jection, and this may be a reason why the authors stopped at 60°N. Certainly there are no plate tectonic or other geological grounds for picking 60°N as a northern limit.

The charts emphasize physiography and sediments to the exclusion of "geophysical" parameters such as gravity and magnetic anomalies and earthquake epicenters. Though large areas of the equatorial and South Atlantic have scarcely been visited by research ships except for isolated traverses, the set of charts as a whole shows a uniform degree of detail. The reader is not made aware of where a chart is simply a cartoon predicting what "textures" are likely to be encountered.

Though the book is flawed, it is a monumental volume that every serious researcher of the Atlantic and its coastal lands will want to own and that many others will want to consult.

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A Biologization at Stake

The Biology of Learning. P. MARLER and H. S. TERRACE, Eds. Springer-Verlag, New York, 1984. x, 739 pp., illus. $31. Dahlem Workshop Reports. Life Sciences Research Report 29. From a workshop, Berlin, Oct. 1983.

In October 1983, 47 psychologists and biologists from six countries gathered to participate in an experiment—its goal, "to reconcile learning theory and natural behavior"; its method, the Dahlem Workshop model. In the volume resulting from the workshop the desired direction of reconciliatory effects is made clear from the start: at issue is learning as the psychologist sees it. How useful are species-general concepts of learning? Is there a future for theories developed largely from a narrow range of animals exposed to arbitrary tasks? The psychologists' habit of looking for species-general patterns of learning emerged historically from earlier philosophical concerns with the mind and from evolutionary considerations concerning mental continuity across animals and humans. But the inability of psychology at the turn of the century to reconcile concepts of mind with those of behavior also figured prominently in forging the history of the subject. Criticism, skepticism, and calls for change are thus nothing new to this area of psychology. The possibility that learning theorists have in fact become habituated to negative comments from intra- and interdisciplinary sources must be kept in mind as one reads the volume. It may explain why they appear so docile in the face of the possibly impending biologization signaled by the volume's title.

The volume begins with five general papers that expose the differences of opinion to be reconciled. H. S. Terrace and H. M. Jenkins contribute the psychologists' views. Terrace provides a sympathetic although critical review of learning theory. Jenkins gives a more contemporary insider's view of conditioning mechanisms while also reiterating that the goal of such work is not only to understand broader forms of learning but also to learn to manipulate and change behavior. The behavioral biologists' view is presented by J. L. Gould and P. Marler, who outline it largely in relation to, or perhaps as a reaction to, the deficiencies they perceive in the psychological perspective. The biological view is presented with much less explanation of methods and concepts and with scant historical perspective, the latter an especially unfortunate lack. The study of behavior is a comparatively recent development in the biological sciences, and behavioral biologists seem to struggle at times to convince their colleagues that the study of the lives of animals is as significant as the study of the lives of cells. An account of how behavioral biologists defend their level of analysis would have been highly informative, if not somewhat therapeutic, for the psychologists.

The two final chapters of the opening group seem somewhat out of place. P. P. G. Bateson advocates a functional-developmental view of learning that tolerates neither the "arcane abstractions" of learning theory nor the "circumlocutions" of biologists about nature and nurture. J.-P. Changeux and colleagues provide the metaphors of Darwinian selection and antibody synthesis to conceptualize learning. Both papers deserve to be read for their interdisciplinary optimism but seem misplaced as general issue papers because neither developmental nor selectionist views figure prominently in the conference. And missing as an opening paper is a treatment of the physiological analysis of learning. Given that more than a third of the subsequent position papers deal primarily with this level of analysis, a paper actively integrating physiology, psychology, and behavioral biology would have been useful—all the more so given that the participants clearly held diverse opinions on, as Gould and Marler put it, the need "to move from words to wiring" (p. 61).

Four sets of position papers and four group reports follow. The study of invertebrates comes first, all participants stressing that the diversity of invertebrate forms and niches coupled with the simple nature of their nervous systems makes them ideal for the integrative study of learning and physiology. W. G. Quinn in detailing work on mollusks reviews the potential utility for learning theory of a "cell-biological alphabet," as Hawkins and Kandel have labeled it. And if, as Quinn puts it, the appeal of *Aplysia* as a model is its resemblance to an old Philco radio, then the appeal of the honeybee is its similarity to the silicon chip. Bees are the subject of papers by B. Heinrich, C. L. Sahley, and J. L. Gould and monopolize the group report. Here more than anywhere in the volume an animal in its world comes alive as we ponder how bees tell time, find food, "major" and "minor" in flower specialties, navigate to and from the hive, and negotiate paths to the nectar. Much of the life comes from Gould, a master interdisciplinary assimilator, especially when he forgets about wiring and gives us words.

The report of the group discussion on invertebrate learning, written by R. Menzel, reveals that the participants judge that reconciliation will come "when we have the neural substrate in our hands." It is of course easier to do so literally and metaphorically with invertebrates. This group report should be a source of positive reinforcement to psychologists because it provides strong validation of the relevance of learning theory to natural behavior.

The next workshop, on learning in nonmammalian vertebrates, deals mainly with birds, especially with pecking by pigeons, following by newly hatched fowl, and singing by songbirds. Here the participants find less to agree on, in part because of the disparate nature of the topics and in part because of apparently unequal interest in reconciliation. Three psychologists describe the considerable diversity of opinion among learning theorists on the nature of general laws of learning. K. L. Hollis suggests that the abstraction of general learning theory can be useful much as are abstractions

such as the vertebrate eye; E. Hearst advocates more analysis of what animals are doing when we say they are learning; and S. E. G. Lea redefines general learning by stripping away instances of specialized learning (such as song learning) to uncover "the common stock" of vertebrate learning.

But the other participants raise altogether different issues. K. Immelmann and P. Marler each rework ethological views on nature and nurture (which they might write as NATURE [and nurture]). P. P. G. Bateson and M. Konishi discuss the neuroanatomy of imprinting and singing, respectively, together with the value of such studies for reconceptualizing learning. The group report written by D. E. Kroodsma does strive at reconciliation, probing how songs might be studied in terms of conditioned and unconditioned stimuli, citing foraging as a working model of interdisciplinary collaboration, and ending with a revealing view of why bird watchers might feel less pressured toward reconciliation than pigeon runners.

Whereas convergence on birds did not seem to stimulate reconciliation in the second workshop, many in the third workshop, on nonhuman mammals, found communication fostered by a common theme, food—how and where animals find it, whether they choose to eat it, what they do if it makes them sick, and what they remember about it. S. J. Shettleworth, S. Revusky, and E. W. Menzel deal with conceptual issues regarding food-oriented behavior, each providing serious criticisms of past attempts to study learning and making heuristic suggestions for changes; these include Shettleworth's articulation of a functional-ecological view and Menzel's emphasis on higher-order cognitive variables for explaining spatial cognition. R. C. Bolles's paper stands out with respect to the reconciliation experiment as a quite personal saga of a "words" theorist reborn as a "wiring" theorist.

The two neurophysiological papers in this section provide a treat for readers hungering for a developmental perspective. Both papers question the traditional distinction between development in the young and learning in the adult by demonstrating other means of studying behavioral plasticity. R. F. Thompson and T. W. Berger provide important caveats to ideas about the greater modifiability of younger organisms. W. Singer forces those who seek to separate genetic and experiential mechanisms to open their eyes. P. C. Holland's group report reinforced this reader's impression of a group that could already communicate well because they manage for the first time to address definitions of learning theory and of natural behavior.

The final workshop, on the biology of human learning, explores human language from the point of view of psycholinguistics (L. R. Gleitman), philosophy (D. N. Osherson and S. Weinstein), neuropsychology (J. W. Brown and L. R. Squire), comparative psychology (M. R. Petersen and P. W. Jusczyk) and human learning theory (W. K. Estes). The intensive emphasis on language is explained in this section and elsewhere by the fact that language epitomizes a natural behavior naturally learned. It is, however, the human behavior least likely to foster reconciliation, because debates about its ontogeny still linger in the either/or stage of development with respect to the roles of maturation and learning. Petersen and Jusczyk's summary of the study of the perception of sounds makes clear, for example, that arguments on the unique processing of language stimuli by the human brain must be reformulated in light of recently discovered capacities in other animals. Their paper also shows how a comparative approach can illuminate the study of both human behavior and evolution. Evolutionary issues concern Brown, who attempts to map brain function in relation to the phylogenesis of language, and Squire, who details the component cognitive skills implicated in language proficiency.

The group report (J. C. Marshall and J. Morton) for this fourth workshop is the only one of the conference that discusses not only the stated Dahlem goal but the theme of the title. It is especially effective in introducing cognitive issues and in urging caution in accepting the absence of evidence otherwise as proof that language is innate. This group also argues for retention of functional and conceptual descriptions of the nervous system and explains why a cell-biological alphabet, even if available, might not satisfy those who actually study how elementary sounds end up as thoughts.

Estes's excellent contribution to the fourth workshop belongs in the opening section. Estes asks psychologists to consider, Why be biologized? If the answer hinges on the value of such work for explaining human behavior, then Estes is doubtful, arguing that those studying human learning have done quite well without recourse to animal learning theory. He points to differences in the level of analysis: much human learning appears to occur for its own sake rather than to deal with an immediate survival problem. And yet immediate problems, whether in the laboratory or the field, define the study of animal learning. Estes's concerns constitute good grounds for a future Dahlem workshop.

Estes's comments also bring us back to the original question of the future of animal learning theory. Now comes the time to say that the answer for psychologists is to adopt a biological perspective and their problems will be solved. But that is not the answer. Such a prescription would be at best an expedient palliative. Learning theory in its present state seems most akin to the unfortunate dog who was wagged by its tail. What is not needed is a new tail substituting relevance to biology for relevance to human psychology. A source of intrinsic motivation can only emerge when animal learning theorists decide for themselves what they hope to explain. Individuals in search of such motivation might do well to consult their colleagues who grew up with traditional learning theory and then left (always intending to come back) to look at animals learning to live their own lives instead of learning to live abstract scenarios from human life.

The underrepresentation at the conference of psychologists who study animal learning outside the more traditional paradigms (but see the contribution by E. W. Menzel) was unfortunate. The presence of developmental psychobiologists who study learning as part of ontogeny, ecological psychologists who study learning as part of the animal-environment relationship, or comparative psychologists who study learning as part of the perceptual, cognitive, and social adaptations of different species would have balanced the interdisciplinary scales. And their presence would undoubtedly have produced more challenges to the biological chauvinism displayed in the volume (which may explain their absence). Such scientists, for example, would have removed some of the historical blinders with regard to the broader field of comparative psychology, of which learning theory is only one area. The truth, for example, of the statement that the study of animal cognition would have been "unthinkable a decade ago" (p. 2) depends on who is doing the thinking. Nor would such scientists have accepted the often-stated assumption that closed genetic mechanisms are favored when environments are predictable and open learned programs only when they are erratic. Imprinting, song learning, the social transmission of food preferences, and diverse instances of conditioning can be thought of as elegant exemplars of the opposite, the exploitation of predictable environments by

learning. The inclusion of a broader range of psychologists might also have helped the learning theorists to evaluate the new clothes being offered to them and to judge whether another audience might still perceive them as in a state of undress.

Finally, there is the matter of the title. Why the *biology* of learning? Why not the psychobiology (or biopsychology) of learning? The title is noteworthy in that, although biologists have come, often grudgingly, to recognize the importance of learning, they have been unable to formulate theories as to its nature, although this may be because they have not really tried. Perhaps, then, the importance of this Dahlem conference is in providing the incentive and instruction for beginning to formulate what an actual biology of learning might look like. Serious attention to history and to the many approaches to the study of behavior is called for if biologists wish to avoid recapitulating the past of the very discipline whose future they came to debate.

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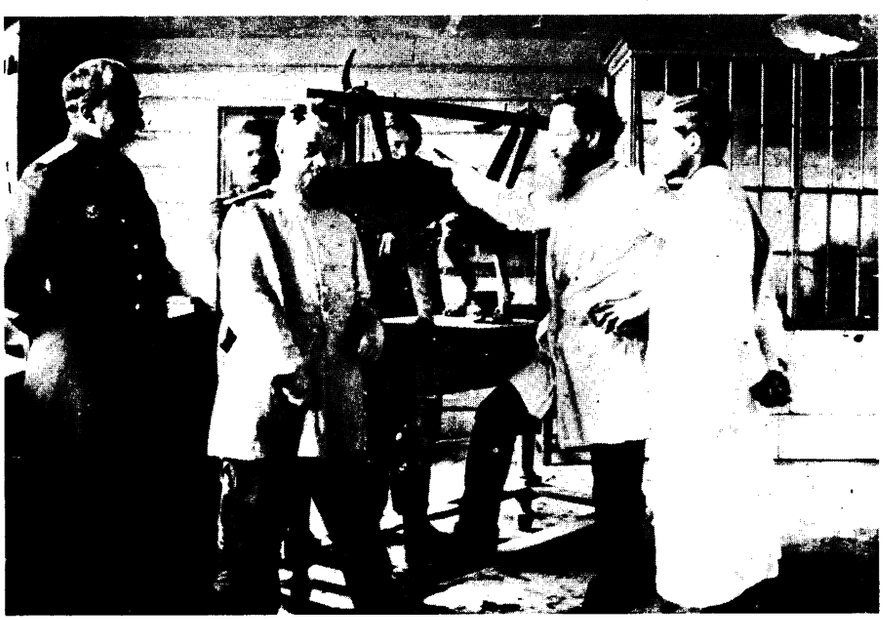
Animal Psychology: A Historical View

From Darwin to Behaviourism. Psychology and the Minds of Animals. ROBERT BOAKES. Cambridge University Press, New York, 1984. xiv, 279 pp., illus. $69.50; paper, $19.95.

Francis Bacon—that maître d'hotel of intellectual fare—recommended that some books were to be tasted, others to be swallowed, and some few to be chewed and digested. This volume goes down easy, without much chewing. Boakes, an experimental psychologist at the University of Sussex, concentrates on the history of ideas about animal mind and behavior, though he gives some attention to their application in the case of humans. For his purposes, the focus is proper. He is interested in delineating the historical foundations of the more stable contributions to contemporary psychological science (especially in the areas of physiology, ethology, and learning theory). He surpasses in depth and color the treatments given in other general histories of such important scientists as the Darwinians Romanes and Lloyd Morgan, the Russian physiologists Sechenov, Pavlov, and Bechterev, and the comparative psychologists and learning theorists Thorndike, Yerkes, and Watson. Boakes tries to plump our interest with wonderful photographs and select portions of the biographies of the scientists whose theories he considers, including some tasty bits of scandal (such as James Mark Baldwin's dalliance in a Baltimore brothel). He is sensitive to questions of institutional surroundings, recognizing the shape that such constraints often give the development of scientific ideas. Yet there is something a bit flat about the whole thing. Despite the intellectual possibilities the material offers and the seemingly capable hands working it, this history neither delights by rich subtlety nor ignites fire in the belly. It has been prepared and served up in the style of a textbook.



Laboratory of the Russian physiologist Sergei Botkin. Ivan Pavlov "is second from the right with his hand resting on the dog. The dog's harness shown here is essentially identical to that used in Pavlov's conditioning experiments, even though this photograph was taken almost twenty years before Pavlov became interested in the conditioned reflex." [Babkin Collection, Osler Library, McGill University; from *From Darwin to Behaviourism*]

Textbooks, of course, have their value, especially in science and mathematics courses. But this genre of literature cannot well sustain even the neophyte in history. Good science textbooks will convey the austere beauty of a structure of ideas, suggest the ways innovative theories dissolve resistant problems, and instruct in the techniques for validating hypotheses. Textbook writers in the natural and social sciences will cite some observational evidence, some facts in support of the theories under consideration, but will quickly dispense with the chore, except when the observations involve (as they often do today) interesting technical problems and auxiliary theories that help secure the data. But even in good history textbooks such as this one, the chronology of facts—the march of men and their ideas—dominates. Missing are overt theory and illuminating explanation to connect the facts. The beauty of a historical explanation can be every bit as alluring as that of a scientific explanation. In science, the resolution of one set of problems often suggests another interesting set. It is that way in history too: a striking explanation of one historical perplexity leads to the recognition of and attack on others. And I do not mean here a large historical theory lurking in the shadow of Hegel or Marx; but small theoretical reconstructions, say, of how Darwin came to apply natural selection theory to behavior, or how William James came to use Darwinian theory in an argument for human freedom. Explanations of this sort also require the historian to specify, at least in passing, a causal theory of idea transformation and development. But such causal accounts and their historiographic justification are not often to be found in textbooks. The history textbook usually fails, in fine, to introduce the novice to historical thinking.

By established practice, if not by definition of their trade, textbook writers do not yield up their own firsthand work, at least not on every subject they cover.