JMSCR Vol||05||Issue||10||Page 28948-28951||October 2017

www.jmscr.igmpublication.org
Impact Factor 5.84
Index Copernicus Value: 71.58
ISSN (e)-2347-176x ISSN (p) 2455-0450
crossref DOI: https://dx.doi.org/10.18535/jmscr/v5i10.80

IGM Publication Journal Of Medical Science And Clinical Research
An Official Publication Of IGM Publication

Functional MRI in Neuroimaging and Psycho Analysis- Recent Challenges and Applications

Authors
Ritu Kela (PhD)[1], Nida Khan (M.Tech)[2], Anand Priyadarshi (B.Sc)[3]
[1]Department of Bio-Chemistry, College of Applied Education and Health Sciences, Meerut, India
Email: *dean@caehs.edu.in*
[2]Department of Bio-Technology, College of Applied Education and Health Sciences, Meerut, India
Email: *nidak.881@gmail.com*
[3]Department of Radiology, College of Applied Education and Health Sciences, Meerut, India
Email: *anand89uk@gmail.com*

Abstract
Functional Magnetic Resonance Imaging (fMRI) is a neuroimaging technology used for measuring and mapping the brain for research and clinical corrections. It is completely non-invasive and free from ionising radiation & generally safe for research as well as in clinical settings. Since its development in 1990s, fMRI has been a popular modality among the researchers associated with the field of neurosciences However with some recent clinical trials actively conducted to understand the benefits of the fMRI, however it has been found inefficient in analyzing huge amount of data structures with their complex correlation patterns.. Evidently fMRI software, which provides valuable data at some point fails in medical decipheration of Neuro analysis and psycho analysis . The aim of this paper is to discuss and review the current status of fMRI in neuroimaging field.
Keywords- *fMRI, Neuroimaging, Non-invasive, Hemodynamic.*

Introduction

Functional magnetic resonance imaging (fMRI) is an effective technique for measuring and mapping the brain activity. It detects the changes in blood oxygenation and flow which changes correspondence to the changes in neural activity. The development of fMRI in the 1990s is generally credited to Seiji Ogawa. The primary form of fMRI uses the blood-oxygen-level-dependent (BOLD) contrast. This is a type of specialised brain and body scan used to map neural activity in the brain or spinal cord by imaging the changes in blood flow (hemodynamic response) related to energy used by brain cells[1]. This technique takes advantage of the inherent paramagnetic qualities of deoxyhemoglobin for use as an endogenous contrast agent. The blood flow and deoxyhemoglobin concentration in cerebral capillaries and veins affect the signal intensity with magnetic resonance imaging. These signal intensity changes can then be used to indirectly measure changes in regional cerebral blood flow (rCBF) secondary to neuronal activity. The term BOLD was coined to distinguish this from the contrast bolus tracking technique. BOLD imaging is completely non-invasive. The theoretical basis for BOLD imaging is thought to be due to net changes in deoxyhemoglobin concentration that accompany changes in rCBF [2]. Beside BOLD fMRI, other methods also have been developed for neuroimaginary which are discussed here.

Perfussion fMRI

It measures regional cerebral blood flow by intravenous Bolus-Tracking fMRI. The use of injectable magnetic compound (gadolinium-DTPA) as well suited to measure slow changes in neural activity and to examine individual differences in brain-behavior relationships[3].

Diffusion fMRI

It measures random movement of water molecules. It provides valuable information on the microscopic obstacles which hinder diffusing molecules, such as membranes or macromolecules and in turn on the tissue cellular structure [4].

MRI Spectroscopy (MRS)

MRS can measures certain cerebral metabolites noninvasively and study brain tissue biochemistry. MRS allows study of non-water hydrogen-containing molecules or molecules containing other magnetic elements. It relies on flipping non-water hydrogen atoms or other magnetic atoms. Magnetic compounds identified by spectrographic peaks [2].

Since it's development, fMRI has been a popular modality in the research of neuroimaging because it is safe for the subject, free from ionising radiation and does not requires any surgery. Over the last two decades fMRI provided new insight to the investigation of how memories are formed, language, pain, learning and other areas of brain research[5]. Latest technical updates and applications have now made functional MRI mapping feasible with MRI in clinical setting with excellent spatial resolution and turning fMRI more advanced than ever. Currently fMRI is one of the fastest developing method which has now found amazingly widespread usage in many branches in neuroscience[6]. Although the invention of fMRI is revolutionary in neuroscience research however, analyzing huge data structures with complex correlation patterns is reported as a serious challenge and should be dealt with highly reliable data and more advanced scientific applications.

fMRI Research

One of the earlier fMRI studies, Ogawa and colleagues scanned rodents in a strong magnetic field of 7T MRI with the manipulation of blood oxygen level to change the proportion of oxygen the animals breathed. As this proportion fall, a map of blood flow in the brain was seen in the MRI after scanning the rodents while monitoring brain activity with EEG[7]. The researchers basically adopted one or more approaches in applying fMRI data to understanding psychological and neural mechanisms:

1. Studies of localisation- It is motivated by an interest in localising psychological functions to brain regions to identify brain behaviour correlations- that is, to discover how psychological processes are localised in brain tissue.

2. Studies of commonalities and distinctiveness in brain activation- A corollary to studies of localisation is this, If two tasks lead to activation of common brain areas, then there two tasks or behaviours are likely to share some process or processes. While studies of distinctive activation when added to studies of common activations enable a program of research that will gradually build an architecture of psychological processing out of an architecture of brain activity [8].

The fMRI method can also be combined with other brain-imaging techniques such as transcranial stimulation, direct cortical stimulation and especially electroencephalography (EEG), magnetoencephalography (MEG) and, near infrared spectroscopy (NIRS) to have supplementary information about both oxyhemoglobin and deoxyhemoglobin[1]. The current ongoing fMRI researches are include-

Neuropolitics (to interplay between the brain and politics based on the methods of cognitive neuroscience)[9], Cognitive psychology, Neurological disorders, fMRI based lie detection technology and other areas fall broadly under the neurosciences.

Clinical Applications

The fMRI research has been passed more than two decades but its use in clinical field is still limited

1. **Cortical Function**

fMRI can be used noninvasively to localise cortical function with respect to a surgical target and a risk related to the planned surgical procedure can be formulated.

2. **Brain mapping**

To determine precisely which part of the brain is handling critical functions such as thought, speech, movement and sensation; assessment of trauma, epilepsy imaging.

3. **Diagnostic Application**

It can be used to diagnose metabolic, degenerative diseases and lesions such as Alzheimer's disease precisely.

4. **Functional MRI**

It can also be helpful to guide the accurate planning of radiation therapy.

5. **Three-dimensional tractrography**

It allows more accurate surgical planning (fMRI-image-guided brain surgery).

Challenges

Despite remarkable progress there are inherent challenges in fMRI research. Currently researchers don't know the exact relationship between neuronal activity and the BOLD signal, making it hard to draw causal conclusions. Additionally, humans are highly variable in their task performance and their neural activity, as these can be influenced by mood, level of alertness, motivation, health and other factors [10]. Patients with brain pathologies are more difficult to scan with fMRI than young healthy volunteers, the typical research-subject population. Tumors and lesions can change the blood flow in ways not related to neural activity. Drugs such as antihistamines and even caffeine can alter fMRI results. Some patients may be suffering from disorders such as compulsive lying, which makes certain studies impossible [11]. There have been a growing number of cautionary voices from neuroscientists that address the limitations of fMRI. The limitations of the methods and the reliability and validity of the conclusions that have been made on the basis of fMRI data. A research claimed that the localisation of cognitive functioning is not consistent with the notion that brain activity for even simple cognitive activities is distributed in neural network[12]. In a study where six different people were given the same spatial memory task to perform, the fMRI scans for each of the six yielded extremely varied pattern of activation. Therefore fMRI results can't be generated to entire populations, as each individual's result is different [12]. In a recent study researchers doubt the validity of fMRI research by questioning the methods-softwares used to analyse fMRI data from the brain scanning machines. Researchers analyzed the software most commonly used to process the result from fMRI and found that it produced a false-positive rate of up to 70% [13]. Now, the results of about 40000 published papers has been in question if this study have to believed. The problem is not the fMRI machine but it is the software used to take the scans and convert them into something useable. Despite the popularity of fMRI, the statistical methods used have rarely been validated using real data. When validation attempted on the neuroimaging data the flaws have been found in fMRI software’s and related and methods [13,14].

Conclusion

Functional MRI has its own specific advantages and disadvantages in neuroimaging with comparison to other neuroimaging modalities, such as positron emission tomography. It's software-method based problems can be reduced with latest software updates. Which have not been validated properly since its introduction in neuroscience research. The desired results with fMRI in near future will definitely be achieved when certain upgradations will be taken place. Highly reliable data and more cautious approach during data analyzing can surely reduce false-positive results and can give more accurate clinical-research evaluations. However for the diagnostic and clinical applications, fMRI is a boom in the field of neuroscience and psychiatry.

Acknowledgements

This research paper was strongly supported by Dr. S P Deshwal (Ph.D Zoology). We thank our colleagues from College Of Applied Education And Health Sciences who provided insight and expertise that greatly assisted in compiling this review. We thank Dr. S K Garg for assistance and sharing his pearls of wisdom with us during the course of this review paper.

References

1. Huettel, S.A.; Song, A. We.; McCarthy, G. (2009), Functional MRI (2 ed.), Massachusetts: Sinauer, ISBN 978-0-87893-286-3
2. Satish K. Bhargava, Textbook of Radiograpy for residents and technicians, 5th edition. PP 449-453.
3. The development and future of perfusion fMRI for dynamic imaging of human brain activity. Vol.62, issue 2, 15 august 2012 PP 1279-1285.
4. Le Bihan D. Nat. Rev. Neurosci. 2003; 4: 469-480.
5. Nutffield department of clinical neurosciences, John Radcliffe Hospital - University of Oxford.
6. Santosh Gupta, Measuring brain activity- PD Hindimaths hospital and medical research centre, Mumbai, India. Indian Journal of Radiology Imaging. Vol-24, 2014, PP:5
7. Logothetis N.K., What we can do and what we cannot do with fMRI. Nature 453 (7197), June 2008), : 869-78
8. Marc G. Berman, John Jonides, Derek Evan Nee. Studying mind and brain with fMRI. Social cognitive and affective neuroscience. Vol-1, issue-2, 01sept 2006, PP 158-161.
9. Zimmer, Carl. Soul made flesh PP 246, 2005.
10. Fostering reproducible fMRI research., Nature communications, www.nature.com
11. Rombouts, S.A.R.B., Barkhoff,; & Sheltens, P; Clinical applications of functional brain MRI, UK, Oxford university press, ISBN 978-0-19-856629-8
12. Dobbs, D., Fact or phrenology?, Scientific American mind, 2005, 16:24-31
13. Anders Eklund, Hans Knutson, Thomas Nichols : 1000 functional connectors., Linkoping University Sweden and University of Warwick, UK.
14. Charlie Sorrel. 20 years worth of fMRI studies may be bunk, thanks to a software error. 07.08.16 www.fastcompany.com