ISSN: 2454-1907
DOI: https://doi.org/10.29121/ijetmr.v4.i11.2017.120

IJETMR
International Journal of Engineering Technologies and Management Research
A Knowledge Repository

FUNCTIONAL BRAIN CORRELATES OF RISK FOR MAJOR DEPRESSION IN CHILDREN AND YOUNG ADULTS

Mr.N.Senthilkumar [*1], Dr. R.Thangarajan [2]

[*1] M.E Scholar, Department of Computer Science, Kongu Engineering College, Perundurai, Dt-Erode, TamilNadu, India

[2] Assistant Professor, Department of Computer Science, Kongu Engineering College, Perundurai, Dt- Erode, TamilNadu, India

Abstract:

***The brain is arguably the most important organ in the human body. It controls and coordinates actions and reactions, allows us to think and feel, and enables us to have memories and feelings. Three brain structures namely the hippocampus, amygdala and prefrontal cortex help the brain determine what is stressful and how to respond. Depression in teenagers is a very serious medical problem that leads to long-lasting feelings of sadness along with a loss of interest in once enjoyed activities. Neuroimaging is the use of various techniques to either directly or indirectly image the structure and function of the nervous system. Magnetic resonance imaging (MRI) are two in types, viz., structural and functional imaging. Functional neuroimaging has greatly helped in understanding the cognitive functions of the brain and its impact on mental health and human behaviour. This paper describes the different types of neuroimaging techniques and its needed software configurations with statistical parametric mapping. This paper also elaborates the basic operations and MATLAB activities and it compare the at-risk and control group depression imaging fMRI analysis techniques with its snapshots*.**

Keywords: *Neuroimaging, Brain, Amygdala.*

Cite This Article: Mr.N.Senthilkumar, and Dr. R.Thangarajan. (2017). "FUNCTIONAL BRAIN CORRELATES OF RISK FOR MAJOR DEPRESSION IN CHILDREN AND YOUNG ADULTS." *International Journal of Engineering Technologies and Management Research*, 4(11), 25-35. DOI: https://doi.org/10.29121/ijetmr.v4.i11.2017.120.

1. Introduction

Human intelligence can be broadly defined as the capacity to understand complex ideas, adapt effectively to the environment and engage in complex reasoning. The brain is arguably the most important organ in the human body. It controls and coordinates actions and reactions, allows us to think and feel, and enables us to have memories and feelings. The cerebellum is below and behind the cerebrum and is attached to the brain stem. It controls motor function, the body's ability to balance, and its ability to interpret information sent to the brain by the eyes, ears, and other sensory organs. Three brain structures namely the hippocampus, amygdala and prefrontal cortex help the brain determine what is stressful and how to respond.

ISSN: 2454-1907
DOI: 10.5281/zenodo.1065338

The hippocampus stores memories of events and responds to stress hormones in the blood. Many mental disorders, including depression, may cause it to shrink or weaken. The amygdala is part of the limbic system, a group of structures deep in the brain that's associated with emotions such as anger, pleasure, sorrow, fear, and sexual arousal. Depression in teenagers is a very serious medical problem that leads to long-lasting feelings of sadness along with a loss of interest in once enjoyed activities. Teen depression affects the way a teen thinks, feels, behaves, and can lead to significant emotional, functional, and physical problems.

2. Neuro Imaging

Neuroimaging or brain imaging is the use of various techniques to either directly or indirectly image the structure and function of the nervous system. Magnetic resonance imaging (MRI) uses changes in electrically charged molecules in a magnetic field to form images of the brain. Neuroimaging falls into two broad categories:

a) Structural imaging, which deals with the structure of the nervous system and the diagnosis of gross (large scale) intracranial disease (such as tumor) and injury.
b) Functional imaging, which is used to diagnose metabolic diseases and lesions on a finer scale (such as Alzheimer's disease) and also for neurological and cognitive psychology research and building brain-computer interfaces.

Hence, this study concentrates the Functional imaging, which enables, the processing of information by centers in the brain to be visualized directly. Such processing causes the involved area of the brain to increase metabolism and "light up" on the scan. Neuroimaging has greatly helped in understanding the cognitive functions of the brain and its impact on mental health and human behaviour.

2.1. Neuro Imaging Techniques

Neuroimaging or brain imaging is the use of various techniques to either directly or indirectly image the structure, function of the nervous system. Neuro imaging techniques consists of following techniques:

- Functional magnetic resonance imaging
- Computed axial tomography
- Diffuse optical imaging
- Event-related optical signal
- Magnetic resonance imaging
- Magnetoencephalography
- Positron emission tomography
- Single-photon emission computed tomography
- Cranial ultrasound

Neuroimaging, which is a term used by scientists who are interested in seeing aspects of the way the brain works and the way the brain is structured, is extremely important for humans' understanding of the nervous system and it seems almost obvious that if we wanted to

 ISSN: 2454-1907
DOI: 10.5281/zenodo.1065338

understand something we would want to see it. Among the above said different techniques, this study concentrates on the Functional magnetic resonance imaging (fMRI).

3. Statistical Analysis

This study aims at finding out the functional brain and its correlates of the risk for major depressions in children and young adults. The datasets are collected from online medical repositories, and pre-processed before analysis using SPM on MATLAB tool. An overview of literatures is collected from various works related to FMRI analysis. The most noteworthy of them are relevant to the current study are being reviewed. Stella W. Y. Chan et al., (2009) proposed a technique for the Risk for depression and neural responses to fearful facial expressions of emotion. The study explored whether these abnormalities underlie risk for depression. In this approach, the neural responses of volunteers who were at high and low-risk for the development of depression (by virtue of high and low neuroticism scores; high-N group and low-N group respectively) during the presentation of fearful and happy faces using functional magnetic resonance imaging (fMRI) where considered.

Michael S. Gaffrey et al., (2013) in the paper titled, Disrupted Amygdala Reactivity in Depressed 4- to 6-Year-Old Children. In this method, Disrupted amygdala activity in depressed adolescents and adults while viewing facial expressions of emotion has been reported. However, only a few data are available to inform the developmental nature of this phenomenon, an issue that studies of the earliest known forms of depression might elucidate. The current study addressed this question by examining functional brain activity and its relationships to emotion regulation in depressed 4- to 6-year-old children and their healthy peers. Leah M.J. Hall et al., (2014) states an fMRI study of emotional face processing in adolescent major depression. The main objective of this work defines Major depressive disorder (MDD) often begins during adolescence when the brain is still maturing. To better understand the neurobiological underpinnings of MDD early in development, this study examined brain function in response to emotional faces in adolescents with MDD and healthy (HC) adolescents using functional magnetic resonance imaging (fMRI).

Frank P. Mac Master et al., (2008) proposed an approach on Amygdala and Hippocampal Volumes in Familial Early Onset Major Depressive Disorder. Abnormalities in the amygdala and hippocampus have been implicated in the pathogenesis of major depressive disorder (MDD). No prior study has examined amygdala-hippocampus anatomy in pediatric patients with familial MDD (at least one first degree relative with MDD). Paul A. Keed well et al., (2005) enumerated an approach on a Double Dissociation of Ventromedial Prefrontal Cortical Responses to Sad and Happy Stimuli in Depressed and Healthy Individuals. The ventromedial prefrontal cortex (VMPFC) is a region implicated in the assessment of the rewarding potential of stimuli and may be dysfunctional in major depressive disorder (MDD). A few studies examining prefrontal cortical responses to emotive stimuli in MDD have indicated increased VMPFC responses to pleasant images but decreased responses to sad mood provocation when compared with healthy individuals.

John D.E. Gabrieli et al., (2014) states the Prediction as a Humanitarian and Pragmatic Contribution from Human Cognitive Neuroscience. Here the neuroimaging findings in the initial brain measures are believed to predict future education, learning, and performance in children

ISSN: 2454-1907
DOI: 10.5281/zenodo.1065338

and young adults. With further advances in study designs and analyses, neuro markers may offer opportunities to personalize educational and clinical practices that lead to better outcomes for people.

3.1. Software Configuration

Operating system	:	Windows 7
Front end	:	Matlab
Simulation environment	:	SPM12

3.2. Statistical Parametric Mapping

Statistical Parametric Mapping (SPM) refers to the construction and assessment of spatially extended statistical processes used to test hypotheses about functional imaging data. These ideas have been instantiated in software that is called SPM. The SPM software package has been designed for the analysis of brain imaging data sequences. The sequences can be a series of images from different cohorts, or time-series from the same subject. The current release is designed for the analysis of fMRI, PET, SPECT, EEG and MEG. The current released version is SPM12.

3.3. Main Features of SPM

- Free and Open Source Software
- Support for various platform such as Linux, Windows and Mac
- Support for file formats such as volumetric images: NIfTI,
- Geometric images: GIfTI, MEG and EEG
- Design matrix can be easily implemented

3.4. Basic Operations

- **Realign:** Realignment refers to same-modality images from same subject. This spatial processing is categorized into three models such as Estimate, Reslice and Estimate &Reslice.
- **Coregister:** Coregister refers in aligning two images from different modalities (e.g. structural to functional image) from the same individual (within subjects). This spatial processing is categorized into three models such as Estimate, Reslice and Estimate &Reslice.
- **Segment:** Segmentation in SPM is obtained from the intensity distribution of the image and prior information for the respective tissue classes. To visualize and analyze image intensity distribution we can plot all values of the image in a histogram.
- **Normalise:** The main aim of normalise is to provide voxel to voxel correspondence between the brains of subjects. A shared space is required to enable us to compare subjects.
- **Smooth:** The purpose of spatial smoothing is to cope with functional anatomical variability that is not compensated by spatial normalization and to improve the signal to

 ISSN: 2454-1907
DOI: 10.5281/zenodo.1065338

noise ratio. It also reduces the number of resolution elements that are assumed to be independent and used for correction of multiple testing

4. MATLAB

MATLAB (matrix laboratory) is a multi-paradigm numerical computing environment. A proprietary programming language developed by Math Works, MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages, including C, C++, C#, Java, Fortran and Python. It also supports various platforms such as windows, Unix/Linux.

Although MATLAB is intended primarily for numerical computing, allowing access to symbolic computing abilities. An additional package, Simulink, adds graphical multi-domain simulation and model-based design for dynamic and embedded systems. Here SPM12 package is used for performing analysis purpose.

4.1. System Implementation

4.1.1. Amygdala Portions

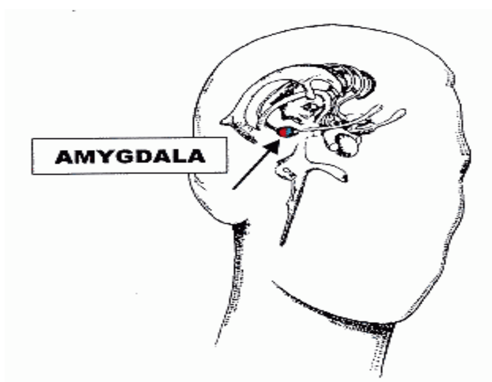


Figure1: explains the Amygdala portions and figure 2 elaborates brain images of two groups

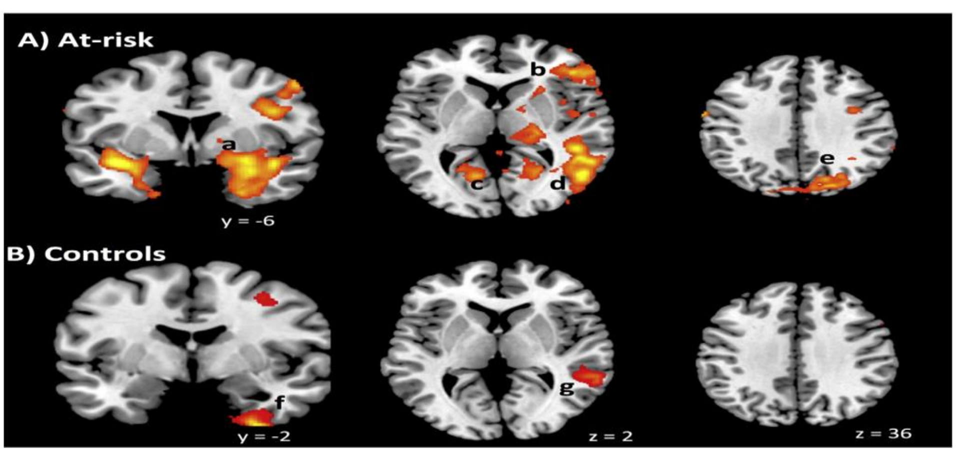


Figure 2: Brain areas with higher activations for fearful faces compared to neutral faces within each group A) At-risk group, B) control group

ISSN: 2454-1907
DOI: 10.5281/zenodo.1065338

a, Amygdala; b, middle frontal gyrus;
c, posterior cingulate cortex; d, superior temporal gyrus; e, precuneus;
f, inferior temporal gyrus; g, superior temporal gyrus.

4.1.2. Comparison Between At-Risk and Control Group

Figure 3 represents comparison between At-Risk and Control Group responses for fearful and happy faces

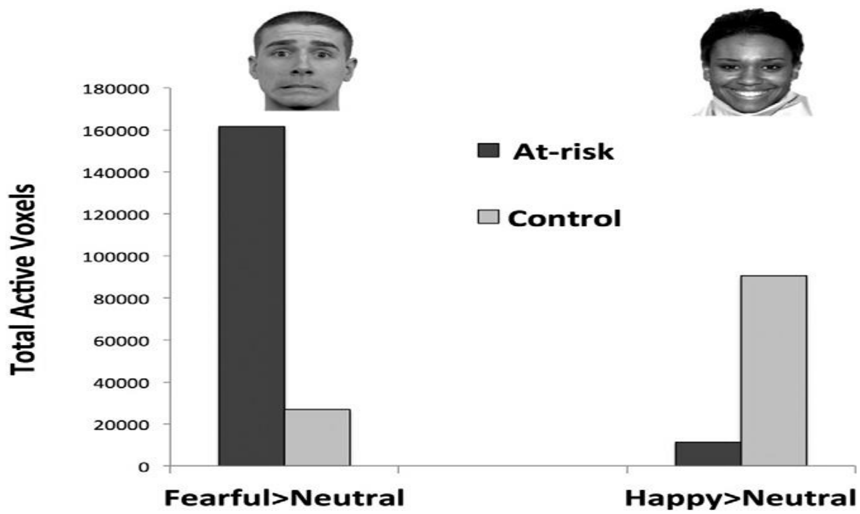


Figure 3: Total numbers of active voxels for the fearful faces > neutral faces and happy faces > neutral faces contrasts in each group

5. Module Description

5.1. Pre-processing

The Pre-processing steps such as realign, coregister, normalise, segment and smoothing are carried out with their appropriate operational functions.

5.2. Realign

This routine realigns a time-series of images acquired from the same subject using a least squares approach and a parameter (rigid body) spatial transformation. The first image in the list specified by the user is used as a reference to which all subsequent scans are realigned. The reference scan does not have to be the first chronologically and it may be wise to choose a "representative scan" in this role. The aim is primarily to remove movement art e fact in fMRI and PET time-series (or more generally longitudinal studies). The headers are modified for each of the input images, such that they reflect the relative orientations of the data. The details of the transformation are displayed in the results window as plots of translation and rotation. A set of realignment parameters are saved for each session, named rp_*.txt. After realignment, the images are resliced such that they match the first image selected voxel-for-voxel. The resliced images are named the same as the originals, except that they are prefixed by 'r'.

 ISSN: 2454-1907
DOI: 10.5281/zenodo.1065338

5.3. Coregister

Coregister refers in aligning two images from different modalities (e.g. structural to functional image) from the same individual (within subjects). The images are also smoothed slightly, as is the histogram. This is all in order to make the cost function as smooth as possible, to give faster convergence and less chance of local minima. At the end of co-registration, the voxel-to-voxel affine transformation matrix is displayed, along with the histograms for the images in the original orientations, and the final orientations. The registered images are displayed at the graphical window. Registration parameters are stored in the headers of the "source" and the "other" images.

5.4. Segment

The Segment is used for performing segmentation, bias corrects, normalizes within the same model. This technique later known as "optimized" voxel-based morphometry (VBM) which performs region-wise volumetric comparisons among populations of subjects. It requires the images to be spatially normalized, segmented into different tissue classes, and smoothed, prior to performing statistical tests. The "optimized" pre-processing strategy involved spatially normalizing subjects' brain images to a standard space, by matching grey matter in these images, to a grey matter reference. The historical motivation behind this approach was to reduce the confounding effects of non-brain (e.g. scalp) structural variability on the registration.

5.5. Normalise

The main aim of normalize is to provide voxel to voxel correspondence between the brains of subjects. A shared space is required to enable us to compare subjects. It allows to matching patterns of functional activation to a standardized anatomical template allows us to average the signal across participants, derive group statistics, and improve the statistical power of the analysis. Advantage of using spatially normalized images is that activations can be reported according to a set of meaningful Euclidian coordinate's within a standard space.

5.6. Smooth

The purpose of spatial smoothing is to cope with functional anatomical variability that is not compensated by spatial normalization and to improve the signal to noise ratio. It also reduces the number of resolution elements that are assumed to be independent and used for correction of multiple testing

 ISSN: 2454-1907
DOI: 10.5281/zenodo.1065338

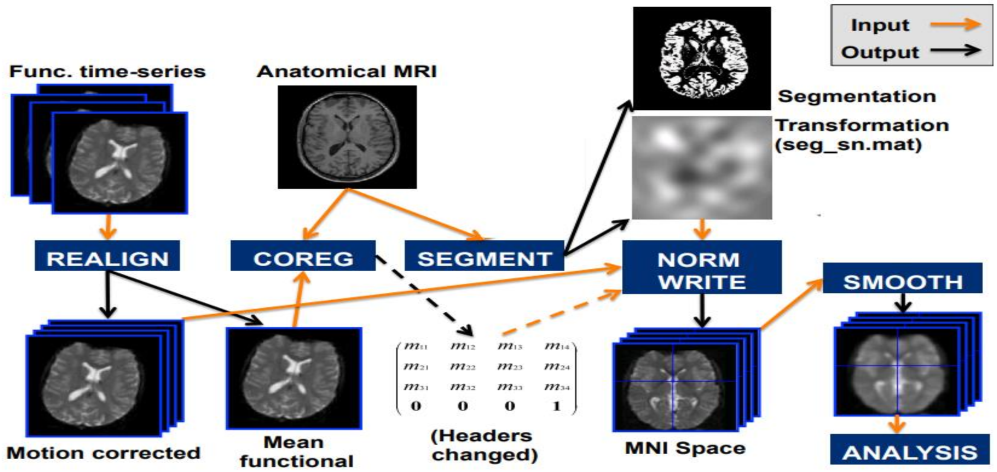


Figure 4: SPM steps

5.7. Fmri Analysis and Its Model Specification

Statistical analysis of fMRI data uses a mass-univariate approach based on General Linear Models(GLMs). It includes specification of the GLM design matrix, fMRI data files and filtering; estimation of GLM parameters using classical or Bayesian approaches and interrogation of results using contrast vectors to produce Statistical Parametric Maps (SPMs).The design matrix defines the experimental design and the nature of hypothesis testing to beimplemented. The design matrix has one row for each scan and one column for each effect

5.8. fMRI model review

When the model specification process completed then the SPM file will be reviewed using Review method. It is useful to check that the experimental variance has not been removed by high-pass filtering. In the first phase of the project, a set of four sample fMRI dataset are taken from online medical repository (especially children and young adults) which consists of several BOLD signals for depression levels where those data are pre-processed using SPM under MATLAB. Both functional and anatomical BOLD signals are inputted as a file format (.bold) into the SPM for first step of pre-processing. The mean value obtained from the results is passed to the next step where the signals are analyzed with the help of histograms against the XYZ coordinates for noise reduction in the signals. The design matrix is used to represent the voxel size coordination with each BOLD signal. Using voxel-voxel space statistical analysis is acquired with the fMRI model review module. The following snapshots used to explain the details of neuroimaging techniques.

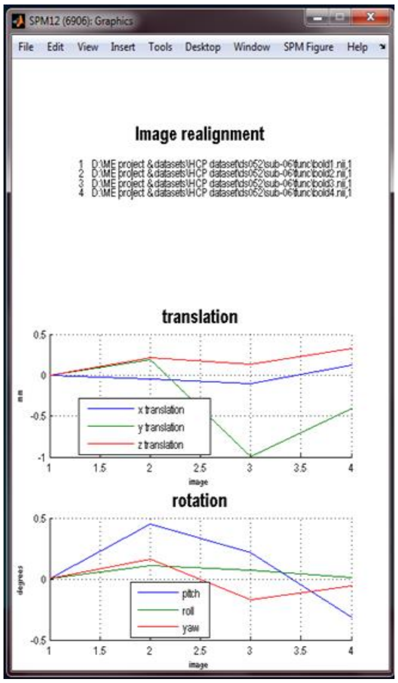
6. Snapshots

The convergence of data from experiments using techniques like these that were developed in other sciences like medical, and the use of the data, methods, and techniques of other sciences generally, will both improve scientists' understanding and also constrain what can be learned from the current level of neuroimaging resolution. While the resolution of fMRI images is not of the quality desired to carry out all the types of experiments needed to explore the brain

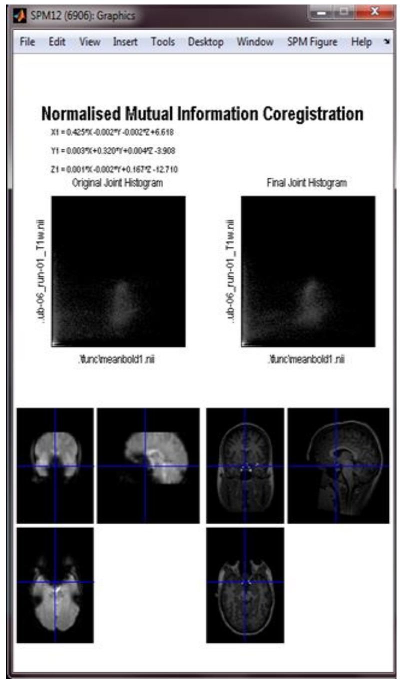
 ISSN: 2454-1907
DOI: 10.5281/zenodo.1065338

phenomena of depression, the quality of images we have is still remarkable. And the promise of these techniques and their successors is enormous for all fields of research involving brain function and the depression of population.

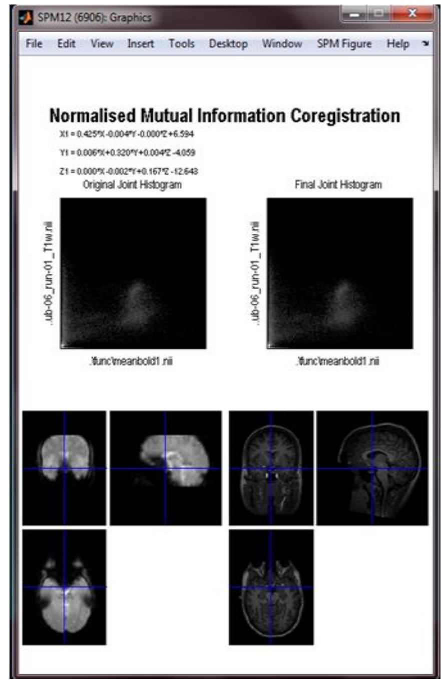
SNAPSHOTS



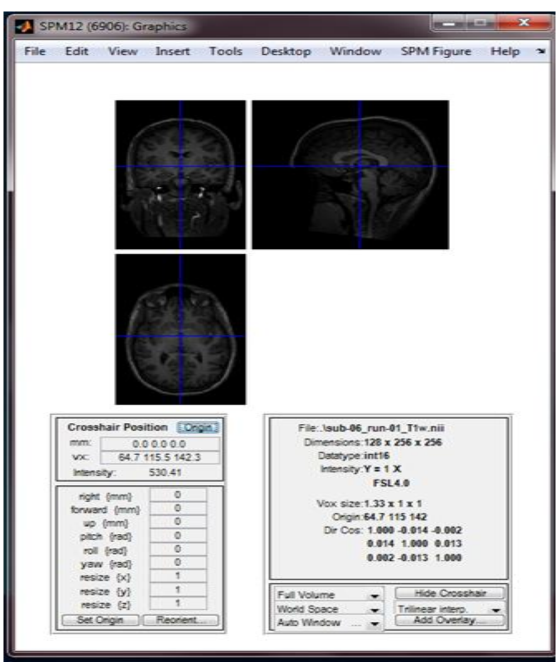
A.1.1 Realign Estimate and Reslice

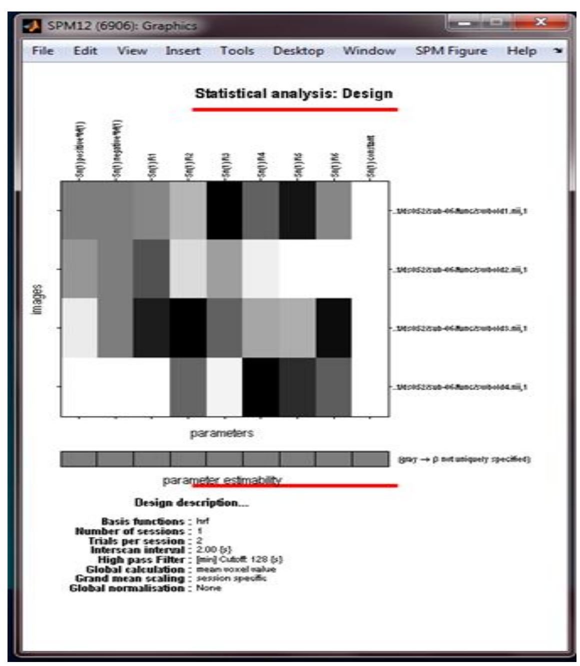


AA.1.2 Coregister_Estimate



A.1.3 Normalise_Estimate and Write

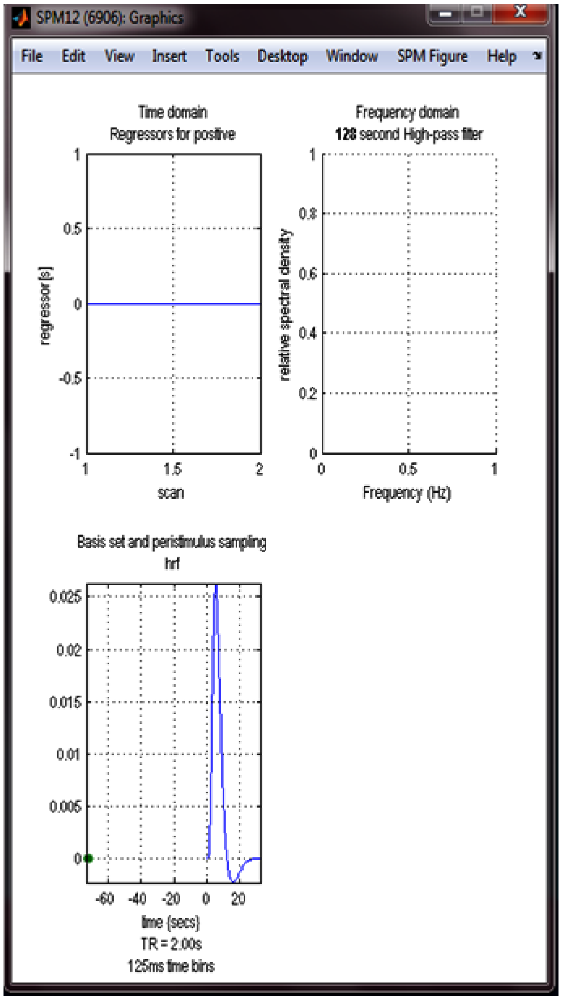


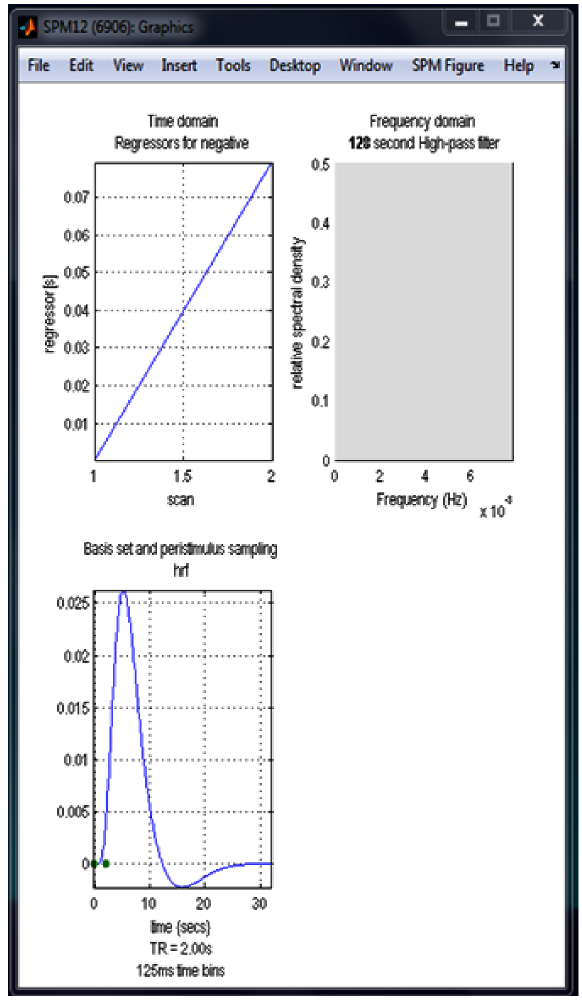


A.1.4 Normalise_Write

A.1.5 Statistical Analysis Design

ISSN: 2454-1907
DOI: 10.5281/zenodo.1065338





A.1.6a Model Review Design **A.1.6b Model Review Design**

7. Conclusion

In order to study the neurological traits of children or young adults based on brain region activations, it is essential to acquire, and pre-process fMRI images. In this report, the various pre-processing stages in fMRI which includes realign, coregister, normalize; segment and smooth are carried out using SPM. The researchers recommended the future suggestions are; further analysis on brain can be done for several tasks such as prediction using tools like General Linear Model (GLM).

References

[1] Chan, S.W.Y., Norbury, R., Goodwin, G.M., Harmer, C.J., (2009). Risk for depression and neural responses to fearful facial expressions of emotion, British Journal of Psychiatry, 194 (2), 139–145.

[2] Frank P. MacMaster, Joseph O'Neill, David R. Rosenberg, (2008). Brain imaging in pediatric obsessive compulsive disorder, National Center for Biotechnology Information, U.S. National Library of Medicine8600 Rockville Pike, BethesdaMD, 20894USA

 ISSN: 2454-1907
DOI: 10.5281/zenodo.1065338

[3] Gaffrey,M.S., Barch, D.M., Singer, J., Shenoy, R., Luby, J.L.,(2013). Disrupted amygdala reactivity in depressed 4- to 6-year-old children, Journal of Am. Academic Child Adolescent Psychiatry, 52 (7), 737–746.
[4] Hall, L.M.J., Klimes-Dougan, B., Hunt, R.H., Thomas, K.M., Houri, A., Noack, E., Mueller, B.A., Lim, K.O., Cullen, K.R. (2014).An FMRI study of emotional face processing in adolescent major depression, Journal of Affect. Disorder, 168, 44–50.
[5] John D.E. Gabrieli, Satrajit S. Ghosh, and Susan Whitfield-Gabrieli (2014).Prediction as a humanitarian and pragmatic contribution from human cognitive neuroscience, Elsevier 85(1), 11-26.
[6] Keedwell, P.A., Andrew, C., Williams, S.C.R., Brammer, M.J., Phillips, M.L (2005). A double dissociation of ventromedial prefrontal cortical responses to sad and happy stimuli in depressed and healthy individuals, Journal of Biological Psychiatry 58 (6), 495–503.
[7] Kennard, Betsy, D (2009). Remission and Recovery Rates in the Treatment for Adolescents with Depression Study: Acute and Long-Term Outcomes. Journal of the American Academy of Child and Adolescent Psychiatry, 48 (2): 186–195.
[8] Leah M.J. Hall, Bonnie Klimes-Dougan, Ruskin H. Hunt, Kathleen M. Thomas (2014).An fMRI Study of Emotional Face Processing in Adolescent Major Depression, Journal of Affective Disorders, 168, 44-50.
[9] Mac Master, F.P., Mirza, Y., Szeszko, P.R., Kmiecik, L.E., Easter, P.C., Taormina, S.P., Lynch, M., Rose, M., Moore, G.J., Rosenberg, D.R (2008). Amygdala and hippocampal volumes in familial early onset major depressive disorder, Journal of Biological Psychiatry, 63(4), 385–390.
[10] Michael S. Gaffrey et al., (2013)Towards the Study of Functional Brain Development in Depression: An Interactive Specialization Approach, Neurobiology of disease, 10.1016/j.nbd.2012.06.012
[11] Paul A. Keedwell, Chris Andrew, Steven C.R. Williams, Mick J. Brammer&Mary L. Phillips (2005).Ventromedial Prefrontal Cortical Responses to Sad and Happy Stimuli in Depressed and Healthy Individuals, 58th Annual Meeting of the Society of Biological Psychiatry, May 15, 2003, San Francisco, California.
[12] Stella W. Y. Chan (2009), The Image of Blood Oxygen dependent percent change, British Journal of Psychiatry, 194: 139-145.
[13] http://bids.neuroimaging.io/
[14] http://www.fil.ion.ucl.ac.uk/spm/
[15] https://www.humanconnectome.org/

*Corresponding author.
E-mail address: drknedn@gmail.com