its original form.

The converging operations we use are of two broad kinds: implicit-theories studies, which show what people mean when they speak of intelligence, and explicit-theories studies, which have people perform tasks testing the investigator's own theory of intelligence. The explicit-theories studies are in turn divided into a number of different kinds. For internal validation, we use componential analysis to study stimulus variance and exploratory and confirmatory factor analysis to study person variance. For external validation, we use correlation and regression methods to validate our measures against indices of various kinds of success on selected external tasks, and we use instructional studies to determine whether teaching people according to the proposed theory results in better performance on various kinds of external tasks.

Any one of these methods or any study within that method can be criticized in various ways. That is the nature of empirical research. The goal of converging operations (Garner, Hake, & Eriksen, 1956) is to show that the same set of substantive conclusions holds across a variety of methods. My goal in this article, therefore, is to give a brief overview of our program of construct validation of the triarchic theory of successful intelligence (Sternberg, 1985a, 1997, 1999b) and how we attempt to show that there is more to intelligence than just *g*, and, in particular, creative and practical as well as academic (analytical) aspects. I then reply to various criticisms we have received over the years.

2. The triarchic theory of successful intelligence

The triarchic theory of successful intelligence defines successful intelligence in terms of one's ability to succeed according to what one values in life, within one's sociocultural context. One achieves success through a balance of adaptation to, shaping of, and selection of environments. One optimizes these interactions with the environment by recognizing and capitalizing on one's strengths and by recognizing and correcting or compensating for one's weaknesses. One does so by a blend of analytical, creative, and practical abilities (Sternberg, 1997, 1999b).

All three kinds of abilities are ultimately the result of the interactions of three kinds of information-processing components: metacomponents, performance components, and knowledge-acquisition components. Metacomponents are executive processes, such as recognizing the nature of a problem, defining the nature of the problem, allocating resources for the solution of that problem, mentally representing information about the problem, and so forth. Performance components, such as inference of relations, mapping of higher order relations, and application of relations, execute the instructions of the metacomponents. Knowledge-acquisition components, including selective encoding, selective comparison, and selective combination, are used to learn how to solve problems in the first place. Metacomponents activate performance components and knowledge-acquisition components, which in turn provide feedback to metacomponents.

Components represent analytical (academic) abilities when they are applied to relatively abstract and academic kinds of problems that are, nevertheless, somewhat familiar. They represent creative abilities when they are applied to relatively novel kinds of tasks and situations. And they represent practical abilities when they are applied to everyday problems requiring adaptation, shaping, and selection. Thus, analytical, creative, and practical abilities are not wholly distinct, but rather related to each other in some degree, depending upon the given problem and the situation in which it is solved (Sternberg, 1984, 1985a).

3. The program of construct validation

As mentioned above, we use both implicit theories and explicit theories to construct-validate the triarchic theory.

3.1. Implicit theories

With regard to implicit theories, we have done a series of studies querying people regarding their conceptions of intelligence. These implicit theories are useful in gauging what people mean when they think about and speak of intelligence. There are a number of reasons why implicit theories are worth studying. First, psychologists need to understand how people conceive of constructs and understanding people's implicit theories enables them to do so. Second, they form the basis of explicit theories; explicit theories typically have their origin in the implicit theory of a theorist. Third, the large majority of judgments made in the world about people's intelligence are made on the basis of people's implicit theories, not on the basis of intelligence-test scores. For example, teachers judge students by their own implicit theories of intelligence; if these implicit theories differ from those of the families from which the children derive, the children are likely to be judged as less able because the skills the children have fall outside the range of the teachers' implicit theories (Okagaki & Sternberg, 1993).

In an early study in the United States, we found that people's conceptions of intelligence go beyond so-called *g*, including practical problem solving, verbal ability, and social competence (Sternberg, Conway, Ketron, & Bernstein, 1981). In a follow-up study, we found that experts' conceptions of intelligence also go beyond *g*, with the exact conception depending upon the field in which the expert worked (Sternberg, 1985b).

Of course, it is possible that this phenomenon is limited to the United States. But a number of investigators have examined implicit theories of intelligence around the world, especially in Africa (e.g., Berry, Poortinga, Segall, & Dasen, 1992; Cole, 1996; Mpofu, 1993, in press; Mundy-Castle, 1967; Serpell, 1993; Wober, 1974; see review in Sternberg & Kaufman, 1998), finding in every case that conceptions of intelligence go beyond *g*. We have ourselves done two such studies, with comparable results. In Taiwan, Chinese people's conceptions of intelligence yielded five factors (Yang & Sternberg, 1997): cognitive skills (a factor very similar to *g*), interpersonal skills, intrapersonal skills (i.e., self-understanding), intellectual self-assertion (knowing when to show one is intelligent), and intellectual self-effacement (knowing when not to show one is intelligent). In Kenya, we found four words used to express intelligence (Grigorenko et al., 2001)—*rieko*, referring to declarative and procedural knowledge; *luoro*, referring to respect; *paro*, referring to initiative; and *winjo*, referring to comprehension of social situations. Only a part of *rieko* is used in referring to the skills measured by tests of *g*.

To my knowledge, every such study ever done has yielded a more differentiated picture with regard to intelligence than is yielded by the theory of *g* and, for the most part, the skills included go beyond those even included in most hierarchical models (e.g., Carroll, 1993; Cattell, 1971). Almost all of the implicit-theories studies seem to suggest some form or forms of practical intelligence in addition to and somewhat distinct from the more conventional kind of academic intelligence. Of course, implicit theories have their limitations. For example, implicit theories, like explicit theories, may be incomplete, or they may provide an otherwise inadequate account of the full range of available data. Thus, implicit theories provide only one converging operation, not a final answer.

3.2. Explicit theories

Our work on explicit theories involves both internal and external validation of the triarchic theory.

3.2.1. Internal validity

One aspect of our work has been the internal validation of our various measures of intellectual skills. These internal validations have taken two forms—analyses focusing on stimulus variance and analyses focusing on subject variance.

3.2.1.1. Componential analyses of stimulus variance. Some of our work has focused on internally validating the theory by componentially analyzing stimulus variance (e.g., Guyote & Sternberg, 1981; McNamara & Sternberg, 1983; Sternberg, 1977, 1980, 1982, 1983; Sternberg & Gastel, 1989a; Sternberg & Kalmar, 1997; Sternberg & Nigro, 1980; Sternberg & Powell, 1983a, 1983b; Sternberg & Rifkin, 1979; Tetewsky & Sternberg, 1986). These techniques have been used primarily on tasks and classes of tasks that require analytical and/or creative thinking. For example, total response time for solving an analogy can be decomposed into the sum of the times spent on encoding, inference, mapping, application, comparison, justification, and preparation/response—six components of analogical reasoning. The goal here is to show that information-processing models of cognitive-task performance provide good models of response times and error rates. These models are quantified using linear or nonlinear regression and then applied to predict the dependent variables both for group-average and for individual data. In general, the models provide high levels of prediction (with squared multiple correlation coefficients typically ranging from the low .80s to the high .90s), and help decompose performance on cognitive tasks in terms of its elementary information-processing components. These studies have shown, for example, that the same performance components that apply to analogical reasoning also apply to other forms of inductive reasoning, such as that used in solving classification and series-completion problems, suggesting that the psychometric general factor in analytical–intellectual may be comprehensible in terms of a set of shared information-processing components across tasks (Sternberg & Gardner, 1982, 1983).

3.2.1.2. Exploratory and confirmatory factor-analytic studies. In these studies, we examine the structure of individual differences in tests of analytical, creative, and practical abilities, to see whether, in general, they correspond to the predictions of the triarchic theory (e.g., Sternberg, Castejón, Prieto, Hautamäki, & Grigorenko, 2001; Sternberg, Ferrari, Clinkenbeard, & Grigorenko, 1996; Sternberg, Grigorenko, Ferrari, & Clinkenbeard, 1999). We find that our results generally conform to the triarchic theory, although not perfectly. In our most recent work, we have found, in a sample of about 1000 high school and college students from very diverse settings, distinct creative and practical factors in addition to an analytical one (Sternberg, 2002).

3.2.2. External (convergent–discriminant) validity

3.2.2.1. Cultural studies. A second way of examining whether there is more to intelligence than *g* is to conduct studies of explicit theories around the world. The goal is to show that intelligence comprises more than *g*, and that part of this something more is practical and/or creative intelligence. In a study in Kenya (Sternberg, Nokes, et al., 2001), we showed that a test of skills important in rural Kenyan villages—procedural knowledge regarding how to use natural herbal medicines for combating parasitic and other illnesses—yielded *negative* correlations with tests of fluid and of crystallized intelligence and of school English and mathematics achievement. The better students were on the practical tests, the worse they were on the academic tests, and vice versa. Thus, not only did the correlations fail to show a positive manifold, they even failed to cluster systematically in a positive direction. Analytical and practical tests show largely reversed patterns. In a related study, Grigorenko and Sternberg (2001) found that, among Russian adults, although both academic and practical intelligence predicted mental and physical health, practical intelligence was the better predictor. Most recently, we found in a recent as yet unpublished study in Alaska that practical but not academic intelligence predicted adults' ratings of Alaskan Yup'ik Eskimo children's hunting skills.

Other studies show related results (e.g., Ceci & Liker, 1986; Lave, 1988; Nuñes, Schliemann, & Carraher, 1993)—namely, a dissociation between the academic and practical sides of intelligence (see Sternberg et al., 2000, for a review of many such studies). These kinds of studies have in common that they use tasks that are important in the environments of the inhabitants that are studied, although not necessarily in the lives of investigators of intelligence. For example, Ceci and his colleagues studied racetrack handicappers, Lave studied housewives shopping in supermarkets, and Nuñes studied Brazilian street children. As is true for any class of studies, they are not foolproof. The tasks are specialized, the samples usually relatively modest in size, and the practical tasks are not standardized. But when the same class of result keeps emerging, as it has many times from many different research programs, it is at least suggestive, as are the studies of implicit theories, that there may be a practical aspect of intelligence that is distinct from *g*.

Such cultural studies also suggest that tests of *g* may measure a different kind of skill in children in underdeveloped countries, say, in rural Tanzania, than they measure in children in developed countries, say, in the United States (Sternberg et al., 2002), because children in developing countries, on average, find the test stimuli much more novel than do children in developed countries. Dynamic testing can be particularly useful in such settings (Sternberg & Grigorenko, 2002).

3.2.2.2. Correlation and regression studies. In this series of studies (e.g., Sternberg, Wagner, & Okagaki, 1993; Wagner, 1987; Wagner & Sternberg, 1985; see Sternberg et al., 2000), we have sought to show convergent–discriminant validity for our measures.

One set of studies emphasizes measures of analytical abilities (e.g., Guyote & Sternberg, 1981; Sternberg, 1977, 1980, 1983, 1987; Sternberg & Gardner, 1983; Sternberg & Powell, 1983a, 1983b). Here, we have looked at convergent/discriminant patterns of correlations of component scores with reference ability tests of various kinds. We have generally found that components that are supposed to be associated with reasoning, problem solving, or knowledge acquisition show correlations with reference tests of these abilities, and components that are not supposed to be associated with these processes do not. One result that, in early studies, seemed surprising was the correlation of the regression constant for a regression equation with scores on *g*-based measures (e.g., Sternberg, 1977; Sternberg & Gardner, 1983). We later realized that our information-processing models separated out performance components but not metacomponents. When we separated out metacomponents (Sternberg, 1981), the predicted patterns of correlations made more sense. For example, we found that higher reasoning time was associated with *decreased* local-planning time, but *increased* global-planning time. Brighter participants spent more time up front analyzing problems so that they could solve the problems more quickly.

We have done two kinds of studies of creative intelligence. In one set of studies (e.g., Sternberg, 1982; Sternberg & Gastel, 1989a, 1989b; Tetewsky & Sternberg, 1986), we performed componential analyses on tasks requiring creative thinking on convergent tasks. We found that we could successfully decompose performance on these tasks, and that the convergent–discriminant patterns of correlations between component scores and reference-ability test scores made sense. In particular, creative people are those who are more adept at moving back and forth between conventional and unconventional conceptual systems.

A second set of studies of creative intelligence (Sternberg & Lubart, 1995) has emphasized divergent tasks, such as writing short stories with unusual titles, preparing artworks, preparing advertisements for boring products, answering creative scientific problems, and the like (Sternberg, 2002). We have found that our measures of creativity show weak to moderate correlations with g-based measures (generally in the range of .3–.6), and that the correlations depend on the nonentrenchment of the g-based tests (see Sternberg, 1985a; Sternberg & Lubart, 1995). The more novel the tests, the higher the correlation. We also have found that creative thinking involves variables that go beyond the intellectual, such as stylistic, personality, and motivational factors.

A final set of studies emphasizes measures of an aspect of practical intelligence, tacit knowledge, which is essentially what one needs to know to success in life that one is not explicitly taught and that usually is not even verbalized. We have predicted external criteria of job and other measures of life performance, but at the same time, our tests do not correlate much or even, sometimes, at all with conventional measures of g (see Sternberg et al., 2000; Sternberg, Nokes, et al., 2001). The range of correlations across studies ranges from about -0.3 to about .3. That is what we have found in the studies we have done so far.

More recently, we have taken the approach of trying to show that triarchically based measures of intelligence improve prediction of school performance at the tertiary level. There are two ongoing studies. One, funded by the University of Michigan Business School, has involved predicting business–school success (GPA at the end of the second year as well as other measures) on the basis of a test of practical intelligence. Our goal in this study has been to examine the incremental prediction provided by our measures over the Graduate Management Admissions Test (GMAT). We found significant increments to prediction for final GPA. We also found that our test, but not the GMAT, predicted grades on a major project required for admission (Hedlund et al., 2001).

In a second collaborative study, funded by the College Board (Sternberg, 2002), we are looking at the prediction of triarchic tests over and above high school grade-point average and SAT scores. We have found in this study at 15 sites, ranging greatly in competitiveness and type of institution, that our triarchic measures significantly increase prediction of freshman GPA. The data are being independently analyzed by individuals other than ourselves (at the Center for the Psychology of Abilities, Competencies, and Expertise at Yale).[1]

3.2.2.3. Instructional studies. A further kind of study aimed at validating the distinction among analytical, creative, and practical intelligence is the instructional study. Here, one attempts to show either that students who are taught to their triarchic pattern of abilities learn better than do children who are not or that students who are taught to their triarchic pattern of abilities, or that triarchically taught students (i.e., those who are taught analytically, creative, and practically, as well as for memory) significantly outperform students who are taught in more conventional ways—either just for memory or for memory and analytical thinking. In a

[1] Preliminary reports on these data are obtainable by e-mailing the author.

series of studies, this is what we have shown. In a first study, we showed that students who were taught in a way that better matched their triarchic pattern of abilities outperformed students who were taught in a way that more poorly matched their triarchic pattern of abilities (Sternberg et al., 1996, 1999). In a second set of studies, we showed that triarchically taught students outperformed students who were taught either primarily for memory or primarily for critical thinking (Sternberg, Torff, & Grigorenko, 1998). And, in a third set of studies, we showed that students who were taught triarchically outperformed students who were taught conventionally, especially with regard to reading (Grigorenko, Jarvin, & Sternberg, 2002).

4. Critiques of the research program

Of course, any research program is susceptible to criticisms. What are the major criticisms, and what are the responses?

4.1. There is much more evidence in favor of g theory than in favor of the triarchic theory

Our factor analyses, like those of others (e.g., Carroll, 1993; Jensen, 1998), often (but do not always) support *g* for the range of tests used in conventional psychometric batteries. They are not so supportive of *g* when the range of tasks is broadened (e.g., Sternberg, Castejón, et al., 2001; Sternberg et al., 1999). In our latest, Rainbow study of roughly 1000 participants with new measures based on the triarchic theory, we found that all paper-and-pencil tests tended to cluster into one factor, and that creative and practical tests requiring more elaborate performances yielded distinct creative and practical factors (Sternberg, 2002) in an exploratory factor analysis.

That said, we agree with critics who state that tests of the triarchic theory are in much shorter supply than are tests of *g*-based theories. The theory of *g* goes back almost 100 years (Spearman, 1904). The triarchic theory goes back almost 20 years (Sternberg, 1984). There has been much more time to test *g*-based theories than to test the triarchic theory. Moreover, it is far easier to test *g* theory than to test the triarchic theory, because it is so much easier to create tests of analytical abilities than to create tests of creative and practical abilities. Analytical abilities lend themselves fairly well to multiple-choice and other straightforward forms of measurement; creative and practical abilities can be measured by multiple-choice items, but are not optimally measured exclusively by such items (Sternberg, 2002; Sternberg et al., 1999). Often the measures require ratings of products, which require training of raters and development of rubrics to ensure inter-rater reliability. But the bottom line is that there is a need for more time to continue testing the triarchic theory so as to determine its stronger and weaker aspects.

4.2. g correlates with many things but the triarchic theory says it does not

This criticism is a misunderstanding of the triarchic theory. According to the triarchic theory, so-called *g* should correlate with performance on virtually any task that has analytical aspects and that requires any amount of abstract thinking. And it does (see, e.g., Schmidt & Hunter, 1998). Many tasks meet such requirements, including many practical tasks. That is, practical tasks can have academic aspects, just as academic tasks can have practical aspects (see Gardner, Krechevsky, Sternberg, & Okagaki, 1994; Sternberg, Okagaki, & Jackson, 1990; Williams et al., 1996, 2002). However, the correlation of *g* with criteria should decrease as the amount of analytical thinking decreases and as the problem becomes more concrete.

It is also important to realize that correlations (and factors) do not necessarily reflect fixed relationships, but rather, relationships in environmental contexts that are in part created by the people who inhabit those environmental contexts (Sternberg, 1997, 1999b). For example, if a society starts to stratify people according to wealth, or social class, or ethnic group, or even height, then it can help create correlations between these variables and various measures of success. For example, if people with green skin are partially or fully restricted from various access routes to job success (e.g., educational opportunities, meeting the people in a field who matter, and so forth), then having green skin can become associated with lesser success. The "invisible hand of nature" to which Herrnstein and Murray (1994) referred, therefore, is in part the result of social systems that humans, not only nature, create.

4.3. The triarchic theory does not acknowledge the causal power of g

g is a descriptive hypothetical construct. Its existence is inferred on the basis of various kinds of evidence. It does not provide a causal explanation of anything because it is just a label, much as "neurotic" is a label for a class of psychological phenomena. But explaining behavior as caused by "neuroticism" does not explain the behavior, anymore than explaining behavior as caused by *g* does. Spearman himself recognized this fact, first (Spearman, 1923) attempting to characterize *g* in terms of cognitive operations (such as eduction of relations) and then in terms of mental energy (Spearman, 1927). Today, some cognitive theorists attempt to understand *g* in terms of modern constructs, such as working memory or speed of neural conduction. But the causal link of any of these constructs to test performance or everyday performance has yet to be demonstrated.

4.4. Practical intelligence is really job knowledge or personality or something other than intelligence

This argument represents a misunderstanding of the nature of tacit knowledge. We have constructed tacit-knowledge measures for students (Sternberg, 2002; Sternberg et al., 1993) and for children living in rural Alaskan and Kenyan villages (as described above). These children have no formal jobs so it is not clear what it would mean to say that their knowledge is "job knowledge." Tests of practical intelligence do not correlate significantly with tests of personality such as the California Personality Inventory (CPI), insofar as we have assessed such correlations (see Sternberg et al., 2000).

We used to believe that tacit knowledge is all domain-specific. Our research has convinced us that this belief was incorrect. We found high correlations between different subtests and tests of tacit knowledge, although we did not find high correlations of these tests with *g*-based measures. Thus, the tacit-knowledge tests seem to yield a general factor that is different from psychometric *g* (Sternberg et al., 2000).

There is one argument allegedly against the triarchic theory that is not really against it, and that we agree with, namely, that practical-intelligence measures are really measures of achievement. So are all existing tests of abilities. If one looks at these tests, they all measure achievement, although sometimes achievements one is supposed to have reached before the testing. And the Flynn effect (e.g., Flynn, 1998) makes clear that even tests of fluid abilities are subject to increase over time.

4.5. The triarchic theory fails to acknowledge the importance of genetic factors in intelligence

The triarchic theory emphasizes the extent to which intelligence represents a set of developing competencies—competencies that often can themselves be developed into various forms of expertise (Sternberg, 1998, 1999b). But genetic factors clearly play a role in the development of intelligence, just as environmental ones do. I tend to emphasize the importance of gene x environment interactions, because environments can modify the effects of genes, just as genes can modulate the effects of environments on an individual. For example, someone with great musical talent, for example, who grows up in a country that forbids music, will never have a chance to develop that talent. Similarly, someone locked in a closet will probably not much develop his or her intelligence, no matter what the genetic potentials.

I have expressed a concern that heritability data often are misinterpreted in the literature on intelligence. Heritability coefficients are not an intrinsic function of the organism. They are a function of the relation between variability in genotypes and phenotypes (Herrnstein, 1971; Sternberg & Grigorenko, 1999). To attempt to determine the heritability of intelligence is thus misguided. Were the range of environments to become more uniform, heritability would rise; were these environments to become less uniform, heritability would fall. Any set of coefficients, therefore, applies to a given time and place under specified conditions, and may be different in other times, places, and conditions.

4.6. Intelligence is fixed, not flexible

We have shown that analytical abilities (Sternberg, 1987; Sternberg & Ketron, 1982; Sternberg & Weil, 1980), creative abilities (Davidson & Sternberg, 1984), and practical abilities are all at least somewhat susceptible to modification. Flynn's (1998) results are consistent with the ideas that abilities not only can grow within a person, but across persons secularly. These and other findings are consistent with the notion of abilities as forms of developing competencies (Sternberg, 1998, 1999a).

4.7. If one corrects for restriction of range and attenuation, one will find tacit-knowledge measures correlate with g

If one corrects for enough things, almost anything will correlate with almost anything, if there is enough power and any relationship whatsoever. Our current tacit-knowledge measures have internal-consistency reliabilities of about .9, so correcting for attenuation is not likely to have much effect. It certainly makes no sense to correct by averaging reliabilities across people (e.g., inter-rater reliabilities) with reliabilities across items (e.g., internal-consistency reliabilities). Correction for restriction of range can make sense if one knows what the normal range is. For some tests, the normal range is that of the US population. For others, it is the range of people who apply to be executives, or sales people, or students at particular ranges of universities, or whatever. As we do not know what these "normal" ranges are, corrections are largely arbitrary. Moreover, we especially do not know the range within these samples for creative and practical abilities. We could only hazard a blind guess. If one does correct, however, it can go either way. In the study mentioned above conducted in Kenya (Sternberg, Nokes, et al., 2001), the correlations between practical-intellectual measures and conventional *g*-based measures would become higher in the negative direction.

4.8. The triarchic theory says that intelligence is all relative, and that is not scientific

The triarchic theory does view the contextual aspect of intelligence as relative. What is intelligent behavior in one place or at one time is not necessarily intelligent behavior at another place and at another time. Implicit-theories research very well demonstrates this point. But the triarchic theory does not view the componential aspect intelligence as relative. The same components underlie the experiential and practical aspects of intelligence at any time or place. One always needs to do things such as recognize and define problems, formulate strategies to solve problems, monitor one's problem solving, and so forth.

4.9. Believing in the value of the triarchic theory somehow diminishes the contributions of psychometric theorists and researchers

The triarchic theory builds upon, rather than strikes down, past and present psychometric theories. What has been called general ability is the core of the analytical aspect of the triarchic theory. The triarchic theory states that there are two other important aspects of intelligence as well, the creative and the practical ones (Sternberg, 1985a). In other words, the triarchic theory argues not that conventional theories of intelligence are wrong, but rather, that they are incomplete. Eventually, it may well be found that the triarchic theory is incomplete as well.

4.10. The triarchic theory is just wrong

This is true. In my view, all current psychological theories are likely to be wrong. The best we can hope for is that they are better than the theories on which they build and that sometimes they replace. If the theories are good, researchers will want to investigate them and, ultimately, they will be built upon and likely replaced by future theories.

5. Conclusion

Although I found the hostile tone and some of the substance of Gottfredson's (2002) critique less than fully constructive, any serious critique in science, whatever its tone, can help advance our understanding of scientific phenomena. Gottfredson's is no exception. All extant scientific theories have weaknesses. The triarchic theory certainly has many. I hope, however, that its strengths will help advance scientific understanding of intelligence, and pave the way for subsequent generations of better theories.

Acknowledgements

Preparation of this article was supported under the Javits Act Program (Grant No. R206R000001) as administered by the Office of Educational Research and Improvement, US Department of Education, grant REC-9979843 from the US National Science Foundation, and grant MDA 903-92-K-0125 from the US Army Research Institute. Grantees undertaking such projects are encouraged to express freely their professional judgment. This article, therefore, does not necessarily represent the position or policies of the Office of Educational Research and Improvement or the US Department of Education, and no official endorsement should be inferred.

References

Berry, J. W., Poortinga, Y. H., Segall, M. H., & Dasen, P. R. (1992). *Cross-cultural psychology: research and applications*. New York: Cambridge Univ. Press.

Carroll, J. B. (1993). *Human cognitive abilities: a survey of factor-analytic studies*. New York: Cambridge Univ. Press.

Cattell, R. B. (1971). *Abilities: their structure, growth and action*. Boston: Houghton Mifflin.

Ceci, S. J., & Liker, J. (1986). Academic and nonacademic intelligence: an experimental separation. In R. J. Sternberg, & R. K. Wagner (Eds.), *Practical intelligence: nature and origins of competence in the everyday world* (pp. 119–142). New York: Cambridge Univ. Press.

Cole, M. (1996). *Cultural psychology: a once and future discipline*. Cambridge, MA: Harvard Univ. Press.

Davidson, J. E., & Sternberg, R. J. (1984). The role of insight in intellectual giftedness. *Gifted Child Quarterly*, *28*, 58–64.

Flynn, J. R. (1998). WAIS-III and WISC-III gains in the United States from 1972 to 1995: how to compensate for obsolete norms. *Perceptual Motor Skills*, *86*, 1231–2123.

Gardner, H., Krechevsky, M., Sternberg, R. J., & Okagaki, L. (1994). Intelligence in context: enhancing students' practical intelligence for school. In K. McGilly (Ed.), *Classroom lessons: integrating cognitive theory and classroom practice* (pp. 105–127). Cambridge, MA: MIT Press.

Garner, W. R., Hake, H. W., & Eriksen, C. W. (1956). Operationism and the concept of perception. *Psychological Review*, *63*, 149–159.

Gottfredson, L. S. (2002). Dissecting practical intelligence theory: its claims and evidence. *Intelligence*.

Grigorenko, E. L., Geissler, P. W., Prince, R., Okatcha, F., Nokes, C., Kenny, D. A., Bundy, D. A., & Sternberg, R. J. (2001). The organization of Luo conceptions of intelligence: a study of implicit theories in a Kenyan village. *International Journal of Behavioral Development*, *25*, 367–378.

Grigorenko, E. L., Jarvin, L., & Sternberg, R. J. (2002). School-based tests of the triarchic theory of intelligence: three settings, three samples, three syllabi. *Contemporary Educational Psychology*, *27*, 167–208.

Grigorenko, E. L., & Sternberg, R. J. (2001). Analytical, creative, and practical intelligence as predictors of self-reported adaptive functioning: a case study in Russia. *Intelligence*, *29*, 57–73.

Guyote, M. J., & Sternberg, R. J. (1981). A transitive-chain theory of syllogistic reasoning. *Cognitive Psychology*, *13*, 461–525.

Hedlund, J., Sternberg, R. J., Plamondon, K., Wilt, J., Nebel, K., & Ashford, S. (2001). *The development and validation of a measure of successful intelligence for MBA admissions*. Ann Arbor, MI: University of Michigan Business School.

Herrnstein, R. J. (1971). IQ. *Atlantic Monthly*, *228*, 43–64.

Herrnstein, R. J., & Murray, C. (1994). *The bell curve*. New York: Free Press.

Jensen, A. R. (1998). *The g factor: the science of mental ability*. Westport, CT: Praeger/Greenwoood.

Lave, J. (1988). *Cognition in practice*. New York, NY: Cambridge Univ. Press.

McNamara, T. P., & Sternberg, R. J. (1983). Mental models of word meaning. *Journal of Verbal Learning and Verbal Behavior*, *22*, 449–474.

Mpofu, E. (1993). The context of mental testing and implications for psychoeducational practice in modern Zimbabwe. In W. Su (Ed.), *Proceedings of the Second Afro–Asian Psychological Conference* (pp. 17–25). Beijing: University of Peking Press.

Mpofu, E. (in press). Being intelligent with Zimbabweans: a historical and contemporary view. In R. J. Sternberg (Ed.), *International handbook of the psychology of human intelligence*. New York: Cambridge Univ. Press.

Mundy-Castle, A. C. (1967). An experimental study of prediction among Ghanaian children. *Journal of Social Psychology*, *73*, 161–168.

Nuñes, T., Schliemann, A. D., & Carraher, D. W. (1993). *Street mathematics and school mathematics*. New York: Cambridge Univ. Press.

Okagaki, L., & Sternberg, R. J. (1993). Parental beliefs and children's school performance. *Child Development*, *64*, 36–56.

Schmidt, F. L., & Hunter, J. E. (1998). The validity and utility of selection methods in personnel psychology: practical and theoretical implications of 85 years of research findings. *Psychological Bulletin*, *124*, 262–274.

Serpell, R. (1993). *The significance of schooling: life journeys in an African society*. New York: Cambridge Univ. Press.

Spearman, C. (1904). 'General intelligence,' objectively determined and measured. *American Journal of Psychology*, *15*(2), 201–293.

Spearman, C. (1923). *The nature of "intelligence" and the principles of cognition*. London: Macmillan.

Spearman, C. (1927). *The abilities of man*. New York: Macmillan.

Sternberg, R. J. (1977). *Intelligence, information processing, and analogical reasoning: the componential analysis of human abilities*. Hillsdale, NJ: Erlbaum.

Sternberg, R. J. (1980). Representation and process in linear syllogistic reasoning. *Journal of Experimental Psychology: General*, *109*, 119–159.

Sternberg, R. J. (1981). Intelligence and nonentrenchment. *Journal of Educational Psychology*, *73*, 1–16.

Sternberg, R. J. (1982). Natural, unnatural, and supernatural concepts. *Cognitive Psychology*, *14*, 451–488.

Sternberg, R. J. (1983). Components of human intelligence. *Cognition*, *15*, 1–48.

Sternberg, R. J. (1984). Toward a triarchic theory of human intelligence. *Behavioral and Brain Sciences*, *7*, 269–287.

Sternberg, R. J. (1985a). *Beyond IQ: a triarchic theory of human intelligence*. New York: Cambridge Univ. Press.

Sternberg, R. J. (1985b). Implicit theories of intelligence, creativity, and wisdom. *Journal of Personality and Social Psychology*, *49*(3), 607–627.

Sternberg, R. J. (1987). Most vocabulary is learned from context. In M. G. McKeown, & M. E. Curtis (Eds.), *The nature of vocabulary acquisition* (pp. 89–105). Hillsdale, NJ: Lawrence Erlbaum Associates.

Sternberg, R. J. (1997). *Successful intelligence*. New York: Plume.

Sternberg, R. J. (1998). Abilities are forms of developing expertise. *Educational Researcher*, *27*, 11–20.
Sternberg, R. J. (1999a). Intelligence as developing expertise. *Contemporary Educational Psychology*, *24*, 359–375.
Sternberg, R. J. (1999b). The theory of successful intelligence. *Review of General Psychology*, *3*, 292–316.
Sternberg, R. J. (2002, February 16). *The Rainbow Project: augmenting the validity of the SAT*. Paper presented to American Academy of Arts and Sciences, Boston, MA.
Sternberg, R. J., Castejón, J. L., Prieto, M. D., Hautamäki, J., & Grigorenko, E. L. (2001). Confirmatory factor analysis of the Sternberg triarchic abilities test in three international samples: an empirical test of the triarchic theory of intelligence. *European Journal of Psychological Assessment*, *17*(1), 1–16.
Sternberg, R. J., Conway, B. E., Ketron, J. L., & Bernstein, M. (1981). People's conceptions of intelligence. *Journal of Personality and Social Psychology*, *41*, 37–55.
Sternberg, R. J., Ferrari, M., Clinkenbeard, P. R., & Grigorenko, E. L. (1996). Identification, instruction, and assessment of gifted children: a construct validation of a triarchic model. *Gifted Child Quarterly*, *40*(3), 129–137.
Sternberg, R. J., Forsythe, G. B., Hedlund, J., Horvath, J., Snook, S., Williams, W. M., Wagner, R. K., & Grigorenko, E. L. (2000). *Practical intelligence in everyday life*. New York: Cambridge Univ. Press.
Sternberg, R. J., & Gardner, M. K. (1982). A componential interpretation of the general factor in human intelligence. In H. J. Eysenck (Ed.), *A model for intelligence* (pp. 231–254). Berlin: Springer-Verlag.
Sternberg, R. J., & Gardner, M. K. (1983). Unities in inductive reasoning. *Journal of Experimental Psychology: General*, *112*, 80–116.
Sternberg, R. J., & Gastel, J. (1989a). Coping with novelty in human intelligence: an empirical investigation. *Intelligence*, *13*, 187–197.
Sternberg, R. J., & Gastel, J. (1989b). If dancers ate their shoes: inductive reasoning with factual and counterfactual premises. *Memory and Cognition*, *17*, 1–10.
Sternberg, R. J., & Grigorenko, E. L. (1999). Myths in psychology and education regarding the gene environment debate. *Teachers College Record*, *100*, 536–553.
Sternberg, R. J., & Grigorenko, E. L. (2002). *Dynamic testing*. New York: Cambridge Univ. Press.
Sternberg, R. J., Grigorenko, E. L., Ferrari, M., & Clinkenbeard, P. (1999). A triarchic analysis of an aptitude-treatment interaction. *European Journal of Psychological Assessment*, *15*(1), 1–11.
Sternberg, R. J., Grigorenko, E. L., Ngrosho, D., Tantufuye, E., Mbise, A., Nokes, C., Jukes, M., & Bundy, D. A. (2002). Assessing intellectual potential in rural Tanzanian school children. *Intelligence*, *30*, 141–162.
Sternberg, R. J., & Kalmar, D. A. (1997). When will the milk spoil? Everyday induction in human intelligence. *Intelligence*, *25*(3), 185–203.
Sternberg, R. J., & Kaufman, J. C. (1998). Human abilities. *Annual Review of Psychology*, *49*, 479–502.
Sternberg, R. J., & Ketron, J. L. (1982). Selection and implementation of strategies in reasoning by analogy. *Journal of Educational Psychology*, *74*, 399–413.
Sternberg, R. J., & Lubart, T. I. (1995). *Defying the crowd: cultivating creativity in a culture of conformity*. New York: Free Press.
Sternberg, R. J., & Nigro, G. (1980). Developmental patterns in the solution of verbal analogies. *Child Development*, *51*, 27–38.
Sternberg, R. J., Nokes, K., Geissler, P. W., Prince, R., Okatcha, F., Bundy, D. A., & Grigorenko, E. L. (2001). The relationship between academic and practical intelligence: a case study in Kenya. *Intelligence*, *29*, 401–418.
Sternberg, R. J., Okagaki, L., & Jackson, A. (1990). Practical intelligence for success in school. *Educational Leadership*, *48*, 35–39.
Sternberg, R. J., & Powell, J. S. (1983a). Comprehending verbal comprehension. *American Psychologist*, *38*, 878–893.
Sternberg, R .J., & Powell, J. S. (1983b). The development of intelligence. In P. H. Mussen (Series Ed.), J. Flavell, & E. Markman (Vol. Eds.), *Handbook of child psychology*, *vol. 3* (3rd ed.) (pp. 341–419). New York: Wiley.
Sternberg, R. J., & Rifkin, B. (1979). The development of analogical reasoning processes. *Journal of Experimental Child Psychology*, *27*, 195–232.

Sternberg, R. J., Torff, B., & Grigorenko, E. L. (1998). Teaching triarchically improves school achievement. *Journal of Educational Psychology*, *90*(3), 1–11.

Sternberg, R. J., Wagner, R. K., & Okagaki, L. (1993). Practical intelligence: the nature and role of tacit knowledge in work and at school. In H. Reese, & J. Puckett (Eds.), *Advances in lifespan development* (pp. 205–227). Hillsdale, NJ: Lawrence Erlbaum Associates.

Sternberg, R. J., & Weil, E. M. (1980). An aptitude–strategy interaction in linear syllogistic reasoning. *Journal of Educational Psychology*, *72*, 226–234.

Tetewsky, S. J., & Sternberg, R. J. (1986). Conceptual and lexical determinants of nonentrenched thinking. *Journal of Memory and Language*, *25*, 202–225.

Wagner, R. K. (1987). Tacit knowledge in everyday intelligent behavior. *Journal of Personality and Social Psychology*, *52*, 1236–1247.

Wagner, R. K., & Sternberg, R. J. (1985). Practical intelligence in real-world pursuits: the role of tacit knowledge. *Journal of Personality and Social Psychology*, *49*, 436–458.

Williams, W. M., Blythe, T., White, N., Li, J., Gardner, H., & Sternberg, R. J. (2002). Practical intelligence for school: developing metacognitive sources of achievement in adolescence. *Developmental Review*, *22*, 162–210.

Williams, W. M., Blythe, T., White, N., Li, J., Sternberg, R. J., & Gardner, H. I. (1996). *Practical intelligence for school: a handbook for teachers of grades 5–8*. New York: HarperCollins.

Wober, M. (1974). Towards an understanding of the Kiganda concept of intelligence. In J. W. Berry, & P. R. Dasen (Eds.), *Culture and cognition: readings in cross-cultural psychology* (pp. 261–280). London: Methuen.

Yang, S., & Sternberg, R. J. (1997). Taiwanese Chinese people's conceptions of intelligence. *Intelligence*, *25*, 21–36.