

ultimately lead to a formal organization, the Rangeland Protective Association, a local interest group affiliated with the Mountain State Resource Council. Thus, through *gesellschaftlich* social action, the cattlemen and their Sagebrush allies are able to find out what is happening in their community and how their waning interpersonal trust can be restored.

In addition to providing insight into the dynamics of community change, Gold compares and contrasts two forms of natural resource development, characterized as contentious and accommodative. Contentious development involves decision-making by energy or other resource producers with little or no consultation with indigenous groups. Discussion with local residents of the risks of pollution, estimates of population growth, anticipated changes in the school age population, potential housing and water supply needs, or the possible duration of an energy development project is avoided. Accommodative development involves local people in planning a project to the point of deciding whether a proposed development should take place and how, how fast, and with what controls. In the accommodative form, "development proceeds only if differences in interests and values and in the handling of ethical issues can be reconciled enough to make acceptable sense to all" (pp. 151-152). Considerable attention is given to specific recommendations for accommodative resource development based upon known cases, and Gold argues for this approach on ethical as well as economic grounds.

Though "Sagebrush" is a pseudonym devised by Gold to protect the many small western towns in which he has worked during the current years of energy shortages, it reflects a reality he has extensively observed. The book is based on more than a thousand interviews with representatives of Indian tribes, teachers, students, homemakers, financiers, ranchers, farmers, business persons, construction workers, clergy, physicians, and others. Gold and his associates traveled throughout Montana, Idaho, Wyoming, and North Dakota in their work, and the analysis of more than a decade of field notes certainly must have been a test of Gold's mettle. What is even more important about this book is the overriding rationale it provides for the accommodative strategy of natural resource development. According to Gold and others, people must adopt this strategy not only to comply with the law of the land but also to face a fundamental ethical problem. Should major techno-

logical developments continue in social contexts where they cause sweeping and irreversible changes to residents largely for the material benefit of people living elsewhere? Though Gold does not pretend to have an answer to this hard question, he believes that accommodative resource development will force participants to deal with it.

Though this book clearly has many strengths, it is not without problems. The voluminous wealth of field notes upon which the work is based causes the author problems with redundancy and sketchiness. A more fundamental weakness appears in the treatment of the deviousness and secretive dealings of the energy corporation. Why do executives of energy production companies engage in contentious natural resource development if this strategy results in conflict, production delays, high turnover in the labor force, and lower labor productivity? One gets some insights into this question at the end of the book in a discussion of corporate commitment to technological progress and narrowly defined notions of economic growth, but they do not match the depth of understanding the author conveys about rural values and social life, and one is still left searching for an explanation why scientists and engineers working for an energy development corporation behave in ways that alienate them from those who control the natural resources that are vital to the survival of a corporate enterprise.

In spite of these shortcomings, Gold brings sociology into the environmental impact assessment process in a way that will capture the interest of scholars, public officials, and the corporate world of natural resource development. His style is forthright and engaging, and his qualitative ethnographic approach gives the reader a view of the human social consequences of technological innovation that is uncluttered by the maze of technical considerations all too often dominant in the environmental impact assessment process. Gold set out to identify theoretically and practically important facets of social change occurring in small towns with large-scale energy production systems in progress, and he has done so in a sophisticated and telling way. One really does learn about home on the range in this book, and for that Raymond Gold should ride tall in the saddle.

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Intelligence Reexamined

Beyond IQ. A Triarchic Theory of Human Intelligence. ROBERT J. STERNBERG. Cambridge University Press, New York, 1984. xvi, 411 pp. \$39.50; paper, \$14.95.

Until 15 years ago, the major theoretical approach to understanding intelligence was factor analysis—a set of mathematical and statistical methods for identifying dimensions underlying the observed relationships between measures of mental performance. In essence, factor analysis, conceived by its pioneers as an exploratory enterprise, attempted to discover underlying order with little resort to theory derived from other data. In the 1970's and '80's, with the growth of cognitive psychology, it became possible to use more direct methods for the analysis of intelligent performance. *Beyond IQ* describes a significant program of research in this current phase of study. In 1977, Robert Sternberg's *Intelligence, Information Processing, and Analogical Reasoning: The Componential Analysis of Human Ability* offered an integration of psychometric and cognitive approaches to intelligence. Sternberg has now attempted to extend the inquiry further, conceiving intelligence not only in terms of the mind's work and what tests measure but "in terms of the context in which it occurs" (p. 43).

Sternberg classifies accounts of intelligence into two categories, explicit and implicit theories. Most investigation of intelligence is based on explicit theories, with psychometric factor techniques and information-processing analyses providing the relevant data. For all their utility, factor-analytic accounts are difficult to falsify, and explicit theories, in general, are weakened by uncertainty concerning the appropriateness of task selection. They fail to capture various aspects of real-world functioning deemed intelligent and are incomplete in not accommodating data on the contexts in which intelligence is used. Implicit theories derive from extant patterns of belief—people's informal conceptions of intelligence at different ages, in different cultures, and in different fields of work. Implicit theories can indicate aspects of intelligence that may be overlooked in explicit theories. Though this book deals primarily with explicit theories, its aspiration is a conceptualization that combines implicit and explicit theorizing—Sternberg's triarchic theory of intelligence.

The triarchic theory consists of contextual, experiential, and componential subtheories. The *contextual* subtheory

views intelligence as mental activity directed toward "purposive adaptation to, and selection and shaping of, real-world environments relevant to one's life" (p. 45). This subtheory calls attention to the demands of the sociocultural setting. The *experiential* subtheory considers performances that develop through experience with particular tasks or situations. Two general cognitive skills are emphasized: the ability to deal with novel situations and the ability to process information with little conscious attention (automatization). These two abilities are indicators of developed intelligence in many cognitive tasks and are closely related in that automatization frees cognitive resources for attending to novel situations. As experience with a task increases, novelty decreases and the task becomes less useful in measuring intelligence on the dimension of novelty, but automatization of skills increases, and intelligence at this point is more aptly measured from the standpoint of ease of processing. Sternberg's discussion of novelty includes analysis of the classical "insight problem" in psychology and a model of the processes involved in understanding a novel task. In discussing automatization, he refers to recent work on the knowledge structures and cognitive processes that characterize expertise in various domains of knowledge.

The *componential* subtheory of intelligence focuses on the fundamental cognitive mechanisms by which intelligent behavior is accomplished. Theories that identify the kinds of behaviors that are considered intelligent often do not specify the underlying component processes. A component is defined as an elementary cognitive process that operates upon internal representations of objects or symbols that constitute the information content of a process. Three kinds of components are proposed as critical to intelligent behavior: metacomponents (which are used in planning, monitoring, and evaluating one's task performance, and which resemble executive control functions); performance components; and knowledge-acquisition components (the least well defined).

The componential analysis of intelligence was the focus of Sternberg's early experimental work, and a significant portion of the book is devoted to an overview of this work such as has not heretofore been available. Experiments on "fluid abilities" (that is, inductive and deductive reasoning) and "crystallized abilities" (for example, knowledge of vocabulary and information processing in verbal comprehension) are reported.

Sternberg attempts to describe how the various classes of components might interact. The discussion is tentative and sketchy but provides a framework for further experimentation.

Sternberg summarizes the triarchic theory in the following definition: "Intelligence is the mental capability of emitting contextually appropriate behavior at those regions in the experiential continuum that involve response to novelty or automatization of information processing as a function of metacomponents, performance components, and knowledge-acquisition components" (p. 128). Behavior is seen as more intelligent to the extent that it involves more of these features.

In elaborating the triarchic theory, Sternberg speculates about key phenomena dealt with in the study of intelligence and how they would be explained within his theoretical framework. In a series of short statements of opinion covering ten pages, he comments on a factor of "general intelligence," multiple factors constituting "primary mental abilities," crystallized versus fluid abilities as factors of intelligence, vocabulary as the best single measure of overall intelligence, increases in the absolute level of intelligence as children grow older, the effectiveness of intelligence tests as predictors of academic achievement, intelligence and creativity, the relation of speed and quality in intelligent performance, and how training might enhance intelligent performance. A separate section discusses exceptional intelligence, that is, giftedness and retardation.

In discussing the implications of the triarchic theory for intelligence testing, Sternberg argues as follows: (i) Insofar as existing IQ tests measure intelligence and predict real-world performance, it is primarily because they implicitly measure metacomponential functioning. Typical IQ tests contain a variety of items that assess these cognitive performances, such as deciding upon the nature of a problem and the strategy to solve it, allocating resources for its solution, and monitoring solution processes. (ii) The emphasis on speed in existing tests is to some extent misguided because experimental work has shown that speed of functioning is not a uniform requirement for the processes that constitute intelligent performance. A more important indicator is how time is allocated. (iii) Although metacomponents appear to be centrally responsible for the correlation between performance on cognitive tasks and performance on psychometric tests, specific components of task performance, such as inductive and

deductive reasoning, also influence intellectual functioning as measured by test items. These performance components are general across tasks that cover a range of content. Virtually all tests commonly used for the assessment of intelligence place heavy content achievement demands, but content should be deemphasized, particularly for children whose environment has offered little opportunity for content mastery. Here, how knowledge and skill are acquired is the significant factor in assessing individual differences. (iv) The experiential subtheory further suggests that intelligence tests should include tasks that involve coping with novelty or the automatization of task performance. Most tests require at least some of each, but what is novel or automatized is very much a function of individual and group. Overall, it is Sternberg's view that an adequate test must measure the aspects of intelligence dealt with by each of the three subtheories. Current tests deal inadequately with contextual aspects, adaptation to real-world environments, assessment of novel situations, and metacomponential planning and decision-making about performance. They best measure the outcomes of knowledge acquisition and the functioning of information-processing components of performance.

The general message of *Beyond IQ* is that theories of intelligence have been dictated by available measures of intelligence and that a broader view must be taken. The locus of intelligence is not only in the individual, or only in behavior, or only in the context of behavior. The triarchic theory attempts to direct attention to all of these. In this effort, Sternberg carries us over the threshold from old to modern thought, but an integrated theory of intelligence remains to be formulated. The triarchic theory has yet to become more than three separate rubrics. The relationships among contextual aspects, learning and experience, and underlying mental mechanisms are considered, but only in speculative ways. It seems to this reviewer that integration of the subtheories will require closer focus on the content of the domains in which intelligent performance takes place. Recent investigations of thinking and problem-solving show that high levels of cognitive competence result from the interplay between previously acquired knowledge and facility of processing. Sternberg separates content and process too much by deemphasizing these reciprocal influences.

A more complete theory of intelligence will also have to take into account

the theory and data that have accumulated since Piaget on the growth of cognitive skills and conceptual understanding early in human development. Cognitive competences more systematic than was previously expected have been found in young children in such domains of knowledge and skill as first language proficiency, general spatial knowledge and related perceptual abilities, elementary concepts of number, causal thinking, and classification. The proficiencies involved appear to be acquired on the basis of interaction between the increasing organization of knowledge and the kinds of cognitive processes described in Sternberg's componential theory.

Beyond IQ is a challenge to further experiment and theory. It also gives evidence that the scientific study of intelligence has moved beyond the stage of measuring undefined entities to a stage of investigating cognitive abilities so that intellectual proficiency can be understood and enhanced.

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A System of Academies

Science Reorganized. Scientific Societies in the Eighteenth Century. JAMES E. MCCLELLAN III. Columbia University Press, New York, 1985. xxxii, 413 pp., illus. \$45.

Scientific societies were the leading institutions supporting natural philosophy in the 17th and 18th centuries. They united natural philosophers in common endeavor, disseminated research through correspondence and the first scientific journals, and provided limited support for research in the form of salaries, laboratories, and access to state scientific employment. They have been celebrated since their earliest foundation by historians, who, however, have generally focused on 17th-century institutions or on the history of individual academies. McClellan's *Science Reorganized: Scientific Societies in the Eighteenth Century* is, to my knowledge, the first monograph to offer a comprehensive survey of the scientific societies during the century of their greatest significance.

McClellan covers all the more important societies and numerous lesser ones, giving a brief history of each and noting its sources of support, internal organization, publications, physical plant, sponsorship of prize competitions, and other

activities. In the course of this survey he rightly traces what he calls a "scientific society movement" (p. 41), in which the numbers of societies grew exponentially. McClellan divides this movement into three periods. The Royal Society of London and the Académie Royale des Sciences at Paris were the only significant and permanent foundations prior to 1700. After 1700 the movement "began to pick up steam" (p. 67), and by 1750 all the major European academies were founded—those at Berlin, St. Petersburg, Stockholm, and Bologna and in several of the French provinces. The last period, 1750–1790, enjoyed "the full flowering of the scientific society system" (p. 68), including several attempts at unification among societies. By the late 18th century every European state either possessed an academy or had felt the stirrings of the movement. The entire system collapsed, however, in the chaos of the French revolutionary era; when they revived after the Restoration, the academies faced tough competition from universities and specialized scientific societies. The "age of academies" had ended.

Except for two chapters on the international relations among societies, McClellan does not base his account on original research. But he has gathered information on a very large subject and systematized it in a useful way. A taxonomy of scientific societies in the first chapter sets forth distinctions regarding modes of patronage, organization, and activities, and two appendixes list all the academies with relevant information in summary form. The narrative sections of the book, the appendixes, and a substantial bibliography offer an excellent overview of the scientific societies of the 18th century.

The book is less strong in its conclusions. Having established the strength of the scientific society movement, McClellan emphasizes that it "was a real thing" (pp. 54, 68). On the other hand he overstates his case in claiming that the movement's importance was "equaled only perhaps by the emergence of medieval universities in the twelfth and thirteenth centuries" (p. 140). Such a conclusion requires some evaluation of the societies' contributions to the institutionalization and content of science; but McClellan has here laid out only the parameters of their existence. Likewise overstated is the argument for an international network of cooperating institutions, for which McClellan offers as evidence little more than their exchange of correspondence and publications. McClellan makes too much of their coordination

and exchange of observations on the occasions of several well-known astronomical and geodesic expeditions—those to Lapland and Peru in 1735 and to observe the transits of Venus in 1761 and 1769. Far from being triumphs of international cooperation, these expeditions were nationalistic undertakings.

Several lines of investigation might have led to more substantial conclusions than are offered here. Comparisons might be drawn among the academies in such respects as size, sources of support, and organization and the results set in the larger history of the Enlightenment. A study of prize competitions, the importance of which McClellan recognizes, would establish the extent of their influence on research. Finally, English usage could be much improved, in particular, the use of "cartology" in preference to "cartography" (p. 119 and *passim*). Attention to any of these matters would have substantially increased the value of this work.

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Gauge Theories

Progress in Gauge Field Theory. G. 'T HOOFT, A. JAFFE, H. LEHMANN, P. K. MITTER, I. M. SINGER, and R. STORA, Eds. Plenum, New York, 1984. x, 608 pp., illus. \$89.50. NATO ASI Series B, vol. 115. From an institute, Cargèse, Corsica, France, Sept. 1983.

Gauge theories have dominated theoretical elementary particle physics for the last 15 years, and they have played an important role in other fields of theoretical and mathematical physics. Based on the "gauge principle" of invariance of physical laws under local symmetry transformations, which first appeared in 1918 in H. Weyl's almost-forgotten attempt to unify electromagnetism with gravity and was generalized to non-Abelian symmetry groups by Yang and Mills in 1954, gauge theories have been the key to the successful unification of weak and electromagnetic forces as well as to the generally accepted description of strong interactions by quantum chromodynamics (QCD) and a large number of attempts to further unify the electroweak and strong forces in a so-called grand unified theory (GUT).

Lately, however, there are signs that the era of the dominance of gauge theories may be over and that the so-called