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Editorial Open Access

fMRI: Clinical and Research Applications

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Editorial

In the last century many researchers have tried to discover the secrets involved in the function of the brain. While the old view about the brain operations was based on the principle of mass action [1], using the new techniques for example using the functional neuroimaging experiments, it has been shown that the structure and the function of the brain are correlated together. Modern neuroimaging techniques demonstrate that there is substantial localization of many functions in the neural tissue of the brain. Recent technological advances have expanded the role of magnetic resonance imaging to include mapping the brain's dynamic function, so that it can be used for basic researches and clinical applications.

Functional Magnetic Resonance Imaging (fMRI) has become the most popular method for assessing major facts of functional brain topography for both research and clinical purposes. fMRI is a powerful non-invasive tool in the study of the function of the brain, used, for example, by psychologists, psychiatrists, neurologists and neuroscientists [2]. fMRI is a technique that uses magnetic resonance imaging to measure brain activity by measuring changes in the local oxygenation of blood, which in turn reflects the amount of local brain activities. While this technique has the advantages of high spatial resolution and non-invasive nature, it has a low temporal resolution respect to other brain imaging techniques. This is because it is not a direct measure; it only measures the secondary physiological correlates of neural activity.

fMRI uses the contrast mechanisms which are correlated to physiological changes in local regions of the brain. The first mechanism used for fMRI is Blood Oxygenation Level-Dependent (BOLD) contrast [3] and the second contrast mechanism is the perfusion contrast obtained using Arterial Spin Labeling (ASL). The ASL uses magnetically labeled arterial blood water as a flow tracer [4]. As compared to the BOLD contrast, that is most useful for detecting dynamic changes in brain activity over short time periods (seconds to minutes), ASL is most useful for characterizing resting states, particularly in pathological conditions that affect Cerebral Blood Flow (CBF), such as cerebrovascular disease, or for measuring slow variations in CBF or neural activity that occur over long periods. fMRI can give high quality visualization of the location of activity in the brain resulting from motor or sensory stimulation or cognitive functions [5]. It therefore allows the study of how the healthy brain functions is affected by different diseases, how it attempts to recover after damage and how drugs can modulate activity or post-damage recovery and how cognitive states are encoded by the brain activities.

The most common use of fMRI is for the study of the functions of the brain regions in the response to various stimulus or effects of diseases on the brain function. Activation is defined as a region showing statistically significant changes in BOLD signal that are strongly correlated with the time course of changes in performance through the probe task. For information extraction from the fMRI data and to define the active areas, it is needed to do pre-processing and post analysis. Statistical analysis is attempted to determine which voxels are activated by the stimulation. Most fMRI studies are established upon the correlation of hemodynamic response function with stimulation. Activation defines the local intensity changes in the images. The statistical methods for this aim can be grouped into two broad categories: the univariate methods (hypothesis testing methods), and the multivariate methods (exploratory methods) [6].

The neuroscientists are interested to decode a person's conscious experience based only on non- invasive measurements of his/her brain activities. Because of the high resolution and non-invasive nature of fMRI, it is used for studying the human cognitive states to collect data about brain activities in human subjects performing tasks such as reading, comparing images, answering questions, driving simulated vehicles, or solving algebra problems, and so.

While the functional neuroimaging techniques in general and fMRI in particular have been used to understand the brain functions and organizations, a major objective in biomedical science is to apply new advantages in the clinical applications. There is a wider potential for fMRI at clinical medicine such as, studying the Alzheimer disease (AD), drug addiction, Dyslexia, epilepsy, mood and anxiety disorders, neurological recovery after stroke, pain, Schizophrenia, and so [7]. In comparison with the application of fMRI in basic researches, clinical fMRI presents unique challenges.

In summary, fMRI is a powerful technique for non-invasive study of human brain functions. fMRI have been used at research fields for many years, but the translation of fMRI from basic cognitive neuroscience to clinical investigation has begun. At present, there are some particular limitations at the use of fMRI as a clinical tool that are tried to be solved.

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