BOOKS: NEUROBIOLOGY

Lack of Attention from Loss of Time

Philip W. Gold

The full syndrome of attention deficit hyperactivity disorder (ADHD) imposes a daunting burden, interfering with behaviors and functions that help define our humanity. At the most basic level, individuals with ADHD cannot depend upon themselves to control their own behavior. They are often impulsive, intrusive, and act without apparent regard for the needs of others. Despite unimpaired intellect and high energy levels, they also apparently lack will. Thus they seem unable to persist in the face of temptation, interruption, or frustration. Finally, they show a global deficit in dealing with time. They cannot easily learn from past mistakes, accurately evaluate their present efforts, realistically plan for the future, or organize and execute tasks that require an orderly temporal sequence. It is not surprising that such deficits profoundly interfere with their social, academic, or occupational lives and elicit harsh, if not continuous, criticism.

ADHD and the Nature of Self Control
by Russell A. Barkley
Guilford, New York, 1997. 432 pp. $40. ISBN 1-57230-250-x.

ADHD is a complex disorder with both genetic and environmental determinants that affects 3 to 7% of children. Of these, 50 to 80% will be affected in adolescence, and 30 to 50% as adults. In the present volume, Russell Barkley, director of psychology at the University of Massachusetts Medical Center, presents a unified theory of ADHD. Based on Virginia Douglas's descriptive model of ADHD and construct of self-regulation, Jacob Brownowski's work on language theory, and Martha Denkla's studies of motor coordination and executive function, Barkley's admirable synthesis also incorporates contemporary information regarding the functions of the prefrontal cortex.

Barkley concludes that one of the important roles of the prefrontal cortex is the mobilization and integration over time of simpler units of behavior into more complex ones. This integration develops a hierarchical structure for behavior that leads to the pursuit and attainment of a goal, one that can persist over long, discontinuous stretches of time. Such single-minded drive towards a target requires that the individual suppress numerous behaviors along the way. He must resist the urge to respond to competing internal and external stimuli. If these distracting behaviors are inadequately restrained by a malfunctioning prefrontal cortex, as in people with ADHD, four critical executive functions that normally bring behavior under the control of internal information—that is, under the control of the "self"—are impaired: working memory; self-imposed regulation of affect, motivation and arousal; internalization of speech; and reconstitution. Although impairment of these functions makes the individual seem unable to pay attention to the task at hand (thus, attention deficit disorder), Barkley argues that this attention breakdown is actually not the central defect in ADHD.

The impairment of working memory in ADHD interferes with the capacity to hold events or information in mind so that they can be considered in the light of both past experience (hindsight) and their implications for future consequences (forethought). It also interferes with the full capacity to reference previous experience in the shaping of future plans, as well as in systematically approaching complex tasks that require orderly sequencing. The impairment in the capacity for self-imposed control of mood, willpower, and arousal leads to deficits in goal-directed activity and a failure to mobilize the persistence necessary to deal with interferences and temporal delays. Deficient internalization of speech interferes with description and reflection, and in turn, with the generation of rule-governed behavior and introspection. Finally, the deficit in reconstitution interferes with the decomposition of sequences of events or messages into their component parts or their resynthesis into entirely new messages or behaviors. This deficit undermines the potential for originality in human language and, as a consequence, in human actions controlled by language.

Based on what is known about the crucial role of the prefrontal cortex in time-dependent complex behaviors, Barkley hypothesizes that the underlying neuroanatomical defect in ADHD lies in this structure, especially in parts of the lateral prefrontal cortex and its connections to the striatum. ADHD is not, however, the only psychiatric disorder in which the prefrontal cortex has been implicated. Both schizophrenia and major depression also likely involve the prefrontal cortex, although the medial part is affected in depression. The prefrontal cortex participates in the extinction of conditioned fear encoded in the amygdala, and it contributes to the assessment of likely reward or punishment on the basis of past experience. Also in its repertoire are mood shifts based on internal or external cues and the modulation of autonomic and neuroendocrine functions. Thus, an impaired medial prefrontal cortex could understandably result in a syndrome associated with intense anxiety about the self, pessimism about the future, perseverance of dysphoric mood, and increased sympathetic nervous system responses.

In ADHD and major depression, the prefrontal cortex plays a pivotal role, and time is an important component in both of these diseases. In ADHD, the past fails to adequately govern present behavior or the shaping of future plans and immediate or intermittent temptations deflect long-range planning for building a future. As a consequence, patients with ADHD cannot imagine what they might become in the future. In depression, a different but no less important subversion of time occurs—the

VIGNETTE

Edison as Luddite?

As a mechanical spectacle, the War of the Currents was a curiously inverted proposition. Show inventors had generally made a point of lessening the shock (so to speak) of inventions through dramatic techniques in order to hasten their acceptance. Edison, on the other hand, did everything possible to *heighten* the sense of alarm, so as to prevent a rival's invention from passing into general use. To electrocute animals, and eventually humans, was to destroy any suspension of disbelief Tesla and Westinghouse hoped to generate, and so to decrease the overall diversity of inventions existing in society. If Edison had prevailed, dc electricity alone would have survived, and ac—at least as a consumer technology—would never have flourished.

–David Lindsay
in *Madness in the Making. The Triumphant Rise and Untimely Fall of America's Show Inventors*
(Kodansha International, Tokyo, 1997)

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systematic darkening of past recollections, the inability to take pleasure in what one has achieved, and the impoverishment of hope for the future. Unlike patients with ADHD, patients with depression cannot only vividly imagine a future, but anticipate in great detail the various forms their subsequent sufferings are likely to take.

Unraveling the genetic and neurobiological mechanisms leading to prefrontal cortex participation in the complex and heartbreaking pictures of ADHD and major depression remains a key challenge for neuroscience in the next millennium. For the present, Barkley presents a scholarly working model of ADHD. In the process he highlights the need for society to re-evaluate its judgmental stance towards behavioral syndromes such as ADHD in which self-regulation is impaired. He also eloquently expresses the urgency for additional resources to treat this major public health problem and to elucidate its fundamental etiology.

BOOKS: PHYLOGENETICS

Bowfins and the Revenge of Comparative Biology

Philippe Janvier

The North American "bowfin" has many other nicknames—dogfish, mudfish, cotton fish, grindle, cypress trout, and lawyer, for example—but they all refer to a single freshwater species, *Amia calva*. This fish is the only living representative of a once flourishing family, the amiids, known from 150 million years ago. Lance Grande and William Bemis use the family to challenge modern biology—that is, to show that an extensive anatomical and paleontological study (one based on examination, as much as possible, of multiple specimens and developmental series) provides highly reliable phylogenetic and historical results.

A Comprehensive Phylogenetic Study of Amiid Fishes (Amiidae) Based in Comparative Skeletal Anatomy
An Empirical Search for Interconnected Patterns of Natural History
by Lance Grande and William E. Bemis

Society of Vertebrate Paleontology, Chicago, 1998. 700 pp. $75. ISSN 0272-4634. Memoir 4.

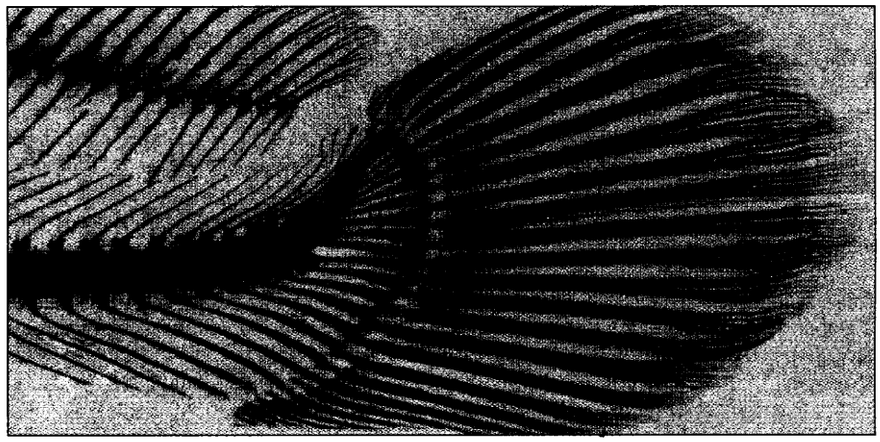
For this monograph, Grande (a paleontologist at Chicago's Field Museum of Natural History) and Bemis (at the University of Massachusetts, Amherst) prepared and dissected new specimens of the living bowfin and traveled around the world visiting all the major collections of Mesozoic and Tertiary fossil amiids. To support their identification of characters for phylogenetic analyses and to provide objective information on specimens that subsequent researchers may be unable to examine, they have thoroughly illustrated well-preserved material in over 1300 photographs (for documentation) and line drawings (for interpretation). Publishing such a detailed and data-rich volume on a relatively minor fish family is a challenge indeed, given the relatively small number of scientists directly interested in the subject. Through this masterpiece, however, the authors demonstrate that even within the scope of a single fish family, hundreds of new insights and new results arise when the work is thoroughly done. One must praise the National Science Foundation and a private foundation for having supported this endeavor, thereby giving a reputedly outdated science the chance to show that it can perfectly compete with "high-tech"' biology. That this admirable attitude of U.S. funding agencies has proved so rewarding should serve as an incentive to other countries.

The authors begin their systematic descriptions of amiids with 117 pages on the living bowfin, focusing their attention on its skeleton. This section includes numerous superb explanatory drawings, stereographs, and color photographs of cleared and stained juvenile specimens. The consideration of the 680 individual bones of *Amia calva* shows that skeletal data alone can provide as many phylogenetically valuable characters as, say, DNA sequences. Through the following 417 pages, Grande and Bemis present descriptions, often detailed, of all fossil amiids, taxa which are known from the Jurassic to Quaternary.

The analytic part of the book is a cladistic survey of the interrelationships of amiids and of their position within a larger group, the halecomorphs (which includes fishes having the symplectic articulating with the lower jaw, a notch in the posterior margin of the maxilla, and a single supramaxilla). Along with this phylogenetic study, Grande and Bemis include detailed descriptions and illustrations of the species used as "outgroups" (the non-amiid taxa that are used to define the primitive states of the characters employed in the analysis). The book ends with a consideration of the distribution of amiids in time and space, seen in the light of plate tectonics. Two pages of "concluding remarks" succinctly outline the goals of comparative biology (the search for replicated patterns in nature) and re-emphasize the fact that actinopterygian (ray-finned) fishes, with their diversity and abundant fossil record, are certainly one of the best animal groups for such studies.

Technically, this book reaches perfection. It also includes detailed taxonomic and subject indices, and two foldouts for the abbreviations in figures and the phylogenetic diagrams, which are extremely helpful.

This book is clearly a "must" for specialists of fossil and Recent ray-finned fishes, but it also includes sections of more general, methodological interest (for example, on historical biogeography and paleoecology), which can easily be read by the lay biologist. To lecturers, thesis supervisors, and postgraduate students, it provides a model of what should be done to carry comparative biology to the level of technical and methodological perfection that will allow the discipline to proudly enter the 21st century and compete on equal terms with molecular phylogenetics.



FROM GRANDE AND BEMIS

Fish tail. Caudal skeleton of a cleared and double-stained (bones, red; cartilage, blue) specimen of an adult bowfin (724 mm total length).

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