Software Review

Brain Atlas for Functional Imaging: Clinical and Research Applications

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New York, Thieme, 2001.

Over the last decade, functional magnetic resonance imaging has progressed from a novel research tool for noninvasively studying brain function to an established technique for evaluating a variety of clinical disorders through use of motor, sensory, and cognitive activation paradigms. Although positron emission tomography, and, more recently, magnetoencephalography, have also provided opportunities to noninvasively evaluate brain function, the excellent spatial and temporal resolution of fMRI and the virtually unlimited range of available potential activation paradigms confer distinct advantages over these alternative approaches to functional neuroimaging. However, accuracy of anatomic localization of activated regions is just as critical in fMRI as the effectiveness of the statistical analysis and the appropriateness of the particular activation tasks employed. The CD reviewed, *Brain Atlas for Functional Imaging: Clinical and Research Applications*, provides one method for the anatomic localization of fMR activation.

This CD offers a *'Preview'* option, which takes the user through a step-by-step introduction to the various features of the program. Following selection of the directory containing the anatomic data images, assignment of slice orientation of these images, and entry of distance between consecutive slices, one is permitted to select any TIFF file from the directory to begin loading and verification of the anatomic dataset. Once the images from the directory are loaded, one is able to scroll through the images in the set to choose a particular image for application of the *'Set Talairach Landmarks'* feature. Using this feature, localization of the anterior and posterior commissures is performed. The landmark cursors which constitute the borders of the Talairach grid are then dragged to the anterior, posterior, right lateral, left lateral, superior and inferior borders of the 3D volume encompassed by the complete set of brain slices. Once the Talairach grid is fit to the anatomic images, the next feature, entitled, '*Warp Data to Atlas,*' is applied. The normalized (warped) anatomic dataset is then displayed with a superimposed multi-color atlas. The program contains an *'Anatomical Blending w.r.t. Atlas'* feature which enables the user to vary the relative degrees of emphasis of the atlas and anatomic data by making one or the other more transparent in the overlay. A similar process of loading of the functional dataset can then be performed with similar overlay of the multicolor atlas onto the functional data; control of the degree of functional vs. anatomic blending is also easily performed using a '*Functional Blending w.r.t. Anatomical*' feature.

The '*Identify/Edit Activation Loci*' feature may then be used to select specific activated regions and to assign thresholds, determine coordinates, and display in triplanar format specific loci of interest. These coordinates for specific loci of interest are then displayed in a '*Loci List*' alongside the brain images in a separate column. This can be performed on multiple images, since scrolling from one image to the next in the series is possible. The '*Get Labels/Values*' feature can then be used to generate an anatomical index of Brodmann areas. By using the '*Edit Locus*' feature, each mark placed on a particular locus of interest may then be moved onto a color-coded atlas region in its vicinity for labeling purposes. The labels and Brodmann values are displayed by clicking an entry in the '*Loci List*'. The final '*Loci List*' containing the final Talairach coordinates, labels, and pixel values can then be saved to an external file using the '*Save List*' feature. The program also permits swapping of the triplanar views such that the labeled structures can be displayed in any of the three orthogonal planes (the axial, coronal, or sagittal image may be made the reference image). A total of up to 30 labeled structures may be simultaneously depicted, with full control of atlas-anatomy-function blending possible during the process of labeling.

This program can be applied to other types of functional images besides simply those obtained through fMRI (such as MR perfusion images) by simply warping the anatomical dataset, blending the atlas with the anatomy, loading the functional dataset, and blending the atlas, anatomy, and function. Similar use of the triplanar format is possible for labeling of individual gyral anatomy using the atlas overlay. These applications of the software are possible even when substantial anatomic distortion exists due to structural lesions such as brain tumors.

Some limitations of this software include the need to download individual anatomic or functional TIFF files containing one image each for application of the atlas. Each file must be an 8-bit file; this is a minor limitation in terms of display of functional data, since color-coded statistical maps are often useful for depicting intensity or significance level of activation, and these images often are not in this format. In addition, if one typically displays multiple brain sections within a single image file, this atlas cannot be readily applied to the multisection data. In addition, inherent limitations of any such anatomic localization software include the inability to discern subtle differences in normal anatomy related to both normal gyral anatomic variability and distortion related to intracranial mass effect or cerebral volume loss. However, advantages of this atlas include its flexibility and easy application even in cases of significant brain structural distortion due to intracranial mass lesions or postsurgical changes. The atlas also provides reliable information regarding actual activated Brodmann areas, in addition to simply labeling of individual

anatomic gyri. The triplanar display format is especially useful. Furthermore, a very detailed and user-friendly *'User Guide'* is available, and a *'Help'* feature is also present, which provides step-by-step instruction on a variety of help topics.

Thus, overall, this CD software is user-friendly, applicable to a wide range of functional imaging techniques, and versatile. The minor limitations described above are, for the most part, common to many anatomic atlas software packages. While certainly not necessary for neuroradiologists involved in functional imaging, this software is recommended for others engaged in research in the exciting multidisciplinary field of functional neuroimaging.

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