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BOOK REVIEW

Functional Neuroimaging: A Clinical Approach

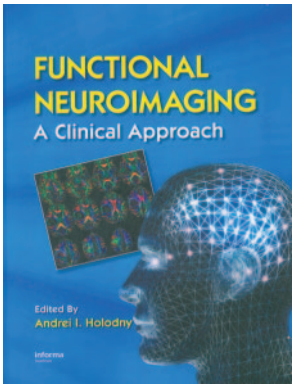
A.I. Holodny, ed. Informa Healthcare; 2008, 352 pages, 320 illustrations, $299.95.

As the specialty of radiology moves from strictly anatomic-based imaging and toward physiologic, biochemical, and quantitative determinations, the studies that can be used to derive this information should be recognized by all radiologists. Nowhere has the incorporation of such information been more striking than in functional imaging of the central nervous system. With that in mind, Andrei Holodny, from Memorial Sloan-Kettering Cancer Center in New York City has edited a multi-authored text on the clinical approach to functional neuroimaging.

There are 29 authors and 18 chapters in this 352-page book, and, although a major emphasis is placed on cortical activation (what many primarily think of when functional imaging is mentioned), the latter half of the book is concerned with diffusion imaging and its derivatives, perfusion images and the metrics derived from such studies, and magnetoencephalography. The book is written for the clinical neuroradiologist, and, aside from some scary-looking formulas and mathematics in the perfusion chapter, the book holds true to that promise.

The book, in easy-to-understand language and with appropriate imaging and graphs, begins by outlining the physical principles of blood oxygen level–dependent functional MR imaging (BOLD fMRI); the statistical considerations in the hemodynamic response time series; the differences in spin-echo echo-planar imaging versus gradient-echo echo-planar imaging to determine BOLD fMRI and the advantages of each; and a short segment on perfusion imaging, both with contrast injection and arterial spin-labeling. As an aside, this useful basic chapter is diminished a bit by the insertion of a small section called "an explanation at a cocktail party." This section was neither helpful nor warranted.

The following chapters deal with optimization of activation paradigms, specifically language localization, motor location, and designing the tasks. Although short in length, this information is important background for those wanting to know how to set up simple functional tasks. Obviously, a huge number of tasks can be tested, and they cannot all be covered in a basic chapter such as this. The importance of selecting a motor task closely related in location to an intracerebral mass is an important concept that is stressed in this chapter. It is clear that not every functional MR imaging task should involve the most common paradigm—finger tapping. The author makes a nice distinction (with graphics) between block design and event-related design and explains how the baseline of a task can be modified.



The chapter on methods of analysis contains information that the entire team performing fMRI needs to take into consideration. Here, the technical details that help improve or, conversely, can cause degradation or loss of information are described. It is fortunate that you do not have to totally (or even partially) understand the mathematics shown here to appreciate the material because the images and legends explain the issues adequately. This chapter, plus the one that follows on artifacts, gives the reader a sense of the technical and patient difficulties involved in fMRI.

For those who will be taking fMRI beyond simple motor and sensory task activation, 2 complete and well-written chapters are concerned first with language and then with vision and higher cortical function. In the language chapter, Jay Pillai describes useable language paradigms. Many interesting items are described and illustrated, such as activation differences seen in bilingual individuals when one uses the native versus nonnative tongue, rhyming pair tasks, comparisons with Wada testing, and future directions for language testing. The cortical plasticity chapter (by Andrei Holodny) discusses relocation of various cortical functions when various diseases destroy eloquent areas of the brain. This topic is, of course, of vital interest to objectively judge the effectiveness of numerous retraining programs. Aside from mislabeling of right versus left in a few figures, this chapter is provocative, opens up new ways of looking at brain function, and emphasizes the brain's ability to relocate areas of function (even in the older patient). One is struck by the nonrobust nature of some of the areas that are illustrated as activated. Plasticity is a subject that requires more investigation to allow one to draw imaging and neuropsychologic correlations.

The most direct clinical applications of fMRI relate to its use in neurosurgery, which is covered in large part in the chapter on functional image–guided neurosurgery. Here, one can read about electrocorticography, the Wada test, and then how the surgeon might use not only cortical activation studies but also diffusion tensor imaging. The authors readily admit that there have been no great changes in neurosurgical practice because of these MR-derived functional images, but they point out that this has been helpful in institutions where it is used, with subtle suggestions that we are just on the threshold of more advances in this field.

Two subsequent chapters apply functional neurosurgery to neurodegenerative disorders and development disorders. These chapters take the readers beyond the usual way neuroradiologists look at a host of disorders such as attention deficit/hyperactivity disorder, autism, Alzheimer disease or mild cognitive impairment, movement disorders, and Huntington disease.

The latter half of the book starts with an explanation of diffusion imaging and tensor physics. This chapter and subsequent chapters strive to keep the clinical neuroradiologist in mind by trying to keep the physics and formulas to a minimum. Follow-up chapters discuss diffusion-weighted imaging in stroke (a particularly important and well-written chapter because of the routinely used diffusion-weighted imaging in acute stroke and its follow-up), in brain tumors, in developmental/pediatric disorders (here emphasizing predominately

diffusion tensor imaging) and in neurodegenerative disorders. Of importance are 2 consecutive chapters on perfusion imaging. One deals with the basic principles; the other demonstrates its application in brain evaluation of abnormalities. In these 59 pages is a description of the anatomic underpinning of brain perfusion and its derivatives, sequences used, quantitative metrics, arterial spin-labeling determination of cerebral blood volume, cerebral blood flow, time to peak, and mean transit time. With those concepts as a background, clinical examples with tumors, infectious processes, and noninfectious inflammatory disease are shown. Because the demand for perfusion-related metrics is increasing at many medical centers, the techniques to derive these maps deserve particular study.

Cortical activation, as described earlier in this text, only indirectly reflects neuronal activity, so this book ends with a chapter on magnetoencephalography. This technique directly measures such activity and, because of its high temporal resolution, could play a useful role in the clinical neurosciences. However, the prospects for widespread deployment of magnetoencephalography are limited for several reasons, including the widespread availability of MR systems and their ability to derive important functional imaging.

In summary, this book is a winner and puts the current state of clinical functional neuroimaging under 1 cover. Perhaps by the next edition of this book, there will have been enough convincing spinal cord work to include it in a functional overview. *Functional Neuroimaging* is highly recommended to all practicing neuroradiologists and trainees in neuroradiology fellowship programs.

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