

Review

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analysis of a certain other primary drive. The serious researcher may discover something that he does not yet know, but that is not too likely. The obese will not discover the 'cure' that has so far eluded them. But the curious reader, he who wishes to gain a fairly detailed understanding of what 'really' drives him to or from the dinner table, and the aspiring researcher who craves an area abounding with hypotheses begging to be tested — these will both find highly palatable food for thought.

C. Peter Herman, *Northwestern University*

Abilities: Their Structure, Growth, and Action

By Raymond B. Cattell. Boston: Houghton Mifflin, 1971. Pp. 583. \$17.95.

The psychology of mental abilities, of intelligence and individual differences, had its heyday during the first third of this century. It was then the most important of the major subdivisions in the field of psychology and in its broadest aspect was called 'differential psychology,' the study of individual and group differences in a wide variety of mental and sensorimotor functions. Its scientific origins date from the seminal works of Sir Francis Galton in the 1870s, and after the turn of the century it flourished in the hands of a number of illustrious researchers who are now generally regarded as among the 'greats' in the history of psychology: Binet, Spearman, Burt, Thorndike, Terman, and Thurstone. (And in retrospect, we see that Piaget, although from a different psychological lineage, also belongs in this list.)

Then, strangely, this most vigorous branch of psychology lost its momentum and slowed to almost a halt. The reasons are obscure, but it appears that the study of abilities and human differences gradually lost its roots in psychology and in biology as the increasing specialization in psychology transformed it into a rather pure and narrow psychometric theory, on the one hand, and into the applied technology of educational, military, and vocational testing, on the other. Statistical psychometrics and the technology of mental testing flourished, while fundamental theoretical interest in the nature and organization of abilities and the causes of individual differences were more or less neglected. The great theoretical issues concerning human abilities all but disappeared from the psychological scene. The study of learning became the dominant theme of the psychology of the 1940s and 1950s, with its emphasis on experimental rather than descriptive and correlational methods, and the controversial theoretical issues revolved around the ambitious programmatic learning theories of Hull, Tolman, and others. Clinical psychology, having gained impetus in World War II, also flourished in this period, but it was mostly dominated by psychoanalytic theory, abnormal psychology, and personality research, and was little concerned with the fundamental issues of differential psychology. It was a time, many will recall, that almost no professor would raise an eyebrow when even the best psychology students, taking their doctoral orals, failed to recognize such names as Spearman, Burt, and Thurstone or could identify g only as the gravitational constant.

Then came the 1960s, with its War on Poverty and the frustrations and disillusionments with enforced universal education as the panacea for social ills. Equality of educational opportunity and inequality of educational performance

(the essential message of the largest educational survey in United States history, now known as the Coleman report) finally forced into public and scientific prominence the whole complex of issues involving achievement, mental abilities, testing, individual and group differences — in short, the subject matter of differential psychology. Goaded by the educational crisis, public interest, and the superficial slogans of the 'IQ controversy' in the popular press, many psychologists began to take scientific stock of differential psychology. Theoretical and methodological issues of a past era were resurrected in hopes of throwing light on present concerns. Numerous articles (often polemics), published symposia, and books of readings on human abilities appeared in rapid succession in the early 1970s. The reviews and collected readings, it is noteworthy, were dominated by the contributions of the first quarter of the century. Since then, psychology had apparently not come very far in this domain, and there were few important landmarks in its recent history. With few exceptions, one had to turn to the distant past for the major contributions. But the field is now quite alive again, with growing scientific activity and theoretical excitement. Many psychology departments, which for years had not offered courses specifically in intelligence or differential psychology, have recently introduced such courses, and the subject is getting greater coverage in journals and in the latest textbooks.

An undoubtedly major event on this scene was the publication in 1971 of Raymond B. Cattell's *Abilities*, the subject of this review. Looking back over the history of the field, I would judge this book to be the single most ambitious and original contribution to the study of mental abilities since Charles Spearman's *The Abilities of Man* (1927). Cattell's book is simply unrivaled in its scope. Whatever the reader's overall assessment of the book's virtues and faults, few who study it thoroughly will fail to think of it as the work of a brilliant and encyclopedic intellect.

Cattell's stated primary aim was to produce "a comprehensive and integrating statement of where this field of knowledge stands today." It would be hard to think of any contemporary psychologist better qualified for the task than Cattell. As a student of Spearman and Burt, and a postdoctoral fellow with E. L. Thorndike, Cattell got into this field from the ground floor. His earliest work was on abilities, before he went into personality research, to which he has devoted the greater part of his distinguished career. But all the while, he kept in close touch with the abilities and made occasional contributions to the field, such as his development of culture-fair tests of *g*, his study of scientific creativity and achievement, his relating of personality factors to mental abilities, and his theory of fluid and crystallized intelligence.

Cattell's *Abilities* deals mainly with intelligence — with, I should add, the psychology and biology of intelligence, not just the psychometric and applied aspects. There is little on psychometric theory per se, although considerable background in this is presupposed. Nor is the book primarily concerned with descriptions and practical applications of mental tests. (For this, readers may go to the excellent texts by Anastasi and by Cronbach.) Although practically all the topics of differential psychology enter into the book, it is not organized around the traditional subdivisions such as sex differences, social-class differences, race differences, and so on, in the fashion of the well-known textbooks of differential psychology by Anastasi and by Tyler. Though Cattell's book deals mainly with

intelligence, he does not regard it as the most important human ability. A more important human trait, says Cattell, is *dependability*.

The reviewer can think of no topic in this broad field that is not at least touched upon by Cattell, although, of course, Cattell is necessarily very selective as to which topics he devotes the most attention. (The bibliography has nearly 800 entries.) The chapter headings give some idea of the book's scope: "Scientific Goals of Ability Study," "Principles and Methods in Investigating General Mental Capacity," "The Nature of Primary Abilities," "Principles in Drawing the Map of Abilities," "The Discovery of Fluid and Crystallized General Intelligence," "Higher-Stratum Ability Structure and the 'Investment Theory' of Intelligence," "The Natural History of Ability: Distribution and Relation to Sex and Age," "Physiological and Neurological Bases of Intelligence," "Ultra-Human Intelligence: Illumination from Evolution of Animals and Machines," "The Debate on Heredity and Environment: Abilities in Relation to Race and Culture," "The Triadic Theory of Abilities Developmentally Related to Structural Learning Theory," "Personality-Ability Interactions and the Prediction of Achievement," "Genius and the Processes of Creative Thought," "Intelligence and Society," and finally, a "Glossary of Technical Terms."

None of the main topics is treated merely as a review of the literature in the fashion of the usual *Psychological Bulletin* article; that, in fact, would be almost unthinkable for Cattell. As much as possible, which turns out to be a great deal, is brought into synthesis with Cattell's own theoretical formulations. Though some readers will view this attempt at synthesis as too egocentric—one is practically forced to see everything through Cattell's eyes—it makes for a unity and intellectual vigor quite unlike the nonevaluative eclecticism that dulls some textbooks.

Cattell's own contributions to the field are his theory of fluid and crystallized intelligence and his new, triadic theory of abilities (presented here in detail for the first time). The triadic theory revises and extends the theory of fluid and crystallized abilities, which Cattell later elaborated as the 'investment theory' of abilities. These formulations grew out of numerous factor-analytic studies but go beneath the surface of specific factor analyses, so to speak, and are treated as dynamic psychological constructs rather than as merely descriptive correlational patterns.

The most fundamental, genetically and constitutionally conditioned, ability is fluid general ability, g_f . It is really the essence of Spearman's g , a broad cognitive factor or capacity that enters into a wide variety of intellectual performances, especially those involving inductive reasoning and the grasping of complex relationships. Crystallized general ability, g_c , is a product of the investment (hence the 'investment theory') of g_f in learned skills and scholastic, vocational, and cultural experiences. Whereas g_f is a general factor genetically and neurophysiologically, g_c is a general factor within a given relatively homogeneous culture only because of the more or less common exposure of individuals to the skills demanded by the culture and, to some extent, to the overlapping of elements and transfer of training among certain classes of skills, especially the scholastic skills commonly taught to everyone. The degree of acquisition and utilization of such skills will depend in great measure on the fluid abilities of the individual, the more so the more equal the opportunities for acquiring skills and the more similar the parental and societal pressures for their acquisition.

This makes for a high correlation between measures of g_f ('culture-fair' tests) and measures of g_c (culture-loaded IQ tests and scholastic achievements).

In culturally homogeneous populations, factor analysis might therefore not reveal any clear separation of g_c and g_f , but only a single general factor, followed by a few small primaries (numerical, verbal, spatial, and so on). Such findings should not be misconstrued as a criticism of the theory. Fluid and crystalized general factors are a conceptual distinction. Their degree of intercorrelation is an empirical matter depending on a variety of conditions, only some of which can reveal the validity of the conceptual distinction. The crystalized components of ability variance increasingly differentiate with age and experience, particularly outside of formal schooling and with the acquisition of different vocational skills in adulthood.

There are other, subsidiary general fluid abilities than the cognitive factor g_f . These are mental speed, memory, and fluency of memory retrieval. Individual differences in all the fluid abilities are mainly genetic or the result of biological influences (e.g., physical trauma, health, nutrition). Thus, Cattell is clearly on the hereditarian side of the so-called nature/nurture controversy. He sees the primary mental abilities of Thurstone (e.g., verbal, numerical, spatial, mechanical), all of which involve a large g component, as examples of crystalized abilities, formed by the investment of fluid abilities. They are factorially distinguishable because of the inherent and distinct structure of the subjects themselves and because of their differing demands on the several fluid abilities. But there is still much more to it than that. In fact, most of the elaboration of Cattell's theory concerns the formation of crystalized abilities. This is formalized in terms of his triadic theory.

The triadic theory is quite complex and can only be sketched here in a somewhat oversimplified way. The empirical underpinnings are even more difficult to describe and evaluate, but they are sufficient to warrant serious consideration of Cattell's formulation as a major heuristic in this area. The three components of the triadic theory are the fluid *capacities*; the *provincials*, a unity of organization based on sensory or motor areas in the brain (e.g., visual, auditory, kinaesthetic); and the *agencies*, a unity of learned transfer and effector proficiencies. The agencies are crystalized 'abilities,' and in the triadic system g_c becomes a_p , and the primary abilities are a_v , a_n , and so on. Any given actual performance is a result of each of these three components: two classes of powers (capacities and provincial powers) and one class of acquired structures (agencies).

Outside this system but acting on it are noncognitive factors, personality and interest. These play an important role, along with specific training and experience, in the development of crystalized abilities. As individuals with initial differences in capacities and provincial powers face various experiences, their performances are differentially successful and differentially rewarded, thus promoting further investment of abilities in different channels. Then they have different feedback loops of developed skills facilitating the further development of different related skills. The variety of exposure, the time and energy spent, the reinforcement schedules in particular areas of experience, the sentiments and motivational systems that grow up around certain activities—these are all involved in the development of crystalized abilities, which can assume an almost infinite variety but, because of formal education and common cultural

demands, show a general factor and a number of 'group factors' or primary abilities.

Cattell also presents the most elaborate review and discussion to be found in the literature on the interaction of ability and personality factors in intellectual achievement and creativity.

Research on the genetics of mental abilities would seem crucial to the validation of Cattell's theory, and indeed, his chapter on heredity and environment is the most thorough and sophisticated in any psychological textbook to date. (He has made original contributions to the methodology of heritability analysis in his MAVA model, which is well known in behavioral genetics.) Cattell's theory, as presently conceived, regards only the fluid abilities as heritable. Crystallized abilities or 'agencies' would show substantial heritability only because they are a product of the investment of fluid ability. But the factor structure of crystallized abilities, according to the theory, resides not in the genotype but in the structure of environmental experience and of learned subject matter. In other words, the Thurstonian primary-ability factors, independently of g_f , are not aspects of the genotype but of the environment.

Cattell cites one study that seems consistent with this important hypothesis. A factor analysis of twin *differences* on a large number of mental tests showed two general factors, identifiable as g_f and g_c , for dizygotic twins (whose differences are both genetic and environmental), and only one factor, g_c , for monozygotic twins (whose differences are completely nongenetic). But this important aspect of Cattell's theory needs further tests. It is intuitively appealing, since it seems unlikely that throughout the evolution of *Homo sapiens* the gene pool and the organization of the nervous system would conform to such relatively recent cultural artifacts as those represented by the primary mental abilities. It is easier to conceive of evolution having acted on the general fluid capacities, in Cattell's system. Differences in primary-ability profiles accordingly would result from experiential factors and possibly also from the differential loadings of the fluid abilities in the primary abilities. Still, there is now some quite strong evidence in the work of Darrell Bock and others that at least one of the primaries (spatial ability) is influenced by a major gene effect of a sex-linked recessive gene for spatial visualization. If this is confirmed in further studies, it should encourage the search for specific gene effects in other primaries.

Today's students will find the book's final chapter, "Intelligence and Society," probably the most significant and provocative. In it Cattell explores the persistent and not yet definitely answered question of whether the level of intelligence is changing for better or worse—a topic with which Cattell has been concerned since at least as far back as 1937, when he wrote *The Fight for Our National Intelligence*. He believes there has been a marked increase in g_c , especially crystallized abilities involving scholastic achievements, over the past half-century, due largely to universal education and the improvement and equalization of educational facilities, as well as to the greater universality of informational media. But Cattell points out that measures of fluid intelligence show no similar gain and possibly even a downward trend in g_f that may have been masked by the use of conventional tests, because of the general improvement of crystallized scholastic abilities. But adequate assessment of the question has not yet been made.

Cattell believes the question demands proper large-scale investigation, and he

outspokenly favors eugenic thinking about the many social implications of the distribution of fluid intelligence in the population. He claims that "there is really no conflict between humanitarian goals and the aim of fostering high intelligence. The suggestion that the low intelligence individuals will be neglected has been simply a rationalization for doing nothing in the field of eugenic exploration." He argues further that "while there is as yet no exact, quantitative proof, indirect evidence and sound logical reasoning support the position that a community's wealth and health is a function of its average level of fluid intelligence." And in the 50-odd pages that follow, Cattell reviews and integrates the relevant evidence on the relationship between intelligence and economic factors, sociopolitical processes, living standards, earnings, welfare trends, and educational attainments of the population. He digs deeper into these crucial societal implications of the distribution of genetically conditioned intellectual resources than any other modern behavioral scientist has yet attempted. Some critics will label Cattell's outspoken eugenical position as intellectually courageous; others will call it foolhardy of a textbook writer to stick his neck out so far on such controversial and emotion-laden issues; and there are still a few remaining on today's university campuses who will shout epithets and clamor that the book be banned. Students who will thoroughly read and think, however, will find much more to think about than they have been accustomed to encountering in most psychology textbooks.

For all its impressive qualities, this work, as a textbook, is not without some drawbacks. These must be weighed by instructors in terms of their own knowledge of their students. The book is not at all easy by current undergraduate standards. It presupposes a strong background in general psychology and in quantitative psychology in particular. Students who have not had courses in statistics through analysis of variance, correlation and regression, and at least an introduction to test theory and factor analysis, will find themselves at sea almost from the beginning. Besides the intrinsic technical difficulty of the subject matter itself, the students must be willing to withstand Cattell's sheer unrestrained ideational fluency throughout many sections of the book. The vast erudition, the lengthy asides, the theoretical forays, and the allusions to earlier works and issues (which are most likely unfamiliar to a vast majority of students) often flow in such profusion as to risk leaving many students completely bewildered. At times the students must, so to speak, listen to Cattell as he thinks out loud and shows no evident self-criticism or revision.

Cattell frequently refers to theories and studies by other psychologists as if the reader should already know about them. There are numerous passing references to Piaget, for example, but never even a brief expository statement of Piaget's views. The 'TOTE' units of Miller, Galanter, and Pribram are mentioned without any explanation of this rather passé acronym. Some famous old studies (e.g., the Skeels studies of orphanage children) are discussed critically in some detail without the reader having been clearly told the basic facts of the study. Cattell seems to forget at times that everything in his own encyclopedic head is not known to the average reader, and the unprovided items of information may easily leave that reader quite stranded. Also, the absence of chapter summaries adds to the student's responsibility for organizing and abstracting the gist of each chapter.

It is perhaps too much to expect in such a broad survey that the author should

apply the same degree of critical acumen to every study he mentions. Cattell is generally outstanding in this respect, but instructors should note Cattell's rare lapses in regard to a couple of the better-known studies, such as his uncritical reporting of the Rosenthal 'teacher-expectancy effect' without also referencing the important critiques by R. L. Thorndike and by Snow, and his uncritical acceptance of Hofstaetter's factor analysis of age-to-age IQ correlations without noting Cronbach's crucial methodological critique of this study. Cattell is, of course, much more critical of studies that fall within the purview of his own theories.

In brief, this book seems to this reviewer to be too demanding for the typical undergraduate course. On the other hand, graduate students in an advanced seminar should not be denied the challenge of this book. In addition to courses in statistics and factor analysis, probably the best prerequisite reading is H. J. Butcher's *Human Intelligence: Its Nature and Assessment* and P. E. Vernon's *The Structure of Human Abilities*. It should go without saying that Cattell's book is a must for teachers of college courses on intelligence and differential psychology. Those with sufficient background will greatly appreciate Cattell's imposing text as an adventurous and enlivening contribution to the psychology of human abilities.

Arthur R. Jensen, *University of California, Berkeley*

An Essay on the Origin of Human Knowledge

By Etienne Bonnot de Condillac. Translated by Thomas Nugent. New introduction by Robert G. Weyant. Gainesville, Fla.: Scholars Facsimiles and Reprints, 1971. Pp. xix, liii, 339. \$17.50.

The serious student of the history of psychology and philosophy can only laud the republication of Nugent's English translation of Condillac's *Essai*. The French original is difficult enough to locate, but this English version is extremely rare. The *Essai* was the first of Condillac's three most important works in psychology: the *Essai sur l'origine des connoissances humaines* (1746), the *Traité des systemes* (1749), and the *Traité des sensations* (1754). While the *Essai* may be considered of less importance in some ways than the *Traités*, it does lay the basis for an understanding of Condillac's relationship to the thought of John Locke and serves as an introduction to the sensationalist emphasis that is Condillac's hallmark.

The value of this reprint is markedly increased by Robert G. Weyant's thoughtful and lucid introduction. Weyant puts the work into perspective in terms of Condillac's other writings as well as the thought of those times. One can wish that Weyant had been given the space to write more on the subject, a statement I can make of very few introductions to reprinted books.

This series of facsimiles appears intended for libraries. The price puts it out of the reach of all but the most serious collectors and certainly makes it unlikely for use in classes. The quality of the facsimile, at least in the copy under review, is not as good as might be desired, with pale reproduction in places. Still, the book is well worth its price for the student interested in Condillac and the psychology of the eighteenth century.

Rand B. Evans, *University of New Hampshire*