THE BEHAVIORAL AND BRAIN SCIENCES (1984) 7, 269–315
Printed in the United States of America

Toward a triarchic theory of human intelligence

Robert J. Sternberg
Department of Psychology, Yale University, New Haven, Conn. 06520

Abstract: This article is a synopsis of a triarchic theory of human intelligence. The theory comprises three subtheories: a contextual subtheory, which relates intelligence to the external world of the individual; a componential subtheory, which relates intelligence to the individual's internal world; and a two-facet subtheory, which relates intelligence to both the external and internal worlds. The contextual subtheory defines intelligent behavior in terms of purposive adaptation to, shaping of, and selection of real-world environments relevant to one's life. The normal course of intelligent functioning in the everyday world entails adaptation to the environment; when the environment does not fit one's values, aptitudes, or interests, one may attempt to shape the environment so as to achieve a better person–environment fit; when shaping fails, an attempt may be made to select a new environment that provides a better fit. The two-facet subtheory further constrains this definition by regarding as most relevant to the demonstration of intelligence contextually intelligent behavior that involves either adaptation to novelty, automatization of information processing, or both. Efficacious automatization of processing allows allocation of additional resources to the processing of novelty in the environment; conversely, efficacious adaptation to novelty allows automatization to occur earlier in one's experience with new tasks and situations. The componential subtheory specifies the mental mechanisms responsible for the learning, planning, execution, and evaluation of intelligent behavior. Metacomponents of intelligence control one's information processing and enable one to monitor and later evaluate it; performance components execute the plans constructed by the metacomponents; knowledge-acquisition components selectively encode and combine new information and selectively compare new information to old so as to allow new information to be learned.

Keywords: abilities; adaptation; cognition; culture; environmental context; individual differences; information processing; intelligence; learning; novelty; relativism

A triarchic theory of human intelligence

The goal of this article is to present a synopsis of a new "triarchic" theory of human intelligence. The theory is "triarchic" in the sense that it comprises three subtheories that serve as the governing bases for specific models of intelligent human behavior. The theory is believed to go beyond many previous theories in its scope, and to answer a broader array of questions about intelligence than has been answered in the past by single theories. The article cannot present all details of the theory, which requires a book-length presentation (Sternberg, in press). Nevertheless, sufficient detail will be presented to convey the scope of the theory and a sense of the kinds of questions it can (and cannot) handle.

The triarchic theory of human intelligence comprises three subtheories. The first subtheory relates intelligence to the external world of the individual, specifying three classes of acts – environmental adaptation, selection, and shaping – that characterize intelligent behavior in the everyday world. This subtheory is thus one of a set of contextual theories of intelligence that emphasize the role of environmental context in determining what constitutes intelligent behavior in a given milieu (see, e.g., Berry 1981; Charlesworth 1979a; 1979b; Dewey 1957; Laboratory of Comparative Human Cognition 1982; Neisser 1976). The second subtheory specifies those points along the continuum of one's experience with tasks or situations that most critically involve the use of intelligence. In particular, the account emphasizes the roles of novelty (see also Cattell 1971; Fagan & McGrath 1981; Guilford 1967; 1982; Horn 1968; Kaufman & Kaufman 1983; Raaheim 1974; Snow 1981) and of automatization (see also Lansman, Donaldson, Hunt & Yantis 1982; Perfetti, in press) in intelligence. The third subtheory relates intelligence to the internal world of the individual, specifying the mental mechanisms that lead to more and less intelligent behavior. This subtheory specifies three kinds of information-processing components (processes) that are instrumental in (a) learning how to do things, (b) planning what things to do and how to do them, and (c) actually doing the things. This subtheory is thus compatible in many respects with other current cognitive theories that emphasize the role of information processing in intelligence (e.g., Campione & Brown 1979; Carroll 1981; Hunt 1980; Jensen 1979; Pellegrino & Glaser 1980; Snow 1979).

The three subtheories in combination provide a rather broad basis for characterizing the nature of intelligent behavior in the world and for specifying the kinds of tasks that are more and less appropriate for the measurement of intelligence. The contextual subtheory specifies the potential set of *contents* for behaviors that can be characterized as intelligent. It addresses the question of which behaviors are intelligent for whom, and where these behaviors are intelligent. The two-facet subtheory spec-

 0140-525X/84/020269-47/$06.00

ifies the relation between intelligence as exhibited on a task or in a situation, on the one hand, and the *amount of experience* with the task or situation, on the other. It addresses the question of when behaviors are intelligent for a given individual. The componential subtheory specifies the potential set of *mental mechanisms* that underlies intelligent behavior, regardless of the particular behavioral contents. It addresses the question of how behaviors are intelligent in any given setting.

The first subtheory is "relativistic" with respect to both individuals and the sociocultural settings in which they live. What constitutes an intelligent act may differ from one person to another, although the needs for adaptation, selection, and shaping of environments do not. The second subtheory is relativistic only with respect to the points at which novelty and automatization are relevant for a given individual. But the relevance of the two facets to intelligence is perceived to be universal. The third subtheory is universal: Although individuals may differ in which mental mechanisms they apply to a given task or situation, the potential set of mental mechanisms underlying intelligence is viewed to be the same across all individuals and sociocultural settings. Thus, the vehicles by which one might wish to measure intelligence (test contents, modes of presentation, formats for test items, etc.) will probably need to differ across sociocultural groups, and possibly even within such groups: but the underlying mechanisms to be measured and their functions in dealing with novelty and in becoming automatized do not differ across individuals or groups.

The context of intelligence

Although many of us act as though intelligence is what intelligence tests measure (Boring 1923; Jensen 1969), few of us believe it. But if intelligence is not identical to what tests measure, then what is it? The approach taken here is that of first conceiving of intelligence in terms of the context in which it occurs.

Consideration of the nature of intelligence will be limited in this article to *individual* intelligence. Although the intellectual level of group accomplishments may be measurable in some sense, and has been shown to be important in a variety of contexts (see, e.g., Laboratory of Comparative Human Cognition 1982), this issue would take the present article too far from its intended purpose. Hence, group intelligence is not dealt with here.

Why propose a contextual framework for understanding intelligence and even theories of intelligence? I believe there are at least three important reasons.

First, a contextual view offers an escape from the vicious circularity that has confronted much past research on intelligence, in which an attempt is made to escape from old conceptions of intelligence (such as the psychometric one that gave rise to IQ tests) by creating new conceptions (such as the information-processing one); the new conceptions are then validated (or invalidated!) against the old conceptions for lack of any better external criteria (see Neisser 1979). There is a need to generate some kind of external standard that goes beyond the view, often subtly hidden, that intelligence is what IQ tests happen to measure. For, whatever its operational appeal, this view lacks substantive theoretical grounding, and when IQ test scores are used as the "external" criterion against which new theories and tests are validated, one is essentially accepting this operational view.

Second, a contextual view of intelligence provides a perspective on the nature of intelligence that is frequently neglected in contemporary theorizing. The bulk of the contemporary research deals with intelligence in relation to the internal world of the individual (see, e.g., Resnick 1976; Sternberg 1982a; 1982b; Sternberg & Powell 1982). Such research provides a means for understanding intelligence in terms of the cognitive processes and structures that contribute to it but has little or nothing to say about intelligence in relation to the individual's external world. If one views intelligence at least in part in terms of adaptive behavior in the real-world environment (as even psychometric theorists, such as Binet and Simon, 1973, and Wechsler, 1958, have done), then it is impossible to understand fully the nature of intelligence without understanding how this environment shapes what constitutes intelligent behavior in a given sociocultural context. "Internal" analyses can elucidate the cognitive and other processes and structures that help form intelligent behavior, and external, contextual analyses can elucidate which behaviors or classes of behavior are intelligent in a given environment or class of environments. The two kinds of analyses thus complement each other.

Third, a contextual viewpoint is useful in countering the predictor–criterion confusion that is rampant in current thinking about intelligence on the part of both lay people and experts. This confusion – epitomized by the view that intelligence is what IQ tests test – results when the intelligence tests (whether they are called "intelligence tests," "mental ability tests," "scholastic aptitude tests," or whatever else) come to be viewed as better indicators of intelligence than the criterial, real-world intelligent behaviors they are supposed to predict. Many of us are familiar with admission and selection decisions where performance in tasks virtually identical to the criteria for such decisions is neglected in favor of test scores that have modest predictive validity, at best, for the criterial behaviors. Often, lower (or higher) test scores color the way all other information is perceived. There seems to be a need to study intelligence in relation to real-world behavior, if only as a reminder that it is this behavior, and not behavior in taking tests that are highly imperfect simulations and predictors of such behavior, that should be of central interest to psychologists and others seeking to understand intelligence.

Contextualist approaches to intelligence are nothing new, and the views presented here draw upon or are compatible with the views of many others who have chosen to view intelligence in a contextual perspective, for example, Berry (1974; 1980a; 1981), Charlesworth (1976; 1979a; 1979b), Cole (1979–1980) and his colleagues (Laboratory of Comparative Human Cognition 1982; 1983), Dewey (1957), Ford and Miura (in preparation), Gordon and Terrell (1981), Keating (1984), and Neisser (1976; 1979). My purpose is to present a contextualist view in one place and, especially, to consider it in light of objections that have been or might be raised against it. Although my own views derive from and draw upon the views of others, I of course make no claim to represent anyone else's position: Contextualist views, like other views, are subject to considerable variation and disagreement (see Sternberg & Salter 1982).

A contextualist subtheory of intelligence

Although it is not possible to summarize all of the various contextualist views in detail, it seems to be fair to describe contextualist theories as representing regions on a continuum of the purported cultural specificity of intelligence. These theories, then, vary in the degree to which they view intelligence as a culturally specific entity. Consider four such theories, each of which is successively less extreme in the degree of cultural specificity it asserts.

At one extreme, Berry (1974) has taken a position he refers to as radical cultural relativism. This "position requires that indigenous notions of cognitive competence be the sole basis for the generation of cross-culturally valid descriptions and assessments of cognitive capacity" (p. 225). According to this view, then, intelligence must be defined in a way that is appropriate to the contexts in which the people of each particular culture reside.

The members of the Laboratory of Comparative Human Cognition (1982) have asserted that the radical cultural relativist position does not take into account the fact that cultures interact. According to their view, it is possible to make a kind of "conditional comparison," in which the investigator sees how different cultures have organized experience to deal with a single domain of activity. This comparison is possible, however, only if the investigator is in a position to assert that performance of the task or tasks under investigation is a universal kind of achievement, and if the investigator has a developmental theory of performance in the task domain. This position thus asserts that certain conditional kinds of comparisons are possible in the domain of intelligence.

Still less "radical" is the position of Charlesworth (1979a; 1979b), whose "ethological" approach to studying intelligence has focused upon "intelligent behavior as it occurs in everyday, rather than in test, situations – and how these situations may be related to changes in it over ontogenesis" (Charlesworth 1979a, p. 212). Charlesworth distinguishes between intelligence of the kind that has been studied by psychometricians and intelligence of the kind that is of particular survival or adaptive value. He believes it necessary to concentrate on the latter kind of intelligence, especially because "test psychologists generally view test performance as a way of indexing the individual's adaptive potential, but take virtually no cognizance of the environmental conditions which tap this potential and influence its expression over ontogenesis" (Charlesworth 1979a, p. 212).

Least "radical" is the position taken by contextualists such as Keating (1984), and Baltes, Dittmann-Kohli, and Dixon (1982), who have combined contextual positions with more or less standard kinds of psychological research and experimentation. For example, Baltes has conducted fairly standard kinds of psychometric research (see, e.g., Baltes & Willis 1979; 1982), but has combined this research with a contextual position on it. Of course, not all contextualists are as optimistic as Baltes regarding the reconcilability of contextual and psychometric kinds of theorizing (see Labouvie-Vief & Chandler 1978).

To summarize, I have considered four (from among many) contextual positions that differ in their degree of radical contextual relativism. The positions range from one of extreme contextual relativism (Berry) to one in which contextualism is in some sense integrated with conventional kinds of psychometric theorizing (Baltes). In the next section of the article, I will present my own contextual view. Like Baltes and others, I believe an integration between standard kinds of theorizing – in my case, both psychometric and information-processing – is possible. My integration is rather different, however, from those previously proposed.

Contextual definition of intelligence and some constraints upon it

I view intelligence in context as consisting of *purposive adaptation to, shaping of, and selection of real-world environments relevant to one's life.* This definition is, of course, extremely general, and further constraints will be placed upon it later. Thus, this view is a starting point rather than a finishing point for a definition of intelligence. Consider what constraints this definition does have.

The real world. First, I define intelligence in terms of behavior in real-world environments. I do so deliberately to exclude fantasy environments, such as might be invented in dreams or constructed by and for the minds of certain of the mentally ill. I would include in the domain of real-world environments those found in some laboratory settings and in certain testing situations that, no matter how artificial or trivial they may be, nevertheless exist in the real world. It is as much a mistake to exclude testlike behavior from one's view of intelligence as it is to rely upon it exclusively.

Relevance. Second, I define intelligence in terms of behavior in environments that are relevant to one's life. The intelligence of an African pygmy could not legitimately be assessed by placing the pygmy in a North American culture and using North American tests, unless it were relevant to test the pygmy for survival in a North American culture and one wished to assess the pygmy's intelligence for this culture (for example, if the pygmy happened to live in our culture and had to adapt to it). Similarly, a North American's intelligence could not be legitimately assessed in terms of adaptation to pygmy society unless adaptation to that society were relevant to the person's life. (See Cole, 1979–1980, and McClelland, 1973, for further perspectives on the importance of relevance to the understanding and assessment of intelligence.) There is one qualification of the relevance criterion, however. As will be discussed later, tasks and situations serve as particularly apt measures of intelligence when they involve some, but not excessive, novelty. Thus, a task requiring a North American to adapt to aspects of a pygmy environment might serve well to measure the North American's intelligence, but only in comparison with other North Americans for whom the task would be equally novel. Similarly, pygmies might be compared with respect to intelligence by their ability to adapt to certain aspects of North American culture. In this case, one is measuring ability to adapt to novelty, an important aspect of adaptation in any culture. A problem arises only when one attempts to compare individuals on the same task across cultures for whom the task is not equally novel. In this case, the task is not measuring the same thing for different individuals. Unfortunately, it is precisely this kind of cross-cultural comparison, which I believe to be invalid, that serves as the basis for much research seeking to compare the levels of intelligence of various individuals and groups from different cultures.

An implication of this view is that intelligence cannot be fully understood outside a sociocultural context, and that it may in fact differ for a given individual from one culture to the next. Our more intelligent individuals might be found to be much less intelligent in another culture, and some of our less intelligent individuals might be found more intelligent. Consider, for example, a person who is deficient in the ability to negotiate a large-scale spatial environment. Such people are often referred to as lacking a good "sense of direction." Although they can usually navigate through old, familiar terrain with little or no difficulty, they may find it difficult to navigate through new and unfamiliar terrains. To someone who comes from a sociocultural milieu where people spend their lives in highly familiar environments, such as their hometown plus a few surrounding towns and cities, the idea of large-scale spatial navigation would never enter into the conception of intelligence, and such navigation would be an essentially unknown cognitive skill. Navigation in unfamiliar spatial terrains would simply be irrelevant to such people's lives, just as the ability to shoot accurately with a bow and arrow is irrelevant to our lives. Were such navigation to become relevant in the sociocultural milieu, then what is "intelligent" would change for that culture. In the Puluwat culture, for example, large-scale spatial navigational ability would be one of the most important indices of an individual's adaptive intelligence (Berry 1980a; Gladwin 1970; Neisser 1976).

One need not go to exotic cultures to find effective differences or changes in what constitutes intelligent behavior. As Horn (1979) has pointed out, the advent of the computer seems likely to change what constitutes intelligent performance in our society. For example, numerical calculation was an important part of some intelligence tests, such as Thurstone and Thurstone's (1962) Primary Mental Abilities Test. But with the advent of cheap calculators and ever cheaper computers, the importance of numerical calculation skill in intelligent behavior seems to be declining. Certainly, using numerical calculation as one of five subtests measuring intelligence, or as the sole or main index of number skill, would seem inappropriate today, no matter how appropriate it may have seemed when the Thurstones devised their test – or even a few years ago when numerical calculation skill was a central part of people's lives in school and out (balancing checkbooks, keeping track of expenses, and so on). The importance of quantitative expertise to adaptive functioning has probably not changed; but what such expertise consists of may well have changed, at least with respect to the requirements of life in today's society. Thus, even in our own culture, we see changes over time, no matter how slow, in what constitutes intelligence. Businesses interested in assessing the intelligence of today's job applicants are much more likely to be concerned about skills in learning to use and in using electronic media, and much less concerned about calculational skills, than they were just a few years ago.

Purposiveness. Third, intelligence is purposive. It is directed toward goals, however vague or subconscious those goals may be. These goals need not be the attainment of the maxima of the goods most valued by society, for example, money, fame, or power. Rather, one may be willing to strive for less of one commodity in the hope of attaining more of another.

Adaptation. Fourth, intelligence is adaptive. Indeed, definitions of intelligence have traditionally viewed intelligence in terms of adaptation to one's environment (see, e.g., Intelligence and its measurement 1921). Adaptation consists of trying to achieve a good fit between oneself and one's environment. Such a fit will be obtainable in greater or lesser degree. But if the degree of fit is below what one considers satisfactory for one's life, then the adaptive route may be viewed, at a higher level, as maladaptive. For example, a partner in a marriage may be unable to attain satisfaction within the marriage; or an employee of a business concern may have values so different from those of the employer that a satisfactory fit does not seem possible; or one may find the situation one is in to be morally reprehensible (as in Nazi Germany). In such instances, adaptation to the present environment does not present a viable alternative to the individual, and the individual is obliged to try something other than adaptation to the given environment. Thus, it may be incorrect simply to equate intelligence with adaptation to the environment.

Shaping. Fifth, intelligence involves shaping the environment. Environmental shaping is used when one's attempts to adapt to the given environment fail. One then attempts to reshape it to increase one's fit with it. The marital partner may attempt to restructure the marriage; the employee may try to persuade an employer to see or do things differently; the citizen may try to change the government, through either violent or nonviolent means. In each case, however, the individual attempts to change the environment so as to result in a better fit rather than merely attempting to adapt to what is already there.

What this means is that there may be no one set of behaviors that is "intelligent" for everyone, because people can adjust to their environments in different ways. Whereas the components of intelligent behavior are probably universal, their use in the construction of environmentally appropriate behavior is likely to vary not only across groups, but across individuals.

What does seem to be common among people mastering their environments is the ability to capitalize upon strengths and to compensate for weaknesses (see Cronbach & Snow 1977). Successful people are not only able to adapt well to their environments, but actually modify the environments they are in so as to maximize the fit between the environment and their adaptive skills.

Consider, for example, the "stars" in any given field of endeavor. What is it that distinguishes such persons from all the rest? Of course, this question, as phrased, is broad enough to be the topic of a book, and indeed, many books have been written about it. For present purposes, however, the distinguishing characteristics to which I would like to call attention are (a) at least one extraordinarily well developed skill, and (b) an extraordinary ability to capitalize upon that skill or skills in their work. For example, generate a short list of "stars" in your own field. Chances are that the stars do not seem to share any one ability, as traditionally defined, but rather share a tendency toward having some set of extraordinary talents that they make the most of in their work. My own list would include a person with extraordinary spatial visualization skills (if anyone can visualize in four dimensions, he can!), a person with a talent for coming up with highly counterintuitive findings that are of great theoretical importance, and a person who has a remarkable sense of where the field is going and repeatedly tends to be just one step ahead of it so as to time the publication of his work for maximum impact. These three particular persons (and others on my list) share little in terms of what sets them apart, aside from at least one extraordinary talent upon which they capitalize fully in their work. Although they are also highly intelligent in the traditional sense, so are many others who never reach their heights of accomplishment.

Because what is adaptive differs at least to some degree, both across people and across situations, the present view suggests that intelligence is not quite the same thing for different people and in different situations. The higher-order skills of capitalization and compensation may be the same, but what is capitalized on and what is compensated for will vary. The differences across people and situations extend beyond different life paths within a given culture.

Selection. Sixth, *intelligence involves the active selection of environments.* When adaptation is not possible or desirable, and when shaping fails, one may attempt to select an alternative environment with which one is able, or potentially able, to attain a better contextual fit. In essence, the person recognizes that attempts to succeed within the given environment have not worked, and that attempts to mold that environment to one's values, abilities, or interests have also not worked; it is time to move out of that environment and find a new one that suits one better. For example, the partner may leave the marriage; the employee may seek another job; the resident of Nazi Germany might have attempted to emigrate. Under these circumstances, the individual considers the alternative environments available and attempts to select that environment, within the constraints of feasibility, with which maximal fit will be attained. Sometimes this option is not feasible, however. For example, members of certain religions may view themselves as utterly committed to their marriages, or an individual may decide to stay in a marriage on account of the children, despite its lack of appeal; or the employee may not be able to attain another job, either from lack of positions, lack of qualifications, or both; or the individual wishing to leave the country may lack permission or the resources to leave.

Consider how environmental selection can operate in career choices. A rather poignant set of real-world examples is provided in Feldman's (1982) account, *Whatever Happened to the Quiz Kids?* The quiz kids were selected for the radio show, and later the television show of the same name, for a number of intellectual and personal traits. Existing records suggest that all or almost all of them had exceptionally high IQs, typically well over 140 and, in some cases, over 200. Yet, one cannot help but be struck by how much less distinguished their later lives have been than their earlier lives, often even by their own standards. There are undoubtedly many reasons for this lesser later success, including statistical regression effects. What is striking in biography after biography is that the ones who were most successful were those who found what they were interested in and good at and then pursued it relentlessly. The less successful ones had difficulty in finding any one thing that interested them, and in a number of cases floundered while trying to find a niche for themselves.

Measurement of contextually directed intelligence

We have made several attempts to measure intelligence as it applies to real-world contexts. I will describe two of these approaches here.

One approach we have taken to understanding intelligence as it operates in the everyday world is that underlying successful performance in many real-world tasks is a set of judgmental skills based upon tacit understanding of a kind that is never explicitly taught, and, in many instances, never even verbalized. Interviews with prominent business executives and academic psychologists – the two populations that served as the bases for our initial studies – revealed a striking level of agreement that a major factor underlying success in each occupation is a knowledge and understanding of the ins and outs of the occupation. These ins and outs are generally learned on the job rather than in any preparatory academic or other work. To measure potential for occupational success, therefore, one might wish to go beyond conventional ability and achievement tests to the measurement of individuals' understanding of and judgment in using the hidden agenda of their field of endeavor.

In particular, we have found three kinds of tacit understanding to be particularly important for success, namely, understanding regarding managing (a) oneself, (b) others, and (c) one's career (Wagner & Sternberg in press). These understandings and the judgments based upon them were measured by items drawing upon decisions of the kinds one typically has to make in the everyday professional or business world. Separate questionnaires were constructed for the business executives and academic psychologists. For example, one item on each questionnaire presented the situation of a relatively inexperienced person in the field who had to decide which tasks were more or less urgent. Subjects rated the priorities of the various tasks. Another item presented various criteria that could be used in judging the success of an executive or an academic psychologist, and subjects had to rate how important each criterion was. Yet another item presented various considerations in deciding which projects to work on; subjects had to decide how important each of the various considerations was in deciding which project to work on. Subjects receiving the psychology questionnaire were a national sample of university psychology faculty and graduate students as well as a sample of Yale undergraduates; subjects receiving the business questionnaire were national samples of business executives and business graduate students, executives at a local bank, and Yale undergraduates. Scores on the questionnaires were correlated at about the .4 level with measures of success among members of each occupation, such as number of articles published in a year or published rating of the university with which a subject was affiliated for academics, and merit salary increases and performance ratings for the business executives. The subscale most highly correlated with successful performance was that for managing one's career. Moreover, at least for the undergraduates, performance on the two questionnaires was uncorrelated with scores on a standard verbal reasoning test, indicating that the correlations with external measures of success were not obtained via a measure that was nothing more than a proxy for an IQ.

A second approach we have used in measuring intelligence in the everyday world is based on the notion that intelligence can be measured with some accuracy by the degree of resemblance between a person's behavior and the behavior of the "ideally" intelligent individual (see Neisser 1979). Sternberg, Conway, Ketron, and Bernstein (1981) had a group of individuals rate the extent to which each of 250 behaviors characterized their own behavioral repertoire. A second group of individuals rated the extent to which each of the 250 behaviors characterized the behavioral repertoire of an "ideally intelligent" person.

The behaviors that were rated had previously been listed by entirely different individuals as characterizing either "intelligent" or "unintelligent" persons. The intelligent behaviors were shown (by factor analysis) to fall into three general classes: problem-solving ability (e.g., "reasons logically and well," "identifies connections among ideas," and "sees all aspects of a problem"); verbal ability (e.g., "speaks clearly and articulately," "is verbally fluent," and "reads with high comprehension"); and social competence (e.g., "accepts others for what they are," "admits mistakes," and "displays interest in the world at large"). No attempt was made to classify the unintelligent behaviors, as they were not the objects of interest in the study.

We computed the correlation between each person's self-description and the description of the ideally intelligent person (as provided by the second group of individuals). The correlation provided a measure of the degree of resemblance between a real individual and the "ideally intelligent" individual. The claim was that this degree of resemblance is itself a measure of intelligence. The facts bore out this claim: The correlation between the resemblance measure and scores on a standard IQ test was .52, confirming that the measure did provide an index of intelligence as it is often operationally defined.

People's conceptions of intelligence can be used not only to predict their own scores on standard psychometric intelligence tests, but also to predict how people will evaluate the intelligence of others. We presented subjects with descriptions of persons in terms of the various intelligent and unintelligent behaviors that had been generated in our initial data collection. The subjects were asked to rate the intelligence of each person described on a 1-to-9 scale. We then attempted to predict people's ratings on the basis of the weights our theory assigned to each behavior in each description of a person. The correlation between predicted and observed ratings was .96. In making their ratings, people weighted the two more academic factors – problem solving and verbal abilities – more heavily than social competence, but all three factors received significant weightings in people's judgments.

Criticisms of the contextual view: Some responses and elaborations

I have outlined above some of the main features of a contextual view of the nature of human intelligence. Contextual views have been criticized in the past on a number of grounds, among them, their relativism, their seeming reinforcement of the status quo and inability to accommodate cultural change, their vagueness and lack of empirical verification, and their seeming over-inclusiveness, by which is meant their placing in the realm of intelligence mental and behavioral phenomena that many would place in other realms, such as those of personality and motivation. In this section I will describe and respond to each of these criticisms.

Relativism. It has been argued that contextualist views give up too much (Jonathan Baron, personal communication) – that they leave one essentially with no firm foundation for understanding the nature of intelligence, because "everything is relative." There are two bases for countering this argument.

First, I do not believe that everything is, in fact, relative. As I will discuss later, I believe that there are many aspects of intelligence that transcend cultural boundaries, and that are, in fact, universal. Moreover, I am aware of no evidence to suggest that either the hardware (anatomy and physiology) of cognitive functioning or the potential software (cognitive processes, strategies, mental representations, and so on) of such functioning differs from one culture or society to the next. What differ, however, are the weights, or importances, of various aspects of mental hardware and software as they apply to defining what constitutes intelligent behavior.

For example, the complex and interactive cognitive skills that are prerequisite for reading are to be found in varying degrees in all people in all sociocultural milieus, at least as far as we know. I include in such prerequisite skills not the knowledge that is taught to participants in literate cultures, but the skills such as pattern perception, articulatory ability, and comparison ability that can be developed but that exist in some amount in individuals whether or not they ever receive formal schooling. Whereas these skills may exist in some degree in members of every culture, however, their importance to intelligent behavior may differ radically from one culture to the next. The skills needed for reading, and especially those specifically relevant for reading but of little or no relevance for other tasks, will be much less important in a preliterate society than in a literate one. In contrast, coordination skills that may be essential to life in a preliterate society (e.g., those motor skills required for shooting a bow and arrow) may be all but irrelevant to intelligent behavior for most people in a literate and more "developed" society.

It is not probable that these skills exist in equal amounts across cultures: Some cultures are likely to put much more emphasis on developing certain kinds of skills than do others, which will in turn place their emphasis on developing other kinds of skills. As a result, two cultures may appear to show mean differences in levels of measured intelligence – but probably only when intelligence is measured in terms of the knowledge and skills required by one of the two (or more) cultures. Yet, it does not make sense to impose one culture's test upon another culture, no matter how fair the test may be for the first culture, unless the adaptive requirements of the two cultures are essentially the same. And even if the requirements are the same, there is no guarantee that a given test will measure the same skills equally well in the two cultures: The within-culture validity of the test needs to be demonstrated independently for the two cultures. Such sameness is probably a rare event. This argument applies as well to multiple subcultures within a single culture. And even if one could find a set of test items that measured just those skills that are common to the adaptive requirements of members of the two cultures, the test would be incomplete because it failed to measure the aspects of adaptation that are specific to but nevertheless relevant in each of the individual cultures; moreover, the test would probably be scored incorrectly in a way that assumed that the weights of the common elements in adaptation were the same across the two cultures.

Stability and change. One might – incorrectly, I believe – interpret the contextualist position as being unable to accommodate cultural change or as reinforcing the status quo. These objections are unfounded, however. In the contextualist view, the nature of intelligence can change within a single culture as well as between multiple cultures. In a rapidly developing culture, what constitutes intelligent performance may actually change over a relatively short span of time. As noted earlier, in our own culture it is likely that the logical skills needed for computer programming and management will become successively more important to intelligent performance in our society as calculational skills become successively less important.

There is, then, nothing in the contextualist view that either supports or vitiates the status quo. The contextualist view simply recognizes the changing nature over space and time of what constitutes intelligent behavior.

Vagueness and lack of empirical verification. Contextual theories tend to be vague, general, and lacking in empirical verification. One of the reasons for this state of affairs, I believe, is that contextual theories cannot make a go of things on their own: They need supplementation. A contextual theory sets a perspective from which one can understand the nature of intelligence, but it accounts for only a limited aspect of intelligence, namely, its relation to the external world. Thus, whereas one could argue that intelligent behavior is adaptive, it would seem that not all adaptive behavior is intelligent, at least in the traditional senses of the word. For example, to know how to put a ribbon in one's typewriter may be adaptive, but the ability and knowledge needed to put the ribbon in are not usually seen as important aspects of intelligence. Hence, I would claim that the problem with contextual theories is not that they are wrong, but rather that they are incomplete. They do not, for example, specify the cognitive skills that underlie adaptation to the environment. In the triarchic theory, contextualism serves as the basis for just one of three subtheories, so that questions not raised by contextualism can be addressed by other aspects of the theory. These other questions include those concerning what, more exactly, (a) are the relationships between amount of experience with a task or situation and the amount of intelligence required to perform on the task or in the situation, and (b) what are the mental mechanisms by which intelligent behaviors are accomplished.

Overinclusiveness. The contextualist view presented here is certainly highly inclusive in the sense that it includes within the realm of intelligence things that might typically be placed in the realms of personality or motivation (see also Baron 1982). For example, motivational phenomena relevant to purposive adaptive behavior – such as motivation to perform well in one's career – would be considered to be part of intelligence, broadly defined (see also Scarr 1981; Zigler 1971).

Another element included in the present view of intelligence is environmental selection. Obviously, one's choice of environment will be limited by many factors of luck over which one has no control. Indeed, the role in life of chance factors such as time and place is almost always passed over lightly in analyses of intelligence (but see Jencks 1972). One can scarcely be faulted for circumstances beyond one's control. The only circumstances relevant to the evaluation of intelligence are those in which one has some behavioral control and in which one has an adequate opportunity to express one's intelligence. The more control one has and the greater the opportunity for expressing intelligence, the more relevant the circumstances are for evaluating one's intelligence. It should be emphasized that I speak here of the control an individual *could* have: People often fail to realize the full extent to which they can control or at least influence their environments.

I would like to say, in closing this section, that the contextualist view is in no meaningful sense warmed-over Social Darwinism. The Social Darwinist viewpoint has never seemed to be well suited to taking into account life circumstances that are beyond one's control. The present view, on the other hand, is "conditionalized" upon such circumstances. What is adaptive for the ghetto-dweller may be different from what is adaptive for the wealthy suburbanite. They are from two distinct subcultures, which may differ as much as two national cultures, and comparing their adaptations may be inappropriate if the same behavioral criteria are used. Moreover, Social Darwinism usually becomes quite absolutist: The adaptive norm is set up as that of the dominant social class. The present view posits a pluralism of niches to which one may ultimately adapt, with the final niche partly determined by one's own choice and partly determined by life circumstances beyond one's control.

Facets of intelligence

One needs more constraints in a full theory of intelligence than contextual views can provide. The two-facet subtheory proposed here provides one set of further constraints.

A two-facet subtheory of intelligence

The two-facet subtheory proposes that a task measures "intelligence" to the extent that it requires either or both of two skills (the nature of which will be specified in greater detail in the next section): the ability to deal with novel kinds of task and situational demands and the ability to automatize information processing. These two abilities apply to the interaction between individuals, on the one hand, and tasks or situations, on the other, precisely at those points where the relation between the individual and the task or situation is most rapidly changing. This fast rate of change makes these two points (or regions) of experience most relevant for assessing intelligence. Consider each of these abilities in turn.

Ability to deal with novel task and situational demands

Novel tasks. The idea that intelligence involves the ability to deal with novel task demands is itself far from novel (see, e.g., Cattell 1971; Horn 1968; Kaufman & Kaufman 1983; Raaheim 1974; Snow 1981; Sternberg 1981a; 1982b). Sternberg (1981a) has suggested, in fact, that intelligence is best measured by tasks that are "nonentrenched" in the sense of requiring information processing of kinds outside people's ordinary experience. The task may be nonentrenched in the kinds of operations it requires, or in the concepts it requires the subjects to use. According to this view, then, intelligence involves

> not merely the ability to learn and reason with new concepts but the ability to learn and reason with new kinds of concepts. Intelligence is not so much a person's ability to learn or think within conceptual systems that the person has already become familiar with as it is his or her ability to learn and think within new conceptual systems, which can then be brought to bear upon already existing knowledge structures. (Sternberg 1981a, p. 4)

It is important to note that the usefulness of a task in measuring intelligence is not a linear function of task novelty. The task that is presented should be novel, but not totally outside the individual's past experience (Raaheim 1974). If the task is too novel, then individuals will not have any cognitive structures to bring to bear on it, and as a result, the task will simply be outside their range of comprehension. Calculus, for example, would be a highly novel field of endeavor for most 5-year-olds, but the calculus tasks would be so far outside their range of experience that they would be worthless for the assessment of 5-year-olds' intelligence. In Piagetian (1972) terms, the task should primarily require accommodation, but it must require some assimilation as well.

Implicit in the above discussion is the notion that novelty can be of two kinds, either or both of which may be involved in task performance. The two kinds of novelty might be characterized as involving (a) comprehension of the task and (b) acting upon one's comprehension of the task. Consider the meaning of each of these two kinds of novelty.

Novelty in comprehension of the task refers to the novelty that inheres in understanding the task confronting one. Once one understands the task, acting on it may or may not be challenging. In essence, the novelty is in learning how to do the task rather than in actually doing it. Novelty in acting on one's comprehension of the task refers to novelty in acting on a problem rather than in learning about the problem or how to solve it. The genre of task is familiar, but the parameters of the particular task are not. It is possible, of course, to formulate problems involving novelty in both comprehension and execution of a particular kind of task and problems that involve novelty in neither. The present account would suggest that problems of these two kinds might be less satisfactory measures of intelligence than problems involving novelty in either comprehension or execution, but not both, because the former problems might be too novel, whereas the latter problems might not be novel enough to provide optimal measures of intelligence.

Novel situations. The notion that intelligence is particularly aptly measured in situations that require adaptation to new and challenging environmental demands inheres both in expert and lay notions of the nature of intelligence (Intelligence and its measurement 1921; Sternberg et al. 1981). The idea is that one's intelligence is not best shown in run-of-the-mill situations that are encountered regularly in everyday life, but rather in extraordinary situations that challenge one's ability to cope with the environment to which one must adapt. Almost everyone knows someone who performs well when confronted with tasks that are presented in a familiar milieu, but who falls apart when presented with similar or even identical tasks in an unfamiliar milieu. For example, a person who performs well in the everyday environment might find it difficult to function in a foreign country, even one that is similar in many respects to the home environment. In general, some people can perform well only under situational circumstances that are highly favorable to their getting their work done. When the environment is less supportive, their efficacy is greatly reduced.

Essentially the same constraints that apply to task novelty apply to situational novelty as well. First, too much novelty can render the situation nondiagnostic of intellectual level. Moreover, there may exist situations in which no one could function effectively (perhaps as epitomized by the situation confronted by the protagonist in Sartre's *No Exit*). Second, situational novelty can inhere either in understanding the nature of the situation or in performing within the context of that situation. In some instances, it is figuring out just what the situation is that is difficult; in others, it is operating in that situation once one has figured out what it is.

Measurement of the ability to deal with novelty

I have attempted directly to measure individuals' skills in dealing with novel tasks using two different paradigms of research and measurement. (As I have not yet attempted directly to measure automatization, I will discuss only the issue of novelty here.) The first paradigm involved novelty primarily in task *comprehension*. The second paradigm involved novelty primarily in task *solution*.

The first paradigm involved presenting individuals with variants of a "concept projection" task. Consider just one of the five variants that were used (Sternberg 1982b). Individuals were presented with a description of the color of an object in the present day and in the year 2000. The description could be either physical – a green dot or a blue dot – or verbal – one of four color words, namely, *green, blue, grue,* or *bleen.* An object was defined as green if it appeared physically green both in the present and in the year 2000. An object was defined as blue if it appeared physically blue both in the present and in the year 2000. An object was defined as grue if it appeared physically green in the present but physically blue in the year 2000 (i.e., it appeared physically green until the year 2000 and physically blue thereafter). An object was defined as bleen if it appeared physically blue in the present but physically green in the year 2000 (i.e., it appeared physically blue until the year 2000 and physically green thereafter). (The terminology is based upon Goodman, 1955.)

Because each of the 2 descriptions (one in the present and one in the year 2000) could take one of either 2 physical forms or 4 verbal forms, there were 36 (6×6) different item types. The individual's task was to describe the object in the year 2000. If the given description for the year 2000 was a physical one, the subject had to indicate the correct verbal description of the object; if the given description for the year 2000 was a verbal one, the subject had to indicate the correct physical description of the object. There were always three choices from which the subject had to choose the correct answer. There were many complexities in the task, which cannot be described here, that rendered the problems quite challenging for the subjects. For example, certain types of items presented inconsistencies, and other types presented information that was only partially valid.

Performance on the task was modeled by an information-processing model of task performance. The model accounted for an average of 92% of the variance in the response-time data (averaged over five variants of the task and five sets of subjects). The median correlation between task performance and scores on a battery of inductive reasoning tests (taken from standard intelligence measures) was $-.62$ (with the correlation negative because response times were being correlated with the number of correct answers on the reasoning tests). Most important, however, was that when individual processing-component scores were correlated with the reasoning measures, it was precisely those components that measured ability to deal with novelty (e.g., time spent in switching from one conceptual system to another, and time spent in recognizing physical transformations from one time period to another) that correlated with the induction tests. The results therefore suggested that it was ability to deal with novelty, rather than more conventional aspects of test performance, that were critical to measuring subjects' reasoning skills.

The second type of novel task involved "insight" problems of the kinds found in puzzle books at any bookstore. Consider some examples of the insight problems we used (Sternberg & Davidson 1983):

1. If you have black socks and brown socks in your drawer, mixed in the ratio of 4 to 5, how many socks will you have to take out to make sure of having a pair the same color?
2. Water lilies double in area every 24 hours. At the beginning of the summer there is one water lily on a lake. It takes 60 days for the lake to become covered with water lilies. On what day is the lake half-covered?

We theorized that three kinds of insights are involved in problems such as these. The first kind of insight, *selective encoding,* involves recognizing those elements of a problem that are relevant for task solution, and those elements that are not. For example, Fleming's discovery of penicillin involved an insight of selective encoding, in that Fleming recognized that the mold that had ruined his experiment had done so by killing off the bacteria in a petri dish. Thus was born the first of the modern antibiotics through a selective encoding of information that would have escaped most scientists. The second kind of insight, *selective combination,* involves figuring out how to combine information that has been selectively encoded. Such information can typically be combined in many ways, only one of which is optimal. For example, Darwin's formulation of the theory of evolution hinged upon his recognizing how the multitudinous facts he and others had collected about species could be combined to yield an account of the transition between species over the course of time. The third kind of insight, *selective comparison,* involves figuring out how new information can be related to old information. For example, Kekulé's discovery of the structure of the benzene ring hinged upon his recognizing that a dream he had had of a snake reaching back and biting its tail provided the basis for the geometric structure of the ring.

We used these problems to test our theory of insight (Davidson & Sternberg 1983; Sternberg & Davidson 1982; 1983). The main question we addressed was whether we could isolate selective encoding, selective combination, and selective comparison in subjects' performance. We were in fact able to isolate all three processes by manipulating the amount of information given to subjects solving problems. In particular, subjects would receive the insight problems either with or without pre-cuing by one of the three kinds of insights. Providing subjects with each of the three kinds of insights substantially improved performance, especially for less able subjects who were less likely to have the insights on their own.

We also sought to determine whether the ability to deal with these novel problems provided a good measure of intelligence. Note that the novelty in these problems is not in understanding the instructions (which are straightforward – namely, to solve the problems), but rather in coming up with a strategy for task solution. Although some of the problems can be solved by conventional algorithms, the problems typically could be solved more easily by shortcuts or heuristics that are not standardly taught in mathematics classes. Solution of problems such as these requires a fair amount of insight, but very little in the way of prior mathematical knowledge. And performance on such problems is correlated about .6 to .7 with IQ. Thus, insight problems measure something related but not identical to what IQ tests measure. What they add to IQ test measurement, however, would seem to be an important part of intelligence, broadly defined.

Ability to automatize information processing

The proposed model of automatization of information processing proposes that controlled information processing is under the conscious direction of the individual and is hierarchical in nature, with executive processes (processes used to plan, monitor, and revise strategies of information processing) directing nonexecutive processes (processes used actually to carry out the strategies that the executive processes select, monitor, and revise). Automatic information processing is preconscious, not under the conscious direction of the individual, and nonhierarchical in nature: There is no functional distinction between executive and nonexecutive processes. Instead, production is in the mode of a production system, where all kinds of processes function at a single level of analysis. In processing information from new domains (and especially novel ones of the kind considered above), the individual relies primarily upon controlled, global processing. A central executive directly activates nonexecutive processes, and receives direct feedback from them. Information processing is of strictly limited capacity, and attention is focused upon the task at hand. The total knowledge base stored in long-term memory is available for access by the processes used in the given task and situation.

In processing information from old domains or domains that are entrenched by nature, the individual relies primarily upon automatic, local processing. A central executive initially activates a system consisting of locally applicable processes and a locally applicable knowledge base. Multiple local systems can operate in parallel. Performance in these systems is automatic and of almost unlimited capacity; attention is not focused upon the task at hand. Only knowledge that has been transferred to the local knowledge base is available for access by the processes utilized in a given task and situation. A critical point is that activation is by executive processes in the global system to the local system as a whole. The executive processes can instantiate themselves as part of this local system; when used in this instantiation, they do not differ functionally from processes of any other kind.

The domains in which one has little expertise have processing that is largely focused in the global processing and knowledge system. As expertise develops, greater and greater proportions of processing are transferred to (or packed into) a given local processing system. The advantage of using the local system is that the system as a whole is activated, rather than individual processes within the system, so that the amount of attention that needs to be devoted to use of the domain is much less than it is under global control. Indeed, attention allocation for a whole local system is comparable to that for a single lower-order process activated by the global system as part of the global system's functioning. The disadvantages of using the local system are that it is able to call upon only a limited knowledge base, in particular, that base that has been packed into that local system, and that the local system is able to call upon only those processes that have been packed into the local system. Experts are able to handle a wide variety of situations through the use of the local system, because they have packed tremendous amounts of information into it. Novices can hardly use local systems at all, because these systems have as yet acquired relatively few processes and relatively little knowledge.

Control passes to a local processing system when an executive process recognizes a given situation as one for which a local system is potentially relevant. The local system is presumed to be of the nature of a production system, with a set of productions ready to act upon the problem at hand. The productions comprise functions that are executive in nature, as well as functions that are not. But all of these functions are integrated into a single, nonhierarchical system. Control is passed back to the global processing system when, during task performance, none of the productions in a system is able to satisfy a given presented condition. When the bottom of the production list is reached and no given condition is satisfied, global processing is necessary to decide how to handle the new task or situation. Once this task or situation is successfully handled, it is possible to pack what has been learned from global processing of the new experience into a given local processing system, so that the next time such a situation is encountered, there will be no need to exit from the local processing system. According to this view, the extent to which one develops expertise in a given domain largely depends on the ability of the individual to pack new information, in a usable way, into a given local processing system and on the ability to gain access to this information as needed.

The experts are at an advantage in their domain of expertise, because their ability to stay for longer periods of time in the better-developed local processing system enables them to free global processing resources for what, to them, are new situations. Novices are overwhelmed with new information, and must engage global resources so frequently that most of the new information encountered is quickly lost. Therefore, the experts are more competent in handling familiar tasks within the domain of expertise. They are also more proficient at learning new tasks, because global processing resources are more readily available for the intricacies of the task or situation confronted. In essence, a loop is set up whereby packing more information and processes into the local system enables them to automate more processing, and thus to have global resources more available for what is new in a given task or situation. Experts are also able to perform more distinct kinds of tasks in parallel, because whereas the global processing system is conscious and serial in its processing, multiple local processing systems can operate in parallel. For novices, for example, driving a car consumes almost all of their available global resources. For experts, driving a car consumes local resources and leaves central resources available for other tasks, unless a new situation (such as a roadblock) is confronted that requires redirection of control to their global resources.

To summarize, the present view essentially combines hierarchical and nonhierarchical viewpoints by suggesting that information processing is hierarchical and controlled in a global processing mode, and nonhierarchical and automatic in local processing modes. Expertise develops largely from the successively greater assumption of information processing by local resources. When these local resources are engaged, parallel processing of multiple kinds of tasks becomes possible. Global resources, however, are serial and of very limited capacity in their problem-solving capabilities.

Automatization as a function of task. Many kinds of tasks requiring complex information processing seem so intricate that it is a wonder we can perform them at all. Consider reading, for example. The number and complexity of operations involved in reading is staggering, and what is more staggering is the rate at which these operations are performed (e.g., Crowder 1982; Just & Carpenter 1980). Performance of tasks as complex as reading would seem to be possible only because a substantial proportion of the operations required in reading are automatized and thus require minimal mental effort (see Schneider and Shiffrin, 1977, and Shiffrin and Schneider, 1977, for a discussion of the mental requirements of tasks involving controlled and automatized information processing). Deficiencies in reading have been theorized to result in large part from failures in automatization of operations that in normal readers have been automatized (LaBerge & Samuels 1974; Sternberg & Wagner 1982).

The proposal being made here is that complex verbal, mathematical, and other tasks can be executed only because many of the operations involved in their performance have been automatized. Failure to automatize such operations, whether fully or in part, results in a breakdown of information processing and hence less intelligent task performance. Intellectual operations that can be performed smoothly and automatically by more-intelligent individuals are performed only haltingly and under conscious control by less-intelligent individuals.

As in the case of novelty, automatization can occur either in task comprehension, task execution, or both. Consider how each of these kinds of automatization operates in various tasks.

The standard synonyms test used to measure vocabulary is highly familiar to most middle-class students at or above the secondary-school level. Indeed, when confronted with a multiple-choice synonyms test, about the only things the students need to check are whether the test is in fact one of synonyms (as opposed to, say, antonyms, which has a similar surface structure) and whether there is a penalty for guessing. Examinees can usually read the directions to such a test cursorily, and could probably skip them altogether if only they were told the name of the task; comprehension of what is required is essentially automatic. But the solution of individual test items may be far from automatic, especially if the test requires discriminating relatively fine shades of meaning. Students may find they have to give a fair amount of thought to the individual items, either because they need to discriminate shades of meaning or because they are unsure of particular words' meanings and have to use strategies to guess the best answers for very difficult items. In the standard synonyms task, comprehension of task instructions is essentially automatic (or nearly so), but solution of test items (beyond the simplest ones) probably is not.

In contrast, experimental tasks used in the cognitive psychologist's laboratory seem to present the opposite situation, in at least one respect. Tasks such as the Posner and Mitchell (1967) letter-matching task and the fixed-set (S. Sternberg 1969) memory-scanning task are probably unfamiliar to most subjects when they enter the cognitive psychologist's laboratory. The subjects do not automatically know what is expected of them in task performance and have to listen reasonably carefully to the instructions. But after the task is explained and the subjects have had some practice in performing the tasks, it is likely that task performance rapidly becomes automatized. The tasks come to be executed almost effortlessly and with little conscious thought.

It is possible, of course, for task performance to be fully automatized, or not to be automatized at all. When one gets hold of a mystery story to read, one knows essentially automatically what one is going to do and how one is going to do it. Comprehension of the task and then performance of it are both quite automatized. In contrast, learning how to solve a new kind of mathematics problem, such as a time–rate–distance problem, is probably not automatized with respect to either comprehension or task execution.

Automatization as a function of situation. Very little is known about how situations affect automatization of task performance. Clearly, one wishes to provide as much practice as possible on the task to be automatized, and to use a fixed-set rather than a varied-set mode of presentation (Shiffrin & Schneider 1977). Presumbaly, one might wish to minimize distraction from the task in order to allow the individual to concentrate on learning and eventually on automatizing it.

Relations between abilities to deal with novelty and to automatize processing

For many (but probably not all) kinds of tasks, the ability to deal with novelty and to automatize information processing may occur along an experiential continuum. When one first encounters a task or kind of situation, ability to deal with novelty comes into play. More-intelligent people will be more rapidly and fully able to cope with the novel demands being made on them. Moreover, the fewer the resources that need to be devoted to processing the novelty of a given task or situation, the more the resources that are left over for automatized performance; conversely, more efficient automatization of performance leaves additional processing resources for dealing with novel tasks and situations. As a result, novelty and automatization trade off, and the more efficient the individual is at the one, the more resources are left over for the other. As experience with the kind of task or situation increases, novelty decreases, and the task or situation will become less apt in its measurement of intelligence from the standpoint of processing of novelty. However, after some amount of practice with the task or in the situation, automatization skills may come into play, in which case the task will become a better measure of automatization skills. According to this view, the most interesting points on the experiential continuum, from the standpoint of measuring intelligence, are those (a) when the task or situation is first encountered and (b) when novelty wears off and automatization begins to set in. Measuring task performance at other times will be less informative with regard to a person's intellectual level. Note that a given task or situation may continue to provide apt measurement of intelligence over practice, but for different reasons at different points in practice: Early in the person's experience, the ability to deal with novelty is assessed; later in the person's experience, the ability to automatize information processing is assessed.

What tasks measure intelligence and why?

The proposed two-facet subtheory suggests some properties of tasks and situations that make them more or less useful measures of intelligence. Consider some of the tasks most frequently used, and the implications of the subtheory for understanding why these tasks are more or less successful.

Laboratory tasks. A variety of laboratory tasks have been claimed to measure intelligence. According to the present view, the simpler tasks, such as simple reaction time, choice reaction time, and letter identification, have some validity as measures of intelligence because they primarily measure automatization of various kinds. For example, simple reaction-time tasks measure in part the extent to which an individual can automatize rapid responses to a single stimulus, and letter-identification tasks measure in part the extent to which access to highly overlearned codes stored in long-term memory is automatized. Speed is a reasonable measure of intellectual performance because it is presumably highly correlated with degree of automatization; but it is only an indirect measure of this degree of automatization, and hence an imperfect one. One might expect some increase in correlation of task latencies with measured intelligence as task complexity increases, even at these very simple levels, because of the increased element of novelty in the higher levels of even simple tasks. Thus, choice reaction time introduces an element of uncertainty that is absent in simple reaction time, and the amount of uncertainty, and hence of novelty, increases as the number of response choices increases.

The more complex laboratory tasks, such as analogies, classifications, syllogisms, and the like, probably measure both degree of automatization and response to novelty. To the extent that subjects have had practice on these item formats (such as taking intelligence and aptitude tests, as well as participating in experiments), their selection and implementation of strategies will be partially automatized when they start the tasks. But even if they have had little or no experience with certain item formats, the formats tend to be repetitive, and in the large numbers of trials typical of cognitive-psychological experiments, subjects are likely to automatize their performance to some degree while performing the tasks. The more complex items also measure response to novelty, in that the relations subjects have to recognize and reason with will usually be at least somewhat unfamiliar.

Psychometric tasks. The psychometric tasks found in ability tests are likely to measure intelligence for the same reasons as the complex laboratory tasks, in that they contain essentially the same kinds of contents. They are apt to be slightly better measures than the laboratory tasks for three reasons. First, the pencil-and-paper psychometric items tend to be harder, because laboratory tasks are often simplified in order to reduce error rates. Harder tasks will, on the average, involve greater amounts of novelty. Second, psychometric test items are usually presented en masse (subjects are given a fixed amount of time to solve all of them) rather than individually (subjects are given a fixed or free amount of time to solve each separate item). Presenting the items en masse requires individuals to plan an interitem as well as an intraitem strategy, and hence requires more "executive" kinds of behaviors. Such behaviors may have been previously automatized in part, but are also necessarily responses to whatever novelty inheres in the particular testing situation confronted (content, difficulty, time limits, etc.). Third, the psychometric test items found in most test batteries have been extensively validated, whereas the items used in laboratory experiments seldom have been.

Implications for task selection. The proposed theory carries with it certain implications for the selection of tasks to measure intelligence. In particular, one wishes to select tasks that involve some blend of automatized behaviors and behaviors in response to novelty. This blending is probably best achieved within test items, but may also be achieved by items that specialize in measuring either the one skill or the other. The blending may be achieved by presenting subjects with a novel task, and then giving them enough practice so that performance becomes differentially automatized (across subjects) over the length of the practice period. Such a task will thereby measure both response to novelty and degree of automatization, although at different times during the course of testing.

The two-facet view suggests one reason it is so exceedingly difficult to compare levels of intelligence fairly across members of different sociocultural groups. Even if a given test requires the same components of performance for members of the various groups, it is extremely unlikely to be equivalent for the groups in terms of its novelty and the degree to which performance has been automatized prior to the examinees' taking the test. Consider, for example, the by-now well-known finding that nonverbal reasoning tests, such as the Raven Progressive Matrices or the Cattell Culture-Fair Test of *g*, actually yield greater differences between members of different sociocultural groups than do the verbal tests they were designed to replace (Jensen 1982b). The nonverbal tests, contrary to the claims that have often been made for them, are *not* culture-fair (and they are certainly not culture-free). Individuals who have been brought up in a test-taking culture are likely to have had much more experience with these kinds of items than individuals not brought up in such a culture. Thus, the items will be less novel and performance on them more automatized for members of the standard U.S. culture than for nonmembers. Even if the processes of solution are the same, the degrees of novelty and automatization will be different, and hence the tests will not be measuring the same skills across populations. As useful as the tests may be for within-group comparisons, between-group comparisons may be deceptive and unfair. A fair comparison between groups would require comparable degrees of novelty and automatization in test items as well as comparable processes and strategies.

In sum, it has been proposed that behavior is intelligent when it involves either or both of two sets of skills: adaptation to novelty and automatization of performance. This proposal has been used to explain why so many tasks seem to measure "intelligence" in greater or lesser degree. Most important, the subtheory provides an a priori specification of what a task or situation must measure in order to assess intelligence. It is distinctive in that it is not linked to any arbitrary choice of tasks or situations. These follow from the subtheory, rather than the other way around.

Components of intelligence

A theory of intelligence ought to specify the mechanisms by which intelligent performance is generated. The purpose of this section is to specify the mechanisms proposed by the triarchic theory. An earlier version of this subtheory was presented in more detail in Sternberg (1980b).

A number of theories have been proposed during the past decade that might be labeled, at least loosely, as "componential" (e.g., Butterfield & Belmont 1977; Campione & Brown 1979; Carroll 1976; 1981; Hunt 1978; 1980; Jensen 1979; Pellegrino & Glaser 1979; Snow 1979). These theories share the cognitive focus of the present view, but differ in some details. Jensen (1979) has suggested that individual differences in intelligence can be understood in terms of speed of functioning in choice–reaction time tasks. Hunt (1978) and Keating and Bobbitt (1978) have proposed that individual differences in intelligence can be understood at a somewhat higher level of processing, in particular, in terms of differences among individuals in speed of access to lexical information stored in long-term memory. Butterfield and Belmont (1977) and Campione and Brown (1979) have emphasized individual differences in cognitive and metacognitive processes and strategies as bases for understanding individual differences in intelligence; and Pellegrino and Glaser (1979), Snow (1979), and Sternberg (1977a) have studied individual differences in intelligence in terms of the still higher-level reasoning processes measured by problems such as analogies, series completions, and classifications. At a still higher level of processing, Simon (1976; see also Newell & Simon 1972) has sought to understand individual differences in intelligence in terms of individuals' component abilities in complex problem solving, such as that used in solving cryptarithmetic, logical, and chess problems. Thus, one way of characterizing differences in emphasis in these cognitive accounts is in terms of the level of processing on which they concentrate: At one extreme, Jensen looks at speed of functioning at very low levels of processing; at the other extreme, Simon looks at accuracy and strategy of functioning at very high levels of processing.

Although all of these theorists look at components of intellectual functioning at various levels of processing, it is important to emphasize that most of the theorists do not place the emphasis on information-processing "components" that I do, nor do the theorists differ solely in terms of the level of processing they emphasize. Another major difference among theorists occurs in their emphasis on speed of functioning. In general, theorists studying lower levels of processing tend to place greater emphasis on speed, whereas theorists studying higher levels of processing tend to place less emphasis on speed; the correlation is not perfect, however. Moreover, the theorists differ greatly in their preferred methods for studying mental processing: Some, like Jensen, place a heavy emphasis upon reaction-time methodology; others, like Simon, emphasize computer simulation; and still others, like Hunt, use both of these methodologies. A more detailed analysis of some of these positions can be found in Sternberg (in press).

A componential subtheory of intelligence

The unit of analysis

Theories of human intelligence have traditionally relied on some basic unit of analysis for explaining sources of individual differences in intelligent behavior (see Sternberg 1980b; 1982b). Theories have differed in terms of (a) what is proposed as the basic unit; (b) the particular instantiations of this unit that are proposed somehow to be locked inside our heads; and (c) the way in which these instantiations are organized with respect to each other. Differences in basic units have defined "paradigms" of theory and research on intelligence; differences in instantiations and organizations of these units have defined particular theories within these paradigms. Some of the units that have been considered have been the factor, the S-R bond, and the TOTE (test-operate-test-exit). The present subtheory designates the information-processing component as the basic unit of analysis. (See Sternberg, 1977b, 1980b, for details regarding this unit and the theory developed around it.)

What is a component? A component is an elementary information process that operates on internal representations of objects or symbols (Sternberg 1977b; 1980b; see also Newell & Simon 1972). The component may translate a sensory input into a conceptual representation, transform one conceptual representation into another, or translate a conceptual representation into a motor output. What is considered elementary enough to be labeled a component depends upon the desired level of theorizing. Just as factors can be split into successively finer subfactors, so components can be split into successively finer subcomponents. Thus, no claim is made that any of the components referred to here are elementary at all levels of analysis. Rather, they are elementary at a convenient level of analysis. The same caveat applies to the proposed typology of components. Other typologies could doubtless be proposed that would serve this or other theoretical purposes as well or better. The particular typology proposed, however, has proved to be convenient in certain theoretical and experimental contexts at least.

Properties of components. Each component has three important properties associated with it: *duration*, *difficulty* (that is, probability of being executed erroneously), and *probability of execution*. Methods for estimating these properties of components are described in Sternberg (1978; see also Sternberg 1977b; in press; Sternberg & Rifkin 1979). The three properties are, at least in principle, independent. For example, a given component may take a rather long time to execute, but may be rather easy to execute, in the sense that its execution rarely leads to an error in solution; or the component may be executed quite rapidly, and yet be rather difficult to execute, in the sense that its execution often leads to an error in solution (see Sternberg 1977b; 1980b). Consider "mapping," one component used in solving analogies such as LAWYER is to CLIENT as DOCTOR is to (a) PATIENT, (b) MEDICINE. Mapping calls for the discovery of the higher-order relation between the first and second halves of the analogy. The component has a certain probability of being executed in solving an analogy. If executed, it has a certain duration and a certain probability of being executed correctly.

Kinds of components

Components perform (at least) three kinds of functions. *Metacomponents* are higher-order processes used in planning, monitoring, and decision making in task performance. *Performance components* are processes used in the execution of a task. *Knowledge-acquisition components* are processes used in learning new things. It is essential to understand the nature of these components, because they form the mental bases for adapting to, shaping, and selecting environments, for dealing with novel kinds of tasks and situations, and for automatizing performance. In this section, I will consider measurement issues simultaneously with the consideration of each of the kinds of components.

Metacomponents. Metacomponents are specific realizations of control processes that are sometimes collectively (and loosely) referred to as the "executive" or the "homunculus" (although, as discussed earlier, they lose their executive character during automatic processing). I have identified seven metacomponents that I believe are quite prevalent in intellectual functioning.

1. *Decision as to what the problem is that needs to be solved.* To solve a problem the individual must first figure out just what the nature of the problem is.

2. *Selection of lower-order components.* An individual must select a set of lower-order components to use in the solution of a given task. Selecting a nonoptimal set of components can result in incorrect or inefficient task performance. In some instances, the choice of components will be partially attributable to differential availability or accessibility of various components.

3. *Selection of one or more representations or organizations for information.* A given component can often operate on any one of a number of different possible representations or organizations for information. The choice of representation or organization can facilitate or impede the efficacy with which the component operates.

4. *Selection of a strategy for combining lower-order components.* In itself, a list of components is insufficient to perform a task. One must also sequence these components in a way that facilitates task performance, decide how exhaustively each component will be used, and decide which components to execute serially and which to execute in parallel.

5. *Decision regarding allocation of attentional resources.* All tasks and components used in performing tasks can be allocated only a limited proportion of the individual's total attentional resources. Greater limitations may result in reduced quality of performance. In particular, one must decide how much time to allocate to each task component, and how much the time restriction will affect the quality of performance of the particular component. One tries to allocate time across the various components of task performance in a way that maximizes the quality of the entire product. Even small changes in error rate can result in sizable changes in solution latency (Pachella 1974).

6. *Solution monitoring.* As individuals proceed through a problem, they must keep track of what they have already done, what they are currently doing, and what they still need to do. The relative importance of these three items of information differs across problems. If things are not progressing as expected, an accounting of one's progress may be needed, and one may even have to consider the possibility of changing goals. Often, new, more realistic goals need to be formulated as a person realizes that the old goals cannot be reached. In solving problems, individuals sometimes find that none of the available options provides a satisfactory answer. The individual must then decide whether to reperform certain processes that might have been performed erroneously, or to choose the best of the available options.

7. *Sensitivity to external feedback.* External feedback provides a valuable means for improving one's task performance. The ability to understand feedback, to recognize its implications, and then to act upon it is a key skill in task performance.

Although my own view emphasizes the role of metacomponents in intelligence, not all investigators share this view (e.g., Detterman 1980; 1982; Egan 1982; Hunt 1980; Jensen 1979). Consider, though, why I believe that accounts such as these alternative ones that emphasize performance components at the expense of metacomponents are inadequate as accounts of intelligence, and indeed, may miss its essence. I will take as an example the importance of the metacomponent of allocation of resources, and how ignoring it leads to erroneous conclusions about the nature of intelligence.

The assumption that "smart is fast" permeates our entire society. When we refer to people as "quick," we are endowing them with one of the primary attributes of what we perceive an intelligent person to be. The pervasiveness of this assumption can be seen in a recent study of people's conceptions of intelligence, in which we asked people to list behaviors characteristic of intelligent persons. Behaviors such as "learns rapidly," "acts quickly," "talks quickly," and "makes judgments quickly" were commonly listed (Sternberg et al. 1981). It is not only the person in the street who believes that speed is associated with intellect: Several prominent contemporary theorists of intelligence base their theories in large part upon individual differences in the speed with which people process information (Brand & Deary 1982; Eysenck 1982; Jensen 1979).

The assumption that more-intelligent people are rapid information processors also underlies the overwhelming majority of tests used in identification of the gifted, including creativity as well as intelligence tests. It is rare to find a group test that is not timed, or a timed test that virtually all examinees are able to finish by working at a comfortable rate of problem solving. I would argue that this assumption is a gross overgeneralization: It is true for some people and for some mental operations, but not for all people or all mental operations. What is critical is not speed per se, but rather, speed selection – knowing when to perform at what rate and being able to function rapidly or slowly depending upon task or situational demands. Thus, it is resource allocation, rather than the resource itself, that is central to general intelligence.

Many of us know people who, although often slow in performing tasks, perform the tasks at a superior level of accomplishment. Moreover, we know that snap judgments are often poor ones. Indeed, in our study of people's conceptions of intelligence, "does not make snap judgments" was listed as an important attribute of intelligent performance. Moreover, there are theoretical reasons for believing that to be quick is not always to be smart. In his classic but little-known book on the nature of intelligence, Thurstone (1924) proposed that a critical element of intelligent performance is the ability to withhold rapid, instinctive responses, and to substitute for them more rational, well-thought-out responses. According to this view, the automatic responses one makes to problems are often not the optimal ones for problem solution, and the ability to inhibit acting upon these responses and to consider more rational forms of response is a critical one for high levels of task performance. More recently, Stenhouse (1973) has arrived at the same conclusion by a comparative analysis of intelligence across different species. Interestingly, his conclusion appears to be wholly independent of Thurstone's; there is no evidence that Stenhouse was aware of Thurstone's book.

A number of findings from psychological research – both my own and others' – undermine the validity of the assumption that smart is always fast. I will cite several of the findings that indicate the fallacy of this view.

First, it is well known that, in general, a *reflective* rather than an *impulsive* cognitive style tends to be associated with more intelligent problem-solving performance (see Baron, 1981, 1982, for reviews of this literature). Jumping into problems without adequate reflection is likely to lead to false starts and erroneous conclusions. Yet timed tests often force the examinee to solve problems impulsively. It is often claimed that the strict timing of such tests merely mirrors the requirements of our highly pressured and productive society, but, for most of us, there are few significant problems encountered in work or personal life that allow no more than the 5 to 50 seconds of time spent on a typical problem in a standardized test. Of course, there are some people, such as air traffic controllers, who must make consequential split-second decisions as an integral part of their work lives. But such people seem to be the exception rather than the rule.

Second, in a study of planning behavior in problem solving (Sternberg 1981a), we found that more-intelligent persons tend to spend relatively more time than less-intelligent persons on global (higher-order) planning, and relatively less time on local (lower-order) planning. In contrast, less-intelligent persons seem to emphasize local rather than global planning (relative to the more-intelligent persons). The point is that what matters is not total time spent, but rather distribution of this time across the various kinds of planning one can do. Although for the problems we used (complex forms of analogies), quicker problem solving was associated, on the average, with higher intelligence, looking simply at total time masked the compensating relations for the two kinds of planning.

Third, in studies of reasoning behavior in children and adults, it has been found that although greater intelligence is associated with more rapid execution of most components of information processing, problem encoding is a notable exception to this trend. The more-intelligent individual tends to spend relatively more time encoding the terms of the problem, presumably in order to facilitate subsequent operations on these encodings (see Mulholland, Pellegrino & Glaser 1980; Sternberg 1977b; Sternberg & Rifkin 1979). Similar outcomes have been observed in comparisons of expert and novice problem solvers confronted with difficult physics problems (Chi, Glaser & Rees 1982; Larkin, McDermott, Simon & Simon 1980). Siegler (1981) has also found that intellectually more advanced children are distinguished especially by their superior ability to encode fully the nature of the problem being presented to them. The point, again, is that what matters is not total time spent, but rather distribution of this time across the various kinds of processing one can do.

Fourth, in a study of people's performance in solving insight problems (arithmetical and logical problems whose difficulty resided in the need for a nonobvious insight for problem solution rather than in the need for arithmetical or logical knowledge), a correlation of .75 was found between the amount of time people spent on the problems and measured IQ. The correlation between time spent and score on the insight problems was .62 (Sternberg & Davidson 1982). Note that in these tests, individuals could take as long as they liked solving the problems. Persistence and involvement in the problems were highly correlated with success in solution: The more able individuals did not give up, nor did they fall for the obvious, but often incorrect, solutions.

Fifth, in a study of executive processes in reading (Wagner & Sternberg 1983), we found that although faster readers, on the average, tended to have higher comprehension and to score higher on a variety of external ability measures, simply looking at overall reading time masked important differences between more and less skilled readers. In the study, which involved reading standard texts of the kinds found in newspapers and textbooks, we found that relative to less skilled readers, the more skilled readers tended to allocate more time to reading passages for which they would be tested in greater detail, and less time to reading passages for which they would be tested in lesser detail.

Obviously, it would be foolish to argue that speed is never important. For air traffic controllers, it is crucially important, and in dangerous situations occurring in driving a car, slow reflexes or thinking can result in an accident. In many other situations, too, speed is essential. But many, if not most, of the consequential tasks one faces in life do not require problem solving or decision making in the small numbers of seconds typically allotted for the solution of IQ test problems. Instead, they require an intelligent allocation of one's time to the various subproblems or problems at hand. Ideally, IQ tests would stress allocation of time rather than time or speed in solving various kinds of problems.

To the extent that simple tasks, such as those used by Hunt (1978), Jensen (1982b), and others, correlate with IQ, it may be in part because of the shared but ecologically unrealistic time stress imposed on performance in both kinds of tasks. I doubt, however, that the speed-demand is the only source of the correlation. What remaining correlation is left after sheer shared-speed requirements are taken into account may well be accounted for in part by metacomponential processing. A finding in Jensen's (1982b) research, for example, is that the correlation between choice reaction time and IQ increases as the number of choices in the reaction-time task increases. This result suggests that the more metacomponential decision making required in selecting from among alternative choices, the higher the correlation obtained with tested intelligence. A finding in the Hunt (1978) research paradigm, which is based upon the Posner and Mitchell (1967) letter-comparison task (in which the subject has to decide whether both members of a pair of letters, such as *Aa*, represent either the same physical appearance or the same letter name), is that as the complexity of the comparison to be made increases, so does the correlation between performance on the comparison task and measured intelligence (Goldberg, Schwartz & Stewart 1977). Again, the result suggests that it is higher-level decision making, rather than sheer speed of simple functioning, that is responsible for correlations obtained between performance on cognitive tasks and performance on psychometric tests. And cognitive tasks such as these may well become automatized over the large number of trials they require for subject performance, and thus will measure efficacy of automatization as well, another key ingredient of intelligent performance.

Performance components. Performance components are used in the execution of various strategies for task performance. Although the number of possible performance components is quite large, many probably apply only to small or uninteresting subsets of tasks, and hence deserve little attention.

Performance components tend to organize themselves into stages of task solution that seem to be fairly general across tasks. These stages include (a) encoding of stimuli, (b) combination of or comparison between stimuli, and (c) response. In the analogies task, for example, I have separated encoding and response components (each of which may be viewed as constituting its own stage) and inference, mapping, application, comparison, and justification components (each of which requires some kind of comparison between stimuli). Why is it important to decompose global performance on intellectual tasks and tests into its underlying performance components? I believe there are several reasons.

First, studies of mental test performance have shown that one set of performance components, the performance components of inductive reasoning – such as inferring relations between terms, mapping relations between relations, and applying old relations to new situations – are quite general across formats typically found in intelligence tests. Sternberg and Gardner (1983) showed that high correlations (with magnitudes as high as .7 and .8) can be obtained between component scores and performance on psychometric tests of inductive reasoning, and high correlations are also obtained between corresponding component scores on the various inductive tasks. Thus, at least these performance components seem to be quite generalizable across both cognitive tasks of theoretical interest and psychometric tests of practical (and for many, theoretical) interest.

Second, decomposition of task performance into performance components is important because there is evidence that different components behave in various ways. Consider three instances of such differences.

One kind of difference, discussed above, is in terms of speed allocation. For most performance components, greater speed of processing is associated with superior overall task performance. But for at least one component, encoding, the opposite pattern holds.

A second kind of difference is in the kinds of representations upon which the various components act. Consider syllogistic-reasoning tasks, for example. Some of the components of syllogistic reasoning operate upon a linguistic representation, and others upon a spatial representation (Sternberg 1980a; Sternberg & Weil 1980). Overall scores on syllogistic-reasoning tests, whether expressed in terms of latencies or errors, are therefore confounded with respect to the linguistic and spatial abilities involved. An individual could achieve a given score through different combinations of componential efficacies, and even through the use of different strategies. For example, Sternberg and Weil (1980) found that untrained subjects spontaneously use at least four different strategies for solving linear syllogisms. To the extent one wishes to understand the cognitive bases of task performance, componential decomposition of task performance is desirable and even necessary.

A third kind of difference is in the centrality of the components of the task to what it is the examiner actually wishes to measure. Most tasks contain components that are of greater and lesser interest for measuring a particular construct. By separating out component scores, it is possible to obtain purer measures of the construct of interest. In the case of inductive reasoning, for example, one would probably wish to separate out the reasoning components (inference, mapping, application, justification) from the others.

Such separation becomes especially important for purposes of diagnosis and remediation. Consider, for example, the possibility of a very bright person who does poorly on tests of abstract reasoning ability. It may be that the person is a very good reasoner, but has a perceptual difficulty that leads to poor encoding of the terms of the problem. Because encoding is necessary for reasoning upon the problem terms as encoded, the overall score is reduced, not by faulty reasoning, but by faulty encoding of the terms of the problem. Decomposition of scores into performance components enables one to separate, say, reasoning difficulties from perceptual difficulties. For purposes of remediation, such separation is essential. Different remediation programs would be indicated for people who perform poorly on reasoning items because of flawed reasoning, on the one hand, or perceptual processing, on the other.

Finally, componential decomposition can be important if the individual's problem is not in the components at all, but rather in the strategy for combining them. A person might be able to execute the performance components quite well, but still do poorly on a task because of nonoptimal strategies for combining the components. By modeling the examinee's task performance, it is possible to determine whether the person's difficulty is in the performance components per se, or rather in the way the person combines those performance components.

Knowledge-acquisition components. Knowledge-acquisition components are processes used in gaining new knowledge. It is proposed that three components are relevant to the acquisition of declarative and procedural knowledge in virtually all domains of knowledge. These components were considered earlier in the context of insight.

1. *Selective encoding*. Selective encoding involves sifting out relevant from irrelevant information. When new information is presented in natural contexts, relevant information for one's given purposes is embedded in the midst of large amounts of purpose-irrelevant information. A critical task for the learner is that of sifting the "wheat

from the chaff": recognizing just what information among all the pieces of information presented is relevant for one's purposes (see Schank 1980).

2. *Selective combination.* Selective combination involves combining selectively encoded information in such a way as to form an integrated, plausible whole. Simply shifting out relevant from irrelevant information is not enough to generate a new knowledge structure: One must know how to combine the pieces of information into an internally connected whole (see Mayer & Greeno 1972).

3. *Selective comparison.* Selective comparison involves relating newly acquired information to information acquired in the past. Deciding what information to encode and how to combine it does not occur in a vacuum. Rather, encoding and combination of new knowledge are guided by retrieval of old information. New information will be all but useless if it cannot somehow be related to old knowledge so as to form an externally connected whole (see Mayer & Greeno 1972).

The emphasis upon knowledge-acquisition components in the present theory contrasts with certain other views regarding what should be emphasized in intelligence. Consider some of these other views.

If one examines the contents of the major intelligence tests currently in use, one will find that most of them measure intelligence as last year's (or the year before's, or the year before that's) achievement. What is an intelligence test for children of a given age would be an achievement test for children a few years younger. In some test items, like vocabulary, the achievement loading is obvious. In others, it is disguised; for example, verbal analogies or arithmetic problems. But virtually all tests commonly used for the assessment of intelligence place heavy achievement demands upon the individuals tested.

The emphasis upon knowledge is consistent with some current views of differences in expert versus novice performance that stress the role of knowledge in performance differences (e.g., Chase & Simon 1973; Chi et al. 1982; Keil, in press; Larkin et al. 1980). And indeed, there can be no doubt that differences in knowledge are critical to differential performance between more- and less-skilled individuals in a variety of domains. But it seems to me that the critical question for a theorist of intelligence to ask is that of how those differences in knowledge came to be. Certainly, sheer differences in amount of experience are not perfectly correlated with levels of expertise. Many individuals play the piano for many years, but do not become concert-level pianists; chess buffs do not all become grandmasters, no matter what the frequency of their play may be. And simply reading a lot does not guarantee a large vocabulary. What seems to be critical is not the sheer amount of experience, but rather, what one has been able to learn from that experience. According to this view, then, individual differences in knowledge acquisition have priority over individual differences in knowledge. To understand expertise, one must understand first how current individual differences in knowledge evolved from individual differences in knowledge acquisition.

Consider vocabulary, for example. It is well known that vocabulary is one of the best, if not the best single predictor, of overall IQ score (Jensen 1980a; Matarazzo 1972). Yet, few tests have higher achievement loadings than do vocabulary tests. Can one measure the latent ability tapped by vocabulary tests without presenting children with what is essentially an achievement test? In other words, can one go beyond current individual differences in knowledge to the source of those individual differences, that of differences in knowledge acquisition?

There is reason to believe that vocabulary is such a good measure of intelligence because it measures, albeit indirectly, children's ability to acquire information in context (Jensen 1980a; Sternberg & Powell 1983; Werner & Kaplan 1952). Most vocabulary is learned in everyday contexts rather than through direct instruction. Thus, new words are usually encountered for the first time (and subsequently) in textbooks, novels, newspapers, lectures, and the like. More-intelligent people are better able to use surrounding context to figure out the words' meanings. As the years go by, the better decontextualizers acquire the larger vocabularies. Because so much of one's learning (including learning beside vocabulary) is contextually determined, the ability to use context to add to one's knowledge base is an important skill in intelligent behavior. We have attempted to measure these skills directly by presenting high school children with paragraphs written at a level well below their grade level (Sternberg & Powell 1983). Embedded within the paragraphs are one or more unknown words. The children's task is to use the surrounding context to figure out the meanings of the unknown words. Our theory of task performance attempts to specify exactly how children accomplish this decontextualization (see Sternberg & Powell 1983). We found high correlations between the predictions of the theory, which specifies the cues people use in decontextualizing word meanings (e.g., spatial, temporal, and class membership cues) and the actual ease with which people can figure out word meanings. Correlations between predicted and observed values were .92 for literary passages, .74 for newspaper passages, .85 for science passages, and .77 for history passages. Note that in this testing paradigm, differential effects of past achievements are reduced by using reading passages that are easy for everyone, but target vocabulary words that are unknown to everyone. We have found that the quality of children's definitions of the unknown words is highly correlated with overall verbal intelligence, reading comprehension, and vocabulary test scores at about .6 in each case (Sternberg & Powell 1983). Thus, one can measure an important aspect of intelligence – knowledge acquisition – directly and without heavy reliance upon past achievement.

Conclusions

I have proposed in this article a synopsis of a triarchic theory of human intelligence. The theory comprises three subtheories: a contextual subtheory, which relates intelligence to the external world of the individual; a componential subtheory, which relates intelligence to the internal world of the individual; and a two-facet subtheory, which relates intelligence to both the external and internal worlds of the individual. The contextual subtheory defines as intelligent behavior that involves purposive adaptation to, selection of, and shaping of real-world environments relevant to one's life. The two-facet subtheory further constrains this definition by regarding as most relevant to the demonstration of intelligence contextually intelligent behavior that involves either adaptation to novelty, automatization of information processing, or both. The componential subtheory specifies the mental mechanisms responsible for the planning, execution, and evaluation of intelligent behavior.

The theory has clear implications for the evaluation of people's intelligence. First, one should test people on behavior that is relevant to, or predictive of, contextually appropriate behavior in their real-world environments. But not every contextually appropriate behavior is equally informative with respect to individual differences in intelligence (e.g., eating). Hence, one should assess behaviors in response to novelty or in the development of automatization. But even here, not all behaviors are equally informative: Response to novelty, for example, would seem to have more to do with intelligence if it involves solving a new kind of complex problem, such as learning calculus, than if it involves solving a new kind of simple problem, such as what to do if a staple falls out of a set of collated pages. Hence, the behaviors most relevant to evaluation are those that more heavily involve components and particularly metacomponents of intelligence. In sum, all three subtheories of the triarchic theory are relevant to the evaluation or assessment of intelligence.

The triarchic theory is able to answer a rather wide range of questions regarding the nature and measurement of intelligence. For example, it can account for many of the results obtained by factor analysts in terms of the mixes of components that enter into different factorial solutions: A general factor tends to be obtained when the factor emphasizes individual-differences variance from metacomponents; group factors tend to be obtained when the factors emphasize individual-differences variance from performance components (see Sternberg 1980a; 1980b). Similarly, the theory can account for many of the results obtained by cognitive theorists: The extent to which cognitive tasks have succeeded in capturing important aspects of intelligence is viewed as depending upon the extent to which the tasks have measured individuals' skills in adapting to novelty and in automatizing information processing.

The theory attempts to capitalize upon people's intuitions that the nature of intelligence is determined at least in part by the contexts in which it is exercised, at the same time that not all aspects of intelligence are contextually determined and hence relative. Thus, intelligent behavior can always be understood in terms of fits to environments, but what fits may differ from one environment to another. Moreover, the extent to which the given adaptive behavior will be viewed as intelligent – as opposed, merely, to adaptive – will be determined by the extent to which that behavior involves adaptation to novelty, automatization of information processing, or both. Finally, the mental mechanisms underlying that behavior can be understood componentially. Although I would argue that the metacomponents, performance components, and knowledge-acquisition components described in this article underlie intelligent behavior in all cultures, the tasks in which they would appropriately be measured will vary from one culture to the next, and the importance of the various components to intelligent behavior may likewise vary.

An important issue concerns the combination rule for the abilities specified by the three subtheories. How does the intelligence of a person who is average in the abilities specified by all three theories compare, say, to the intelligence of a person who is high in some abilities but low in others? Or what can one say of the intelligence of people whose environmental opportunities are so restricted that they are unable to adapt to, shape, or select any environment? I am very reluctant to specify any general combination rule at all, in that I do not believe that a single index of intelligence is likely to be very useful. In the first case, the two individuals are quite different in their pattern of abilities, and an overall index will hide this fact. In the second case, it may not be possible to obtain any meaningful measurement at all from the person's functioning in the environment. Take as a further example, the comparison between (a) a person who is very adept at componential functioning and thus likely to score well on standard IQ tests, but who is lacking in insight or, more generally, in the ability to cope well with nonentrenched kinds of tasks or situations, and (b) a person who is very insightful but not particularly adept at componential operations. The first individual might come across to people as "smart" but not terribly "creative"; the second individual might come across as creative but not terribly smart. Although it might well be possible to obtain some average score on componential abilities and abilities to deal with nonentrenched tasks and situations, such a composite would obscure the critical qualitative differences between the functioning of the two individuals. Or, consider a person who is both componentially adept and insightful, but who makes little effort to fit into the everyday environment. Certainly one would not want to take some overall average that hides the person's academic intelligence (or even brilliance) in a combined index that is lowered because of scant adaptive skills. The point to be made, then, is that intelligence is not a single thing: It comprises a very wide array of cognitive and other skills. Our goal in theory, research, and measurement ought to be to define these skills and learn how best to assess and possibly train them, not to figure out a way to combine them into a single, but possibly meaningless number.

The triarchic theory is empirically testable in many of its aspects, and indeed, a large number of tests of various aspects of the theory have been conducted and are reviewed elsewhere (Sternberg, in press). Nevertheless, it is obviously not without limitations. First, the subtheories, and especially the contextual one, are in need of more detailed specification. Second, the connections among the subtheories, particularly with regard to how the components of information processing are used in adaptation, dealing with novelty, and attainment of automatization, need more detailed treatment. Third, although the componential subtheory has been empirically tested in some detail, only the part of the two-facet subtheory dealing with novelty has received any test, and the contextual subtheory has received only the most minimal empirical verification. Finally, the kinds of testing instruments generated by the theory (e.g., the tacit-knowledge questionnaires and the concept-projection task measure) have yet to be subjected to the kind of extensive empirical validation that earlier psychometric instruments have received.

The proposed theory is multifaceted and complex, and there are those who may say that it is just too complicated, or that it is grandiose. Nevertheless, I believe that an account of intelligence that strives for completeness will necessarily be complex in order to take into account a very wide range of theoretical and empirical questions. The triarchic theory is probably more nearly complete in the range of questions that it can address than are alternative theories that seek to understand all of intelligence within a single perspective, whether it be psychometric, Piagetian, cognitive, contextualist, or whatever. The triarchic theory draws from all of these in an attempt to center on the whole phenomenon of intelligence, rather than on any one particular paradigm for understanding it.

ACKNOWLEDGMENTS
Development of the componential subtheory was supported in part by Contract N0001483K0013 from the Office of Naval Research and Army Research Institute. Development of the two-facet subtheory was supported in part by the above-mentioned contract and in part by a grant from the Spencer Foundation. Development of the contextual subtheory was supported in part by a contract from El Dividendo Voluntario para la Comunidad and La Universidad Metropolitana de Venezuela.
Requests for reprints should be sent to Robert J. Sternberg, Department of Psychology, Yale University, Box 11A Yale Station, New Haven, Conn. 06520.

Open Peer Commentary

Commentaries submitted by the qualified professional readership will be considered for publication in a later issue as Continuing Commentary on this article. Integrative overviews and syntheses are especially encouraged.

Criteria and explanations

Jonathan Baron
Psychology Department, University of Pennsylvania, Philadelphia, PA. 19104

It is useful to think of a theory of intelligence as consisting of two kinds of statements, criterial and explanatory. A criterion tells us what is to be explained, that is, which behavior we should classify as intelligent. An explanation tells us what accounts for success and failure (or for individual differences) in meeting one or more criteria. An explanation must not restrict itself to a description of ways in which intelligent behavior is successful. It must tell us how that success is achieved (or not) in terms that do not refer to the success itself. We cannot explain success in investing by saying that good investors buy low and sell high: such a statement is, rather, a criterion of a good investor.

It seems that Sternberg's first two subtheories are criterial. The first tells us that intelligence has to do with adaptation and the like. The second tells us that it has to do with behavior at certain points in the course of learning. Such criteria provide a rationale for the development of intelligence measures, and it is here that much of the value of this theory may lie. Sternberg is to be applauded for taking seriously the need for such a rationale. For at least one use of such measures, the diagnosis of retardation, the theory calls our attention to the variety of types of adaptation that are relevant (in the spirit of Mercer, 1973), and to the variety of stages of learning at which intelligence can be measured. It is noteworthy that some retardates who perform badly in novel situations can perform quite well after extensive practice at single tasks, such as calendar calculation (Hill 1978). By taking such possibilities into account, Sternberg's theory might lead to more comprehensive measures of states of adaptation and to better predictors of different kinds of adaptation than current IQ tests now provide.

I do have some quibbles with Sternberg's criteria:

1. Sternberg admits that adaptation must be defined in terms of the subculture a person has chosen, not just the whole culture. Why not go one step further and define it in terms of the goals each individual would (rationally) choose (Baron, in preparation)? These goals will ordinarily include more than adaptation to the standards of a group or subculture.

2. I would like to see a deeper rationale for selecting the criteria provided. Why divide up the pie just this way and not some other way, such as in terms of accuracy and speed, or acquisition of knowledge and use of knowledge, or cognition, memory, divergent production, convergent production, and evaluation (Guilford 1982)? My own approach (Baron, in preparation) is to redefine intelligence somewhat in terms of a single criterion, roughly, as those intellectual qualities that help a person achieve his rational goals, whatever they might be. Sternberg's approach is to try to define several criteria, each of which might be useful for different purposes (I assume). This approach may succeed, but I would like to know what holds it all together. Where does the theory of intelligence stop and the general theory of test construction and validation (for any purpose) begin?

3. Several empirical studies are reported in connection with the discussion of criteria, but why are they relevant? If they had not been done, would we have any less reason to accept the criterial parts of the theory? The real support for criterial theories – and the method for improving them – is philosophical reflection. In this regard, the criterial concept of intelligence is like the concept of rationality (Daniels 1979; Stich & Nisbett 1980).

The third subtheory, which describes the "mental mechanisms that lead to more or less intelligent behavior," is apparently intended as explanatory. Some of the components appear to provide real explanations. For example, the speed (and thoroughness) of the various steps of inductive reasoning can explain the overall speed and accuracy of performance of inductive tasks. (I leave aside the question of empirical correctness.) However, the knowledge-acquisition components of selective encoding, combining, and comparing – and some of the metacomponents, such as sensitivity to feedback – are criterial rather than explanatory. To say that a person selects relevant information, for example, is to say that the person is *successful* in selecting relevant information. Yet it is just such success that needs to be explained. Do more successful subjects spend more time trying to draw inferences from different subsets of the total evidence? Do they have more knowledge of the type of information likely to be relevant in a given problem? (In this case, as Sternberg notes, we might well ask why they have more knowledge.)

A theory of intelligence can give us other goods than intelligence measures, for example, a classification of abilities into those that are malleable and those that are not (Baron, in press), or a set of prescriptions for the teaching of good thinking (Baron 1981; in press), insofar as that can be taught. I would like to see Sternberg address these questions (now or later). If he does, I think he will find that explanations are needed. For example, it seems likely that for each criterion, some mechanisms that contribute to success will be malleable and others will not be, so a list of criteria alone will not tell us which mechanisms can be improved through practice or training. Likewise, if we are to teach people to think well, it would be helpful to be able to tell them what to do in terms that don't refer to the success they are trying to achieve. What students of good thinking might want to know is, not that they ought to select what is relevant and ignore what is irrelevant, but how to go about doing so.

Cultural relativism comes in from the cold

J. W. Berry

Psychology Department, Queen's University, Kingston, Ontario, Canada K7L 3N6

The triarchic theory of human intelligence is a major advance in the contemporary discussion of intelligence; this is particularly so because of the emphasis given to the contextual subtheory, and the accompanying attention paid to the cultural relativity of intelligence – "first conceiving of intelligence in terms of the context in which it occurs" (Section 2).

Among the varieties of cultural relativism discussed by Sternberg is my own "radical" version (Berry 1972). Since the time of that work a good deal of research has been conducted, which has attempted to obtain insights into how various peoples conceive of, define, and express their own notion of intelligence (see Berry, in press, for a comprehensive review of these studies). There has also been a good deal of attention paid to the assessment of the contexts in which intellectual and other behaviours are nurtured and expressed (see Berry, 1980b, for a systematic proposal, and Irvine & Berry, 1983, for the proceedings of a symposium on contexts).

The points to be taken from this decade of work are:

1. Culturally relative concepts of intelligence have now been identified in only a few cultures.
2. There is no unanimity about what is considered "intelligent" (or its nearest conceptual equivalent); other dimensions, particularly those involving social knowledge and practical daily activity, are frequently incorporated in local conceptions.
3. Systematic frameworks have been proposed, which can replace the earlier one-shot cross-cultural studies, and which will enable researchers to pursue panhuman generalizations (via comparisons) based upon the expected communalities in intelligence.
4. Despite these advances, however, it is still not possible to abandon the initial starting point of cultural relativism advocated a decade ago: Only a few of the many possible conceptual studies have actually been conducted in various cultures, even fewer attempts at operationalization have been made, and the proposed systematic frameworks for making comparisons remain virtually unused and untested.

If the triarchic theory leads to the amelioration of this situation, then it will be of benefit; if, however, it puts an end to the effort because contextualism or cultural relativism is now accepted by intelligence theorists, then it will be self-defeating. With this new-found legitimacy, though, one can hope that more and more researchers will attend seriously to the highly variable display of the human intellect to be discovered around the world, and allow it to become represented in our theories of intelligence as fully as it deserves to be.

Some psychometric considerations

John B. Carroll

The L. L. Thurstone Laboratory, University of North Carolina, Chapel Hill, N.C. 27514.

In this target article, Sternberg exhibits his talent for organizing a diffuse lot of ideas – many of them obvious and well accepted, others of a more speculative nature – into a plausible and appealing theory. With its several compartments, the theory does pretty well in encompassing many of the issues that have been addressed by writers on "intelligence" over the years. The space constraints under which he was operating in preparing the article precluded his giving the detail that would be required in defending the theory exhaustively. I look forward to his book (Sternberg, in press).

In considering any theory of human intelligence that is offered as a striking advance over previous theories, I am forced to ponder whether the new theory can deal adequately with the range of empirical evidence that has come to scientific attention in the past, and whether it deals with that evidence more adequately than previous theories. Sternberg has neatly laid out "subtheories" dealing with the relations of intelligence with the "external and internal worlds" of the individual, and it can be argued that this can lead to clarity in addressing different kinds of issues. For example, it is possible that predictor-validity problems are better dealt with in a "contextual" subtheory than in a "componential" subtheory. On the other hand, a truly detailed examination of the predictive use of intelligence tests will undoubtedly appeal to consideration of what metacomponents, performance components, and so on are relevant in a given class of criterion tasks. I am not at all sure that one can so easily draw a line between problems of context and problems of componential analysis. Sternberg seems to recognize this in setting forth a "subtheory" that deals with external and internal worlds simultaneously. One is likely to arrive at the impression, however, that the triarchic theory is to some extent merely a pat scheme for organizing logical discussion. Such an impression could be countered, of course, if the theory is successful in making new testable predictions.

As presented thus far, the "two-facet theory" is disappointing. Its principal feature seems to be the assertion that "a task measures 'intelligence' to the extent that it requires either or both of two skills . . . : the ability to deal with novel kinds of task and situational demands and the ability to automatize information processing." Currently I am engaged in surveying the extensive factor-analytic literature on cognitive abilities. Sternberg's two-facet subtheory prompts me to wonder whether this theory will be helpful in interpreting this literature. In particular, I wonder whether novelty and automatization can exhaustively account for tasks that empirical evidence suggests are measures of intelligence. Given that, according to writers like Horn (1978), there may be 30 or more different factors of tested intelligence, at "primary" and perhaps two higher orders, it seems likely that novelty and automatization can give only a very partial account of what makes these factors different. Indeed, the strange thing about this compartment of Sternberg's theory is that novelty and automatization are in a sense complementary, or at poles of a continuum. One can conjecture that any task that is initially novel can ultimately become automatized, wholly or in part. If novelty and automatization are the sole criteria for tasks measuring intelligence, it would seem that the intelligence of an individual simply reflects the degree to which that individual has automatized performance of a given task, or some class of tasks. Such a conclusion hardly seems reasonable. It also seems to reflect a kind of pure environmentalist theory that ignores the possibility that there are limits to which a given individual could come to automatize a given task or class of tasks.

The theory also seems to fail to address adequately what appear to me to be striking facts about human abilities: that individuals differ with respect to the average level of task difficulty that they can perform at a liminal level (e.g., at 50% passing), that the tasks relevant to any given ability can be arranged according to their average difficulty for members of a population, and, finally, that the task difficulties can be related to distinct characteristics of the tasks. For example, the difficulties of vocabulary items can be related to frequency and other characteristics of words; the difficulties of spatial-ability items can be related to compositional and rotational characteristics of stimulus material (Pellegrino & Kail 1982); and so on for other factors of cognitive ability. Thus, an ability can be defined in terms of a psychometric relation between individual characteristics and the characteristics of tasks that can be performed at varying probabilities. It is not yet clear how Sternberg's triarchic theory would deal with such considerations, although I think I can conceive of ways in which it could.

Understand cognitive components before postulating metacomponents, etc., part 2

Douglas K. Detterman

Department of Psychology, Case Western Reserve University, Cleveland, Ohio 44106

Sternberg has attempted to develop a theory, more comprehensive than his previous efforts, which accounts for a wide variety of intellectual performances. I have commented on his previous efforts (1980; 1982), urging that basic cognitive components be more thoroughly investigated before introducing higher-order constructs that may be unnecessary. Not surprisingly, he failed to heed my advice. And it will probably not surprise Sternberg that I will offer an elaborated version of that advice again.

Facts. These are the most salient facts we know about human intelligence: (1) Psychometric tests of intelligence are highly intercorrelated and all predict criteria of school success moderately well. (2) When batteries of psychometric tests are factor analyzed, they produce a general factor, "g," which accounts for a substantial portion of the variance in the psychometric tests. (This is just another way of representing the fact that the tests are highly intercorrelated.) (3) Cognitive tasks representing basic abilities (performance components, in Sternberg's nomenclature) have only low (0.20 to 0.30) correlations with psychometric tasks and with academic criteria. Researchers have been discouraged by this finding for years (Tuddenham 1963). (4) Batteries of cognitive tasks of basic abilities have low intercorrelations. (5) When basic cognitive tasks are factor analyzed, *g* is reduced or absent, that is, group factors result. (This is just another way of representing the fact that basic cognitive tasks have low intercorrelations.) All of these facts are alluded to by Sternberg.

Phenomena to be accounted for. Besides the facts listed above, Sternberg's triarchic theory is designed to account for a number of phenomena not well accounted for by current theories or not predicted well by current psychometric measures: (1) Current psychometric instruments do not predict a number of outcomes they might be expected to predict such as the success of quiz kids in later life, differences in success of careers, and the like. It is not surprising that they do not predict these things since they were designed to predict school success, but a well-developed theory of intelligence should. (2) There are probably substantial differences in abilities required to adapt to different environments both within and between cultures. (3) Adaptation within context requires appropriate responses to novelty and the ability to automatize information processing.

Now for the good part. Is it possible to account for all of the above on the basis of a few basic cognitive abilities or is it necessary to introduce higher-order constructs? Assume that there are 10 basic abilities, represented as $a, b, c, \ldots, j$, which account for a large portion of the differences in intellectual ability. Further assume that these abilities are independent of each other and operate in a serial fashion. All of these assumptions may well be wrong but they simplify the argument. (Additional complications would strengthen the argument.)

By varying task complexity, it should be possible to develop tests that represent fewer or more of these basic processes. Assume that at the highest level of complexity, psychometric tests of intelligence, eight randomly drawn abilities are represented by each test. These tests will be indicated as $P1, P2, P3, \ldots, Pn$. Now suppose that tasks of basic cognitive abilities each represent four randomly selected abilities and that ideal tasks of cognitive abilities represent only one ability each. These tasks will be referenced as $T1, T2, T3, \ldots, Tn$, and $I1, I2, I3, \ldots, In$, respectively.

This is what an assortment of these various types of tests might look like if their underlying structure were known:

Psychometric tests	*Cognitive tasks*	*Ideal*
$P1 = a + b + c + d + e + f + g + h$	$T1 = a + b + c + d$	$I1 = a$
$P2 = a + b + c + d + e + f + i + j$	$T2 = e + f + g + h$	$I2 = b$
.	.	.
.	.	.
.	.	.
$Pn = c + d + e + f + g + h + i + j$	$Tn = a + b + i + j$	$In = j$

Given the above array, the results that would be obtained seem obvious. Psychometric tests would be more likely to correlate with criterion measures and would be more highly correlated with each other, yielding substantial *g* loadings. Cognitive tasks would be weakly to moderately correlated, would have generally low intercorrelations, yielding small *g* loadings, and would not be highly correlated with psychometric measures. The ideal cognitive tasks would be uncorrelated, yielding no g factor, and would have small correlations or none with psychometric measures.

The reason for this array of findings is that more complex tests contain more of the basic processes important in intelligent behavior. Simply apply combinatorial principles and all of the facts listed above can be accounted for.

Note also that the exclusion of higher-order factors in the above exposition is not optional but mandatory. If all of the above equations were rewritten to include the *g* term as a higher-order ability, the *g*-factor loadings should stay constant or increase as task complexity decreased. Very probably, *g* loadings should increase with decreased task complexity because there are fewer other sources of variance. The only retort would be to argue that tests of basic cognitive abilities do not reflect intelligent behavior. But Sternberg believes they do and, anyway, why would they correlate at all with psychometric tasks if they didn't?

So far it has been shown that the important facts that are known about human intelligence can be predicted by assuming that a small number of independent basic abilities exist. What about the additional phenomena Sternberg wishes to account for? Can they be explained by this position?

As was pointed out before, the ideal cognitive tasks would have only small correlations with psychometric tasks. If there were 10 equally important cognitive abilities, each task should account for about 10% of the variance in a psychometric test in which that ability was included. But all of the ideal tasks together representing all of the underlying basic abilities could perfectly predict all of the psychometric tests with 20% of the variance in basic abilities left over.

There are two questions, then. How inclusive of basic abilities are current psychometric tests? Does each psychometric intelligence test include less than the 80% of basic abilities represented in the above model? The answer is probably yes. Second, do current psychometric tests accurately reflect the potential pattern of abilities that could occur? The answer is probably no.

Thus, a completely explicated theory of basic abilities might well be more predictive of nonacademic (and academic) behaviors than are standard psychometric instruments. Further, different patterns of ability required to adapt to different environments would also be explained if current tests are insensitive to differing patterns of ability. Finally, contextual adaptation to novelty and automatization of information processing could easily be accounted for by the basic abilities themselves. For example, automatization may simply reflect greater memory capacity or faster learning rates.

In conclusion, it would appear that a simple theory that includes only a few assumptions about a small number of underlying abilities and their interrelationship is all that is required to account for the known facts and a good many additional phenomena. If this is the case, doesn't the law of parsimony dictate that this theory be invalidated before more complex explanations are proposed? I still think Sternberg would be better off investigating performance components.

ACKNOWLEDGMENT
Preparation of this manuscript was partially supported by Grants #HD-07176 and HD-15518 from the National Institute of Child Health and Human Development.

Intelligent dissension among the Archói is good for the people

Judith Economos
2 Edgemont Road, Scarsdale, N.Y. 10583

Sternberg's triarchic theory is an intelligent notion of intelligence, which tries to reconcile some profound conflicts. In so doing, it illustrates the conflicts. Although I am not sure it heals them, it helps.

The opposition lies between the contextual archon and the other two. It is exactly the opposition between a realist and a relativist view of human intelligence. This is a philosophical conflict, but it is kin to some nonphilosophical ones: intelligence as performance versus intelligence as capacity; intelligence as learned versus intelligence as hereditary; as what the tests measure versus what they ought to measure; as what (allegedly) entitles some people to wealth and power versus a fiction invented by some to exclude others from access to wealth and power. It would be easier to sort out these conflicts if it were not that people have a strong interest in how the issues are resolved.

Sternberg tries to please both sides. The context archon is there for the side that urges the relative, unfixed, extrinsic nature of intelligence, in which the person who is enviably advantaged in one culture may be laughably inept in another. In this view, a person should be trainable to any level of intelligence. Sternberg's other two archons are based on the opposite supposition: Intelligence is a capacity in a person accounting for the quality of his performance, and is not the performance itself. A person who is adept in one culture is likely to become adept in another; a poor performer in his own culture is unlikely to shine in another – at least for those tasks not requiring special perceptual or physical abilities. This exception prevents open warfare between the contextual subtheory and the other two, since examples in support of the contextual subtheory involve special skills and gifts as opposed to "purely intellectual" abilities. Sternberg suggests that certain spatial abilities or hand–eye coordination can plausibly be considered part of intelligence.

The point is reasonable, but unprofitable. There are many kinds of human excellence – beauty, voice, strength; quickness, dexterity, grace; integrity, courage, generosity; authority, sweetness of character, cheerfulness; musical, artistic, and poetic talents, as well as intellectual gifts. None of them, for some reason, provokes the rancor that intelligence does. I think it is useless to absorb relatively clear notions of human attainments and talents (like the ability to navigate) into the mushy, controversial notion of general intelligence. Rather we should narrow the concept to its central core. This Sternberg eventually does; the components he details are problem-solving, "intellectual" activities (except for raw speed, which he does not much like).

Has he reconciled the opposing views? To the extent that people not overcome by the politics of intelligence can agree that probably intelligence is an endowed capacity that can be atrophied, twisted, or destroyed by unfavourable conditions (and developed and nourished by favourable ones), he has. Although he takes, finally, a realist view, he softens it in several ways. He allows abilities dependent on special gifts like perceptual acuity, fine motor control, or superior spatial sense to count in some cultures as a more important part of human competence than purely abstract conceptual abilities. This extended notion of intelligence does not make it any more acquirable – since these gifts are as capriciously distributed – but it spreads the good fortune around and looks less WASPish. He mentions, but does not emphasize, the involvement of motivation in the expression of intelligence: depressed, disturbed, lazy, or timid people do not demonstrate their full powers. Similarly, a desperate subsistence situation is a great intellectual leveller.

These constraints on the realist concept of intelligence are useful. Sternberg has tempered the absolutist view with his contextualism. Equally valuable may be his sensible effort to think through the components of intelligence with a view to making IQ testing more relevant to what intelligence really is (and demonstrably less that passport to the ruling class that some suspect it to be). If we can discern what abilities constitute competence, and recognise that these components are certainly possessed and developed in various degrees and varying combinations by different people (at different ages, even), then we may replace the provocative, one-dimensional IQ with a more objective, realistic, and – incidentally – humane assessment of human intelligence.

Intelligence versus behaviour

H. J. Eysenck
Department of Psychology, Institute of Psychiatry, University of London, London SE5 8AF, England

Any commentary on Sternberg's paper can usefully begin with the old differentiation between intelligence A, intelligence B, and intelligence C. Intelligence A, it will be remembered, is the underlying physiological structure of the nervous system that enables individuals to behave intelligently and that causes individual differences in intelligence. Intelligence B is the application of this innate ability in everyday life. Intelligence C is the attempt to measure, by means of IQ tests, intellectual functioning, usually more closely related to intelligence B than intelligence A.

From the beginning of attempts to study intelligence scientifically, there have been two alternative paradigms. The first is that of Sir Francis Galton, the second that of Alfred Binet. Galton concentrated on intelligence A as being scientifically the more important; Binet concentrated on intelligence B as being practically the more important, and he constructed his IQ tests accordingly. Psychologists have always followed Binet rather than Galton, with the result that, for practical purposes, IQ tests have been very successful, but from a scientific point of view, the study of intelligence along these lines has been rather disappointing.

The main reason for this disappointment is, of course, that intelligence B is a compound of many different factors, and hence has no scientific meaning. Success in life and ability to solve practical problems are compounds of intelligence A, personality, learning, cultural and educational factors, socioeconomic status, luck, and many other variables too numerous to mention. A high degree of anxiety or neuroticism, psychotic breakdown, or other personality dysfunctions can have a severe negative effect on a person's ability to solve practical problems in everyday life and render useless a high degree of intelligence A.

The situation is very similar to that obtaining in the measurement of heat. There is heat A, which is the physical movement of molecules or atoms, as in the Bernoulli theory; this constitutes the fundamental basis of differences in temperature. Heat B is the subjective impression of heat in everyday situations reported by different people. This is in part determined by heat A, but also by many other factors, such as the chill factor, humidity, intake of food and drink, exercise, and so on. Clearly heat B, although of practical importance to the individuals concerned, is not a scientific concept, and for scientific study we are more concerned with heat A. Heat C is constituted of the many different devices that have been used to measure temperature. There is the mercury-in-glass thermometer, depending on the change in volume of the mercury with increase in heat; the constant-volume gas thermometer dependent on the reactants of the welded junction of two fine wires; resistance thermometers, depending on the relation between resistance and temperature; thermocouples, depending on the setting up of currents by a pair of metals with their junctions at different temperatures, and so forth. These are geared to measure heat A, just as intelligence tests should be geared to measure intelligence A, precisely because heat A (and intelligence A) is scientifically meaningful, whereas heat B (and intelligence B) is not.

Sternberg's whole theory, as he seems to realise, is overinclusive, as is inevitable because of its concern with intelligence B. As he points out: "The contextualist view presented here is certainly highly inclusive in the sense that it includes within the realm of intelligence things that might typically be placed in the realm of personality or motivation." Precisely. It is this overinclusiveness that makes the theory scientifically meaningless and unacceptable. It deals, not with intelligence, but with possible ways in which intelligence is used in everyday life, modified by temperamental and motivational factors, and influenced by educational, cultural, and other factors. It is important to study these things, but the theory of human intelligence should be related to intelligence A and a fundamental understanding of what that is. Unless we know and can measure it precisely, we cannot really discuss it successfully in relation to other factors, or study the enormously complex amalgam of intelligence, personality, motivation, education, and the rest that constitutes intelligence B.

Sternberg dismisses too easily the attempts to measure intelligence A by means of reaction-time experiments, or the even more fundamental attempts to measure it by means of evoked potential (Eysenck 1982). There is now evidence from several quarters to show that when the right indicators are chosen, the correlation of evoked-potentials measures with ordinary IQ tests is above .80; this is higher than the correlation of one IQ test with another (Eysenck & Barrett, in press). Considering the fairly close relationship between such IQ tests and intelligence B (Eysenck 1979), it would be very difficult for Sternberg to suggest that such close relationships are irrelevant to his thesis. He fails to deal with the problems arising from this work. (Admittedly, much of it is quite new, and some unpublished; nevertheless, enough has been published to pose a problem that the theory cannot avoid.)

Sternberg does make a reference to my own theory, based on this work, but he mistakes it. I do not make, as he suggests, mental speed a crucial factor in intelligence A; as I have pointed out (Eysenck 1982), I regard mental speed as a secondary consequence of differences among individuals in ability to process information accurately; inaccurate processing leads to delays and thus to longer latencies. However, these are secondary to failures in the central nervous system to process information correctly, and Sternberg's objections to the speed theory do not apply to my own view of what is implied.

There is, of course, an urgent need for psychologists to study in earnest relationships between intelligence A and intelligence B. Fortunately, the discovery of methods of measuring intelligence A with considerable accuracy through the use of evoked potentials, reaction-time experiments, and other means, gives a proper basis for undertaking such work. I believe that Sternberg's contribution would be useful and important in accomplishing the urgent task of showing how intelligence A becomes integrated into the individual's actual life, how it is affected in its manifestations by personality, motivational and other factors, and how we can best predict life-success and life-intelligence by a combination of these factors. However, Sternberg does not seem to recognise the need for any scientific theory to use pure measures of the various concepts involved; we must first of all realise the need for measuring intelligence A without ambiguity before we can embark on the very ambitious pursuit, which he has undertaken. His concern, ultimately, is with behaviour, rather than with intelligence, and I believe that the title of his target article is misleading in that sense. He is concerned with the triarchic theory, not of human intelligence, but of adaptive behaviour. The proper theory of human intelligence remains to be discovered.

Finding the right tools for the task: An intelligent approach to the study of intelligence

Martin E. Ford
School of Education, Stanford University, Stanford, Calif. 94305

Different kinds of mechanical problems require different kinds of tools. Sometimes a tool designed for one kind of problem can be used to solve a different kind of problem (e.g., under some circumstances a wrench could be used to hammer a nail), but often this is inefficient and produces unsatisfactory results. Similarly, different kinds of intellectual problems require different kinds of intellectual tools (i.e., theories). Theories rarely work well outside the range of problems they were designed to solve. Sometimes theories can be applied successfully to problems outside their primary point of application (indeed, this is a commonly used criterion for evaluating theories), but there are usually rather sharp limitations to the range of problems that can be adequately addressed. In general, then, to successfully deal with the kinds of problems presented by complex, multifaceted phenomena (such as human intelligence), one will usually need to use a *set* of tools, each of which is designed to handle a different kind of problem presented by the object of study.

Sternberg is to be congratulated on recognizing the need for such a strategy in dealing with the phenomenon of human intelligence, and for successfully implementing this strategy by providing sensible, useful, and generally testable subtheories dealing with the three major sets of problems associated with the study of human intelligence, namely:

1. What kinds of tasks (goals, outcomes, results, accomplishments) are relevant to an assessment of intelligence?
2. What kinds of functional processes contribute to efficient and effective performance of these tasks?
3. What kinds of developmental processes account for changes in a person's performance of these tasks?

The first question is addressed primarily by the contextualist subtheory, which asserts that tasks must be personally and/or culturally relevant to be considered valid indicators of intelligence. However, the componential and two-facet subtheories are also pertinent in that they restrict the range of relevant tasks to those that involve theoretically specified components and metacomponents and that are neither too hard (i.e., too novel) or too easy (i.e., too automatized). This is consistent with White's (1959) proposal that humans tend to seek out environments that have "difference-in-sameness," and it is in such environments that aspects of competence can be best observed.

The second question is addressed mainly by the componential subtheory. This subtheory offers a description of the nature and organization of information-processing components that is more comprehensive and more sophisticated than most competing theories that attempt to explicate the processes that contribute to intelligent behavior.

Finally, the third question is a focus of all three subtheories. The list of processes nominated by Sternberg as being relevant to the development of intelligence is intriguing and somewhat more comprehensive than most theories of cognitive and behavioral development, which tend to focus more on the changing size and organization of cognitive representations and behavioral repertoires than on the processes by which such changes occur. Although other developmental processes may be relevant (D. H. Ford, submitted), Sternberg's list (i.e., adaptation, environmental shaping, environmental selection, selective encoding, selective combination, selective comparison, and automatization) appears to be able to account for a wide range of changes in intellectual functioning and behavioral competence.

There are limitations to the triarchic theory of intelligence; indeed, Sternberg has pointed out most of the key ones in his conclusions (e.g., the generality of the contextualist subtheory and the lack of interconnections among the three subtheories). However, there are at least two other important limitations that are not explicitly mentioned (although they may be related to those noted above). The first of these pertains to the role of nonintellectual processes in intelligent behavior. Sternberg's contextualist subtheory, because of its emphasis on purposive adaptation, asserts that motivational processes are important contributors to intelligent behavior. Yet his process subtheory, the componential subtheory, places almost no emphasis on motivational processes, despite the fact that extensive research has demonstrated the importance and relevance for adaptive behavior of a wide range of such processes, including goal-setting processes (Locke, Shaw, Saari & Latham 1981), perceptions of control and competence (Bandura 1982; M. E. Ford 1983; Lefcourt 1976), and emotional responsiveness to goal-attainment failures (D. H. Ford, submitted; M. E. Ford, in press; Seligman 1975). Thus, before the contextualist subtheory can be effectively integrated with the componential subtheory of intelligence, nonintellectual processes or components will need to be added to the componential subtheory. These processes are clearly not beyond the scope of what a theory of intelligence should try to represent (an assertion with which Sternberg would presumably agree), since behavior-in-context is *always* the result of the organized functioning of both cognitive and noncognitive processes (D. H. Ford, submitted).

Another limitation of the triarchic theory of intelligence is the lack of specific guidelines for defining relevance and therefore for assessing intelligence. As noted earlier, some useful examples and general guidelines are provided (e.g., the theory states that a task should have an optimal degree of novelty and automatization and should tap theoretically important components and metacomponents), but how one would actually go about operationalizing the relevance criterion is not clear. Would a task be relevant if it was considered as such by a certain proportion of the population? What about tasks that are important for some individuals but not others (e.g., computer competence, public speaking, manipulation of law enforcement officials, etc.)? Can such a theory deal with the problems of specialization and the division of labor? Because individuals tend to selectively engage different aspects of their environment according to their personal interests, will individual goals need to be considered in defining relevance (because, at the very least, individual goals will affect which aspects of the environment are novel and which are automatized)? Perhaps the answer to these questions is, "it depends" (e.g., on the purpose of the assessment or the nature of the task). However, this is not clearly specified. More information is needed before the relevance criterion, which is not only a theoretically crucial one but also logically necessary, can be successfully applied to assessments of intelligence.

A rose is not a rose: A rival view of intelligence

Lloyd D. Humphreys

Department of Psychology, University of Illinois at Urbana-Champaign, Champaign, Ill. 61820

Sternberg has provided a conceptualization of intelligence. It is not a theory, in that there are no hypotheses that can be rejected by empirical tests. It may actually be invulnerable. His conceptualization covers a wide domain, involving abilities, personality attributes, and motivation as ordinarily conceived. Intelligence is also highly contextual. "What constitutes an intelligent act may differ from one person to another." There are universals. These are the information-processing components, but a literal interpretation of the contextual requirements allows only highly individualized measurement. It might be inferred, as a matter of fact, that no form of measurement is possible for one who has not had "adequate opportunity to express one's intelligence." "One can scarcely be faulted for circumstances beyond one's control." Here and elsewhere the author posits a *real intelligence* that is not measured by a standard test of intelligence.

I have espoused a very different and more modest definition of intelligence that has a number of desirable characteristics (Humphreys 1971; 1979). Among these is its family resemblance to intelligence as a score on an intelligence test. The latter is the definition that fails to satisfy Sternberg and others. It is indeed too specific, but staying close to empirical correlates of the measuring instrument is advantageous. I have defined intelligence as the repertoire of knowledge and skills available to an individual at a particular point in time that is *sampled* by a standard test of intelligence. In restricting the repertoire to the kinds of behavior sampled by certain tests, there is an arbitrary aspect to the definition, but this also implies that the definition can and should change if change becomes useful theoretically.

Intelligence is an observable, phenotypic, behavioral characteristic of an individual. When an appreciable number of intelligent acts are observed, either by a rater or on a test, their positive intercorrelations provide the basis for a mathematical dimension along which individuals may be reliably and validly placed. The construct is tied to measuring instruments that are widely used and widely useful, practically and theoretically. From the beginning, this intelligence was derived from real-world problems related to education, jobs, and performing in society. There are many correlates of scores on standard tests that further understanding of the behavior of individuals and of broader social phenomena. These correlates are congruent with my definition. There is no need to posit a *real intelligence* underlying the individual's repertoire other than the psychobiological organism with its sensori–neural–motor mechanisms, both innate and acquired. These mechanisms allow for the acquisition, storage, retrieval, and utilization of the repertoire, that is, for the information processing that Sternberg discusses.

In this view, intelligence is not a capacity or a potential. As is true of phenotypic height, intelligence changes during growth and decay. As group averages change there is also change in the ordering of individuals within homogeneous age groups. Intelligence is only one component, but an important one, of adaptation as defined by Sternberg. There are contextual constraints on these measures. One can measure the construct in the populations of developed nations with very similar materials, formats, and so forth, but measurement in preliterate cultures is more difficult. One cannot sample the intellectual repertoire adequately without sampling the language skills that separate homo sapiens most sharply from other primates. As long as one does not draw inferences about differences in *real intelligence*, there are fewer contextual constraints placed on subcultural differences. Whatever the causes may be, persons belonging to sexual, ethnic, or social-class subcultures perform, succeed or fail, and live with their phenotypic traits. Low intelligence may not be within the individual's power of control on either genetic or environmental grounds, but the research questions concern the degree to which change is possible at a given stage of development and at what cost in time, money, and effort.

There is no imperative placed on a scientist to define a construct in a way that will please either laymen or other scientists. The criterion is usefulness in research and theory. Sternberg's conceptualization conforms in certain respects to a common, traditional point of view. It may also be pleasing because it provides a basis for discounting (unwisely) differences in certain group means on current tests. Comprehension of aural and written language, speaking and writing the language, arithmetic computation, and basic mathematics are major components in the intellectual repertoire. A highly contextual conceptualization of intelligence does nothing to remedy deficits in these areas.

The contexts of triarchic theory

Sidney H. Irvine
Department of Psychology, Plymouth Polytechnic, Plymouth PL4 8AA, England

Sternberg criticises his own work in this fashion: "First, the subtheories, and especially the contextual one, are in need of more detailed specification." I found that statement surprising at first, and in the end, all too true. Let me explain.

The context of human assessment has already had detailed specification in the immense cross-cultural literature that dates from Rivers (1905). Its fullest flowering is found, not in Jensen's (1969, 1980) North American ethnic studies, but in the work of psychologists resident outside the western hemisphere. By 1969, for example, Raven's Progressive Matrices was not only discarded as a nonverbal, culture-free test, but definitive studies (Irvine 1969) showed both strategy and group variance in considerable amounts. A review of 91 cross-cultural, factor-analytic studies (Irvine 1979) contains a specification of variance sources in measures derived from individuals in alien contexts. This is an update of a model first proposed (Irvine 1965) almost 20 years ago. These examples from my own work are only symptomatic of the wealth of material that Sternberg might have incorporated into his contextual framework. Other forms of definition exist in Cole's early experimental studies among the Kpelle (Cole, Gay & Glick 1968), in Biesheuvel's General Adaptability Battery for African mine workers (Biesheuvel 1952; 1954), and in Bhatia's virtually ignored account of performance-test transfer to India (Bhatia 1955). More recently the papers on item behavior across cultures by a group of Dutch scholars (Mellenbergh 1972; 1983; Poortinga 1971; 1983; van der Flier 1983) demonstrate yet another paradigmatic definition of context. My first criticism, then, is that Sternberg's argument for context is implicit in the great majority of cross-cultural studies in cognition, and explicit in several.

Then I reflected that Sternberg's case for detail in the contextual subtheory rests on a definition of context that is far more inclusive than that available in cross-cultural studies. That, though, is an empirical question that literature review will answer. Sternberg's use of the term "context" is polymorphous, and his attempt at synthesis is unique. Synthesis in theory construction is parsimonious, and commendable. It becomes self-defeating only when the diversity it encapsulates renders the theory incapable of falsification. Sternberg's wide spectrum of meaning embraces everything from cultural identity to the word on the printed page. That span of definition can be contrasted with Berry's deliberate constraint in his empirical work (Berry 1976) on context as hunting and gathering versus pastoral lifestyles. That single dimension proved straightforward enough to link with measures of cognitive style, but the measures themselves were not free from criticism. Nevertheless, the theory was falsifiable. Even if Sternberg moulds context into a taxonomy – as I write an elegant hierarchy suggests itself – and the debate about what constitutes a measure of cognitive process recedes, the theory may prove to be untestable.

I suspect that the context part of Sternberg's troika can only be defined in the sense that it constitutes a search for a key to understanding. This is the fifth sense of the definition used by Miles (1957) in his essay on the logic of intelligence theories. It is mandatory reading for all who commit themselves as boldly as Sternberg to a grand design for cognitive abilities. A general application of Miles's essay to Sternberg's complete theory determines that it is meanwhile a stipulative exercise. He is announcing that he is using the word "intelligence" in a novel way that he commends to others. Psychometric theory abounds in stipulative theories whose essence is that the same measures are used by different people who call the products – be they means, regression slopes, or factors – by different names. That has been a recipe for disaster.

Sternberg's work in the seventies was far from an exercise in stipulative definition, because he avoided traditional psychometric approaches. He actualised his components in new types of measures. If he is to verify his theory in outline as a coherent statement of individual differences, he will perhaps begin to see some structural problems by considering this framework. Triarchic theory can be operationalised in idealized form by three broad classes of measures. These can be intercorrelated. Figure 1 illustrates this approach.

The first matrix, R11, consists of measures of context; the second, R22, of measures of ability to deal with novelty; the third, R33, of measures of process automisation. The cross-matrices, R12, R13, and R23, will provide the test of construct definition. But wait. Sternberg's system needs R44, the components of control. These, too, must be measured in the same

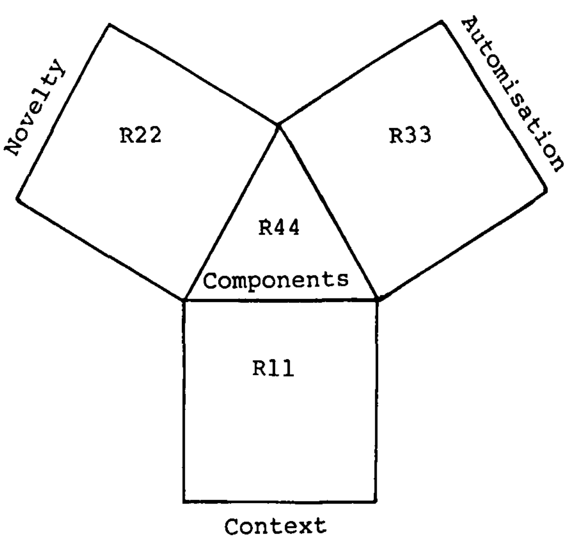

Figure 1 (Irvine). The triarchic theory operationalised in idealised form.

gigantic sample as the triarchy and related to all the other hypothetical measures. While the multivariate verification model for intelligence testing across contexts has been in place for some years (Irvine 1970), it has never been implemented.

I doubt that Sternberg's theory is capable, in its present form, of verification in the way that I describe. That does not decry his effort, which makes the strongest of cases for incorporating the paradigms of cross-cultural psychology into mainstream cognitive theory. His claim that the theory synthesises much will undoubtedly prove correct, in the long run. The short run requires instrumentation on a scale never before demanded. As delay of theoretical stratification has seldom awaited the proper instrumentation of the last theory, at least in mental testing, Sternberg's theory may remain at the stipulative level, even though it deserves not to. Whether or not it does will define, not only intelligence, but the kind of science that psychology can become.

Intellectual giftedness: A theory worth doing well

Nancy Ewald Jackson

Department of Parent and Child Nursing, University of Washington, Seattle, Wash. 98195

In his target article Sternberg offers an all-encompassing, multileveled, cross-paradigmatic theory of intelligence. The first question to answer is whether we need a theory whose breadth creates imprecision and awkwardness. Judged as cognitive theory, Sternberg's work achieves its scope at the expense of introducing disturbing gaps, ambiguities, and inconsistencies. On the other hand, it is a reasonable start toward a goal that most cognitive psychologists have not even recognized – the development of an information-processing account of intellectual giftedness.

Relative to existing conceptions of giftedness (e.g., Tannenbaum 1983), Sternberg's theory is exceptional in its rich detail and heuristic potential. The triarchic theory addresses the difficult problem of defining intelligence with reference to both individual and cultural processes. This dual perspective has relevance for understanding intelligence at all levels, but it is especially useful in attempting to understand giftedness. Intellectual deficiency can be general and absolute; excellence is often relative and situation specific. For this reason, explaining giftedness may be the most difficult test for any cognitive theory. If Sternberg ever meets this challenge, his triarchic theory will have enormous theoretical and practical impact. Unfortunately, the present paper shows how difficult it is to transform a collection of ideas from diverse theoretical and empirical contexts into a coherently structured theory. The limitations of this preliminary effort are evident both in the treatment of specific issues, such as the role of speed in intelligent performance, and in the general organization of relationships among the subtheories.

Sternberg's discussion of the relationship between speed and intelligence is especially weak. In his previous work, cited in the target article, Sternberg (like other cognitive psychologists) has repeatedly found that the execution of most kinds of information-processing components is faster among individuals who score high on standard intelligence tests. In the new two-facet subtheory, he also proposes that more intelligent individuals perform "smoothly and automatically" those intellectual operations that the less intelligent perform only "haltingly." However, seemingly trying to have it both ways, Sternberg downplays the empirical links between speed and intelligence by arguing that intelligence tests pose time constraints that are not characteristic of most everyday intelligent behavior. He bolsters this line of reasoning with the valid but irrelevant argument that slow and reflective problem solving is often superior to hasty work. He does not even mention the complex and theoretically important relationship between speed and automaticity (Kaye, Brown & Post 1981; Shiffrin & Schneider 1977).

Although it may be true that few everyday situations require split-second overt responses to complex problems, there are a great many contexts in which slow execution of component processes is likely to lead to a cumulative deficit in performance. One such situation is the classroom lecture. Students who are slow to encode the teacher's remarks, retrieve relevant context from past experience, or operate on incoming information to anticipate the teacher's development of a logical argument suffer a serious disadvantage. Anyone who has struggled to keep up with an instructor's presentation of a statistical proof should appreciate the advantage available to those who can automatically *and* rapidly process the symbols and operations involved. Processing speed may also have a substantial influence on the progress of self-paced learning. When struggling statistics students are reading a text, they may find that much less time is required to process the verbal text and figures than to comprehend the algebraic formulas. If study time or motivation is limited, the students may concentrate on the information they already handle well, exacerbating their inefficiency in dealing with equations. Perhaps this is what Sternberg would call an unintelligent choice. However, if the students do choose to work slowly through the formulas, some other duty or pleasure may be shortchanged. Individuals who process information slowly are forced to make choices that the efficient can ignore; they are blocked from options that will be open to the swift.

The problem with Sternberg's argument, that slow responses are often of better quality, was noted by Keating (1980) in his commentary on the componential subtheory. The trade-off between speed and accuracy (or thoroughness) of processing is one issue; the importance of speed when quality of response is held constant is another. Other things being equal, our society rewards speed. Perhaps this is unfair and sometimes counterproductive, but it is the kind of contextual reality that a theory such as Sternberg's must accommodate.

Another central weakness of the current version of the triarchic theory lies in the description of how elements of each of the three subtheories interact across subtheory boundaries. Specification of these connections is essential to a multilevel theory, but Sternberg avoids or muddles the issues. For example, the componential subtheory is described as specifying universal mental mechanisms underlying all intelligent behavior. References to the importance of metacomponent-like choices in intelligent adaptation to real-life situations (in the contextual subtheory) and references to the role of the knowledge-acquisition components of selective encoding, comparison, and combination in solving insight problems (in the two-facet subtheory) appear to be consistent with this organization. On the other hand, these connections are never fully developed, and Sternberg at one point (in his Conclusions) even asserts that they should not exist – that componential intelligence, the ability to deal with nonentrenched problems, and everyday adaptive skills are separable factors of intelligence for which no combination rule can be specified. Although there are abundant data supporting Sternberg's argument that a person may be a smart test taker without being an insightful problem solver or an effective professional, the greatest strength of the triarchic theory is in its potential power to explain such uneven performance. The explanation must involve carefully coordinated references to environmental factors, individual history, and general principles of information processing. All of these elements should be brought to bear on a set of problems that transcend the current empirical contexts of the three subtheories.

If Sternberg continues to neglect the challenge of explaining the behavior of the socially maladept prodigy or the modestly intelligent creative superstar, his triarchic theory will never have much value. If he does accept the challenge, he may have to move beyond the halfway measures of the current theory and create an entirely new paradigm for cognitive research. The task is worthwhile, but it will certainly require more precision in definition of constructs, specification of levels of analysis, and articulation of relationships among theory components than is characteristic of this article.

Mental speed and levels of analysis

Arthur R. Jensen
Institute of Human Learning, University of California, Berkeley, Calif. 94720

Sternberg's impressive attempt to synthesize and systematize much of the broad spectrum of behavioral phenomena associated with the concept of intelligence deserves admiration. Considerable beneficial effects on the advancement of a science of human ability are bound to stem from this effort. While it is still taking shape in Sternberg's programmatic research, however, it might prove helpful to point out one facet of the present formulation that, in my opinion, is most in need of rethinking and more sophisticated analysis. I refer to Sternberg's treatment of "mental speed." I use quotation marks, because the meaning of the term depends on our level of analysis. When this is not explicitly specified, only confusion and misunderstanding on this topic will prevail.

Sternberg's treatment of "mental speed" is confusing because it fails to distinguish clearly between speed at the level of the most elementary or basic cognitive processes that underlie intelligence and at the level of complex behavioral manifestations of intelligence. We are confronted by such seeming paradoxes, for example, as the popular notion that "smart is fast" (to use Sternberg's words), and that "quick-witted" persons are commonly seen as bright, although a number of the world's undisputed geniuses have been described by themselves or by their closest associates as "slow thinkers" – Darwin and Einstein, for example, and Beethoven, for whom composing was a slow, laborious struggle as compared with, say, the quick facility of Rossini.

Yet, in performance of various simple and choice reaction-time tasks, we find positive correlations between individual differences in speed of reaction and scores on traditional tests of intelligence and scholastic achievement (Carlson & Jensen 1982; Jensen 1982a; 1982b). Various criterion groups show reaction times on extremely simple tasks involving only the most elemental aspects of information processing, which, on average, are perfectly in accord with the groups' levels of general intelligence, as this concept is commonly understood. University students show faster reaction time (RT) than vocational college students, who are in turn faster than unskilled factory workers, who are faster than the mentally retarded (Jensen 1979; 1980b; Jensen, Schafer & Crinella 1981; Sen, Jensen, Sen & Arora 1983; Vernon 1981; 1983).

On the other hand, when the task is something as complex as solving relatively difficult reasoning problems, such as the items in Raven's Progressive Matrices, the correlation between individual differences in average response latency to the test items and psychometric intelligence (as measured by the total number of items gotten right on the Raven or any other standard intelligence test) vanishes completely, as I have noted elsewhere (Jensen 1980b; 1982b). On the other hand, if we obtain the mean latency (i.e., averaged over subjects) for each item, we find that there is a virtually perfect rank-order correlation between item latency and item difficulty as measured by the percentage of subjects who select a wrong answer. That is, more difficult items require more time for correct solution. I have termed this phenomenon the *test-speed paradox* – the seeming paradox being the fact that (a) average response latency is directly related to item difficulty and (b) individual differences in the speed of executing relatively elementary cognitive processes are correlated with psychometric intelligence, whereas (c) the speed of solving much more complex problems is correlated little, if at all, with psychometric intelligence. I do not believe that the latter fact (c) can be used to contradict or denigrate the importance of the former fact (b) for understanding the nature of intelligence. I have discussed this "paradox" in detail and suggested a possible explanation elsewhere (Jensen 1982b). The phenomena (a), (b), and (c) are not theoretically incompatible when each is explained at a different level of analysis in the hierarchy of information-processing components, ranging from the lowest, most elemental processes to the complex coordination of multiple processes or metacomponents. It is theoretically possible, and, I think, likely, that the underlying mechanisms of general intelligence are essentially simpler than their manifestations in complex problem solving and other "real-life" behavior.

In my view, several well-established concepts and principles of cognitive psychology provide a rationale for the importance of a time element in mental efficiency. The first such concept is that the conscious brain acts as a one-channel or *limited capacity* information-processing system. It can deal simultaneously with only a very limited amount of information; the limited capacity also restricts the number of operations that can be performed simultaneously on the information that enters the system from external stimuli or from retrieval of information stored in short-term or long-term memory (STM or LTM). Speediness of mental operations is advantageous in that more operations per unit of time can be executed without overloading the system. Second, there is *rapid decay* of stimulus traces and information, so that there is an advantage to speediness of any operations that must be performed on the information while it is still available. Third, to compensate for limited capacity and rapid decay of incoming information, the individual resorts to *rehearsal and storage* of the information into intermediate or long-term memory, which has relatively unlimited capacity. But the process of storing information in LTM itself takes time and therefore uses up channel capacity, so there is a "trade-off" between the storage and the processing of incoming information. [See also Broadbent: "The Maltese Cross," *BBS* 7(1) 1984.] The more complex the information and the operations required on it, the more time that is necessary, and consequently the greater the advantage of speediness in all the elemental processes involved. Loss of information due to overload interference and decay of traces that were inadequately encoded or rehearsed for storage or retrieval from LTM results in "breakdown" and failure to grasp all the essential relationships among the elements of a complex problem needed for its solution. Speediness of information processing should therefore be increasingly related to success in dealing with cognitive tasks to the extent that their information load strains the individual's limited channel capacity. The most discriminating test items would thus be those that "threaten" the information-processing system at the threshold of "breakdown." In a series of items of graded complexity, this "breakdown" would occur at different points for various individuals. If individual differences in the speed of the elemental components of information processing could be measured in tasks that are so simple as to rule out "breakdown" failure, as in the various RT paradigms we have used, it should be possible to predict individual differences in the point of "breakdown" for more complex tasks. This is the likely basis for the observed correlations between RT variables measured in relatively simple tasks and total scores on complex g-loaded tests. Most of Sternberg's research and thinking has been focused on a different level of analysis, higher in the hierarchy of complexity of information processing and closer to the behavioral expression of intelligence than the more elementary level of information processing on which I, Earl Hunt (1978), and others have focused our attention.

I have suggested, in fact, that even individual differences in the speed of elemental information processing may not be the most basic source of individual differences in intelligence but may be only a secondary phenomenon, derived from a still more basic source of individual differences – a hypothetical construct I have termed "neural oscillation," which would account for individual differences in intertrial variation in RT as well as in individual differences in RT averaged over a given number of trials (Jensen 1982b). Eysenck (1982) also regards differences in mental speed and RT as derivative, in the sense that a person's average RT is not directly attributable to the speed of neural conduction or synaptic transmission. He hypothesizes that speed differences arise from individual differences in the rate at which errors occur in the transmission of neural impulses in the cortex. The stimulus message must persist until the "pulse train" of neural impulses exceeds a certain fidelity threshold. The more random "noise" or error tendency in the neural system, the more time this takes, and hence speed of reaction is a derivative phenomenon.

Sternberg's postulated components still bear a bit too much resemblance to autonomous homunculi, or "ghosts in the machine," to be entirely comfortable for me, from a natural science standpoint. (This seems a rather general characteristic of cognitive psychology at present.) But even assuming that the componential theory is essentially correct, Sternberg will sooner or later have to confront the question of what governs individual differences in the speed or efficiency with which his "homunculi" operate. There is a large general factor even among the different elementary processing components, that is, they are intercorrelated. Why? Is this fact not the real crux of explaining individual differences in psychometric *g* and all its correlates?

It appears to me that one of the differences between Sternberg's approach and mine is that he is working from the top down, whereas I am working from the bottom up, so to speak. I am trying to determine how much of the variance in psychometric *g* can be accounted for purely in terms of the speed of execution of a limited number of the most elemental cognitive processes. It already appears that something approaching half the total variance in *g* can be accounted for in terms of individual differences in RT (and its associated intraindividual variability) to a few elementary cognitive tasks, and it is possible that further exploration will raise the "explained" variance even higher, perhaps to three-quarters, or more, of the total reliable variance in psychometric *g*. Unlike Sternberg, moreover, I do not believe that more than a tiny fraction, if any, of the variance in *g* accounted for by RT is attributable to "time-pressure" or "speediness" factors in the psychometric tests. The evidence clearly contradicts this notion that RT is correlated with psychometric intelligence because some IQ tests are given with a time limit. Timed and untimed tests show the same correlation with RT. If it turns out that a large proportion of the variance in psychometric *g* is explained by the elementary cognitive processes reflected in RT measurements, what will be left over for Sternberg's metacomponents to account for, unless it is mainly the "real-life" manifestations of *g* in educational and occupational achievements? But that is a worthwhile enterprise, too, of course, because the imperfect correlation between *g* and achievement is itself in need of more exact explanations than we now possess.

In what sense does intelligence underlie an intelligent performance?

David R. Olson

Center for Advanced Study in the Behavioral Sciences, Stanford, Calif. 94305

What can one say? If one attempts to detail all of the factors ranging from social structures to local situation to specific tasks on the one hand, and to prior knowledge, available processes, and strategies on the other, and to constraints such as novelty and adaptiveness on a third – should one have a third – one would end up with an omnibus theory of intelligence of the sort that Sternberg has competently assembled. Although the increase in variables increases the scope of the theory, it offers little advance in our understanding of intelligent action. What is needed is a new concept of intelligence.

The fundamental assumption that Sternberg, unlike Piaget, for example, never seriously examines – except to adopt it – is that "intelligence" is a personal quality of mind, a trait, which differs importantly from individual to individual, which is prior to and independent of experience, learning, and achievement, and which thereby causes and explains variation in human competence. It consists, he says, of "the *ability* to deal with novel . . . demands" and "the *ability* to automatize information processing" [emphasis added]. Thus, although the vehicles by means of which one measures these "abilities" will need to differ across social groups, the underlying mechanisms to be measured and their functioning are common to all groups. A theory of intelligence, Sternberg says, is concerned with how individuals vary not in their mechanisms and functions, for these are universal, but in their *abilities* with these mechanisms and functions. Thus, intelligent people have more ability to automatize procedures and to deal with novelty. Again, intelligence explains intelligent performances: it is a quality of mind, the quantity of which differs from individual to individual, that explains differences in performance. And, of course, once one makes that assumption, the race is on to find the best technique for getting at that variability. Some experimenters try choice-reaction times; some try timing retrieval from memory: some, like Sternberg, try analogy problems, and so on. But the assumption that there is something about the quality of the mind that basically, and perhaps genetically, varies from person to person is uncontested ground. That assumption, although commonsensical, is in my view the major weakness of the theory.

There is an alternative possibility. Piaget thought that the search for intelligence as quality of mind was a block to understanding intelligence rather than a means to that understanding. He viewed intelligence as systems of schemes or structures of mind people use to do things. Although intelligence presupposes biological structures and an environment in which to operate, it was for Piaget intrinsically interactive. There is no basic quality of mind postulated to explain the degree to which one benefited from experience in becoming competent. Intelligence was simply the assembly of mental structures used in coping with the physical and social world, and that intelligence develops through a series of quite fundamental reorganizations of cognitive structure. Intelligence is the set of structures for doing things; it is not something that underlies or makes possible the acquisition of those structures. Put another way, intelligence is not the ability to reorganize cognitive structure, but it is those reorganized cognitive structures in themselves; it is not the *ability* to assimilate and accommodate, but it is assimilation and accommodation per se; it is not the ability to automatize (restructure) procedures, but it is those automatized procedures in themselves.

Let me try to make the point a different way. Sternberg approvingly cites Hunt's (1978) and Keating and Bobbitt's (1978) claim that "individual differences in intelligence can be understood . . . in terms of differences among individuals in speed of access to lexical information stored in long-term memory." For Sternberg, as for Hunt and Keating and Bobbitt, speed of access is fast for some individuals *because* they are intelligent. They have the ability to automatize procedures, Sternberg might add. There is no question that people differ in the speed of lexical access or in the degree of automatization, or, for that matter, in anything else. But, and here is the crucial question, is that speed the result of being intelligent, or is it a sample of a competently performed activity? I would think that it is the latter. And it is that competence, not something supposedly underlying it, that I suggest we should think of as intelligence. Testers of intelligence at least since Galton, and including Sternberg, have thought of intelligence as the explanation of the degree of automatization or the speed of access or of the ability to solve problems. I would argue that intelligence should be thought of not as the explanation of the degree of competence but as a description of particular forms of competence. Intelligence is a description of a set of cognitive structures underlying a form of activity: it is not a *cause* of those structures or an *explanation* of those structures.

I realize that this point is difficult to make. Piaget left it largely implicit. He wrote as if individual differences theory as an approach to a theory of intelligence was better ignored. He began anew by describing intelligence and its transformations in the course of development. More intelligent for him meant more cognitive structures. Rather than taking intelligence as a "person" variable, invariant across the lifespan, he took intelligence as what grows and develops over a life span. Differences in performance implied differences in those underlying structures.

Some of the experimental procedures and analytic techniques developed and described by Sternberg are enormously superior to the more informal ones used by Piaget. However, an improved theory of intelligence depends not only upon increased empirical power but upon seeing the problem differently. The problem for a theory of intelligence is not how best to assess a general quality of a person's mind but to describe how the structures and operations of the mind come to utilize the symbols and technologies of the culture in order to solve a broad array of personal, physical, and social problems (see Gardner 1983; Olson & Bialystok 1983). Sternberg provides a good account of some of these structures and operations, but he has hooked them to a defunct concept of intelligence.

Context and novelty in an integrated theory of intelligence

James W. Pellegrino and Susan R. Goldman

Department of Education, University of California, Santa Barbara, Calif. 93106

Sternberg's overview of a theory of human intelligence certainly strikes us as adaptive to the current intellectual environment. It has become almost commonplace to recognize that testing an individual's intelligence presupposes that the tester has a conception of what constitutes acting intelligently in a particular situation or in a particular culture. It is thus hard to argue with Sternberg that the contextual subtheory is not an important aspect of intelligent theories of intelligence. Similarly, the two-facet subtheory of the role of novelty and automaticity also meshes with our intuitions regarding the issues that must be accommodated within a comprehensive theory of intelligence. The componential subtheory is most closely related to Sternberg's previous efforts to develop a theory of intelligence. As augmented here, this subtheory is the framework within which one analyzes how an individual achieves or fails to achieve a particular "intelligent" response or behavior. However, as Sternberg makes clear, he is moving "Toward a Triarchic Theory of Human Intelligence." In order to increase the forward momentum of the present formulation, we focus our commentary on several issues within the "new subtheories" and on the difficulties that arise as integration of the three subtheories is attempted. Finally, we provide a general consideration of what the function(s) of such a theory of human intelligence might be.

The contextual subtheory discusses the importance of considering what is intelligent within a particular cultural or sociocultural setting. As a psychologist, Sternberg appears to be content to leave the terms "culture" and "sociocultural setting" undefined, much as an anthropologist might be content to leave the terms "intelligence" or "cognitive process" undefined. While the consensual everyday understanding of "culture" and "sociocultural context" may be fine in the present formulation, moving ahead demands a great deal more attention to the defining features of these terms. This becomes particularly cogent when we come to the third major term in this subtheory, "environment." For example, is school as compared to home a different culture, sociocultural setting, or environment? Given Sternberg's present formulation, there is no basis for deciding. Yet there is good reason to make clear distinctions, especially when one considers the other important concepts introduced in the contextual subtheory: the notions of adapting, shaping, and selecting environments so that success can be achieved. Success, by the way, also strikes us as a culturally biased criterion. Sternberg discusses the idea that it is an intelligent act to change environments when there is a mismatch between the individual and the current environment regardless of how much shaping and/or adaptation have occurred. There are two relevant points to make in this regard. First, at what point do we conclude that a person's adaptation, shaping, or selecting is intelligent? After one unsuccessful try at adaptation? After two? When does changing environments reflect not intelligence but rather running away from certain adaptations that individuals ought to make for their own emotional well-being? Many of us have had experiences with people who have changed college majors or jobs five or six times in two or three years. Some of these people may be acting intelligently, others not. The important point is that understanding the degree to which adaptation, shaping, or selection is in fact an intelligent behavior requires a great deal more specificity and intellectual effort.

We have been using the terms "acting intelligently" and "intelligent behavior." The contextual subtheory reminded us of the distinction made some years ago that many parents have adopted in their parenting efforts: the distinction between being a good (or bad) child as compared with doing a good (or bad) thing. The current contextual subtheory needs to address the relationship between "acting intelligently" and "being intelligent." Perhaps we need to drop the global concept of intelligence as some general personality trait, just as Sternberg suggests we should stop trying to get some global score that reflects "intelligence." Even if psychologists were to recommend the obliteration of global intelligence traits, we doubt that the person in the street would stop making such attributions. Rather, observers' inferences that some person is intelligent need to be tied to the range of contexts and manners in which the person has on a series of occasions (or maybe just once) "acted intelligently."

The two-facet subtheory raises a critical question with respect to how we are to determine which tasks or situations are most relevant for assessing novelty or automaticity. Any task or situation that an individual encounters represents a point on a continuum of familiarity and thus will differentially tap various components of cognitive functioning. Sternberg argues that those tasks that emphasize adaptation to novelty and/or efficacious automatization are most relevant to determining intelligence. This argument appears to be based on the contextual subtheory's emphasis on adaptation. However, this tie gives rise to a dilemma, which Sternberg acknowledges to some extent: If we wish to compare individuals, even if we wish to compare only cognitive components, these abilities must be assessed on tasks that are equally novel for the individuals being tested. However, to find such tasks, we may have to settle for some that are so artificial or contrived that they bear little resemblance to the types of tasks that must be dealt with in adapting to one's actual environment. Good examples of such tasks are those found in puzzle books and those used as criteria for entry into groups such as Mensa. Even if we were to restrict our reference or comparison group to literate Western society, we doubt that there would be a consensus that these are representative tests of the capacity to adapt to novelty in the environment. Thus, in our effort to consider the implications of one subtheory for the others, we find ourselves faced with a rather troublesome dilemma. As further attempts are made to move the triarchic theory forward, integration of the subtheories will be a critical feature. Our sense is that integrative attempts will quickly generate a succession of similar dilemmas.

Our effort at integration also leads us to the final point of our brief commentary: What is the function(s) of measuring intelligence, whether one is measuring cognitive components or obtaining some global test score? One reason that conventional intelligence tests were developed and have been widely used is that they assess how well an individual has adapted to a certain environment, that of the academic system of Western, literate society. However, it is also well known that academic achievement is not very predictive of personal achievement outside the academic world. As Sternberg notes, it may not even be predictive of success among professional academicians. It seems clear to us that moving forward demands an examination of our purpose in attempting to develop a theory of human intelligence. Only then can we understand how to integrate the three subtheories and develop measures of "intelligence" that are themselves adaptive and appropriate to the cultural, sociocultural, and environmental settings in which they function.

How intelligent can one be?

Kjell Raaheim
Department of Cognitive Psychology, University of Bergen, Norway

The title I have chosen for my commentary on Sternberg's article is intended to indicate a query to which I shall finally return. Generally, however, I shall not try to be clever in finding weak points in the theory put forward. This implies, among other things, that I shall abstain from speculating about whether or not the first subtheory, about the context of intelligence, follows logically from what is held within another subtheory – the two-facet one – where intelligence is discussed in relation to task novelty. Nor shall I raise arguments to defend my own choice of concepts (Raaheim 1961; 1974) concerning the various types of difficulty challenging a person's intelligence, even if, again, I believe that the implications of the "clash" between experience and novel tasks ought to have been worked out more fully by Sternberg. Since I am confident that his fresh and unbiased search of this field will pay off, I shall, instead, attempt to enlarge a bit on some important points he has already raised.

Sternberg states that intelligence involves the ability to learn and reason with new *kinds* of concepts. This is, to me, a very central point. In the attempts to "reconcile" past experience with the demands of a new task, the intelligent individual seems to be able to *re*categorise stored knowledge in various ways and thus often succeeds in building upon something already known without the individual previously being aware of it. The seemingly new task is then, as a consequence, transformed into a familiar *type* of task, even if there will still be some difficulties before the task is efficiently mastered. A test constructed to assess the ability to recategorise past experience has in fact been found to yield scores that are highly correlated with other signs of intelligent behaviour (Hellesnes 1980; Hellesnes, Raaheim & Bengtsson 1982).

Another statement by Sternberg, which upon further analysis may turn out to be related to the one above, is that more-intelligent persons will be more rapidly and fully able to cope with the novel demands being made on them. It follows from the above that, to the more-intelligent persons, fewer aspects of a given situation may appear to be new. The ability to *recognise* the past in the present (as stressed by the philosopher Price, 1953) may in fact be seen as *the* most important intellectual ability. In differential psychology we have the general tests of abstraction (e.g., "similarities" subtest on the Wechsler tests), where less-gifted persons see something new, or different, while more-intelligent ones discover that various phenomena are of the same sort.

A brief comment in passing on Sternberg's views on the question of *speed*, for example, in solving tasks on an intelligence test: I find his points well taken and do agree that speed *selection*, or knowing when to work fast, is often crucial. Thus intelligent persons, if motivated to do so, may speed up on a test because they realise that time is important here. When Sternberg holds that a reflective rather than an impulsive cognitive style is associated with intelligent problem-solving performance, I would like to add that even where an active exploration of a situation is found to be more important than intelligently reflecting upon one's past experience (Kaufmann & Raaheim 1973; Raaheim & Kaufmann 1972), it has been observed that successful solvers pause a little longer than unsuccessful ones after the start signal and before engaging in some activity.

Another important issue, and one that comes close to my own current research, is raised by Sternberg in asking how differences in knowledge develop. He states that what seems to be critical is not the sheer amount of experience, but rather, what one has been able to learn from that experience. Self-evident as this may seem, it is nevertheless very difficult to arrange for a way of assessing the abilities in question, because, *initially*, one and the same 'situation' – as seen from the experimenter's point of view – may look different to different individuals.

A strategy adopted in my own research is to present a group of individuals with some information concerning a task on which success has *not* previously been found to correlate with scores on intelligence tests. (Such a task may be looked upon as *too* unfamiliar for past experience to be of any use; see also my final point.) Then, after having taken part in what might, in popular terms, be described as "a guided tour" into the unknown land, the subjects have been given another chance to do well on the task. With such different tasks as puzzle solving and university essay writing (perhaps they are similar in a more fundamental sense), it is repeatedly found (Raaheim, in press) that *after* the task has been made more familiar, achievements *do* correlate with test scores. Admittedly, the technique does not provide any quick answer to Sternberg's question, but it may perhaps be seen as a means of approaching a better understanding of the processes involved in knowledge acquisition.

My final point, to which the title of my commentary leads, concerns the question of whether or not intelligence has its limitations as a means of problem solving. Sternberg states that too much novelty can render a situation "nondiagnostic of intellectual level." Referring to a work of mine (Raaheim 1974), he also argues that if a task is too novel, individuals will not have "any cognitive structures to bring to bear on it, and as a result, the task will simply be outside their range of comprehension."

Perhaps no one would consider intelligence to be of much use in a completely new situation, where any type of past experience is totally irrelevant. The question that is only touched upon here by Sternberg, however, is, in my opinion, seldom taken seriously by researchers in this field. It is not only a question of whether there are situations that we cannot resolve by intelligently using past experience, but it is also a question of the extent to which people repeatedly engaged in serious attempts to do just that (Raaheim, in press) fail, in situations where a "fresh look," leading to a discovery of some new pieces of information, might otherwise have secured a reasonably quick adjustment.

Intelligence, adaptation, and inverted selection

Marc N. Richelle
Institut de Psychologie Expérimentale, Université de Liège, Liège 1, Belgium

Sternberg's target article is an interesting attempt to integrate in a unified though composite theory a number of aspects of intelligent behavior (i.e., of what people intuitively label by these words) that are left out by most traditional psychologies of intelligence, especially those theories based on the measure of IQ and the like. Such measures, as is widely recognized today, evaluate only those intellectual performances that are closely related to school training, and, beyond it, to the particular context of Western society. Theories derived from mental testing have altogether ignored cultural relativism and that part of intelligence that is revealed in real-life situations rather than in academic settings. Even Piaget's theory, though it claims to deal with universal mechanisms, and though it is totally alien to the mental testing approach, has been criticized for putting exclusive emphasis on the formal aspects of intelligence at the expense of the more practical social aspects – *knowing* versus *know-how.* Modern conceptions try to integrate both, and in so doing, they necessarily give sociocultural context the attention it deserves and look at individual differences in terms of "styles" rather than of rankings on a unidimensional scale.

Sternberg's triarchic theory is one of these conceptions, and a very ambitious one. It has a number of merits, some of which I shall point out as indicating that the theory, though quite in tune with the *Zeitgeist*, does not indulge in some naive views *à la mode*, especially in the educational version of psychological theories. Sternberg emphasizes the roles of novelty *and* automatization in intelligence. The more automatized routines individuals have available for solving a variety of problems or parts of problems, the more likely they are to deal efficiently with new ones. This is no new discovery, as Sternberg himself admits, but the complementarity of automatization and novelty had been forgotten by advocates of creativity, as a potential for free expression that would be hampered by any sort of systematic learning (or teaching), with some well-known consequences for the school curriculum.Though he draws mainly from cognitivist psychology for his componential subtheory, Sternberg proposes a qualified view of the use of *speed* as a measure of intelligence; he suggests that this fashionable measure, derived from laboratory studies, valuable as it may be, is not less ethnocentric than the old IQ; it reflects an obsession of our society for time-saving. He appropriately brings in the concept of inhibition, withholding immediate action often being a condition for solving a problem. Anyone who has watched children at various ages confronted with practical problem-solving tasks has observed the difference it makes in performance to engage immediately in (often unsuccessfully repeated) action or to withhold action for a while, "thinking about the problem." Similar observations were made long ago, of course, concerning chimpanzees.

Sternberg's theory also recommends itself by taking diversity into account, and by giving up unidimensional characterizations and measurements of intelligence. Intelligence is no simple thing and we should not simplify it. The triarchic theory, however, has some important flaws and limitations, some of which I shall comment on briefly.

At the methodological level, one can call into question the use (not exclusive, but important) of questionnaires asking people how they characterize and rate intelligence. Data obtained in this way seem more relevant to a theory of attribution than to a theory of intelligence itself.

The concept of adaptation, as used by Sternberg, is vague and inconsistent. It is tempting to think of intelligence in terms of adaptation, but it is not clear at the sociopsychological level what the criteria for adaptation are. There is the danger of falling into a conformist view – the better you adjust to your environment as it is, the more intelligent you are – but this goes counter to our intuition that people who object to the present state of affairs, or who are ahead of their time, are not necessarily stupid. Sternberg is aware of this, although he also argues that individuals adapt to their particular "niche" – that is, cultural or subcultural niche – a term obviously reminiscent of the biological, ethoecological view of adaptation. I am prepared to share this view, and its qualification, as being distinct from crude Social Darwinism. But where we do get into trouble if we adhere to a biological definition of adaptation extended to intelligent behavior is in the concept of *selection* as it is used by Sternberg. Under the heading *selection* and throughout his argument, Sternberg assumes a process that is exactly the converse of selection in the biological sense. *Environmental selection,* for Sternberg, refers to individuals' selecting the environment that best fits them. Eventually, this will lead them to modify the environment, or, if this is not possible, to move elsewhere. The partner leaving the marriage, the employee leaving the job, or the resident of Nazi Germany leaving the country are proposed as examples of the latter solution. In these and similar cases, an alternative explanation would put the selection pressure on the environmental conditions, rather than putting the power to select in the hands of the individual. Escape and avoidance behavior can be explained in a very satisfactory way in terms of contingencies of reinforcement or control by consequences without resorting to any decision of the organism to change its environment or to move away. This alternative account does not imply that such behaviors – occurring also, obviously, in humans as Sternberg's relevant examples remind us – have nothing in common with intelligence. After all, mechanisms of learning are but aspects of what has evolved as intelligent behavior. This is not to say that there is no such thing as an individual "making a choice" of an environment – as we all do when visiting dozens of apartments and houses before settling down in a new place – but, if we think of human behavior, be it of the most sophisticated kind, with the conceptual tools of biology, we are left with the problem of explaining how selection *of* an environment has evolved as a product of selection *by* the environment, a major problem for a general theory of intelligence. Sternberg completely ignores it, though well-known psychologists have dealt with it in a heuristically successful manner (Piaget 1967; 1974; 1976; Skinner 1969; 1981). One of them is Skinner, whose view, centered on the selective action of the environment, is akin to modern biological thinking – though, for some reason, his writings are often disregarded, unappreciated, and misrepresented. [See special issue on works of B. F. Skinner: forthcoming *BBS* 7(4) 1984.] Another is Piaget, whose lifelong endeavor has been accounting for the emergence of knowledge and logic in the framework of biological theory. (Incidentally, Piaget's contribution has practically no place in Sternberg's theory, which looks to European readers like building a general theory of physics leaving out Bohr's contribution – not just Bohr's name.)

What sets Sternberg's view in opposition to Piaget's theory (and, for that matter, to Skinner's approach) is that it is essentially *subject centered,* while Piaget and Skinner offer an *interactionist* conception. Because his theory is subject centered and does not recognize the role of selection *by* the environment, Sternberg is unable to avoid a normative definition of adaptation, despite his claim to the contrary. The biological model is the only one that provides a nonnormative concept of adaptation, but it has no place for the one-way *environmental selection* of Sternberg's theory. The author, being reluctant to decide from outside what is adaptive or not, is led to rely on the subject's own feeling about his adaptation – or on others' opinion, as in the questionnaire method mentioned above. In both cases, the definition of adaptation is normative, in the sense that it is loaded with value judgments.

The triarchic theory takes for granted that intelligence is a sort of inherent property of the individual, a sort of competence that is expressed by means of a series of strategies and under specific forms, depending upon the peculiarities of the cultural context (looked at as a stage on which the subject will eventually choose a given behavior or strategy rather than another). This is of course in line with current cognitive theories. It leaves out the dynamics of intelligence: How does the individual come to perform some tasks intelligently? To answer this question, one has to look at the development of intelligence or at learning processes. Sternberg gives explicit attention neither to development nor to learning. True, we are told that, at some point, intellectual skills can become automatized and ready for use in solving novel problems. However, in spite of offering rather abstract speculations concerning the *ability* to automatize information processing, Sternberg tells us little about the way this automatization *takes place*. It would seem that understanding intelligence, and therefore building a general theory of it, would imply understanding the way it is built in the individual. Here again, one is surprised not to find any allusion to the constructivist theory of Piaget, and to the large amount of research derived from it. If Sternberg's ambition is to "answer a broader array of questions about intelligence than has been answered in the past by single theories," why does he not address himself also to some important questions that have been answered, at least partly, in the past, even though by less comprehensive theories? Omission of such an important contribution as Piaget's developmental theory would require some explanation.

This brings me to a last general comment. Reading Sternberg one cannot help having a feeling of *déjà vu* at many of his points, already made years ago by now forgotten authors. In at least one case, he is aware of the convergence, quoting Thurstone on withholding responses. But except for Thurstone (1924) and Dewey (misleadingly referred to in a 1957 reissue), the naive reader might have the impression that nothing intelligent had been written on intelligence until 1960 or so. I trust that Sternberg knows his classics, and, for those he might not know, I praise him for having rephrased by himself some of the things they had said earlier. Still, explicit reference to authors before the sixties or seventies would be useful. Limiting myself to contributions in French – because they are so widely ignored by American researchers – I think that psychologists of the Geneva School, before and besides Piaget, namely, Claparède (1933) and Rey (1946; 1962; 1963) have anticipated many of the ideas developed by Sternberg. One should go back to their work not just for the sake of historical erudition, or for founding one's theorizing on authorities of the past (Claparède and Rey certainly won't give Sternberg the prestigious support the *Grammaire de Port-Royal* brought to Chomsky), or for the moral pleasure of being fair to one's forerunners. In the controversal field of intelligence, looking back at earlier works that did not have much influence in their day is a way to detect the extra-scientific factors that account for the acceptance of a given paradigm, at a given time, and a way to put the scientific debate in a healthy relativistic perspective. Theories of intelligence that prevailed in the past may have been biased: the same is not necessarily true of all that has been said by some uninfluential authors, possibly too intelligent for their contemporaries. Perhaps they were maladapted?

What are the interrelations among the three subtheories of Sternberg's triarchic theory of intelligence?

Barbara Rogoff
Department of Psychology, University of Utah, Salt Lake City, Utah 84112

In order to become an integrated theory of intelligence, the triarchic theory must be more than three separate lists of criteria for assessing intelligence – contextual aspects, extent of experience in a task, and mental mechanisms. The goals of the theory appear to include both assessing individual differences in intelligence and understanding the processes of intelligence, that is, how people manage to do intelligent things. It may be sufficient to provide three lists of criteria for the purpose of the assessment of intelligence, but a theory for understanding intelligence requires considering how the various parts of the theory work together.

The relations among the three subtheories are not discussed in detail in Sternberg's target article. Specification of the roles of the subtheories appears limited to defining their domains of explanation: The contextual subtheory deals with the contents of intelligent behaviors; the two-facet subtheory (unfortunate label) deals with intelligent treatment of a task according to previous experience with it (novelty and automatization); and the componential subtheory involves the mental mechanisms used in behaving in an intelligent fashion, independent of the particular contents of the task. Each subtheory has points to recommend it, but a theory requires more integration.

I would like to suggest a direction in which the three subtheories could find more integration, by focusing on a problem in Sternberg's account of the contextual subtheory. Sternberg proposes that the role of context is to provide the content on which intelligent processes work. This separation of content and process is fallacious, in that processes convert into contents depending on the perspective from which they are viewed. Cross-cultural psychology provides many examples in which cognitive processes (such as control processes in memory) appear to be specific content areas with which individuals from particular cultures are familiar. (See discussions of the contextual nature of cognitive processes in Laboratory of Comparative Human Cognition 1983; Rogoff 1982; Rogoff & Mistry, in press; Scribner & Cole 1981.) Although the metacomponents discussed by Sternberg have not received direct attention in cross-cultural studies, it is reasonable to predict that they, too, would not be identifiable independent of specific task.

In addition, Sternberg's separation of content and process is logically unverifiable. He asserts that, although the content of intelligence varies across cultures, the hardware (anatomy and physiology) and potential software (cognitive processes, strategies, mental representations) are found in varying degrees in all people in all sociocultural milieus. To demonstrate this would require giving tests across several cultures with valid measures of both content and process. But Sternberg argues that one cannot impose a test upon several cultures without being certain that the adaptive requirements of the skill are the same in those cultures. And to be certain of this seems to require equivalence of performance. So how would we interpret a finding of differences in the processes of intelligence? The difference could indicate that the test was not tapping the process with equal validity in the different cultures, or it could refute the assumption that the processes of intelligence are independent of context and culture. It may be more parsimonious not to separate content and process and instead to regard intelligence as being contextually grounded through and through.

The stance that all aspects of intelligence are related to context suggests that contextual aspects of intelligence may play an overarching role coordinating the other two subtheories. Contextual aspects of intelligence focus on the purpose of the individual's actions, the fit of the chosen means with the outcomes regarded as desirable in that context, and social conceptions of intelligence and socially provided tools and techniques for thinking. Hence these contextual aspects of an activity coordinate how the individual brings previous experience to bear on novelty and automating skilled processes (the two-facet subtheory), and how the person attempts to plan, monitor, and make decisions (componential subtheory) based on the skills, tools, and techniques familiar through practice of culturally organized activities.

Sternberg in fact makes points that support this view in arguing that novelty and automatization are closely tied in with the activities people have practiced, and in arguing against the use of speed without concern for whether speed is appropriate in the particular problem context.

However, other aspects of Sternberg's argument are at odds with my suggestion that contextual considerations may be basic to interrelating the three subtheories. First, as already discussed, he separates content and process. Second, he separates knowledge-acquisition components from performance components, as well as from the two facets of treatment of novelty and of automatization. From the standpoint that intelligence develops through becoming skilled in particular activities in context, it seems awkward to separate knowledge-acquisition components from the activities in which people are learning (i.e., their performance and their adaptation to the challenge of novel information).

Finally, while Sternberg's argument for the plurality of niches for which people's intelligence adapts is consistent with a contextual perspective, he contradicts this by repeatedly referring to intelligence in terms of "level" achieved. Sternberg defines intelligence in terms of behavior in real-world situations, but he continually finds himself in the position of validating observations of intelligent behavior with its correspondence to measures of IQ. He laments the lack of better external criteria, but his triarchic theory is based on IQ as the arbiter of intelligence. (Both of Sternberg's examples of contextual studies rely on IQ as a criterion.) Perhaps differences in performance are better characterized in terms of differing patterns of skills rather than as diagnoses of intellectual level. If we simply described what people know how to do rather than attempting to find a central indicator, our descriptions of their skills would be inherently linked with the context of their practice. And we may get closer both to understanding the processes of intelligence and to the prediction of individual performances in school, on the job, or surviving in the streets.

Speed and adaptivity in intelligence

Harry C. Triandis

Department of Psychology, University of Illinois at Urbana-Champaign, Champaign, Ill. 61820

Sternberg's is a broad theory that accounts not only for individual differences in intelligence but also for creativity. It uses a set of abstract constructs and mechanisms that may be weighted differentially in each culture. Thus it contains both universal and culture-specific elements. It makes clear the methodological difficulties of cross-cultural comparisons of intelligence and stresses the need for independent validation of the measurements in each culture. It provide novel, theory-based procedures for the measurement of intelligence. These are very important strengths of the theory.

The proposed theory fits well with my own views of the determinants of behavior in cross-cultural perspective (Triandis 1980). Particularly, the stress on the importance of automatic processing of information versus the processing of novel information as two distinct phenomena requiring different mechanisms is a most valuable aspect of the theory. The theory can also account for the different conceptions of intelligence found in different cultures, such as the emphasis on "being right" versus "being quick." A good case is made that speed selection and not speed per se uses important skills reflecting intelligence, so that smart is not always fast. That agrees with the view of intelligence found in many non-Western cultures.

Two minor clarifications of the theory would be helpful. First, it would help to have further elaboration of what is meant by *adaptation*. Is it a high probability of reaching self-defined goals? Is it knowing what behaviors have what consequences? Is it knowing what behaviors are needed to reach particular goals? Is it all of the above?

Second, it would be useful to relate the theory to those behavioristic frameworks that do not require "information processing" as a mediating variable. I am thinking of responses that are habitually elicited by a complex configuration of cues. The grand master in chess, for instance, in tournament play, sometimes looks at a complex configuration of positions for a very short time and then selects a move without analyzing each of the possible consequences. The speed of the response selection is often so great that it makes the information-processing hypothesis seem implausible. Rather, in the case of chess masters, the cue-configuration, response-selection link has been overlearned. Such behavior must be considered intelligent, but it seems not to have been included in the present account.

Some possible implications of Sternberg's triarchic theory of intelligence

Leona E. Tyler

88604 Third Avenue, Florence, Ore. 97439

Since the beginning of the testing movement, the problem of defining the word "intelligence" has repeatedly been recognized but never solved. A symposium in 1921 (Intelligence and its measurement, 1921, pp. 123–47, 195–216), at which the foremost authorities of that time presented their views, showed that there was no general agreement among those who were attempting to measure intelligence as to what the essential features of this characteristic were. In the more than half-century since then, this diversity of interpretation has continued.

Two general approaches to theorizing about intelligence can be differentiated. Some thinkers start with broad, inclusive concepts based on manifestations of intelligence in human affairs and comparisons of species at different evolutionary levels. From this point of view, intelligence is the quality that makes adaptation to complex situations and demands possible. It is clear, however, that the intelligence tests we have developed do not adequately measure the characteristic we have defined thus. The second kind of theorist, more pragmatically oriented, starts with the individual differences revealed by the tests themselves. Such thinkers use data from validational and factor-analytic studies, as they become available, to formulate increasingly accurate statements about what we mean by *test* intelligence and warn test users that broader meanings should *not* be attached to the term "intelligence."

Against this background, Sternberg has delineated an unusually comprehensive theory of intelligence as manifested in history, individual careers, laboratory investigations, and test scores, more inclusive than any previous theory. It is a sort of three-legged stool, the legs of which are subtheories about (1) *context* and culture, (2) two *facets*, novelty and automatization, and (3) *components*, the actual cognitive processes used in intelligent behavior. The theory transcends the limitations of both the main approaches outlined in the previous paragraph, utilizing psychometric, experimental, and cross-cultural evidence, as well as self-evident commonsense ideas. It is indeed an impressive accomplishment.

It is with regard to the value or utility of this or any other general theory of intelligence that some doubts arise. What is the ultimate objective of such theorizing? Is it to *understand* what we have been talking about and attempting to measure, and, based on this understanding, to construct more adequate tests? In some sections of the article, it sounds that way. Although Sternberg is very critical of the circularity of some psychometric research that uses scores on established tests as criteria for new tests, he cites research evidence of this sort in reporting some of his own studies, as when he states that scores on his insight measures correlated about .6 to .7 with IQ. In one place he suggests that the two-facet subtheory could provide the basis for a more satisfactory selection of tasks to be included in intelligence tests. But if all of the variables to which the triarchic theory points are involved in intelligent behavior, is it realistic to suppose that we shall ever have a single test or set of tests that will provide an adequate assessment of intelligence?

It would be very useful to parents, teachers, and clinicians to have tests that would enable us to diagnose specific intellectual strengths and weaknesses and to design training procedures for developing and improving component skills, thus raising the intellectual level of many or all individuals. But the complexity of the theory and the nature of some of the variables make it appear unlikely that this will ever happen.

Could it be that the implications of this theory are more revolutionary than its author intended them to be? For this commentator, they cast doubt on the whole concept of intelligence as a trait or set of traits. Sternberg raises the question whether a single score can ever be an index of a person's intellectual level, representing as it does so many components that can be combined in so many ways. It is quite conceivable that individuals possess a repertoire of component skills, from which they select different ones for different occasions and make different decisions about how they are to be combined. Furthermore, it seems possible, even probable, that these components cannot all be considered continua and thus measurable by our standard techniques. Perhaps the whole measurement approach is becoming obsolete, and we should be seeking ways to characterize systems, structures, and processes. Scientists and philosophers no longer consider measurement to be essential to science.

Sternberg points to the pluralism inherent in the theory when he says that "there may be no one set of behaviors that is 'intelligent' for everyone, because people can adjust to their environments in different ways." He then goes on to emphasize how important it is for an individual to possess at least one well-developed skill and capitalize on it. Is this "intelligence" or is the whole concept irrelevant here?

Psychologists of the future may no longer ask, "How high is this person's IQ?" or "Where does this person stand in a norm group with regard to various measured traits?" but rather, "How does this person function?" in various situations. The answers to some of these questions may be qualitative, not quantitative. For this commentator, Sternberg's target article is important because it is a first step toward a general theory of human functioning rather than a theory of intelligence.

Intelligence: Some neglected topics

Philip E. Vernon
Department of Educational Psychology, University of Calgary, Alberta, Canada T2N 1N4

The title of Sternberg's book, summarised in this target article is *Beyond IQ* (in press); like several contemporary writers, he is disenchanted with psychometric approaches to the nature of intelligence and believes that an approach based on cognitive psychology and information theory will be more fruitful. Sternberg's discussion is a major contribution, which is replete with interesting and original ideas. It is, however, rather loosely structured and difficult to follow, largely because his description and arguments are purely verbal. Some kind of flowchart or map of his components would have been helpful. Also, there is confusion at the outset because the two-facet subtheory is listed as the third of his triad, but is then discussed second.

An author is, of course, entitled to choose what aspects of intelligence he regards as relevant or as unimportant, but I would think that a comprehensive theory should be linked, if possible, to aspects considered important by previous writers. Among the main lacunae are:

1. No mention is made of the biological evolution of the brain and its functions in prehuman as well as human species. Is all the evidence derived from studies of cognition and learning in rats and primates, and the rest, irrelevant?

2. Similarly, the anatomy and neurology of the brain are ignored. True, our knowledge of these is limited, but studies of brain damage surely throw some light on information processing.

3. The recent move by Eysenck (1982) and Jensen (1982b) to predict intelligence from reaction times, inspection times, and evoked potentials is a threat to Sternberg's cognitive theory. However, he includes a useful discussion of the role of speed in intelligence.

4. There are no references to developmental psychology, though surely the growth of cognitive skills and concepts from birth on helps in understanding processing in adults. Moreover, Sternberg's own experiments have mostly been carried out with college students as subjects – hardly a representative sample of adults.

5. Sternberg does not attempt to relate his present theory to those of other theoreticians, such as Spearman, Burt, Hebb, Piaget, Guilford, Cattell, and several of the contributors to Resnick's book (1976), apart from referring to Jensen, Carroll, and E. B. Hunt as examplars of componential analysts. Possibly his book will cover this topic (Sternberg, in press).

6. Factor analysis is not ignored, and it is used in some of Sternberg's own investigations, but his suggestion that metacomponents correspond to general (or second-order) factors and performance components to group (presumably primary) factors is implausible. Also, one might be more willing to accept his lengthy list of components if some of them had proved to be distinguishable factors.

7. Most noticeable is the lack of any mention of the role of genetic factors in intellectual functioning. Sternberg frequently refers to cognitive abilities as acquired, and therefore modifiable. He does not say whether there are innate individual differences in the capacity to build up high, or not so high, intelligence. Very likely he prefers to bypass such a controversial topic. But there is no need to ally himself with either Kamin's position or that of Jensen and Eysenck. It would be helpful to know whether he agrees, like most psychologists, that intellectual abilities are phenotypes, which derive from the interaction of genotypes with envirnomental stimulation (Vernon 1979).

There have, indeed, been many studies showing that reasoning and other cognitive skills can be imporved by effectively devised training programmes. But the amount of gain is usually small, and there is seldom any transfer to other apparently similar skills. Thus, the Head Start programme clearly failed to achieve the expectations of its advocates, even though there is now some evidence of valuable and long-lasting indirect effects. Again, training in creative problem solving may produce higher scores on divergent thinking tests, but it is not known to bring about improved artistic or scientific creativity generally. Unlike many environmentalist writers, Sternberg does not believe that skills such as vocabulary are acquired merely as a result of training at home or at school. Children are, of course, often told difficult words, but they seldom retain them or use them correctly unless they have reached sufficient intellectual maturity to understand the concepts that the words stand for. Sternberg explains the high correlation between vocabulary and general intelligence as due to "differences in knowledge acquisition," that is, the ability to learn from experience. Does this correspond to Hebb's genetic potential or to intelligence A?

Sternberg does give a valuable survey of the relations of intelligence to the external environment (his first subtheory). In discussing how intelligence is relative to each particular culture, he suggests that the underlying cognitive processes are common to most cultures, even though their concepts may vary widely. What one misses in his analysis is any attempt to provide a taxonomy of the major environmental variables. His categories include, for example, adaptation to the particular environment, and selection and shaping of suitable environments by the individual; but he curiously omits the shaping of individuals by environmental pressures. Jensen (1973) pointed out the snags in demonstrating the dependence of mental abilities on environmental conditions and in our frequent resort to speculative and unvalidated "X-factors."

Sternberg does not fall into this trap, but his account of intellectual processes seems to derive mainly from his personal observations and introspections, with too little backing from his own experiments, or those of others. This is true also of his interesting discussions of the internal components of intelligence and of novelty and automatization (omitted here for lack of space). My hope is that the target article and book will stimulate psychologists to operationalize Sternberg's categories and concepts, and to investigate them more objectively.

A triarchic reaction to a triarchic theory of intelligence

Steven R. Yussen
Department of Educational Psychology, University of Wisconsin-Madison, Madison, Wis. 53706

Sternberg presents here an ambitious model of intelligence and intellectual functioning. It attempts to cast a broad and inclusive net over a variety of cognitive phenonena, not all of which have traditionally been thought of in the past as being about "intelligence." The target article is a synopsis of a book (Sternberg, in press) about to be published on the topic.

His ideas have much appeal and form perhaps the most comprehensive attempt I've seen to integrate (a) psychometric ideas about intelligence, (b) information-processing analyses of mental functioning, and (c) notions about the deployment and acquisition of natural skills and domains of expertise. Indeed, there are so many imaginative and clever arguments presented in this model, one hardly knows where to begin to evaluate it. Let me offer three general comments.

I note first of all that the model forces us to be quite liberal in our definitional boundaries or canonical examples of intelligence. Intelligence can be manifest in actions taking a few moments of time, or hours and days of goal-directed human activity. It can be studied in domains as diverse as logical reasoning, school-based skills, success at work, use of artistic or creative talents, social skills, the ability to manage others, athletic prowess, and much more. It can (and as Sternberg claims, *should*) be studied in the context of either very novel circumstances where new learning and adaptation must occur or highly overlearned, automatized skills, where relatively rapid deployment of mentation is possible.

This broadness of the theory has both salutary and unfortunate consequence. On the positive side, it suggests an openness and richness of things we might begin to study in human beings. If intelligence can be found everywhere and is manifest in virtually any meaningful human endeavor, we can begin to catalog, measure, and provide instruction in a whole host of "intelligent" skills and activities – all of which are about the same entity, intelligence – as the concept is explicated in the target article. Such an openness seems fortunate in light of the narrow focus we have inherited from nearly a century of the psychometric tradition, and the large collection of homogeneous intelligence tests, which ultimately serve to concretize and validate what the field is all about. On the negative side, I am bothered by the possibility that if all these diverse phenomena were to be subsumed under the rubric of "intelligence," we would then have seemed to equate intelligence with virtually all of cognition and thereby highly oversimplified modern cognitive psychology. When I take the various definitions and features of subtheories in Sternberg's paper seriously, I am hard pressed to see what aspects of cognition are not part of legitimate inquiry here. Are cognition and intelligence synonymous, then?

I note secondly that, broad as the theory might seem to be, and sensitive as it is to the measurement of individual differences, it has, in a strange way, avoided any real treatment of two important matters – how intelligence develops and what accounts for the development of individual differences in any subtheoretical feature (such as an individual's skill in shaping the environment, ability to deal with novelty, or skill in information processing, such as *selective encoding, selective combination*, or *selective comparison*). To be sure, Sternberg's target article amply documents what the loci of differences among people are likely to be – it is adequately *descriptive*. But the treatment seems to lack a convincing *explanation* of how people get to be that way; that is, what forces and principles help to explain the processes by which individuals develop intelligence and beome different from one another in their expressed levels of it in some domain or with respect to some feature of it? I am sure Sternberg has a number of ideas on these issues, and I would very much encourage him to develop these with his other notions of intelligence.

A third and final reaction to the article concerns the status of the three subtheories that collectively define Sternberg's complete theory of human intelligence. My feeling is that the subtheories are differentially amenable to careful scientific analysis, operationalization, and testing. In the first subtheory, for instance, despite the cleverly chosen examples, I remain skeptical of how easily or objectively we shall be able to reach consensus on such matters as an individual's purposiveness, adaptiveness, or tendency to shape the environment. Although nomination procedures and lists of "stars" in a field lend strong intuitive appeal to the scientific status of studying such properties, these techniques are a far cry from objective measurement of clearly defined attributes in the individuals themselves. "Novelty and automatization" would seem to pose less of a problem for the second subtheory, although here I would be careful to rely on more than face-validity information that a situation is really novel or handled automatically by an individual. Criteria for novelty and automatization need to be specified in advance and tested for, independently of any claims made about how individuals handle novel tasks or behave in an "automatic" mode. In the examples cited in the target article, I don't know that care has been taken to separate the measurement of these characteristics of the tasks from the predicted consequences of them.

The componential theory is the most elegant subtheory and the one amenable to the easiest forms of verification or falsification. This is not surprising, since it is the componential subtheory that Sternberg has thought about and worked on longest.

Contextual and psychometric descriptions of intelligence: A fundamental conflict

Barry J. Zimmerman
Graduate School and University, Center of the City University of New York, New York, N.Y. 10036

One of the many attractive features of Sternberg's work is his sensitivity to current trends in research on intelligence and his willingness to include these developments in his own theorizing. His synthesis of information-processing and factorial approaches to intelligence is a major contribution to the field. However, in attempting to expand his theory to include contextualism, he must not only span differences in theory but also in metatheory. This formidable task will require the resolution of a fundamental conflict in world view between psychometric and contextual approaches.

This problem involves how "relevant" context is defined. In many of the examples he uses to illustrate his contextual subtheory, Sternberg defines context in terms of membership in a particular social group – a primitive tribe versus an industrialized society. He also indicates that context could be defined more narrowly, in terms of social subgroups. Two questions arise concerning the selection of comparison groups.

The first question is how narrowly should one define "relevant" context? I suggest that there is a disquieting trade-off: The more specifically context is defined (e.g., firefighter in New York City), the more predictive the measure of intelligence in those particular situations, but the less universal the meaning of the measure (about the person). To a contextualist, intelligence is not a description of a *person* per se, but a description of a person's mental and physical *performance* in a particular setting. According to this view, a person has different "intelligences" depending on the context in question (e.g., fighting fires and succeeding in school). This trade-off occurs because of a fundamental conflict between psychometric and contextualist views of intelligence. The psychometric descriptions assume the transsituational generality and stability over time of knowledge. Because contextualist descriptions are inherently situation-relative, they often appear unstable over time, task variations, and settings. However, consistency in performance and predictability of transfer over settings will be evident if specific contextual factors are taken into account (Mischel & Peake 1982; Zimmerman 1983).

McClelland (1973) has argued that the situational sensitivity of measures should be the highest criterion of validity in psychological testing. The more sensitive a measure is to changes due to experience or to changes in context, the more confidence researchers can place in their results. This contextual sensitivity criterion stands in contrast to the consistency criterion advocated by psychometric theories (Campbell & Fiske 1959). In item analyses based on psychometric theories, variation in response to specific items is viewed as inconsistency, not contextual sensitivity, and is treated as a form of error. Awareness of these fundamental shortcomings of the psychometric approach has led educational psychologists interested in promoting children's achievement (i.e., adaptation in schools) to develop an alternative "edumetric" model (Carver 1974).

With the need to define the comparison group narrowly assumed, a second question concerns the particular contextual criterion that should be used. Clearly each person can be described according to a variety of social-group characteristics such as race, age, geographic location, and socioeconomic class. Contextualists feel that social-group membership is but one rather general description of context, and the choice of a relevant comparison group is itself contextually specific. Consider, for example, the decision about how to interpret a Mexican-American child's intelligence test score. A contextualist would argue that this decision depends on a theorist's goals and previous and concurrent contextual information. In order to make a valid interpretation, a psychometrician should know the child's facility in English, length of residence in the United States, and the user's intended purpose for the test results. This example illustrates an important property of contextual metatheory (Pepper 1970): No single criterion for relevance is accepted. Validity is seen as relative to particular goals, persons, and contexts. This pluralistic view of truth contrasts with idealist premises underlying classic psychometric notions of intelligence (Labouvie-Vief & Chandler 1978).

Sternberg seeks to deal with the contextual relevance question with his two-facet subtheory. However, as they are presently described, novelty and automaticity do not appear to be contextual constructs in the usual sense, but rather seem to be descriptions of performance (at the beginning of a learning sequence and at asymptote). Sternberg classifies these terms as "abilities," and this implies that he views them as transituational properties of performance. Most contextualists will be skeptical about how well responses to "novel" test items will predict a person's reactions in real-world contexts. A similar argument can be advanced about automaticity. Although interesting as properties of functioning, novelty and automaticity do not appear to be sufficiently detailed as descriptions of context to allow much prediction. Herein lies the dilemma: Contextual detail must be sheared away in order to make descriptions of intelligence transsituational (as abilities). Yet it is this detailed information that provides the basis for explanation and prediction in contextual approaches.

This problem, although fundamental, is not totally intractable. It will require Sternberg to consider further epistemological issues such as a user's goal for descriptions of intelligence. Compromises on the degree of specificity may be ultimately justifiable on empirical grounds. Sternberg's target article represents a thoughtful effort toward rapprochement between these divergent views of intelligence.

Author's Response

If at first you don't believe, try "tri" again

Robert J. Sternberg
Department of Psychology, Yale University, New Haven, Conn. 06520

The commentators raise many important issues concerning both theories of intelligence in general and the triarchic theory of intelligence in particular. First I will address the general issues that transcend any one theory of intelligence; next I will address those issues that are relevant to the triarchic theory, in particular; finally, I will make some general remarks regarding the place of the triarchic theory in the historical stream of theorizing about intelligence.

This reply to the commentaries of my colleagues has a unifying theme, and the theme is the same as that of the target article: We should seek complementarity where in the past we have found conflicts. I believe that many, although certainly not all, of the criticisms raised against the triarchic theory derive from attempts to perpetuate conflicts and incompatibilities that exist only in our minds, and not in the constructs we have sought to study.

The goals of a theory of intelligence. Perhaps the most fundamental issue raised in the commentaries is that of the goals or purposes of a theory of intelligence. This issue is raised explicitly by **Pellegrino & Goldman, Tyler,** and **Zimmerman,** but the issue is implicit in many, if not most, of the other commentaries as well.

The triarchic theory of human intelligence seeks to specify the loci of human intelligence, and at least something of how these loci operate in generating intelligent behavior. It provides a somewhat broader conceptualization of intelligence than do most conventional theories. This broader conceptualization may help us understand not only the 10% to 25% of variance in real-world performance accounted for by traditional intelligence tests, but also a sizable chunk of the remaining variance. No matter how well traditional psychometric or cognitive theories account for performance on intelligence tests, they do not seem to go much beyond the tests in their ability to account for intelligence in the everyday world.

The general issue of the purpose of a theory comprises at least three subissues: the object(s) of a theory of intelligence; the level or depth of a theory of intelligence; and the scope or breadth of a theory of intelligence. I shall deal with each of these three subissues in turn.

The object of a theory of intelligence. The triarchic theory of intelligence is a theory of individuals and their relations to their internal worlds, their external worlds, and their experiences as mediators of their internal and external worlds. The locus of intelligence, however, is in the individual. This locus is not beyond question. For example, **Rogoff** views intelligence as "grounded through and through" in the context of behavior. **Olson** views intelligence as emanating from behavior, rather than any intrinsic disposition that gives rise to, or somehow, generates the behavior. In contrast, **Eysenck** is disappointed in the triarchic theory because it is a theory of behavior rather than of intrinsic dispositions themselves. The issue of the relation between intelligence, on the one hand, and behavior and its contexts, on the other, is also raised by **Economos, Jensen, Pellegrino & Goldman,** and **Vernon.**

The triarchic theory will not totally satisfy those scholars who seek the locus of intelligence only in the individual, or only in behavior, or only in the contexts of behavior, because the triarchic theory postulates the locus of intelligence to be in all three: The componential subtheory deals with the internal dispositions of the individual and their manifestations in behavior; the contextual subtheory deals with the contexts in which the individual lives and behavior takes place; and the two-facet subtheory deals with how experience mediates the interactions of the individual with the environment. I believe that it has been and continues to be important to study how these loci contribute and interact in defining intelligence, but I believe it counterproductive to seek a unique locus of the nature and origins of intelligence when no single locus exists.

The literature of psychology is replete with instances of fruitless "either-or" debates: propositional versus imagery theories of mental representation; process versus knowledge accounts of expertise in problem solving; spatial versus linguistic accounts of transitive inference; feature versus nonfeature accounts of psychological meaning; factorial versus process theories of intelligence; and so on. In each of these instances, and in many other cases as well, debate became far more productive when the issue was not which account was uniquely correct, but the particular circumstances in which one kind of account was correct or preferred and other particular circumstances in which the other kind (or kinds) of account was correct or preferred. In each of these debates, the original arguments were fruitless because it was so easy for either side to amass evidence in its favor. And the reason it was so easy was that each side was right, usually under the limited circumstances of the experimental paradigms or situations used by the proponents of each particular view. I believe that useful progress was made only when views that had been seen in opposition to each other were recognized as complementary and even mutually supportive rather than mutually exclusive. The same is true for the nature of intelligence: Die-hard contextualists will continue to argue that intelligence inheres only in the environment; die-hard mentalists will seek to understand intelligence only in respect to the mental structures and processes of the individual. The debate will never be resolved, because the debate exists only in the minds of the theorists, and in the contexts they create. Contextual and mentalistic views of intelligence are complementary, not contradictory. Intelligence inheres in both the individual and the environments that the individual inhabits.

Level (depth) of theorizing. Theories of any construct can be posed at multiple levels of analysis. No single theory can deal with every level of analysis, and there is no one correct level. Rather, the optimal level of analysis depends upon the purpose the theory is intended to serve. A somewhat hackneyed but nevertheless useful analogy can be made to the malfunctioning of an automobile. The operation of an automobile can be understood at many levels – an atomic level, a molecular level, and a level dealing with the functioning of discrete parts of the automobile, to name just three. If a part malfunctions, this malfunctioning could be understood at the level of atoms and their transformations, but such a level would not be particularly useful for the mechanic who needs to repair the automobile, or for the driver who seeks to get to a given destination in a reasonable amount of time. The same issue arises in theories of intelligence.

Eysenck and **Vernon** are concerned that I do not deal with physiological indicators of intelligence. Perhaps they are concerned that my failure to deal with such indicators indicates a lack of respect for their validity or usefulness. If so, their concern is unnecessary. I believe that current work being done on the physiological indicators of intelligence is extremely interesting – and it may even be ground breaking. But for **Eysenck** to state that theorizing about the application of innate ability to everyday life has no scientific meaning is a disservice to both the field and himself. There simply is no single scientifically meaningful level for the study of intelligence. Eysenck is impressed, as am I, by the high levels of correlation that have been obtained in certain studies linking measured intelligence to physiological indicants, such as evoked potentials. Suppose, however, that the correlation were 1 or close to it. What, exactly, would such a correlation mean? Does the correlation mean that these physiological indicants somehow cause intelligence, or measure a cause of it? Of course not. We all know that correlation does not imply causation. It is just as likely that intelligent behavior generates certain physiological responses, or that both the physiological indicants and the intelligent behavior are dependent upon some other element, which might itself be studied at multiple levels of analysis. For example, we know that certain attentional responses give rise to a certain pattern in the P300 evoked potential. Is anything to be gained by stating that the P300 causes the attentional responses?

I do not mean to denigrate the physiological work: It is essential that research be carried out at this level, and I am delighted that progress is being made. But I see no gain in arguing that intelligence should be studied only at this level. Even if IQ correlated perfectly with some physiological measure, what would this correlation tell us about (a) the cognitive processes that underlie intelligent behavior, (b) what constitutes an intelligent behavior, or (c) why IQ tests themselves are so imperfect as predictors of intelligent behavior in the real world? One might as easily fault the physiological index as praise it, claiming that the measure is incomplete in dealing only with the same subset of intelligence as does an IQ test. To conclude, intelligence should be studied at multiple levels, with our goal being the ultimate linkage of these levels.

The same argument applies to points made regarding my lack of attention to the genetic bases of intelligence and intelligence in infra-humans (**Vernon**). Two other issues, the training of intelligence (**Baron**) and intelligence at various points in the life span (**Richelle, Vernon, Yussen**), are ones with which I deal in some detail in other work (e.g., Sternberg, in press).

Scope (breadth) of theorizing. The commentaries make clear that there is wide disagreement among theorists of intelligence regarding how broad a concept intelligence should be. Some commentators believe the triarchic theory to be too broad in scope (e.g., **Eysenck, Humphreys, Tyler,** and **Yussen**), and perhaps better characterized as a theory of adaptative behavior (Eysenck), of competence (Tyler), or of cognition (Yussen) rather than of intelligence. Others see the theory as a bit too narrow, paying perhaps too little attention, for example, to motivation (**Economos, Ford**). Clearly, my conception of intelligence is broader than typical conceptions, although not broader than previous conceptions. Conceptions such as Binet's (Binet & Simon 1973), Wechsler's (1958), Piaget's (1972), or Guilford's (1967) are at least as broad as my own. These authors and I believe that if we have erred, it has been in the direction of too narrow a conception of intelligence. If I have failed to give sufficient acknowledgment to them and other theorists with a broad perspective on the nature of intelligence, as suggested by **Irvine** and **Richelle** in different contexts, it is for lack of space, not of gratitude. A more adequate account of their work can be found in Sternberg (in press). As long as we persist in narrow conceptions of intelligence, we shall be stuck with tests that provide unsatisfactory predictors of real-world performance, and theories that provide unsatisfactory explanations of it.

General issues. Many of the points raised in the commentaries dealt with specific concerns regarding the triarchic theory of intelligence. I consider such points in this section. I will divide my reply to these commentaries into four parts. First, I will discuss general issues concerning the triarchic theory, then issues relating specifically to each of the contextual, two-facet, and componential subtheories, respectively.

Although there is no universally accepted list of "good" properties for a theory to have, there are a number of such properties that are widely accepted by consensus. The extent to which such properties can be said to apply to the triarchic theory has been questioned by various commentators. I will now consider the main properties that have come into question: falsifiability, parsimony, structural adequacy, empirical adequacy, and quantifiability.

1. *Falsifiability.* The utility of a theory is seriously impaired if it is not falsifiable, and several commentators question the falsifiability of the triarchic theory (**Baron, Humphreys, Irvine**). To the extent that falsifiability is a problem for the triarchic theory, it is a problem for all other theories of intelligence as well: They (like theories of many other psychological constructs, such as extraversion, motivation, or paranoia) define the construct that is their object. And definitions, or at least stipulative definitions, are clearly not falsifiable (as Irvine points out). Thus, there is a sense in which *no* theory of intelligence is falsifiable.

Fortunately, the picture is not so bleak as it might first appear to be. Although theories of intelligence may not be falsifiable, specific models generated by these theories are. The question therefore becomes one of whether the theory generates models of human performance, which in turn generate empirically falsifiable predictions. From this point of view, the triarchic theory certainly does generate falsifiable predictions. For example, the componential subtheory has generated a number of quite specific and precisely quantifiable models for task performance. These models have been tested quantitatively, and have been found to give quite good accounts of response-time and response-choice data (Sternberg, in press). The two-facet subtheory also makes specific predictions regarding the relations of more and less novel behavioral patterns to other constructs, and these relations have also been tested and found to be consistent with the observed data. Finally, the contextual subtheory makes predictions regarding the relations between tacit knowledge of adaptive behavior and success in jobs, and these predictions, too, have been confirmed. The contextual subtheory is obviously the broadest of the three, and yet even in its broad form, it is at least partially falsifiable: It claims, for example, that straightforward adaptation to a set of circumstances can be less intelligent than other courses of action (namely, selection and shaping of environments). This prediction is in contrast to contextual theories that define intelligence simply in terms of adaptation.

Sternberg (in press) describes a large number of empirical tests that have been conducted to test specific predictions of the task models generated by the triarchic theory. I think it would be fair to say that the triarchic theory is one of the more extensively tested theories of intelligence, although the tests are unevenly distributed across subtheories as a function of their "age": The componential subtheory, which in its original form dates from 1977, has been most extensively tested; the two-facet subtheory, which dates in its earliest form only from 1981, has received an intermediate amount of testing; the contextual subtheory, which is only about a year old, has received the least testing.

A particularly thorny issue in intelligence research concerns the external criteria used as bases for falsification. **Rogoff** and **Tyler** correctly point out that despite my reservations about intelligence tests, I often use them as a criterion against which to validate empirical predictions. The problem, of course, is that there is no one criterion that is universally accepted as providing an adequate standard against which to test new theories or new measures of intelligence. In the absence of a universally accepted or (in my opinion) single adequate criterion, I have resorted to the use of multiple relevant criteria, none of which is adequate in itself, but the collection of which is at least useful. Intelligence test scores form just one of these criteria.

Most of the tests of specific models that I have performed involve two forms of validation: internal and external. Internal validation involves testing a psychological theory of task performance against data generated by performance on that task. External validation involves testing model-generated scores of task performance against outside standards. These standards include, among others, intelligence test scores, measures of professional success (such as merit raises, performance ratings, measures of productivity, measures of influence, etc.), and cognitive task scores. External validation generally includes both convergent and discriminant validation. In convergent validation one seeks to show high correlations between model-derived variables and certain external measures; in discriminant validation one seeks to show low correlations between the model-derived variables and other external measures. I would not claim that the theory-testing and model-validating procedures I have performed are complete, but I believe that they are at least as complete as those used by anyone else investigating human intelligence.

2. *Parsimony.* A theory becomes less interesting as the number of theoretical constructs, or intervening variables, increases beyond a certain optimal point. Thus, most people are willing to grant a theory a reasonable number of constructs, but not a number much in excess of this reasonable number. There are, of course, two sticky problems in assessing parsimony. The first is that the number of constructs is usually not immediately obvious. Theories that may seem parsimonious on their surface often turn out to have large numbers of constructs or assumptions hidden beneath the surface. An alternative theory may seem less parsimonious, but only because it fully shows all of its constructs and assumptions. The second sticky problem is the determination of what constitutes a reasonable number of constructs. At the extremes, one might feel that a one-construct theory of general intelligence, such as Spearman's (1927), is too parsimonious, and that a 150-construct theory, such as Guilford's (1982), is too imparsimonious. But just what number of constructs is reasonable for a theory of intelligence?

I doubt there is any one "reasonable" number of constructs. Rather, one must decide whether the number of constructs is right for the job the theory sets out to do. Consider, for example, the objections raised by the two commentators who question the parsimony of the theory.

Detterman claims that what I refer to as "performance components" can do the whole job the triarchic theory seeks to do. The other constructs, in his view, are superfluous. (Ironically, the other critic of the theory's parsimony, **Rogoff,** claims that performance components cannot do even the job they were intended to do, much less, more than they were intended to do!) Detterman provides what he believes to be a logical demonstration that performance components can do the whole job. The problem is that the demonstration is flawed. For example, it predicts that *g* (general intelligence)-factor loadings should stay constant or increase as task complexity decreases. But the facts run exactly opposite to this, as acknowledged even by other theorists emphasizing performance components in their theories (e.g., Hunt 1978; Jensen 1980a; 1982b). Cognitive tasks tend to show only weak-to-moderate correlations with psychometric tests, largely because they are less complex than the tests. As their complexity increases, the correlation with psychometrically measured *g* increases (Goldberg, Schwartz & Stewart 1977). Detterman further claims that the ideal cognitive tasks would have "small correlations or none with psychometric measures." But in this case the tasks are measuring a construct or set of constructs totally different from the psychometric measures, and it would be hard to argue from this, as Detterman does, that "more complex tests contain more of the basic processes important in intelligence behavior." Detterman's "logical" demonstration is not logical, and does not support his point of view.

Rogoff's concern is with the need to postulate knowledge-acquisition components (in the componential subtheory) separately from the ability to deal with novelty (in the two-facet subtheory). There is good reason to keep them separate, however. The ability to deal with novelty is not limited to the workings of knowledge-acquisition components. For example, the ability to deal with novelty in conceptual projection tasks (Sternberg 1982b) derives from the functioning of certain performance components, not knowledge-acquisition components. Moreover, a given knowledge-acquisition component can be applied to either novel or nonnovel material. In more conventional language, some learning situations require learning unusual kinds of concepts (e.g., one's initial learning of new concepts in calculus); others require learning conventional or ordinary kinds of concepts that are not novel (e.g., learning a list of common words in a standard serial-learning task). In sum, there is good reason to separate the matter of knowledge-acquisition components from the kind of material to which they are applied.

3. *Structural adequacy.* Some of the commentators have questioned the structural adequacy of the triarchic theory. Two basic questions were raised: First, are the interrelations among subtheories clearly specified or specifiable? Second, is the particular partitioning of the subtheories an appropriate one? I will consider each of these questions in turn.

First, so many commentators raised the issue of the interrelations among subtheories (**Baron, Ford, Jackson, Pellegrino & Goldman, Rogoff**) that I am forced to conclude that I simply did not spend sufficient space in the target article in specifying these interrelations. They are specified more fully in my book (Sternberg, in press). I will therefore attempt to remedy this deficiency in this response, attempting to show how the three subtheories are, in a sense, "crossed" with each other.

The interface between the componential and two-facet subtheories resides in the fact that some, but not all, components of information processing (a) can be involved in dealing with novelty (at least for a given individual) and (b) are susceptible to automatization of functioning (again, for a given individual). For example, the performance component of processing a negation in linear syllogistic (and other forms of) reasoning is not applied to novel material (except in very young children who are first learning the meaning of *not*), and is also probably not susceptible to complete automatization. Thus, one goal of empirical research is to determine exactly which metacomponents, performance components, and knowledge-acquisition components can be used in dealing with novel tasks and situations, and which of these components can become automatized in their functioning. At one level, then, one understands the ability to deal with novelty in terms of the components that constitute this ability; similarly, one understands automatization at one level in terms of those components that can or cannot become automatized via the mechanisms described in the target article.

The interface between the componential and contextual subtheories resides in the fact that environmental adaptation, selection, and shaping are "macrocomponents" that are constituted of the "microcomponents" specified by the componential subtheory. In other words, "adaptation" is no more a basic process than is "dealing with novelty." Rather, adaptation is constituted of more elementary processes, such as recognizing the nature of a problem and knowing what steps to use to solve it (metacomponents), properly encoding the terms of a problem and inferring relations among its elements (performance components), and knowing how to put together the information in one's environment in a proper way (a knowledge-acquisition component). As with the two-facet subtheory, there is a need to identify those components of human intelligence that are involved in adaptation to, selection of, and shaping of environments.

If components functioned in exactly the same way in all kinds of situations, there would be no need for separate subtheories. But this does not appear to be the case. As pointed out by the members of the Laboratory of Comparative Human Cognition (1982) in their review of relevant literature, and by **Berry** and **Rogoff** in their commentaries, there is considerable situational specificity in behavior. I do not accept what I view as the too extreme positions of cultural relativism taken by these investigators. For example, Rogoff argues that content or situation and process are inseparable. I believe there is too much evidence for at least some process generality (e.g., Carroll 1976; 1981; Ford & Miura, in preparation; Hunt 1980; Keating & Bobbitt 1978; Lansman Donaldson, Hunt & Yantis 1982; Pellegrino & Glaser 1980; Siegler 1981; Sternberg & Gardner 1983) to accept this position. At the same time, the somewhat limited paradigms and subject pools of cognitive psychologists have left them perhaps not sufficiently sensitive to the lack of generalization between laboratory tasks and real-world performance; and I think that contextual theories in general, and the contextual subtheory of the triarchic theory, in particular, guard against overgeneralization. At present, one can only speculate on the extent to which components are generalizable, both because components that have been identified have not been tested fully for generalization, and because there undoubtedly remain components that have not yet been identified.

The interface between the two-facet and contextual subtheories resides in the roles of novelty and automatization in intelligence expressed in context. One's life is filled with automatized behaviors of which one is hardly aware – bottom-up processes in reading, certain aspects of driving an automobile, scripted behavior in social interaction that can be performed "almost without thinking," and so on. Similarly, all people encounter in their lives numerous situations that are novel. Our first encounter with any kind of experience is bound to carry with it some adjustment to novelty. Visits to new environs, learning new kinds of academic material, dealing with new kinds of situations and stresses in interpersonal relationships, and the like, all involve coping with novelty. Thus, the two facets of novelty and automatization form an important part of what is required in environmental adaptation, selection, and shaping. From the standpoint of the triarchic theory, the regions of environmental experience involving coping with novelty and automatization of processing are those most critical to intelligence.

It is important to emphasize here, as in the target article, that very likely no task or situation will partake of all aspects of the triarchic theory. Tasks and situations involve intelligence in greater or lesser degrees as a function of the extent to which they do partake of the elements of the theory. But it would probably be futile – and possibly counterproductive – to seek a single task or situation that involves all elements of all three subtheories.

Second, **Baron** has questioned whether the particular partition of subtheories represented by the triarchic theory is optimal, or even nonarbitrary. I would not claim that this is the only way to slice the "intelligence pie." There is nothing psychologically absolute about this particular division. My only claim for it is heuristic usefulness, and I believe the theory has shown at least initial indications that the division does provide this. In the past, theories of intelligence have tended to deal primarily with either the individual (e.g., factorial and cognitive theories), the context of the individual (e.g., radical cultural relativism), or the experience of the individual (e.g., Piagetian theory). More generally, my review of the literature of theories of intelligence (Sternberg, in press) leads me to conclude that earlier theories have generally had as goals the elaboration of one or more of these three elements (internal mechanisms of intelligence, relations of intelligence to external context, relations of intelligence to experience). The triarchic theory is one attempt to integrate these emphases into a single theoretical package. It is not the only way of doing so. Subsequent attempts at integration will undoubtedly provide a basis for comparison regarding the heuristic usefulness of alternative attempts to accomplish the same goals. Ultimately, heuristic usefulness is probably one of the most important characteristics a psychological theory can have, at least for now.

4. *Empirical adequacy.* Several commentators have questioned the ability of the triarchic theory to account for various empirical findings. I believe that all of these questions can be satisfactorily answered by the theory.

First, **Carroll** questions the ability of the theory to account for the known facts of cognitive-task difficulty. This question surprises me, because I believe that the componential subtheory can probably account for a wider range of findings about cognitive-task difficulty than any of the alternative theories available. That individuals differ in the level of task difficulty that results in a 50% pass rate for them is entirely consistent with different levels of power in the execution of the various kinds of components, and in differential levels and quality of interaction among these kinds of components. The componential subtheory has been shown to account for task difficulty in analogies, series completions, classifications, metaphors, causal inferences, categorical syllogisms, conditional syllogisms, linear syllogisms, vocabulary learning, conceptual projection, quantitative insight problems, and other tasks. This seems like a reasonable beginning, at least!

Second, **Humphreys** suggests that the triarchic theory unwisely discounts demonstrated group differences in intellectual functioning. I assume he refers to observed differences in performance of various population subgroups on intelligence tests. This point represents a misunderstanding of the triarchic theory, perhaps because of my own lack of clarity in presenting it. The theory does not discount these differences; rather, it seeks to explain them. It is an empirical fact, for example, that, on the average, blacks tend to score about one standard deviation lower than do whites on intelligence tests. The triarchic theory does not discount this difference or somehow deny its existence. It does seek to explain the difference, however, in terms of differential life experiences of typical black and white test takers. Such an account is independent of hereditary-versus-environmental contributions to group differences, so long as one is willing to accept any role at all for environment, which, in my knowledge, every reputable theorist of intelligence does.

Many people will be uncomfortable with the notion that comparisons of intelligence among groups or even individuals will always be at least slightly amiss, because intelligence is not quite the same thing for different groups and individuals. Yet, we are all aware, at least implicitly, that intelligence is not quite the same thing for different individuals. Both in their everyday lives and even in taking tests, people draw upon different skills in order to solve problems. For example, a linear syllogism might be solved using a spatial strategy, a linguistic strategy, or a combination spatial-linguistic strategy (Sternberg & Weil 1980). The same time or accuracy score may be obtained in different ways. On a larger scale, people accomplish the same ends through quite different means: Great scientists, for example, draw upon very different skills in their work. Although great scientists may all do great work, in some sense, their greatness lies in different domains (as noted in the target article). What these scientists have in common is not a set of skills, but their ability to capitalize in their work on whatever pattern of skills they have. This is not to say that comparisons never can or should be made. If, for example, there is a slot for a senior scientist at a university, a rank-ordering may become necessary, even though one often has the feeling when doing such a rank-ordering of comparing apples and oranges. Similarly, in writing letters of recommendation for graduate students, one often becomes aware that two of the students may be quite distinguished, but in different ways. In sum, although we often need to make comparative judgments of people's intelligence or other skills, we ought to keep in mind that we are placing on a unidimensional scale attributes that are intrinsically multidimensional, with the result that the comparisons, although pragmatically useful, are not wholly valid.

Third, some commentators are concerned about the case of the nonadaptive or even maladaptive genius. **Jackson** is concerned that the theory fails to account for the intelligence of the socially maladapted prodigy, and **Richelle** argues that the theory does not give sufficient credit to individuals who are ahead of their time. Again, I believe that these comments spring from a misunderstanding of the theory. The theory most definitely allows for different profiles of intelligence, perhaps more so than any other existing theory of intelligence. There are some individuals who are, say, particularly adept contextually, but who are not particularly strong on academically oriented applications of the components or facets of intelligence. Such individuals may acquire reputations as "operators." They seem to know how to manipulate their environments to maximum advantage, despite limited intellectual gifts in the traditional senses of intellect (as dealt with by the componential subtheory, and particularly the performance-componential aspects of it). Then there are other individuals who are extremely creative or well able to deal with novelty, but who never seem to be able to deal well with the world, and who may not be particularly "smart" in a componential sense. Such individuals may have brilliant ideas, which they leave to other individuals to operationalize or follow through on. Finally, there are individuals who are extremely bright in the componential skills that tend to be emphasized in testlike and academic settings, but who rarely have creative ideas; their careers seem to peak when they graduate from high school (or possibly college) because of their inability to actualize their academic potential in worldly settings. Each of these three hypothetical types of individual is intelligent, but only in a limited sense of the word. The triarchic theory does allow for their differences in kinds of intelligence, at the same time that it highlights their weaknesses as well as their strengths. Contrary to the concerns of these commentators, the triarchic theory allows for a wealth of "types," only three of which are discussed above. A particular strength of the theory is that it *can* account for unusual types of intelligence, whereas traditional theories have more difficulty doing so. The triarchic theory does not make a low IQ a sure sign of low intelligence; but neither is a high IQ a sure sign of high intelligence, in the full sense of the word.

Fourth and finally, **Triandis** believes that no information-processing theory could account for the speed with which a chess master chooses a high-quality move in a chess tournament. It would seem that the chess master must select the best move without considering all possible moves or their consequences, given the extremely large numbers of moves and patterns of subsequent moves possible at most points in a chess game. Here, I simply must disagree with Triandis. I believe that Chase and Simon (1973) and many others have provided excellent initial accounts of information processing in chess masters. Moreover, at least some computer programs have begun to simulate the heuristics chess masters use in selecting moves. I agree with Triandis that we do not yet have a full information-processing account of how chess masters select their moves, but whether or not such an account can be provided is an empirical question, and I see no evidence that discounts the possibility of an information-processing theory, in principle. To the contrary, considerable progress seems to have been made toward providing just such an account.

5. *Quantifiability.* A number of commentators have

voiced concern regarding the measurement problems that arise from the triarchic theory. **Eysenck** does not believe I recognize the need for pure measures of intelligence (whatever they are). **Humphreys** believes that my definition departs too much from a family resemblance to what intelligence tests measure. **Irvine** notes that the theory will require instrumentation on a scale never before required. **Tyler** and **Yussen** question whether it is now or ever will be possible to have a set of measures that adequately assesses the set of skills theorized by the triarchic theory to be involved in intelligence. My response to these reasonable concerns is a simple one. The history of theories of intelligence has been one of theories constrained by – I believe, even dictated by – available measures. In my opinion, the fundamental mistake that has been made by the large majority of theorists of intelligence, in the psychometric, cognitive, and other traditions, has been to start with measures and then develop theories on the basis of existing or preferred measures. Sometimes this starting point has been obvious; at other times it has been subtle, or even concealed. However, a careful consideration of existing psychometric and cognitive theories will show that the measures dictate the theories, rather than the other way around. The time has come to turn the tables: The theory comes first, and the measures follow from the theory. If there are unmeasurables, then instrumentation should be a priority for future research and development. But we should not let available instruments canalize our thinking. In fact, I think that all or most aspects of the triarchic theory are susceptible to measurement. I give several examples in the target article, and many more in Sternberg (in press), but these instruments are still crude and in need of further development. Moreover, instrumentation, like theory development, has proceeded further for some subtheories (especially the componential) than for others (especially the contextual). I plan to continue to develop instruments, and hope others do so as well. I have no intention, however, of letting instrumentation dictate theory development, rather than the other way around.

The contextual subtheory. The contextual is the newest and least well specified of the three subtheories, and this lack of specification is noted in several commentaries.

1. *Matters of definition.* It is suggested by **Baron, Ford,** and **Zimmerman** that the concept of *context* needs more explicit definition; Ford also suggests the need to define *relevance* more carefully, so that what is meant by a context relevant to one's life is clearer; **Pellegrino & Goldman, Richelle, Triandis,** and **Zimmerman** suggest the need to define the concepts of *adaptation, selection,* and *shaping* in a more detailed fashion, if only to make it clearer when each is or is not the intelligent course of action; and Pellegrino & Goldman question the meaning of *success.*

These various terms are definable, at least at some level. By *context,* I mean the full set of environments in which an individual lives. By *relevance,* I mean those aspects of the environmental context that impinge upon an individual's life. Such aspects may be potentially relevant, in that at a given time they do not impinge upon that individual's life, but might in the future. By *adaptation,* I mean individuals' attempts to adjust their given environmental contexts. By *selection,* I mean individuals' placing themselves in new environments, which then change the contexts for the individuals. By *shaping,* I mean individuals' attempts to adjust their environmental contexts to their own desires or preferences. As **Berry** notes, the contextual subtheory as it now exists is a first step; it is one that needs to be taken in research on intelligence.

2. *Cross-cultural comparisons.* What she believes to be an interesting paradox is noted by **Rogoff:** Verification of the claim that the components of intelligence are universal would require cross-cultural assessments of these components; but the contextual subtheory implies that such comparisons are difficult to make because of differences in the contextual relevance of the assessment instruments. I concur with Rogoff's point. Cross-cultural and even cross-individual comparisons are *much* more difficult than most investigators have realized. Simple exportation of translations of the tests used in North American settings does not provide a valid basis for comparison. Developmental researchers encounter essentially the same problem in assessing cognitive structures and processes across age groups. The greater the difference between age groups, the less valid the comparisons using the same instruments become. This difficulty does not make good developmental research impossible, but it does make such research difficult (see also Cole & Means 1981). The fact that the theory points out the extreme difficulty of such comparisons does not invalidate the theory or vitiate its usefulness. On the contrary, it shows its sensitivity to the comparative issue. Would we rather have a theory that simplifies comparisons at the expense of the validity of such comparisons? I think not. I believe it a strength rather than a weakness of the theory that it should give pause to researchers who are too eager to make invalid comparisons.

The greater the difference between cultures, the more difficult it will be to perform valid cross-cultural comparisons. To the extent that comparisons are possible, it will be through measuring a given set of componential mechanisms on contents that are equated across cultures for (a) novelty and automatization of processing and (b) contextual relevance. Obviously, in equating facets and contexts, one sacrifices sameness of content. I believe that this sacrifice is a necessary one: What is critical is that the task or tasks be comparable as measures of intelligence in the two cultures, not that they be totally equivalent in content and format (probably impossible, in any case, if only because of linguistic differences). The same difficulty obviously applies in developmental research: There is no strict comparability across groups. But rough comparisons may be useful, even if they are not wholly valid. The important thing to recognize is that such comparisons cannot by their nature be wholly valid. There will always be uncontrolled variables. The important decision thus becomes which variables to control and which to leave uncontrolled, as controlling some variables will result in decontrol of others. The researcher and consumer of the research must therefore each decide just how much, and what kind of, invalidity is tolerable.

3. *Contextual effects on the individual.* The contextual subtheory deals with the relations of the individual to the environment. **Richelle** argues that the relations, as specified, are too unidirectional: Whereas a great deal of

attention is given to the effects of the individual on the environment, little attention is given to the effects of the environment on the individual. I agree with Richelle. The theory does not sufficiently specify the important effects that the environment has on the individual. I am currently working on further development of the contextual subtheory along these lines.

The two-facet subtheory. The two-facet theory evoked a variety of reactions from the commentators. **Triandis** seems to have viewed it as a particular strength of the triarchic theory, whereas **Carroll** seems to have viewed it as a particular weakness. Consider three specific points raised in the commentaries.

1. *Are there more than two facets?* Two of the commentators, **Carroll** and **Raaheim**, suggest that the two facets of novelty and automatization are not enough to cover the range of tasks that have been shown to correlate with intellectual performances of various kinds. Consider their specific complaints.

Carroll suggests that the triarchic theory implies that "the intelligence of an individual simply reflects the degree to which that individual has automatized performance of a given task, or some class of tasks. Such a conclusion hardly seems reasonable." I agree. But nothing in the theory implies this, and Carroll seems to be the only commentator who has drawn this inference. To the contrary, the triarchic theory posits that intelligence reflects a large number of skills, not just the single one of automatization. Carroll also argues that the subtheory reflects a "kind of pure environmentalist theory that ignores the possibility that there are limits to which a given individual could come to automatize a given task or class of tasks." Again, Carroll has simply misread the article. There is nothing there to suggest that intelligence is determined purely by environmental influences, and I certainly do not believe this to be so. I did not attempt to deal with the heredity–environment issue in the target article, because I viewed it then and I view it now as a digression from its purpose. Nor is there any basis for Carroll's claim that the theory implies no limits to automatization of performance. There are certainly limits to automatization. Some performances are never automatized; others are only partially automatized. Finally, Carroll points out that novelty and automatization are at opposite ends of a continuum. I agree: More exactly, they represent regions on the continuum of an individual's experience with a task or situation.

Raaheim notes that he and others have found that after a task has been made more familiar, achievements continue to correlate with test scores. This is true, but it is consistent with the theory. As familiarity increases, so does the degree of automatization of all or some of the components of a task. Thus, correlations of experimental task scores with test scores may remain high, but because of automatization rather than novelty. I say as much in the target article.

2. *Are the facets descriptive rather than explanatory?* The facets of novelty and automatization are descriptive rather than explanatory, **Zimmerman** suggests. As I have dealt with this issue earlier in a more general context, I shall be brief here: Because theories can be and are presented at many levels, what is explanatory at one level is descriptive at another level. For example, specifying a set of performance components for analogical reasoning is explanatory in accounting for total task time and errors in terms of underlying processes and for individual differences in time and errors in terms of the combined effects of unobservable components. But such a specification is descriptive in the sense that the effects of the components themselves need to be accounted for: What, say, is an inference, and what accounts for the fact that some individuals are better or faster inferrers than others? Similarly, whatever construct is used to account for the effects of the components will itself be explanatory at one level and descriptive at another. This same principle (theories that are explanatory at one level are inevitably descriptive at another) applies to the triarchic theory as a whole (as well as to other theories), not just to the two-facet subtheory.

3. *Preference for novelty.* The important issue of preference for or seeking out of novelty (see also Fagan & McGrath 1981) is raised by **Raaheim.** I agree that this preference ought to be considered in a full assessment of intelligence. Although I have stated this view elsewhere (Sternberg 1981b), it was not stated in the target article.

The componential subtheory. The commentators make several particular points about the componential subtheory, which I address here.

1. *The role of sheer speed in intelligence.* Speed clearly plays some role in intelligence. **Jackson** and **Jensen** believe I understate the importance of this role. Indeed, Jensen has built an entire theory of intelligence around the concept of speed of functioning. I almost certainly do believe speed to be less important than they do, but I do not believe it to be unimportant. I have used response times as a primary dependent variable in many of my own studies of intelligence, and like Jackson and Jensen, have found it to be an important dependent variable to study. At the same time, I believe that the importance of speed in intelligence has been overestimated in much theory and research, particularly in the information-processing mode. Response time is a convenient dependent variable, and I sometimes wonder whether this experimental convenience has not resulted in a more-than-justified infiltration of time-based concepts into theorizing about intelligence. In any case, I never deny that speed of mental processing plays an important part in intelligence. To the contrary, I agree with Jackson, Jensen, and others that speed is important and think that their work has been valuable in elucidating the role of mental speed in intelligence. I do believe, however, that speed should be viewed as subsidiary to speed- or time-allocation. To be intelligent, an individual needs the capacity for speed, but the individual also has to know when to be fast and when not to be. Someone who has speed but does not know when to use it will perform many tasks in a hasty, impulsive way. Someone who knows when to function fast but cannot will not always be able to perform tasks at the speeds they require. The individual needs both attributes.

2. *How many kinds of components are there?* The number of kinds of components one needs to postulate is questioned by Detterman and Rogoff. For example, are metacomponents really distinct from performance components? Questions such as this are heuristic, not empirical. In other words, it is possible to test for the existence,

duration, difficulty, and probability of execution of various hypothesized components. It is not possible, however, to test for the existence of kinds of components, because the distinction among kinds of components is one of heuristic usefulness. Thus, for example, one could say that whereas performance components operate on data, metacomponents operate on other components. But does this mean that they are really two kinds of components? The question can be answered only in terms of whether the proposed distinction is theoretically and heuristically useful. Researchers studying metacognition obviously believe it is. Others, like Detterman, seem to believe it is not. I doubt there will be any final resolution of this problem, because it is not an empirically testable one.

Conclusions. The triarchic theory of human intelligence, like the componential theory it subsumes, is an attempt to understand intelligence in a broad, pluralistic way. The componential theory (Sternberg 1980b) was, in retrospect, primarily a *methodological* integration. It was one attempt to put together psychometric and cognitive approaches to understanding intelligence in a way that would enhance our understanding of the construct beyond that which could be achieved using either approach by itself. The triarchic theory is a *substantive* as well as a methodological integration. It attempts to put together approaches studying the relation of intelligence to the internal world of the individual (including both the psychometric and cognitive approaches) and approaches studying the relation of intelligence to the external world of the individual (contextual approaches). Thus, the componential theory sought to expand the ways in which intelligence is studied; the triarchic theory seeks to expand the ways in which intelligence is conceptualized as well as studied.

The triarchic theory is still in its initial stages of development. Hence, I am not so troubled as I might otherwise be by the gaps pointed out by the commentators. For all its incompleteness, the triarchic theory is probably among the most comprehensive theories of intelligence that have been proposed. The details – especially of the contextual and two-facet subtheories – need to be filled in, and this is a task that I (and possibly others) will address in future years. If the triarchic theory in its present state of development sets the proper framework for the study of intelligence, then it has accomplished what I view as its primary present goal.

References

Baltes, P. B., Dittmann-Kohli, F. & Dixon, R. A. (1982) Intellectual development during adulthood: General propositions towards theory and a dual-process conception. Unpublished manuscript. [taRJS]

Baltes, P. B. & Willis, S. L. (1979) The critical importance of appropriate methodology in the study of aging: The same case of psychometric intelligence. In: *Brain function in old age*, ed. F. Hoffmeister & C. Mueller. Springer-Verlag. [taRJS]

(1982) Plasticity and enhancement of intellectual functioning in old age: Penn State's adult development and enrichment project (ADEPT). In: *Aging and cognitive processes*, ed. F. I. M. Craik & S. E. Trehub. Plenum. [taRJS]

Bandura, A. (1982) Self-efficacy mechanism in human agency. *American Psychologist* 37: 122–47. [MEF]

Baron, J. (1981) Reflective thinking as a goal of education. *Intelligence* 5: 291–309. [JB, taRJS]

(1982) Personality and intelligence. In: *Handbook of human intelligence*, ed. R. J. Sternberg. Cambridge University Press. [taRJS]

(in press) What kinds of intelligence components are fundamental? In: *Thinking and learning skills: Current research and open questions*, ed. S. Chipman, J. Segal & R. Glaser. Erlbaum. [JB]

(in preparation) *Rationality and intelligence*. Cambridge University Press. [JB]

Berry, J. W. (1972) Radical cultural relativism and the concept of intelligence. In: *Mental tests and cultural adaptation*, ed. L. J. Cronbach & P. J. D. Drenth. Mouton. Condensed and reprinted in *Culture and cognition: Readings in cross-cultural psychology*, ed. J. W. Berry & P. R. Dasen. Methuen, 1974. [JWB, taRJS]

(1976) *Human ecology and cognitive style*. Sage-Halsted. [SHI]

(1980a) Cultural universality of any theory of human intelligence remains an open question. *Behavioral and Brain Sciences* 3: 584–85. [taRJS]

(1980b) Ecological analyses for cross-cultural psychology. In: *Studies in cross-cultural psychology*, ed. N. Warren. Academic Press. [JWB]

(1981) Cultural systems and cognitive styles. In: *Intelligence and learning*, ed. M. Friedman, J. P. Das & N. O'Conner. Plenum. [atRJA]

(in press) Towards a universal psychology of cognitive competence. *International Journal of Psychology*. [JWB]

Bhatia, C. M. (1955) *Performance tests of intelligence under Indian conditions*. Oxford University Press. [SHI]

Biesheuvel, S. (1952) Personnel selection tests for Africans. *South African Journal of Science* 49: 3–12. [SHI]

(1954) The measurement of occupational aptitudes in a multiracial society. *Occupational Psychology* 28: 189–96. [SHI]

Binet, A. & Simon, T. (1973) *Classics in psychology: The development of intelligence in children*. Arno [taRJS]

Boring, E. G. (1923) Intelligence as the tests test it. *New Republic* (June 6): 35–37. [taRJS]

Brand, C. R. & Deary, I. J. (1982) Intelligence and "inspection time." In: *A model for intelligence*, ed. H. J. Eysenck. Springer-Verlag. [taRJS]

Butterfield, E. C. & Belmont, J. M. (1977) Assessing and improving the cognition of mentally retarded people. In: *Psychology of mental retardation: Issues and approaches*, ed. I. Bialer & M. Sternlicht. Psychological Dimensions. [taRJS]

Campbell, D. T. & Fiske, D. W. (1959) Convergent and discriminant validation by the multitrait multimethod matrix. *Psychological Bulletin* 56: 81–105. [BJZ]

Campione, J. C. & Brown, A. L. (1979) Toward a theory of intelligence: Contributions from research with retarded children. In: *Human intelligence: Perspectives on its theory and measurement*, ed. R. J. Sternberg & D. K. Detterman. Ablex. [taRJS]

Carlson, J. S. & Jensen, C. M. (1982) Reaction time, movement time, and intelligence: A replication and extension. *Intelligence* 6:265–74. [ARJ]

Carroll, J. B. (1976) Psychometric tests as cognitive tasks: A new "structure of intellect." In: *The nature of intelligence*, ed. L. B. Resnick. Erlbaum. [tarRJS]

(1981) Ability and task difficulty in cognitive psychology. *Educational Research* 10: 11–21. [tarRJS]

Carver, R. P. (1974) Two dimensions of tests: Psychometric and edumetric. *American Psychologist* 29: 512–18. [BJZ]

Cattell, R. B. (1971) *Abilities: Their structure, growth and action*. Houghton Mifflin. [taRJS]

Charlesworth, W. R. (1976) Human intelligence as adaptation: An ethological approach. In: *The nature of intelligence*, ed. L. B. Resnick. Erlbaum. [taRJS]

(1979a) An ethological approach to studying intelligence. *Human Development* 22: 212–16. [taRJS]

(1979b) Ethology: Understanding the other half of intelligence. In: *Human ethology: Claims and limits of a new discipline*, ed. M. von Cranach, K. Koppa, W. Lepenies & D. Ploog. Cambridge University Press. [taRJS]

Chase, W. G. & Simon, H. A. (1973) The mind's eye in chess. In: *Visual information processing*, ed. W. G. Chase. Academic Press. [tarRJS]

Chi, M. T. H., Glaser, R. & Rees, E. (1982) Expertise in problem solving. In: *Advances in the psychology of human intelligence*, vol. 1, ed. R. J. Sternberg. Erlbaum. [taRJS]

Claparède, E. (1933) La genèse de l'hypothèse: Étude expérimentale. *Archives de Psychologie* 24: 1–155. [MNR]

Cole, M. (1979–1980) *Mind as a cultural achievement: Implications for IQ testing*. Annual report of the research and clinical center for child development. Sapporo, Japan: Hokkaido University, Faculty of Education. [taRJS]

Cole, M., Gay, J. & Glick, J. (1968) A cross-cultural study of information-processing. *International Journal of Psychology* 3: 93–102. [SHI]

Cole, M. & Means, B. (1981) *Comparative studies of how people think*. Harvard University Press. [rRJS]

Cronbach, L. J. & Snow, R. E. (1977) *Aptitudes and instructional methods.* Irvington. [taRJS]
Crowder, R. G. (1982) *The psychology of reading: An introduction.* Oxford University Press. [taRJS]
Daniels, N. (1979) Wide reflective equilibrium and theory acceptance in ethics. *Journal of Philosophy* 76: 256–82. [JB]
Davidson, J. E. & Sternberg, R. J. (1983) Insight in the gifted. Paper presented at Annual Meeting of Society for Research in Child Development, Detroit. [taRJS]
Detterman, D. K. (1980) Understand cognitive components before postulating metacomponents. *Behavioral and Brain Sciences* 3: 589. [DKD, taRJS]
(1982) Does "g" exist? *Intelligence* 6: 99–108. [DKD, taRJS]
Dewey, J. (1957) *Human nature and conduct.* Modern Library. [MNR, taRJS]
Egan, D. E. (1982) A heuristic for componential analysis: "Try old goals." *Behavioral and Brain Sciences* 5: 348–50. [taRJS]
Eysenck, H. J. (1979) *The structure and measurement of intelligence.* Springer-Verlag. [HJE]
(1982) *A model for intelligence.* Springer-Verlag. [HJE, PEV]
(1982) Introduction. In: *A model for intelligence*, ed. H. J. Eysenck. Springer-Verlag. [ARJ, taRJS]
Eysenck, H. J. & Barrett, P. (in press) Psychophysiology and the measurement of intelligence. In: *Methodological and statistical advances in the study of individual differences*, ed. C. Reynolds & V. Willson. Plenum. [HJE]
Fagan, J. F. III & McGrath, S. K. (1981) Infant recognition memory and later intelligence. *Intelligence* 5: 121–30. [tarRJS]
Feldman, R. D. (1982) *Whatever happened to the quiz kids?* Chicago Review Press. [taRJS]
Ford, D. H. (submitted) *Humans as self-constructing living systems.* [MEF]
Ford, M. E. (1983) Competence: Current conceptual and empirical status and implications for mental health. In: *Behavioral sciences research in mental health*, vol. 2. Report to the Director, National Institute of Mental Health by Behavioral Science Research Review Consultant Panel, April, 1983. [MEF]
(in press) Linking social-cognitive processes with effective social behavior: A living systems approach. In: *Advances in cognitive-behavioral research and therapy*, vol. 3, ed. P. C. Kendall. Academic Press. [MEF]
Ford, M. E. & Miura, I. (in preparation) Children's and adults' conception of social competence. [tarRJS]
Gardner, H. (1983) *Frames of mind: The theory of multiple intelligences.* Basic Books. [DRO]
Gladwin, T. (1970) *East is a big bird.* Harvard University Press. [taRJS]
Goldberg, R. A., Schwartz, S. & Stewart, M. (1977) Individual differences in cognitive processes. *Journal of Educational Psychology* 69: 9–14. [tarRJS]
Goodman, N. (1955) *Fact, fiction, and forecast.* Harvard University Press. [taRJS]
Gordon, E. W. & Terrell, M. D. (1981) The changed social context of testing. *American Psychologist* 36: 1167–71. [taRJS]
Guilford, J. P. (1967) *The nature of human intelligence.* McGraw-Hill. [tarRJS]
(1982) Cognitive psychology's ambiguities: Some suggested remedies. *Psychological Review* 89: 48–59. [JB, tarRJS]
Hellesnes, T. (1980) The recategorizing test. *Psykologisk Rapportserie* 1, (No. 1). University of Bergen. [KR]
Hellesnes, T., Raaheim, K. & Bengtsson, G. (1982) Attempts to predict intelligent behavior. 3. The relative importance of divergent and convergent production. *Scandinavian Journal of Psychology* 23: 263–66. [KR]
Hill, A. L. (1978) Savants: Mentally retarded individuals with special skills. In: *International review of research in mental retardation*, vol. 9, ed. N. R. Ellis. Academic Press. [JB]
Horn, J. L. (1968) Organization of abilities and the development of intelligence. *Psychological Review* 75: 242–59. [taRJS]
(1978) Human ability systems. In: *Life-span development and behavior*, vol. 1, ed. P. B. Baltes. Academic Press. [JBC]
(1979) Trends in the measurement of intelligence. In: *Human intelligence: Perspectives on its theory and measurement*, ed. R. J. Sternberg & D. K. Detterman. Ablex. [taRJS]
Humphreys, L. G. (1971) Theory of intelligence. In: *Intelligence: Genetic and environmental influences*, ed. Robert Cancro. Grune & Stratton. [LGH]
(1979) The construct of general intelligence. *Intelligence* 3: 105–20. [LGH]
Hunt, E. B. (1978) Mechanics of verbal ability. *Psychological Review* 85:109–30. [ARJ, DRO, tarRJS]
(1980) Intelligence as an information-processing concept. *British Journal of Psychology* 71: 449–74. [tarRJS]
Intelligence and its measurement. A symposium. (1921) *Journal of Educational Psychology* 12: 123–47, 195–216, 271–75. [taRJS, LET]
Irvine, S. H. (1965) Adapting tests to the cultural setting: A comment. *Occupational Psychology* 39: 12–23. [SHI]
(1969) Figural tests of reasoning in Africa. *International Journal of Psychology* 4: 217–28. [SHI]
(1970) Affect and construct: A cross-cultural check on theories of intelligence. *Journal of Social Psychology* 80: 23–30. [SHI]
(1979) The place of factor analysis in cross-cultural methodology and its contribution to cognitive theory. In: *Cross-cultural contributions to psychology*, ed. L. Eckensberger, W. Lonner & Y. Poortinga. The Netherlands: Swets and Zeitlinger. [SHI]
Irvine, S. H. & Berry, J. W., eds. (1983) *Human assessment and cultural factors.* Plenum. [JWB]
Jencks, C. (1972) *Inequality.* Harper & Row. [taRJS]
Jensen, A. R. (1969) How much can we boost IQ and scholastic achievement? *Harvard Educational Review* 39: 1–123. [taRJS]
(1973) *Educability and group differences.* Methuen. [PEV]
(1979) *g*: Outmoded theory or unconquered frontier? *Creative Science and Technology* 2: 16–29. [ARJ, taRJS]
(1980a) *Bias in mental testing.* Free Press. [tarRJS]
(1980b) Chronometric analysis of intelligence. *Journal of Social and Biological Structures* 3: 103–22. [ARJ]
(1982a) The chronometry of intelligence. In: *Advances in the psychology of human intelligence*, vol. 1, ed. R. J. Sternberg. Erlbaum. [ARJ]
(1982b) Reaction time and psychometric *g*. In: *A model for intelligence*, ed. H. J. Eysenck. Springer-Verlag. [ARJ, tarRJS, PEV]
Jensen, A. R., Schafer, E. W. P. & Crinella, F. M. (1981) Reaction time, evoked brain potentials, and psychometric *g* in the severely retarded. *Intelligence* 5: 179–97. [ARJ]
Just, M. A. & Carpenter, P. A. (1980) A theory of reading: From eye fixations to comprehension. *Psychological Review* 87: 329–54. [taRJS]
Kaufman, A. S. & Kaufman, N. L. (1983) *Kaufman assessment battery for children (K-ABC).* American Guidance Service. [taRJS]
Kaufmann, G. & Raaheim, K. (1973) Effect of inducing activity upon performance in an unfamiliar task. *Psychological Reports* 32: 303–6. [KR]
Kaye, D. B., Brown, S. W., & Post, T. A. (1981) The development of letter processing efficiency. *Memory and Cognition* 9: 132–41. [NEJ]
Keating, D. P. (1980) Sternberg's sketchy theory: Defining details desired. *Behavioral and Brain Sciences* 3: 595–96. [NEJ]
(1984) The emperor's new clothes: The "new look" in intelligence research. In: *Advances in the psychology of human intelligence*, vol. 2, ed. R. J. Sternberg. Erlbaum. [taRJS]
Keating, D. P. & Bobbitt, B. L. (1978) Individual and developmental differences in cognitive-processing components of mental ability. *Child Development* 49: 155–67. [DRO, tarRJS]
Keil, F. C. (in press) Mechanisms in cognitive development and the structure of knowledge. In: *Mechanisms of cognitive development*, ed. R. J. Sternberg. Freeman. [taRJS]
LaBerge, D. & Samuels, J. (1974) Toward a theory of automatic information processing in reading. *Cognitive Psychology* 6: 293–323. [taRJS]
Laboratory of Comparative Human Cognition (1982) Culture and intelligence. In: *Handbook of human intelligence*, ed. R. J. Sternberg. Cambridge University Press. [tarRJS]
(1983) Culture and cognitive development. In: *Handbook of child psychology:* vol. 1, ed. P. Mussen; vol. 3, *Cognitive development*, ed. J. H. Flavell & E. M. Markman. Wiley. [BR, taRJS]
Labouvie-Vief, G. & Chandler, M. (1978) Cognitive development and life-span developmental theories. Idealistic vs. contextual perspectives. In: *Life-span development and behavior*, vol. 1, ed. P. B. Baltes. Academic Press. [taRJS, BJZ]
Lansman, M., Donaldson, G., Hunt, E. & Yantis, S. (1982). Ability factors and cognitive processes. *Intelligence* 6: 331–45. [tarRJS]
Larkin, J., McDermott, J., Simon, D. P. & Simon, H. A. (1980) Expert and novice performance in solving physics problems. *Science* 208: 1335–42. [taRJS]
Lefcourt, H. M. (1976) *Locus of control: Current trends in theory and research.* Erlbaum. [MEF]
Locke, E. A., Shaw, K. N., Saari, L. M. & Latham, G. P. (1981) Goal setting and task performance: 1969–1980. *Psychological Bulletin* 90: 125–52. [MEF]
Matarazzo, J. D. (1972) *Wechsler's measurement and appraisal of adult intelligence*, 5th ed. Williams & Wilkins. [taRJS]
Mayer, R. & Greeno, J. G. (1972). Structural differences between learning outcomes produced by different instructional methods. *Journal of Educational Psychology* 63: 165–73. [taRJS]

McClelland, D. C. (1973) Testing for competence rather than for "intelligence." *American Psychologist* 28: 1–14. [taRJS, BJZ]
Mercer, J. R. (1973) *Labelling the mentally retarded.* University of California Press. [JB]
Mellenbergh, G. J. (1972) Applicability of the Rasch model in two cultures. In: *Mental tests and cultural adaptation*, ed. L. J. Cronbach & P. J. D. Drenth. The Hague: Mouton. [SHI]
(1983) Conditional item bias methods. In: *Human assessment and cultural factors*, ed. S. H. Irvine & J. W. Berry. Plenum. [SHI]
Miles, R. T. (1957) Contributions to intelligence testing and the theory of intelligence. 1. On defining intelligence. *British Journal of Educational Psychology* 27: 153–65. [SHI]
Mischel, W. & Peake, P. K. (1982) Beyond *déjà vu* in the search for cross-situational consistency. *Psychological Review* 42: 518–28. [BJZ]
Mulholland, T. M., Pellegrino, J. W. & Glaser, R. (1980) Components of geometric analogy solution. *Cognitive Psychology* 12: 252–84. [taRJS]
Neisser, U. (1976) *Cognition and reality: Principles and implications of cognitive psychology.* Freeman. [taRJS]
(1979) The concept of intelligence. *Intelligence* 3: 217–27. [taRJS]
Newell, A. & Simon, H. (1972) *Human problem solving.* Prentice-Hall. [taRJS]
Olson, D. & Bialystok, E. (1983) *Spatial cognition: On the structure and development of mental representations of spatial relations.* Erlbaum. [DRO]
Pachella, R. G. (1974) The interpretation of reaction time in information-processing research. In: *Human information processing: Tutorials in performance and cognition*, ed. B. H. Kantowitz. Erlbaum. [taRJS]
Pellegrino, J. W. & Glaser, R. (1979) Cognitive correlates and components in the analysis of individual differences. In: *Human intelligence: Perspectives on its theory and measurement*, ed. R. Sternberg & D. K. Detterman. Ablex. [taRJS]
(1980) Components of inductive reasoning. In: *Aptitude, learning and instruction: Cognitive process analyses of aptitude*, vol. 1, ed. R. Snow, P. A. Federico & W. Montague. Erlbaum. [tarRJS]
Pellegrino, J. W. & Kail, R., Jr. (1982) Process analyses of spatial aptitude. In: *Advances in the psychology of intelligence.* vol. 1, ed. R. J. Sternberg. Erlbaum. [JBC]
Pepper, S. C. (1970) *World hypotheses.* University of California Press. [BJZ]
Perfetti, C. (in press) Reading ability. In: *Human abilities: An information-processing approach*, ed. R. J. Sternberg. Freeman. [taRJS]
Piaget, J. (1967) *Biologie et connaissance.* Gallimard. (transl. *Biology and knowledge*, University of Chicago Press, 1971). [MNR]
(1972) *The psychology of intelligence.* Littlefield Adams. [tarRJS]
(1974) *Adaptation vitale et psychologie de l'intelligence.* Hermann. [MNR]
(1976) Le comportement, moteur de l'évolution. Gallimard. (transl. *Behaviour and evolution*, Routledge & Kegan Paul, 1979). [MNR]
Poortinga, Y. (1971) Cross-cultural comparison of maximum performance tests: Some methodological aspects and some experiments with simple auditory stimuli. *Psychologia Africana:* Monograph Supplement no. 6. [SHI]
(1983) Psychometric approaches to inter-group comparison: The problem of equivalence. In: *Human assessment and cultural factors*, ed. by S. H. Irvine & J. W. Berry. Plenum. [SHI]
Posner, M. I. & Mitchell, R. F. (1967) Chronometric analysis of classification. *Psychological Review* 74: 392–409. [taRJS]
Price, H. H. (1953) *Thinking and experience.* Hutchinson's University Library. [KR]
Raaheim, K. (1961) Problem solving: A new approach. *Acta Universitatis Bergensis. Series Humaniorum Litterarum*, No. 5. [KR]
(1974) *Problem solving and intelligence.* Oslo: Universitetsforlaget. [KR, taRJS]
(in press) *Why intelligence is not enough.* Bergen, Norway: Sigma Forlag. [KR]
Raaheim, K. & Kaufmann, G. (1972) Level of activity and success in solving an unfamiliar task. *Psychological Reports* 30:271–74. [KR]
Resnick, L. B., ed. (1976) *The nature of intelligence.* Erlbaum. [taRJS, PEV]
Rey, A. (1946) *Etude des insuffisances psychologies. 1. Méthodes et problèmes.* Delachaux et Niestle. 2d ed. 1962. [MNR]
(1962) *Interprétation de dessins et développement psychologique.* Delachaux et Niestle. [MNR]
(1963) *Connaissance de l'individu par les tests.* Dessart. [MNR]
Rogoff, B. (1982) Integrating context and cognitive development. In: *Advances in developmental psychology*, ed. M. E. Lamb & A. L. Brown, vol. 2. Erlbaum. [BR]
Rogoff, B. & Mistry, J. (in press) Memory development in cultural context. In: *The cognitive side of memory development*, ed. M. Pressley & C. J. Brainerd. Springer-Verlag. [BR]
Scarr, S. (1981) Testing for children: Assessment and the many determinants of intellectual competence. *American Psychologist* 36: 1159–66. [taRJS]
Shank, R. (1980) How much intelligence is there in artificial intelligence? *Intelligence* 4: 1–14. [taRJS]
Schneider, W. & Shiffrin, R. (1977) Controlled and automated human information processing: 1. Detection, search, and attention. *Psychological Review*, 84: 1–66. [taRJS]
Scribner, S. & Cole, M. (1981) *The psychology of literacy.* Harvard University Press. [BR]
Seligman, M. E. P. (1975) *Helplessness.* Freeman. [MEF]
Sen, A., Jensen, A. R., Sen, A. K. & Arora, I. (1983) Correlation between reaction time and intelligence in psychometrically similar groups in America and India. Applied Research in Mental Retardation 4: 139–52. [ARJ]
Shiffrin, R. M. & Schneider, W. (1977) Controlled and automatic processing: 2. Perceptual learning, automatic attending, and a general theory. *Psychological Review* 84: 127–90. [NEJ, taRJS]
Siegler, R. S. (1981) Developmental sequences within and between concepts. *Monographs of the Society for Research in Child Development* 46 (Serial No. 189). [tarRJS]
Simon, H. A. (1976) Identifying basic abilities underlying intelligent performance of complex tasks. In: *The nature of intelligence*, ed. L. B. Resnick. Erlbaum. [taRJS]
Skinner, B. F. (1969) *Contingencies of reinforcement.* Appleton-Century-Crofts. [MNR]
(1981) Selection by consequences. *Science* 213: 501–04. [MNR]
Snow, R. E. (1979) Theory and method for research on aptitude process. In: *Human intelligence: Perspectives on its theory and measurement.* ed. R. J. Sternberg & D. K. Detterman. Ablex. [taRJS]
(1981) Toward a theory of aptitude for learning: 1. Fluid and crystallized abilities and their correlates. In: *Intelligence and learning*, ed. M. Friedman, J. P. Das & N. O'Conner. Plenum [taRJS]
Spearman, C. (1927) *The abilities of man.* Macmillan. [rRJS]
Stenhouse, D. (1973) *The evolution of intelligence: A general theory and some of its implications.* Harper & Row. [taRJS]
Sternberg, R. J. (1977a) Component processes in analogical reasoning. *Psychological Review* 84: 353–78. [taRJS]
(1977b) *Intelligence, information processing, and analogical reasoning: The componential analysis of human abilities.* Erlbaum. [taRJS]
(1978). Isolating the components of intelligence. *Intelligence* 2: 117–28. [taRJS]
(1980a) Factor theories of intelligence are all right almost. *Educational Researcher* 9: 6–13, 18. [taRJS]
(1980b). Sketch of a componential subtheory of human intelligence. *Behavioral and Brain Sciences* 3: 573–84. [tarRJS]
(1981a) Intelligence and nonentrenchment. *Journal of Educational Psychology* 73: 1–16. [taRJS]
Sternberg, R. J. (1981b) Novelty-seeking, novelty-finding, and the developmental continuity of intelligence. *Intelligence* 5: 149–56. [rRJS]
(1982a) A componential approach to intellectual development. In: *Advances in the psychology of human intelligence*, vol. 1, ed. R. J. Sternberg. Erlbaum. [taRJS]
(1982b) Natural, unnatural, and supernatural concepts. *Cognitive Psychology* 14: 451–88. [tarRJS]
(in press) *Beyond IQ: A triarchic theory of human intelligence.* Cambridge University Press. [JBC, tarRJS, PEV, SRY]
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. [taRJS]
Sternberg, R. J. & Davidson, J. E. (1982) The mind of the puzzler. *Psychology Today* 16 (June): 37–44. [taRJS]
(1983) Insight in the gifted. *Educational Psychologist* 18: 51–57.
Sternberg, R. J. & Gardner, M. K. (1983) Unities in inductive reasoning. *Journal of Experimental Psychology: General* 112: 80–116. [tarRJS]
Sternberg, R. J. & Powell, J. S. (1982) Theories of intelligence. In: *Handbook of human intelligence* ed. R. J. Sternberg. Cambridge University Press.
(1983) Comprehending verbal comprehension. *American Psychologist* 38: 878–93.
Sternberg, R. J. & Rifkin, B. (1979) The development of analogical reasoning processes. *Journal of Experimental Child Psychology* 27: 195–232. [taRJS]
Sternberg, R. J. & Salter, W. (1982) Conceptions of intelligence. In: *Handbook of human intelligence* ed. R. J. Sternberg. Cambridge University Press. [taRJS]
Sternberg, R. J. & Wagner, R. K. (1982) Automatization failure in learning disabilities. *Topics in Learning and Learning Disabilities* 2 (July): 1–11. [taRJS]
Sternberg, R. J. & Weil, E. M. (1980) An aptitude-strategy interaction in linear syllogistic reasoning. *Journal of Educational Psychology* 72: 226–34. [tarRJS]

Sternberg, S. (1969) The discovery of processing stages: Extensions of Donders' method. *Acta Psychologica* 30: 276–315. [taRJS]
Stich, S. & Nisbett, R. (1980) Justification and the psychology of human reasoning. *Philosophy of Science* 47:188–202. [JB]
Tannenbaum, A. J. (1983) *Gifted children: Psychological and educational perspectives*. Macmillan. [NEJ]
Thurstone, L. L. (1924). *The nature of intelligence*. Harcourt, Brace. [MNR, taRJS]
Thurstone, L. L. & Thurstone, T. G. (1962) *Tests of primary mental abilities*, rev. ed. Science Research Associates. [taRJS]
Triandis, H. C. (1980) Values, attitudes and interpersonal behavior. In: *1979 Nebraska Symposium on Motivation*, ed. H. E. Howe & M. M. Page. University of Nebraska Press. [HCT]
Tuddenham, R. D. (1963) The nature and measurement of intelligence. In: *Psychology in the making*, ed. L. Postman. Knopf. [DKD]
van der Flier, H. (1983) Some applications of an iterative method to detect biased items. In: *Expiscations in cross-cultural psychology*, ed. J. B. Deresowski, S. Dziurawiec & R. S. Annis. The Netherlands: Swets and Zeitlinger. [SHI]
Vernon, P. A. (1981) Reaction time and intelligence in the mentally retarded. *Intelligence* 5:345–55. [ARJ]
(1983) Speed of information processing and general intelligence. *Intelligence* 7: 53–70. [ARJ]
Vernon, P. E. (1979) *Intelligence: Heredity and environment*. Freeman. [PEV]
Wagner, R. K & Sternberg, R. J. (1983) Executive control of reading. Manuscript submitted for publication.
(in press) Practical intelligence in real world pursuits: the role of tacit knowledge. *Journal of Personality and Social Psychology*.
Wechsler, D. (1958) *The measurement and appraisal of adult intelligence*, 4th ed. Williams & Wilkins. [tarRJS]
Werner, H. & Kaplan, E. (1952) The acquisition of word meanings: A developmental study. *Monographs of the Society for Research in Child Development*, No. 51. [taRJS]
White, R. W. (1959) Motivation reconsidered: The concept of competence. *Psychological Review* 66: 297–333. [MEF]
Zigler, E. (1971) The retarded child as a whole person. In: *Advances in experimental clinical psychology*, vol. 1, ed. H. E. Adams & W. K. Boardman. Pergamon Press. [taRJS]
Zimmerman, B. J. (1983) Social learning theory: A contextualist account of cognitive functioning. In: *Advances in cognitive developmental theory*, ed. C. J. Brainerd. Springer-Verlag. [BJZ]