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BOOK REVIEWS

Neuroimaging From Two Different Angles

Localization and Neuroimaging in Neuropsychology, by Andrew Kertesz. 1994. New York: Academic Press. 662 pp., $89.95.

Functional Neuroimaging: Technical Foundations, by R. Thatcher, M. Hallett, T. Zeffiro, E.R. John, and M. Huerta. 1994. New York: Academic Press. 303 pp., $150.00.

Reviewed by Erin D. Bigler, PhD, *Department of Psychology, Brigham Young University, Provo, UT 84602*.

Prior to the advent of modern neuroimaging (ca., 1975), visualization of the *in-vivo* workings of the human brain was essentially unknown. Thus, neuropsychology developed in a relative vacuum with regard to neuroimaging procedures that could demonstrate the presence or absence of brain pathology. In some respects, this was probably good for the field because it forced clinicians and researchers to develop theories of brain function by inference based on behavior and known neuroanatomic–behavioral relationships. For example, the classic disconnection syndrome as described by Geschwind and Kaplan (1962) inferred the lesion to be at the level of the corpus callosum, long before there were methods to pursue the *in-vivo* study of the integrity of the corpus callosum. Now it is hard to imagine a comprehensive investigation of neuropsychological function without some type of brain imaging study. This is exemplified by the two books herein reviewed.

Kertesz's edited text is an outgrowth of his 1983 landmark text, *Localization in Neuropsychology*. The first edited text by Kertesz came at a critical time in neuropsychological research because much of neuropsychological theory at that stage was based on single case study findings with a paucity of imaging data. The current text is a complete update and extension of the 1983 text, but with a focus on brain imaging techniques. The expected topic of imaging methods, with particular reviews of CT and MRI, are presented with updates on such imaging procedures as positron emission tomography (PET), single photon emission computed tomography (SPECT), and other cerebral blood flow (CBF) studies, as well as a variety of electrophysiologic techniques.

Kertesz authors the first chapter, "Localization and Function: Old Issues Revisited and New Developments." In updating different issues of imaging, theory, and localization of function with different imaging modalities, this chapter sets the stage for all subsequent chapters. The next eight chapters focus on methodology, all written by well-known researchers and clinicians. Since much is known about routine CT and MR methods, these authors assume that the reader has some knowledge of CT and MR techniques and therefore they focus more on PET, functional MRI (fMRI), and certain contemporary electrophysiological techniques. The fMRI chapter by Binder and Rao is particularly well done. This is a most important chapter because in the area of localization of function, fMRI offers great promise by melding MRI structural imaging quality with an index of function.

The next nine chapters focus on clinical syndromes and symptoms. Some syndromes, such as aphasia, have a long tradition in lesion localization research and are fully addressed in chapters by Metter and Hanson ("Use of Positron Emission Tomography to Study Aphasia"), Kertesz and Naeser ("Anatomical Asymmetries in Cerebral Lateralization"), Naeser ("Neuroimaging of Recovery of Auditory Comprehension in Spontaneous Speech in Aphasia With Some Implications for Treatment in Severe Aphasia"), and Rapcsak and Rubins ("Localization of Lesions in Transcortical Aphasia"). Also discussed are allied aphasic syndromes of alexia (Black & Behrmann), agraphia (Roeltgen), apraxia (Gonzalez, Rothi, Read, & Heilman), agnosia (Jankowiak & Albert), and neglect (Heilman, Watson, & Valenstein).

While Kertesz's book presents a balance of clinical syndromes with various neuroimaging techniques, *Functional Neuroimaging* is dedicated to neuroimaging techniques. It too is excellent, but suffers from the problem of any text devoted to the subject of neuroimaging techniques: Technological ad-

vancements render some of the technical points obsolete more quickly than a text focused on clinical interpretation.

This edited text is organized into four major sections: "I–Relating Structure to Function: Local *Versus* Systems Perspectives;" "II–Intrasubject Activation Techniques;" "III–Intersubject Comparison Techniques;" and "IV–Multimodal Registration Techniques." The objectives stated by its editors are to publish "in one place some of the most recent advancements in the field," and to "integrate and find common ground within and between subdisciplines (xvii)". The need for this integration is due to the explosion in neuroimaging research in the last two-and-a-half decades and contemporary multi-specialty requirements of the interdisciplinary nature of work in this area. The text focuses on MRI, PET, EEG, with particular emphasis on the integration of these technologies. For example, obviously MRI is the superior method for anatomic identification, but anatomy tells little about function. PET studies reveal metabolic activation patterns (or lack thereof), but have poor anatomic resolution. By integrating the anatomic precision of MRI with functional changes on PET, fMRI or EEG yield new insights into the brain–function relationship. Such advancements have been particularly impressive when recently achieved 3-D technologies are applied to this process.

With 29 chapters from 75 contributors and an average chapter length of approximately 10 pages in an 8 × 11-inch format, several chapters are quite brief and very technical. For example, Herscovitch's chapter "Radiotracer Techniques for Functional Neuroimaging with Positron Emission Tomography" is, as its title implies, a technical summary of common methods used in functional neuroimaging.

This text provides much of the detailed technical information necessary to carry out functional neuroimaging and interpret the findings, but only a modest amount of clinical information is presented. Special emphasis has been placed on attempts to achieve some standardization of methods and image analysis, particularly how to handle variability. The issue of variability in imaging research is very important because any structure comprised of billions of cells is bound to have some "normal" variability. Only when individual differences emerge in unique ways is support garnered for certain brain–behavior relationships. This is particularly true when attempting to identify clinically significant findings. For example, in "normal" aging, there is a loss of brain mass. From this arises the problem of distinguishing degenerative changes that are associated with "normal" aging *versus* disease-based (i.e., Alzheimer's). Several chapters focus on how to differentiate either clinically relevant neuroimaging data or how to best differentiate stimulus relevant activation *versus* background.

In summary, both texts provide excellent, contemporary reviews of brain imaging methods as they relate to neurobehavioral function. Kertesz's book is really a clinician's handbook to this topic, whereas Thatcher et al.'s text is more of a research handbook to the topical area of neuroimaging and behavior. Both should be in the possession of the clinician and/or researcher interested in *in vivo* methods of brain imaging and behavior.

An Introduction to Behavioral Neurology

The Neurological Side of Neuropsychology, by Richard E. Cytowic, 1996. Cambridge, MA: The MIT Press. 529 pp., $55.00.

Reviewed by D. Frank Benson, MD, *Augustus S. Rose Professor Emeritus of Neurology, University of California at Los Angeles.*

When I first looked at *The Neurological Side of Neuropsychology* by Richard Cytowic I felt that it was mistitled as it stressed neurology, not neuropsychology. A neurologist friend, however, disagreed in that he found the volume contained too much psychology for most neurologists. Actually the author has attempted to fulfill his stated goal, a presentation of contemporary behavioral neurology for use by neuropsychologists; in general, he has succeeded. He is a true clinician and the book reflects his rich clinical experience. While the volume presents a requisite portion of up-to-date neuroscience, most of this material is linked to reality, the behavioral problems seen in clinical practice.

The book contains three sections, each with multiple subsections. The three major sections are titled: "Conceptualization," "Clinical Assessment," and "Specific Neuropsychological Topics." In the first section the author presents selected background material plus his own views on concepts of mind followed by descriptions of neural tissues and their operations. In the second section the author outlines his own approach to the neurobehavioral examination, his opinions concerning formal neuropsychological assessment (the author prefers the Halstead-Reitan battery but actually proposes a fairly broad selection of neuropsychological tests) and concludes this section with a discussion of the symptoms produced by focal brain lesions, classic localization.

The third and longest section of the book discusses specific neuropsychological topics. The author's list includes (1) disconnection syndromes; (2) emotion, consciousness, and subjectivity; (3) memory and amnesia; (4) dementia; (5) the epilepsies; (6) spatial knowledge, and (7) language.

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Within these topics he describes many separate syndromes, discussing some in detail but many more in outline only.

The author's major contributions to investigation of neural function have focused on the processing of visual stimuli, with particular emphasis on the rare but fascinating topic of synesthesia. His interests and expertise are notable in the chapter on spatial knowledge in which he leads the reader through some of the intricacies of current neurophysiologic explanations of the cortical processing of visual stimuli followed by descriptions of a variety of cortex-based visual dysfunctions.

In a volume in which the author has attempted to introduce the neuroscientific bases for a myriad of clinical problems, a remarkably small amount of technical trivia is presented. The author has concentrated on important, relevant data, supplemented by his own, frequently sage, opinions. In most instances this approach has been successful. If there is a fault to this volume it is that too much has been attempted. Many of the discussions of clinical entities lack sufficient detail to be satisfactory for either the clinician or the student; selected references are available but are not sufficiently numerous to provide material for the serious student. *The Neurological Side of Neuropsychology* is accurately described on the jacket blurb as a primer for neurology residents, graduate students and established professionals who wish to learn about behavioral neurology.

Important New Atlas for Neuroimaging in Humans

Human Brain Anatomy in Computerized Images, by Hanna Damasio, MD. 1995. New York: Oxford University Press. 303 pp., $85.00.

Reviewed by Margaret A. Naeser, PhD, *Department of Neurology, Boston University School of Medicine; Director, Neuroimaging Aphasia Research Section, Boston University Aphasia Research Center, Boston DVA Medical Center.*

This elegant atlas should be on the shelf of any clinician or researcher working with brain imaging in humans. It is extremely well-organized and easy to use. Dr. Damasio takes into account both anomalies in human brain anatomy, as well as variation in MR and CT scan angulation, and has been able to incorporate this information into a most usable text, with 252 figures in seven chapters.

Dr. Damasio is Professor of Neurology and Director of the Human Neuroanatomy and Neuroimaging Laboratory at the University of Iowa College of Medicine. Her laboratory has developed a computer technique, Brainvox, that permits reconstruction of a brain MR scan in three dimensions in such detail that all major sulci and gyri can be identified with about the same degree of precision as would be achieved at the autopsy table. Once identified, the sulci can be traced with different colors, and the outline of these tracings can be transferred automatically to the original 2-D MR images. Because the 3-D reconstruction obtained with Brainvox is a voxel rendering (the image of a 3-D volume), that volume can be cut in any spatial plane—for example, axial, coronal, parasagittal, or oblique. The color-coded sulci tracings from the 3-D image are then carried onto the MR slice to be studied, and the sulci are permanently identified: "In fact, we can go further than we would at autopsy because we are not limited to one plane of cut, but rather are free to recut as necessary," Dr. Damasio notes.

All normal MR brain images in this atlas are from healthy volunteer adult subjects between the ages of 20 and 50 years. All the subjects are right-handed, to help control for any possible macroscopic anatomic differences that may exist between right- and left-handers. With regard to sex differences, however, Dr. Damasio explains: "There is . . . no comparable evidence for systematic differences between the brains of men and women, and gender was thus not a consideration in the preparation of this atlas."

This atlas identifies major sulci and gyri on MR scans for 26 different human brains without pathology (Brains A–Z). The various anomalies that exist in sulcal and gyral patterning across the 26 brains is especially easy to see and appreciate, from the manner in which all the MR slices are presented for each brain. For example, on one page, two MR slices are presented for a given brain where the *sulci* are labelled with arrows, and on the facing page, the same two MR slices are presented again, where the *gyri* are labelled with arrows. It becomes clear that without the correct labelling of the specific sulci (obtained from the Brainvox program), the location of the specific gyri would be quite difficult, if not impossible.

The two brains that receive the most attention are Brain A (dolichocephalic) and Brain B (brachycephalic). The shape of Brain A is the most commonly depicted "standard" brain image. Surface MR images of Brains A and B are shown in lateral, mesial, inferior, superior, anterior, and posterior views for each hemisphere. The images that mark the sulci are in black-and-white; the images that mark the gyri are in color. For Brain A, the planum temporale is also shown from a superior view, where the frontal and parietal opercula have been removed. The cytoarchitectonic fields of Brodmann are marked in color images of the surface of Brain A.

Brain A is later shown in seven different series of MR cuts, each with a different angulation of the scan. For example, the first series of MR images for Brain A, shows 12

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MR slices performed at the most common angulation for MR scan of 0° to the orbitomeatal line (Figures 53–64). In each figure, two MR slices are presented, where the sulci are marked on the first pair of MR slices, and on the facing page, the same two MR slices are again presented, where the gyri are marked. Figures 53–64 will likely be the most commonly used figures of the book for viewing standard transaxial MR images.

The other most important set of images for Brain A, is the set that was performed at the more common CT angle of 15° from the orbitomeatal line (Figures 82–94). Again, in each figure, two MR slices are presented, where the sulci are marked on the first pair of MR slices, and on the facing page, the same two MR slices are again presented, where the gyri are marked. Figures 82–94 will likely be the most commonly used figures of the book for viewing standard CT scan images.

The importance of knowing the angulation used for a given set of MR or CT scan images on a patient is emphasized in the last chapter of the book, where lesions are shown for five stroke patients. For each patient, a series of MR images are presented, where at least two different scan angulations are used—usually a positive angulation (+10 or +15° to the orbitomeatal line) and a negative angulation (−15°). These sets of images are again thoughtfully presented, so that the reader can view two sets of MR slices, together, on two pages facing each other. For example, for Patient 1, the left frontal lobe infarct is shown in six slices performed at +10° on one page, and the same left frontal lobe infarct is shown in six slices performed at −15°, on the facing page. The reader can readily see why it is important to have the exact sulcal landmarks, especially in the negative angle scan, to determine the exact location of the area of infarction.

This atlas will help all researchers and clinicians to better understand brain anatomy in neuroimaging. Ideally, everyone would have access to Brainvox, or a similar program. However, without access to Brainvox, this atlas is so meticulously put together, that a great deal of brain localization work will be possible with reference to this invaluable atlas.

Basal Ganglia Basics

Models of Information Processing in the Basal Ganglia, J.C. Houk, J.L. Davis, and D.G. Beiser (Eds.) 1995. Cambridge, MA: The MIT Press. 374 pp., $60.00.

Reviewed by Bruce Crosson, PhD, *Department of Clinical and Health Psychology, College of Health Professions, University of Florida, Gainesville, FL 32610-0165.*

Models of Information Processing in the Basal Ganglia is an edited book which, as the title implies, addresses the information processing capacities of the basal ganglia. The project endeavors to elucidate the neurobiology of the basal ganglia by covering both (1) recent research developments, with some emphasis on anatomic circuitry and cellular morphology and physiology, and (2) theoretical models of basal ganglia function, focusing on "network approaches to engineering control." The book's 17 chapters are divided into 4 parts. Part I covers basic issues in these areas and was intended to serve as an introduction to the book. Part II goes into greater depth, exploring architecture, physiology, and models related to motor control and working memory. Part III addresses evidence and models regarding the participation of the basal ganglia in behavioral reinforcement processes. Part IV considers a few cognitive and memory applications and theories. The editors have made comments at the end of every section, attempting to tie together the various chapters. They have assembled a stellar group of contributors that include, but are not limited to Patricia Goldman-Rakic (Yale University School of Medicine), Philip Groves (University of California, San Diego, School of Medicine), Ann Graybiel (Massachusetts Institute of Technology), Charles Wilson (University of Tennessee), and Peter Strick (State University of New York Health Science Center at Syracuse). This review is addressed to the reader who has a substantial interest in human or cognitive neuropsychology.

Even in an area as circumscribed as information processing in the basal ganglia, the current expanse of research demands some choices regarding breadth of coverage *versus* focus. The current volume has definitely made a choice to focus on specific issues, emphasizing current knowledge regarding the neurobiology of the basal ganglia and models of engineering control. The chapters focusing on neurobiology are superb reviews of recent research and afford the reader an opportunity to explore or to catch up on recent developments in the area. In particular, these chapters tend to focus on morphology and physiology within the striatum. Topics include, but are not limited to firing states of striatal output (spiny) neurons and influences on these firing states, compartmentalization within the striatum (including striosomes and matrisomes), the nature and structure of dopaminergic synapses within the striatum, the organization of motor projections (motor cortex, supplementary motor area, lateral premotor cortex) within the basal ganglia, and responses of midbrain dopamine projection neurons to reward.

In general, the theory-driven chapters are excellent examples of integration of neurobiological mechanisms to explain certain behavioral events, though the range of behaviors with which theoretical discussion deals is at times limited.

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The editors and authors have endeavored to provide multiple theoretical perspectives which, given the current state of knowledge and consensus, is a reasonable (if not mandatory) approach to the subject matter. Thus, the book is not unified around a single theoretical approach or resolution of varying points of view. Nonetheless, unifying themes between some chapters have been orchestrated, with one chapter building upon the information provided in preceding chapters. Theoretical discussions include the relationship between dopaminergic responses to reward and synaptic changes encoding learning, the influences of "direct" (cortex to striatum to pallidum to thalamus to cortex) and "indirect" (cortex to striatum to lateral pallidum to subthalamic nucleus to medial pallidum to thalamus to cortex) loops on behavior, the nature of endogenous *versus* exogenous inputs to basal ganglia loops, the function of the basal ganglia in implementing behavior, and the function of basal ganglia in working memory. To this reviewer, the chapters that focused almost exclusively on engineering control models were unnecessary, and attempts to integrate discussion of neurobiological systems with these models were distracting. Neurobiological systems models could have been explained more cogently without reference to the engineering control models.

In addition to the excellent reviews of neurobiology and theoretical discussions, the book is notable for what it is not. The discussion of human cognition is limited to three chapters. Although these chapters on working memory and attention are good, they are necessarily limited in scope. Further, discussion of cognition is not always integrated with the neurobiological theories presented in other chapters. Opportunities are missed to apply theoretical discussions to human disease states. Readers must use their imagination to apply hypotheses to human disease states and cognition. Finally, the theoretical focus on engineering control models is also confining. Indeed, the overreliance on such models causes some authors to ignore previous theoretical work, particularly models developed in the study of human disease states. In some instances, various authors could have used the previous models as a contrast to their own innovations; in other instances, hypotheses are similar to those developed earlier in other arenas.

In spite of some significant limitations, *Models of Information Processing in the Basal Ganglia* is an excellent text for those who wish to learn about recent research and models regarding the basal ganglia. The basic neurobiology and theories covered in the book are essential for the serious student of brain systems to understand. However, while the book provides excellent coverage of fundamental knowledge and theory, those interested in applications to human cognition should be prepared to generate their own ideas.

OTHER BOOKS OF INTEREST

Brown, J.W. (1996). *Time, will, and mental process*. New York: Plenum Press. 257 pp., $42.50.

Finger, S. (1994). *Origins of neurosciences*. New York: Oxford University Press. 462 pp., $79.00.

McGaugh, J.L., Weinberger, M.M., & Lynch, G. (Eds.). (1995). *Brain and memory: Modulation and mediation of neuroplasticity*. New York: Oxford University Press. 350 pp., $75.00.

Riddoch, M.J. & Humphreys, G.W. (Eds.). (1994). *Cognitive neuropsychology and cognitive rehabilitation*. Hove, U.K.: Lawrence Erlbaum Associates. 106 pp., $19.95.
