7 Imaging Human Brain Function

7.1 Scientific Imaging with Voxel-Based Morphometry

The imaging we are considering here, scientific imaging with voxel-based morphometry, is not radiology; it is scientific measurement involving taking a series of images which constitute massive data sets. Corrections are made for various artifacts that might occur at the time the images are being recorded (Fig. 1). To obtain information about subject groups, images are taken from a population with brains of different sizes and shapes and all of the image data are put into a common stereotactic space which can be referenced with coordinates. The results need to be statistically robust. Thresholds for inference must be set appropriately, because there are many millions of data points in the images collected in a typical experiment; a recent advance in statistical theory
from the early 1990s permits us to do that. In addition, investigators often attempt to relate the data to hypotheses or models to derive meaningful results, which are usually presented as images of a standard brain on which statistically significant changes or correlations are identified.

Thus, with functional neuroimaging we examine brain states and modify them experimentally under different conditions or contexts and then try to draw functional inferences about how the brain is organized and how it responds to manipulation or injury. The functional image data sets are matrices of voxel-elements (voxels). One can carry out exactly the same types of analysis on structural images. This is a method known as voxel-based morphometry (VBM). Essentially one collects appropriate images, puts them into standard space and then segments out those parts of the image that are of interest, e.g., gray matter, white matter, CSF, etc. (Fig. 2). The composite (or average) structural image can be that of an individual or, more interestingly for us, that of a group. So, for example, one can create a structural image of 60-year-old males, or of people who were diagnosed with Alzheimer’s disease 5 years ago. One could check how that image changes every year by constructing a parametric image of the structural changes over 5 years. One has