Book Reviews

Ontogeny of Thought

Intellectual Development. Birth to Adulthood. ROBBIE CASE. Academic Press, Orlando, Fla., 1985. xx, 461 pp., illus. $39.50. Developmental Psychology Series.

For most of the past quarter century, two rival theoretical traditions have guided efforts to understand intellectual development. Jean Piaget described cognitive development as a sequence of qualitatively different stages. Each stage consists of an organized set of logical reasoning skills that underlies all of an individual's cognitive functioning. Alternatives to Piaget's theory have emphasized acquisition of more molecular units. In the 1950's and 1960's, neobehavioristic theorists described cognitive change in terms of the cumulative acquisition of associations between stimuli and responses; in the 1970's and 1980's, information processing theorists described much the same change in terms of children's acquisition of rules and algorithms in specific content domains.

This history is described in detail in the first five chapters of this book. Case claims, quite correctly, that the time is ripe for new theories of intellectual development, theories that encompass the strengths of these traditional adversaries. He describes such a theory, one that draws upon many of the proven features of Piagetian and information processing theories, and, to a lesser extent, upon theories that have emphasized the role of cultural transmission of knowledge.

Case describes children as problem solvers whose goals and strategies for achieving goals change with development. Intellectual development is said to consist of four qualitatively different stages that are differentiated by the control structures that are used to solve problems. During the sensorimotor stage infants learn the relations between objects and actions. During the stage of relational thought, which begins at approximately 18 months, the relations learned in the sensorimotor stage become the units of thought and problem solving. In the dimensional stage, beginning at approximately five years, underlying dimensions are abstracted from specific relations. Finally, in the vectorial stage, which coincides with adolescence and early adulthood, information from two dimensions is integrated to form a vector. Each of these stages consists of three parallel substages in which the basic units are extended to ever broader and more complex domains.

These stages resemble Piaget's stages, an ancestry that Case readily acknowledges. However, the mechanisms of stage transition go considerably beyond traditional Piagetian constructs. Case proposes four general regulatory processes: problem solving, exploration, imitation, and mutual regulation. These processes are thought to produce progressively more powerful levels of thought because each yields novel combinations of problem solving strategies. However, collectively they are insufficient as a transition mechanism because they cannot explain, for example, why cognitive development is so protracted, spanning years instead of days or months. To explain this and other features of intellectual development, Case argues that short-term storage space constrains the amount of problem solving that can occur at a given time. Short-term storage space increases with age, thereby producing developmental change in level of problem solving. In turn, increases in storage space are thought to be due to increases in operating efficiency and to maturational factors such as neural myelinization.

Case's theory is exceptional for its scope. I mean this in three ways. First, unlike many theorists who focus on a particular segment of development, Case aims to provide a continuous account of intellectual development from birth to maturity. Second, whereas some theorists have simplified the analytic task by subdividing intellectual development into more manageable components (for example, development of quantitative or memory skill), Case has insisted that a theory of intellectual development must address both cognitive changes that are domain-specific and those that are not. Finally, unlike many developmental theorists who offer vague promises that their efforts may lead to insights into methods for optimizing intellectual development, Case describes in detail and has evaluated some of the instructional implications of his work.

Throughout, Case first describes with great care the categories of evidence that would test his theory and then presents illustrative findings. For example, if problem solving, exploration, imitation, and mutual regulation drive much of development, then they should (i) be detectable very early in life, (ii) be common throughout development, and (iii) produce cognitive change when manipulated experimentally. In fact, these properties characterize each of the four proposed regulatory processes.

Particularly interesting are the new data Case reports from his research group at the Ontario Institute for Studies in Education. Some of the work he describes will surely be controversial. I, for one, would like converging evidence concerning the executive control structures that mediate task performance and concerning the processing demands of different tasks. However, in these and other instances, Case is suitably circumspect concerning the strength of support that his experimentation provides for his theory.

In sum, this book can be read with many aims: to understand the critical issues that must be addressed by any theory of intellectual development, to understand a new theory that will surely be one of the reference points of the 1980's for cognitive developmental theorists, and to learn the outcomes of an extensive and imaginative program of research. For any of these aims, Case's book is highly recommended reading.

ROBERT KAIL
*Department of Psychological Sciences,
Purdue University,
West Lafayette, Indiana 47907*

Developments at MIT

A Century of Electrical Engineering and Computer Science at MIT, 1882–1982. KARL L. WILDES and NILO A. LINDGREN. MIT Press, Cambridge, Mass., 1985. xiv, 423 pp., illus. $15.

This is a history written by engineers, principally by Wildes, assisted in the final stages by Lindgren. They have produced a bifurcated work. The first half is disjointed, its events and figures connected merely by chronology and the story's locus in the Massachusetts Institute of Technology. Its chapters center on individuals, first as department chairmen, then as researchers. This half moves fitfully from the founding of the Institute and its electrical engineering program through the departmental administrations of, primarily, Dugald C. Jackson and Harold L. Hazen, taking their stories to 1952. Several more chapters tell the stories of the early researchers, including Vannevar Bush and the differential analyzer, Hazen and the network analyzer, Edward L. Bowles and the development of a communications option at MIT, and Harold Edgerton and the stroboscope.

In the preface, the authors offer a unifying theme in the notion of "scientific and technological progress," which they understand to be the source of an "environment of continual change" in the nation (p. viii). It is a view rapidly fading among students of science and technology, this idea of technology dragging along the social order. In any case, the authors' progressive faith does not work as an integrating theme. The ideas behind the Institute's Technology Plan, devised in the 1920's but reflecting the Institute's original mission, would have better served the authors. The notion of applying science, as the Institute's founder wrote, to the "arts, manufactures, and commerce" blends well with the principles that guided Dugald Jackson's nearly 30 years as department head. Coupling this with the rising commitment to research after 1910, the authors might have smoothed over the rough joints in the first half of the book. They could have emulated the professional historian and made a study of, for example, the histories of A. Hunter Dupree, Daniel N. Kevles, David F. Noble, Ronald C. Tobey, and Edwin T. Layton, Jr., supplemented with some intensive research in the massive collections of Dugald Jackson's papers in MIT's University Archives and Vannevar Bush's at the Library of Congress.

Fortunately for this richly detailed history of MIT's dominant engineering discipline, continuity comes to the second half of the book with the integrating power of the Second World War, abetted by the personal experience of Wildes, who joined the department in 1926. The war initiated an era of military funding at MIT which today sees no end, decisively shaping the fields of electronics and computer science that have come to characterize the discipline of electrical engineering.

Most revealing of the organizing force of the national security state is the content of the final 11 chapters: eight focus on the work of research laboratories and programs established primarily to pursue military purposes, ranging from the wartime Radiation Laboratory of the Office of Scientific Research and Development to Gordon S. Brown's Servomechanisms Laboratory (later the Electronic Systems Laboratory) to the Lincoln Laboratory and the Computation Center. (The genealogy of MIT's postwar laboratories is as complex as a *Mayflower* family's and can only be hinted at here.) In spite of the extensive documentation throughout the book of the military presence, the authors unfortunately fail to consider its import for the theme of their last, interpretative chapter, "seeking a new paradigm in engineering." After describing a department whose members' work is dominated by industrial and military funding, the authors depict the department and the discipline of electrical engineering as essentially autonomous. This is unfortunate, since it would have been helpful to have the authors' thoughts on the impact of mission-directed research on electrical engineering and computer science in the late 20th century.

In the end, however, it matters little. The authors have told their story with energy and in the detail dear to the hearts of alumni and historians. The persistent federal presence does the rest. That the story is that of the premier home of the leading engineering discipline of our time, moreover, makes it a story of interest to us all.

A. MICHAL MCMAHON
4604 Springfield Avenue,
Philadelphia, Pennsylvania 19143

"Students [at MIT] studying the action of direct and alternating currents under different conditions, 1919. This kind of laboratory work, repeating earlier experiments, was still leagues away from the kind of participatory teacher-student research on new problems that would begin to evolve in the next decade." [From *A Century of Electrical Engineering and Computer Science at MIT, 1882–1982*]

Transplanted Neurons

Neural Grafting in the Mammalian CNS. ANDERS BJÖRKLUND and ULF STENEVI, Eds. Elsevier, New York, 1985. xxiv, 709 pp., illus. $157.50. Fernström Foundation Series, vol. 5. From a symposium, Lund, Sweden, June 1984.

This collection of papers begins with a brief historical introduction to neuronal grafting by the editors. It continues with contributions ranging from "how-to-do-it" chapters to case histories of patients with Parkinson's disease who have had brain grafts of their own adrenal glands. In between are detailed accounts of the cellular anatomy and electrophysiology of grafts, axonal growth in and around grafted tissue, and the synthesis and release of dopamine, acetylcholine, and several peptides and hormones from grafted neurons. Finally there is a 26-page bibliography of material from before the turn of the century through 1983.

The volume is much more like a book than the usual collection of isolated chapters discussing the latest results of each participant. This is well illustrated by the section on methodology. There are seven chapters that cover the preparation of both the host tissue and the neuronal graft. Procedures are described for making small explants of neural tissue and also cell suspensions that can be injected into the host. Implantation sites include the cerebral ventricles, the brain