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Functional MRI: Basic Principles and Clinical Applications

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Functional MRI: Basic Principles and Clinical Applications

S.H. Faro and F.B. Mohamed, eds. New York: Springer; 2006, 480 pages, 177 illustrations, \$179.00.

This 480-page book features the contributions of 32 authors from 23 institutions, most in the United States and Canada, with Europe and Japan represented as well. The book is organized into 3 parts, with 19 chapters and an appendix. Part 1 is composed of 5 chapters covering basic principles and methods for blood oxygen level-dependent (BOLD) functional MR imaging (fMRI); part 2 is a brief neuroanatomic atlas of fMRI maps; and the 13 chapters of part 3 cover a broad array of topics relating to applications of fMRI. Color illustrations of fMRI mappings abound (134 full-color illustrations in all), and each chapter is extensively referenced.

The title is somewhat misleading, because the scope of the book extends well beyond what most readers would consider to be "clinical applications," at least currently. In fact, with the explosion of peer-reviewed journal reports describing both clinical and research applications for fMRI over the last decade, the editors faced a daunting task in attempting to provide a rather comprehensive overview of fMRI applications. Many of the individual chapter headings are authored by recognized leaders within their fields, lending the authority of their expertise to the text. However, the effect is somewhat of a challenge to the reader due to widely varying writing styles, levels of presumed background knowledge, and frequently overlapping coverage of multiple chapters. The expert level of the authors sometimes makes the information difficult to grasp when the scholarly discourse presumes that the reader has ample previous knowledge of the subject. Many chapters are probably not suitable for a novice fMRI practitioner hoping to gain workable insights into clinical fMRI procedures. Some of the individual chapters offer excellent insights into their heading topics, but the book as a whole, like many multi-authored texts, suffers from a rather disjointed and, at times, overly redundant presentation of the material.

Chapter 1 is not an entry-level discussion, but it does present a scholarly, mathematical development of the biophysical basis of the BOLD signal intensity for those readers

who are comfortable with MR physics. Chapter 2 offers highly technical and detailed explanations of spin-echo, gradient-echo, and echo-planar pulse sequences in the context of BOLD imaging, but again, readers alienated by such terms as "spin isochromats" or " $\pi/2$ -radian RF pulse" will find this chapter difficult. Chapters 3–5 feature well-written, thorough explanations of fMRI experimental design and data analysis, as

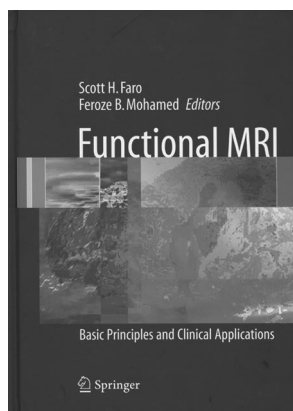
well as a broad array of technical, biophysical, and clinical pitfalls and limitations inherent in fMRI work. These chapters will be more accessible to those less technically/mathematically inclined, and together they represent a major strength of the book. Chapter 5 in particular, "Clinical Challenges of fMRI," may be the best chapter in the book for neuroradiologists and others seeking to incorporate fMRI into their clinical practice. The inherent weaknesses and limitations of fMRI in clinical settings are convincingly presented, including thoughtful arguments on how task design and analysis can greatly affect fMRI results. The need for greater standardization and validation of reliability in clinical fMRI is a welcome emphasis of this chapter's conclusions.

The Part 2 neuroanatomic atlas is a laudable attempt to provide visual examples of many commonly studied clinical fMRI mappings. Unfortunately, the maps represent only 1 of many approaches for visual presentation of fMRI data (the wide variance of which is evident throughout the text) and are hampered by inadequate supplementary information on how each map was acquired; further explanation of the fMRI paradigm applied for each mapping would have been useful to a reader attempting to replicate some of the examples. The maps are variably labeled, some by anatomic reference and others by brain function, with no explanation offered for choice of either anatomic or functional labeling.

Part 3 is a collection of 13 chapters that each cover a particular application of fMRI. Chapter 7 casts a wide net, covering applications in both neurosurgery and cognitive neuroscience. An fMRI task battery studied in surgical patients is presented in detail, accompanied by several case examples. Most of the best-known cognitive fMRI paradigms (N-back, Stroop, Go-No-Go, Oddball, etc) are also described in detail. Chapter 8 presents an overview of psychiatric fMRI. Because of the diversity of methods and applications in this area, the information provided here has a rather piecemeal feel to it; however, a welcome feature is a series of tables summarizing the results of major studies relating to fMRI in schizophrenia, autism, mood disorders, obsessive-compulsive disorder, and substance abuse. Importantly, the authors note that most ongoing neuropsychiatric fMRI research involves groups of subjects, with limited application to individual patients.

Chapter 9 provides specific information on episodic, semantic, and working memory mapping in aging and dementia populations. Chapter 10 covers fMRI applied to mapping language systems. Particularly informative is a list of common task paradigms and their expected mappings when contrasted with different control conditions. Chapter 11 presents a comprehensive, erudite review of the literature comparing fMRI to the intracarotid amobarbital (IAT) or Wada test. Numerous papers are cited relating IAT and fMRI results for language and memory. The authors conclude that fMRI has proved capability for lateralizing language, whereas memory mapping remains an area for further investigation. Chapter 12 describes fMRI applications specific to epilepsy; though there is some redundancy with the previous 2 chapters where language mapping and Wada testing are concerned, there is also informative discussion of ictal, interictal, and electroencephalographic-correlated fMRI.

Chapters 13 and 14 are devoted to the visual and auditory systems, respectively. Rather than exhaustively reviewing the extensive neuroscientific research literature in these areas,



both chapters do an excellent job of maintaining a clinical focus, and both include helpful examples of fMRI paradigms, as well as sections devoted to technical challenges. These are substantially more detailed for the auditory than the visual system, and the auditory chapter includes a review of relevant anatomy that the visual chapter lacks.

Chapter 15 addresses the peculiarities of pediatric fMRI and features a highly practical discussion of such issues as subject movement and sedation, as well as the developmental, neurologic, hemodynamic, and behavioral differences from adults that are most relevant to fMRI. A brief chapter 16 devoted to fMRI of clinical pain might have been excluded, given the paucity of literature in this area and the limited clinical relevance currently; its inclusion speaks to the editors' laudable effort to provide as complete an overview as possible. Pharmacologic applications are addressed in chapter 17, which includes only a brief discussion of the mechanisms by which drugs may alter the BOLD signal intensity, including at the level of neurovascular coupling and/or strictly neural or strictly vascular levels. The chapter also includes excessive off-topic coverage of several other imaging modalities; in its place I would like to have seen a discussion of specific agents and their effect on the BOLD signal intensity (especially the ubiquitous caffeine, which receives no mention despite its well-known neural and vascular effects).

The bulk of chapter 18, covering cognitive neuroscience applications, belongs more properly in part 1, because it addresses such fundamental issues as the hemodynamic response, paradigm design, temporal/spatial resolution, statistics, and so forth. This material, though important and well written, is largely redundant with other portions of part 1. The final chapter, written by the editors and titled "Clinical Overview and Future fMRI Applications," is a superfluous and scattershot overview of the previous 12 chapters (part 3), peppered with samples of the authors' own work that seem random and out of place. The appendix offers an introduction to the relatively obscure application of independent component analysis to the processing of fMRI data; this is a puzzling choice for an appendix topic, more suited to an overview of fMRI statistical procedures than a book on basic principles and clinical applications.

It is difficult to identify an audience to whom the book can be recommended wholeheartedly. Young fMRI researchers would certainly benefit from a careful reading of the introductory material, after which they would probably use whatever chapter(s) pertain to their area of study as an entrée to the relevant journal articles; experienced researchers may be better served going straight to the original articles. The more clinically oriented reader to whom the book is ostensibly targeted can find much useful information within its pages but may grow frustrated sifting through the more research-oriented topics, sorting out redundantly covered material, and finding much of the discussion poorly matched to his or her level of previous knowledge. On the other hand, today's research is tomorrow's clinical practice, and anyone seeking a fairly comprehensive overview of fMRI principles and applications in a wide variety of settings may find this amply illustrated and referenced book just the ticket.

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BOOK REVIEW

Brain Tumor Pathology: Current Diagnostic Hotspots and Pitfalls

D. Schiffer, ed. New York: Springer; 2006, 272 pages, 151 illustrations, \$129.00.

This monograph by an accomplished neuropathologist is centered largely on contemporary difficulties encountered in the histopathologic diagnosis of brain tumors. Particularly useful are his approaches to oligodendrogliomas and their anaplastic variants; distinctions among mixed astro-oligodendrogliomas, pleomorphic xanthoastrocytoma (PXA), and juvenile pilocytic astrocytoma; ependymoma and its anaplastic variant; differentiation of ganglioglioma from oligodendroglioma, dysembryoplastic neuroepithelial tumor, cortical dysplasias, PXA, and juvenile pilocytic astrocytoma; and pitfalls in overinterpreting anaplastic features in the latter tumor.

The author also covers newly identified neoplasms: liponeurocytoma, rosette-forming glioneuronal tumor, and chordoid glioma, as well as neoplasms of uncertain nosology, derivation, and growth (astroblastoma, capillary hemangioblastoma, gliomatosis cerebri, and chordoid glioma of the third ventricle).

Other than meningiomas, nonneuroectodermal tumors (ie, schwannomas and chordomas, among others) are not discussed. Chapters on tumor cell migration and invasion, apoptosis, the ubiquitin proteasome system, and angiogenesis round out this volume.

Advantage is taken of the evolving field of molecular genetics, intracellular signaling mechanisms, and conventional immunohistochemical methods to arrive at a histopathologic diagnosis. The details provided using these methods are a major emphasis of this book and are of exceptional value.

All of the microphotographs are in black and white; most of these are satisfactory. For the uninitiated, however, some of the photographs might be challenging, because there are no arrows depicting items mentioned in the legends. The latter occasionally suffers from terseness, as at times it is unclear what is being illustrated. The addition of normal controls, especially with immunohistochemical photographs, would have been helpful. The photomicrographs are occasionally complemented by MR images and CT scans.

This readable monograph is highly recommended to surgical pathologists. It is likely to be of lesser value and interest to the neuroradiologist. For neuroradiologists interested in histopathology, especially with imaging correlations, other texts might be more suitable. On the other hand, discussions on glioneurogenesis, molecular genetics, growth factors, stem cells, and intracellular signaling mechanisms involved in the

