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BI-MONTHLY Neurofeedback Newsletter

this issue

"APNA New Board Members Elected"

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EDITOR-IN-CHIEF'S NOTE

Assoc. Prof. Dr Aamir Saeed Malik
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The Future Trends of Neurofeedback in Education

This is the 5th issue of NeuroEastern. As it is a bi-monthly newsletter of APNA, the 5th issue is for September and October 2016. To start with, I would like to share the experience of the main event of the 2nd APNA conference which was held at Sunway Hotel, Georgetown in Penang from 21 to 23 July, 2016.

The keynote speakers and authors presented their research work and clinical practice on the first two days of the conference (i.e. 21st and 22nd July). Many experienced practitioners shared their neurofeedback and biofeedback practice, as well as the feedback from their clients of success stories. The third day was reserved for post-conference workshops with hands-on training on neurofeedback, HRV feedback and QEEG analysis with hands on examples. Many participants attended the post-conference workshops and discussed their concerns about NFB, BFB and the QEEG analysis.

The main article in this issue is on 'The Future Trends of Neurofeedback in Education', since, the fundamentals of neurofeedback and its various applications were reported in the previous issues of NeuroEastern. In this article Hafeez Ullah Amin briefly highlights the EEG bands involved in the cognitive processes, including memory, and sheds lights on the possible trends of NFB training in education, especially for learning and memory performance. Few good references are provided of the related work of NFB on cognitive processes, including attention, problem solving, and working memory. However, he mentions that there is a potential for NFB researchers to work in the field of education.

The resource pages discuss the SPM, a free software tool. It is one of the important tools for fMRI analysis and source localization. Mr. Raheel Zafar provides detailed information about the SPM and discusses the various features of the software and how it can be useful in fMRI analysis.

We look forward to your feedback on this issue.

Aamir

Asia Pacific Neuro-biofeedback Association (APNA)

President's Message

Dr. Kenneth Kang

Head of Spectrum Learning

It is my sincere pleasure to welcome you to join APNA.

APNA was established to provide an oversight of the field of neurofeedback and biofeedback so as to promote and expand it, as well as to safeguard consumer interests.

I would like to express my deepest gratitude for the practitioners and researchers who have come together to help make the establishment of APNA possible. With that, I also want to extend my warmest invitation to anyone who is passionate about this field to come join us and grow this field, hand in hand, with the community for the benefit of mankind.

Brief Description

APNA is a non-profit organization for the purpose of joining the expertise of clinicians and researchers who are involved in the health care research and clinical applications of neurofeedback and biofeedback for serving the society. There is a growing number of professional clinicians, biomedical, and computing engineers, who have expertise in medicine, psychology, therapy, engineering, and development of new advanced computing solutions to biomedical problems.

These diverse experts started sharing their expertise, joint research collaboration, organizing joint events, and developing their professional network under the umbrella of APNA. These activities are at initial stages and expected to peak in the future, including all the countries in the Asia Pacific region. It is very encouraging that the growing network of these professionals is promoting the clinical use of neurofeedback and biofeedback interventions to the general public for maximum benefits. Consequently, it will help people consult certified practitioners of neurofeedback rather than non-certified consultants.

VISION

1. To deepen our understanding of Asian mindfulness and meditation techniques and its health benefits with rigorous science
2. To promote its application in society to improve health, performance and quality of life

MISSION

1. To promote research collaboration between researchers, clinicians and the community
2. To promote professional clinical use of neurofeedback and biofeedback in the AP region
3. To promote awareness of the benefits of neurofeedback and biofeedback to the general public

2nd Asia Pacific Neurofeedback/Biofeedback Conference

Penang, Malaysia, July 21-22 2016

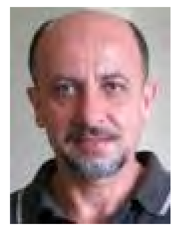
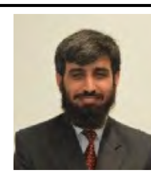
Spectrum Learning organized the 2nd Asia Pacific Neurofeedback/ Biofeedback Conference on 21-22 July 2016 at Sunway Hotel, Georgetown, Penang, Malaysia. There was a pre-conference workshop on 'Neurofeedback with hands on experience' on 20 July, 2016 at the same venue in which many new NFB researchers and practitioners participated and took advantage of the vast NFB experience of Dr. Kenneth Kang.

In this conference, many experienced and new researchers and clinicians participated and presented their work on many applications of NFB and BFB, as well as related research on EEG. The list of speakers is following.

The Keynote Speaker Prof. See Ching Mey talked on the mind and body connection, and highlighted the mind-body axis, including muscle-Brain axis, Hypthalamus-Pituitary-Adrenal axis, Heart Rate Variability-Brain axis, and Gut-Brain axis. Her interesting talk was followed by Dr. Kenneth Kang's discussion on QEEG analysis and Neurofeedback, and he shared his vast experience of using QEEG analysis and NFB sessions of his different clients. Further, he shed light on the importance of the EEG based NFB training and the main aim of this conference to the participants.

The third talk was by Prof. Gabriel, who presented his most updated finding in the field of BFB and NFB. In his talk, he first defined the biofeedback (BFB) and neurofeedback (NFB) and provided brief historical notes on their development and evolution. Then, he discussed how the evidence was gathered based in the standards of efficacy used. There were many other interesting talks on the applications of NFB and BFB, as well as success stories. Overall the keynote speakers covered each and every aspect of NFB and BFB applications, which made the conference successful, especially for the intermediate and novice researchers and clinicians in the field of NFB and BFB trainings.

In addition, there were two post-conference workshops on the 'Application of neurofeedback and biofeedback for depression and anxiety' and QEEG Analysis with hands on examples. The former was conducted by Prof. Gabriel Tan, who is an expert in clinical psychology and working at National University of Singapore. Prof. Gabriel discussed the benefits of the use of NFB and BFB training for depression and anxiety and the related applications.

Keynote Speaker		
		
Dr. Kenneth Kang	Prof. See Ching Mey	Prof. Gabriel Tan
		
Dr. Banerji Subhasis	Prof. Norsiah Fauzan	Dr. A.S. Malik
		
Prof. M O K Wahidi	Dr. Nidal Kamel	Mr. Alex Ng
		
Mr. Hiro Koo	Mr. Hafeez Ullah Amin	Ms Low Ting Min
		
Ms Eleanor Fong	Ms Jerry Lee	Ms. Vernice Si Toh
		
Dr. Eva Wong	Mr. Joachim Lee	Dr. Sophian
		
Mr. Dawen Lim	Ms. Kim Lee	

The 'QEEG analysis' workshop was organized by Dr. Aamir Saeed Malik and his team from Universiti Teknologi PETRONAS, Malaysia. They started with the fundamental of EEG signals, data acquisition, preprocessing, extracting EEG features with MATLAB programming and interpreting the results. Many researchers and practitioners attended the workshop and discussed the issues and challenges of QEEG analysis and interpretation, especially for NFB and BFB.

There were exhibitions during the conferences of different products regarding NFB and EEG, such as MITSAR EEG System, Brain Trainer NFB System, Propectin Food Supplement, and OMNIUM system for body and mind relaxation.

At end of conference, a meeting of APNA members was conducted and duties were assigned to new elected members, i.e., president, vice presidents, secretaries, treasurer, and committee members. The following is the new board list for APNA.

Founding President:	Dr Kenneth Kang
President:	Prof Dato' Dr See Ching Mey
Vice President 1:	Associate Prof Dr Nidal Kamel
Vice President 2:	Dr Norsiah Fauzan
Secretary 1:	Ms Jerry Lee Shin Ying
Secretary 2:	Mr Dawen Lim Thiam Wang
Treasurer:	Ms Low Ting Min

Committee Members:

- Associate Prof Dr Aamir Saeed Malik
- Dr MOK Wahedi
- Dr Panu Khuwuthyakorn
- Dr Gan Bo
- Dr Alex Ng Wei Siong
- Kim Lee

The conference was sponsored by the following companies and organizations.

EASTBAY WELLNESS	GraceTime Asia (SG) Pte Ltd.	H&A Medical Supply Sdn Bhd	Spectrum of Life

THE FUTURE TRENDS OF NEUROFEEDBACK IN EDUCATION

By **Hafeez Ullah Amin**
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In the previous issues of this newsletter, articles covered the fundamentals of neurofeedback (NFB) and its potential applications in brain disorders. In this article, the future trends of NFB in education are highlighted. Here, I am looking at how NFB can help in education, especially in learning and memory retention.

NFB can regulate an individual's brain pattern in a certain frequency e.g., Alpha waves, through a series of training sessions [1]. The common and widely accepted brain imaging technique for NFB is electroencephalography (EEG) because of its flexibility, low cost, ease of use, and robust feature of time resolution. However, magnetic imaging resonance (MRI) is also another option for NFB [2]. The principle behind NFB for regulating a certain brain wave is like the operant conditioning of Berry Sterman [3], where it rewards desirable brain waves and discourages unwanted frequencies. The clinical applications of NFB across the fields of neuropsychology and neuroscience are stroke [4], depression [5], stress [6], epilepsy [7], drug addiction, Attention Deficit Hyperactivity Disorder (ADHD) [8], motor disabilities [9] and learning disabilities in children [10].

All of these applications are handled with the same principle of operant conditioning in NFB, thought they are not all related with education. However, this could be practiced in education research, especially by targeting the brain waves which are responsible for encoding new information, consolidation and transfer of information into long-term memorization, and retrieval of stored information. In education, cognitive processes including learning, memory, attention, information processing, and reasoning, all play important roles. Memory has different types depending on the functions, information processing, and time of retention. In education, different types of memory are required for individuals to show their best academic performance. Here, I have listed the memory types, along with the associated brain regions and EEG frequency bands involved in the process of learning and memory.

The working memory has limited capacity and active during listening lecture or watching academic videos. The attentional resources for handling the sensory information of interest to active neuronal networks of information encoding for long-term memory are allocated. Thus, new memories are formed either semantic or episodic. Other cognitive processes, such as perception, information processing, decision making, and understanding are working in parallel with learning and memory systems and provide support. The key brain regions are the prefrontal cortex (PFC), the medial temporal lobe (MTL), the hippocampus and the surrounding cortices, such as parahippocampal and perirhinal [11-14], see Figure 1. The important EEG frequency bands which are reported in neuroimaging studies are theta, alpha and gamma for working memory, encoding, retrieval, and consolidation [15-23].

NEXT

Table 1: Memory and Brain Waves in Learning and Memory

Memory	Brain Region	EEG Waves	Functional Role in education
Working Memory	Prefrontal Cortex	Theta and Alpha	Problem Solving and reasoning
Long-term encoding	Fronto-temporal	Theta and gamma	Creating new memory and learning
Long-term retrieval	Medial Temporal lobe and Prefrontal Cortex	Theta and Alpha	Performing exam and tests
Semantic Memory	Hippocampus and related cortices, frontal lobe		Learning facts and concepts
Episodic Memory		Theta, alpha and Gamma	Writing an essay from past
Procedural Memory	Basal Ganglia	Alpha	Playing games, musical instruments

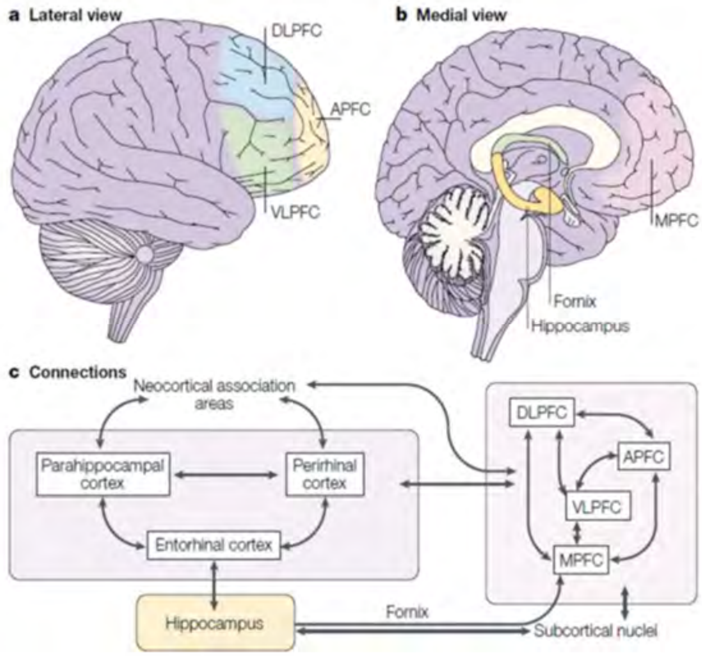

Figure 1: Interaction of PFC and MTL during memory process [24]

In education, working memory plays a key role in problem solving and reasoning, required for subjects such as mathematics and statistics. Further, the use of long-term semantic memory is very common because, in education, every day in the classroom the students are learning new concepts of science, and techniques for solving complex problems in mathematics, statistics, etc. There are few NFB studies which address the improvement of students in problem solving with NFB therapy [25]. However, it will be interesting to explore the encoding, consolidation, and retrieval of semantic long-term memory, which is required by the students, especially in exams to recollect their memories to answer questions and achieve high grades in education. In addition, the creativity of students need to be enhanced and be productive, especially in the growing stage of school children. It has been reported that NFB works well for improving the creativity of students [26]. The same researchers' team reported that children's music performance and attention improved with alpha/theta NFB trainings [27].

In general, NFB seems to have a role in many aspects of cognitive processes which will be helpful to explore with NFB training in education. Therefore, NFB would be an interesting research aspect for the future of educational research and overall community of educational psychology and practitioners.

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Statistical Parametric Mapping (SPM)

By Raheel Zafar
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Introduction:

SPM is a statistical technique for examining the differences in brain activities which are recorded using different modalities. It is a reliable and widely used tool for analysis of brain data. It can construct and assess the spatially extended statistical process, which can be used to test the hypothesis about the functional imaging data. SPM can also be used for neurofeedback data.

SPM is mostly used to identify the human brain responses. It is also the most dominant approach to illustrate functional anatomy and the changes occurred due to any type of disease. SPM is a voxel-based approach, which is based on classical inference, which can make some comments about the responses to experimental factors. The observed response is assigned to a particular brain structure after fitting the data into anatomical space [1].

SPM was created by Karl Friston and the software package has been designed for the analysis of brain imaging data. This data includes different images and signals from different time-series of the same subject. The current release of SPM is SPM12, which is the fifth edition, and is designed for the analysis of fMRI, PET, SPECT, EEG and MEG. It may also refer to a specific piece of software created by the Wellcome Department of Imaging Neuroscience (part of University College London) to carry out such analyses www.fil.ion.ucl.ac.uk/spm. SPM is a freely available tool which is widely used for the analysis of brain data. This is a complete analysis package, as a suite of MATLAB (The MathWorks, Inc) functions and subroutines with some externally compiled C routines.

Fig 1shows the initial window of SPM, which has different options like PET & VBM, M/EEG and fMRI. Data of these modalities can be processed in SPM. After selecting any modality, three windows appeared. The main window is the command window shown in Fig 2, while the others are the process window and the graphic window. The main window has three parts, the upper one is for pre-processing, the middle one has statistical functions, and the lower one has different visualization options. The process window shows the current processes, while the graphic window presents the result.

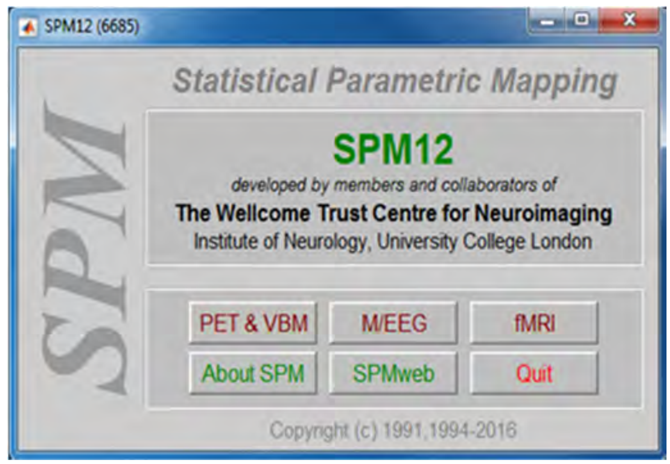

Figure 1: SPM starting window

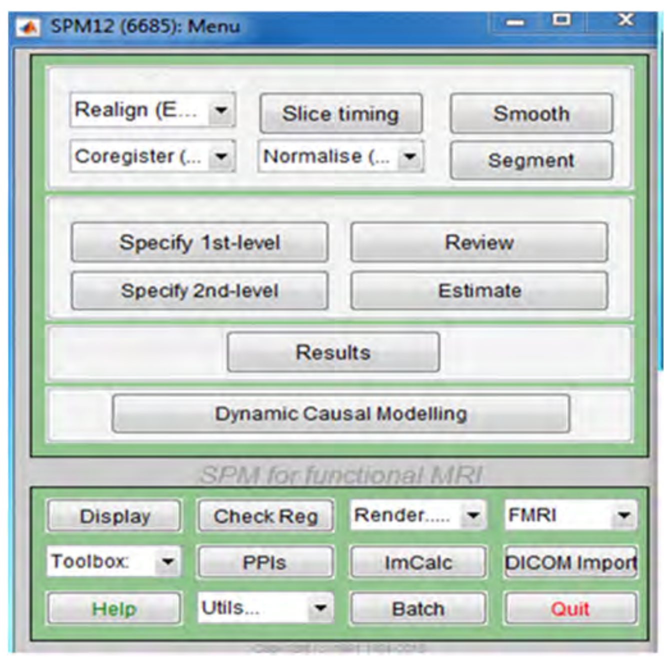

Figure 2: SPM main / command window

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Statistical Comparison:

The purpose of examining the brain is to find the brain areas which are significantly more active during a task compared to another task or baseline. To highlight the active areas and the most significant difference, SPM uses a well-developed statistical method which is known as the general linear model. It gives estimation values which are later used in different significant tests to find the difference in brain activations between the states. The most common tests are T-test and F-test [2].

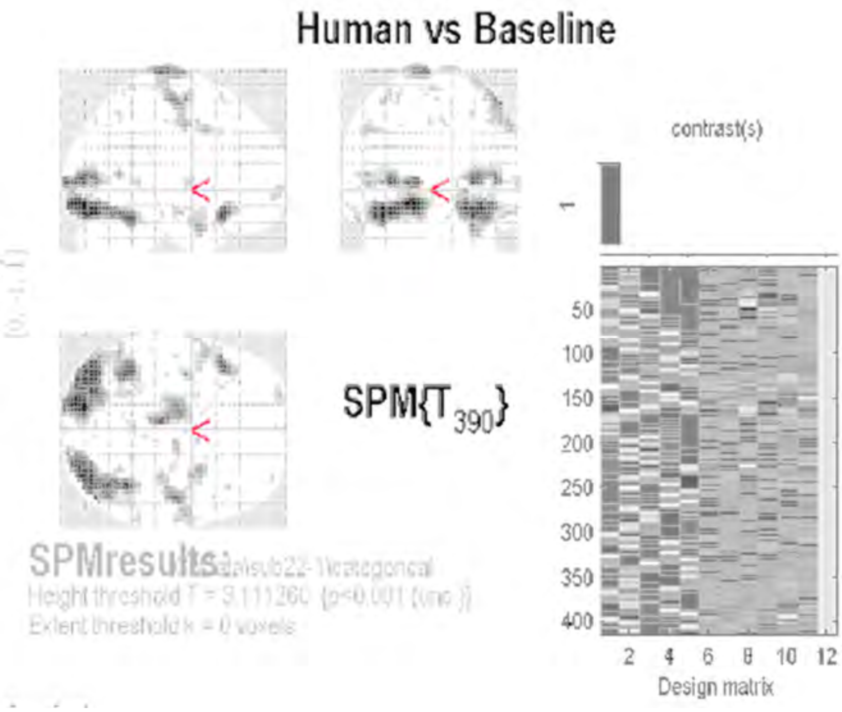

Figure 3: 1st level analysis between two categories. One is task and the other is baseline.

Graphical representations:

One of the main advantages of SPM is the graphical representation of the results. In SPM, the results are presented in both table and graphical form. In graphical view, statistically significant differences between the conditions are shown in Fig 3. In the given example, the design matrix has only one regressor. This is because in SPM, there is no need to define a separate regressor for baseline. The activation regions in Fig 3 are mapped to the statistical values, such as t-values or z-scores, found in statistical comparisons between different conditions.

In Table 1, significant voxels, active clusters, T-values, Z-values and the coordinates with most significant difference are also presented.

Table 1: Detail of complete statistical analysis with T, Z values, significant voxels, position, p-value and number of significant clusters.

Statistics: *p-values adjusted for search volume*

set-level		cluster-level				peak-level					mm mm mm		
p	c	$p_{FWE-corr}$	$q_{FDR-corr}$	k_E	p_{uncorr}	$p_{FWE-corr}$	$q_{FDR-corr}$	T	$(Z_\equiv)$	p_{uncorr}			
0.002	45	0.000	0.000	2094	0.000	0.000	0.000	9.75	Inf	0.000	-15	-85	4
						0.000	0.000	9.67	Inf	0.000	-9	-91	1
						0.000	0.000	8.94	Inf	0.000	-27	-61	-2
		0.000	0.000	80	0.000	0.007	0.003	5.25	5.15	0.000	57	23	52
						0.328	0.047	4.44	4.38	0.000	54	32	34
		0.000	0.000	118	0.000	0.013	0.006	5.12	5.03	0.000	-45	-1	40
						0.029	0.010	4.96	4.88	0.000	-36	-4	61
						0.953	0.190	3.90	3.86	0.000	-45	-7	55
		0.005	0.001	39	0.000	0.026	0.010	4.98	4.90	0.000	24	-67	61
						1.000	0.676	3.35	3.32	0.000	30	-73	73
		0.004	0.001	40	0.000	0.037	0.012	4.91	4.83	0.000	-15	68	40
		0.000	0.000	248	0.000	0.071	0.020	4.77	4.70	0.000	27	11	70
						0.143	0.029	4.62	4.56	0.000	21	23	67
						0.221	0.037	4.52	4.46	0.000	9	17	73
		0.000	0.000	64	0.000	0.082	0.021	4.74	4.67	0.000	-24	-10	76
						0.620	0.117	4.24	4.19	0.000	-12	-19	85
						0.677	0.000	4.20	4.15	0.000	-30	-16	76
		0.205	0.021	16	0.008	0.082	0.021	4.74	4.67	0.000	75	-19	7
						1.000	0.777	3.27	3.25	0.001	69	-13	7
		0.000	0.000	123	0.000	0.087	0.021	4.73	4.66	0.000	33	47	1
						0.174	0.031	4.58	4.51	0.000	24	38	-11

table shows 3 local maxima more than 8.0mm apart

Height threshold: T = 3.11, p = 0.001 (1.000)
Extent threshold: k = 0 voxels, p = 1.000 (1.000)
Expected voxels per cluster, <k> = 2.012
Expected number of clusters, <c> = 28.41
FWEp: 4.846, FDRp: 4.427, FWEc: 27, FDRc: 14

Degrees of freedom = [1.0, 391.0]
FWHM = 7.7 7.9 7.6 mm mm mm; 2.6 2.6 2.5 {voxels}
Volume: 1481436 = 54868 voxels = 2846.7 resels
Voxel size: 3.0 3.0 3.0 mm mm mm; (resel = 17.29 voxels)
Page 1

SPM for fMRI:

For fMRI, SPM can be used starting from pre-processing till statistical analysis. Fig 4 shows the complete picture of fMRI data analysis. After acquiring the data, different pre-processing steps can be done in SPM, as shown in Fig 4. After pre-processing, statistical analysis of the data can be performed using GLM [3]. In GLM, a matrix with explanatory variables, known as the design matrix, exists. This design matrix has a role in parameter estimation. Based on these estimated parameters, a statistical parametric map can be made which shows the difference between states. It may be between task and baseline or between different tasks based on the design matrix. These statistical methods can be applied on single, as well as on multiple subjects [4].

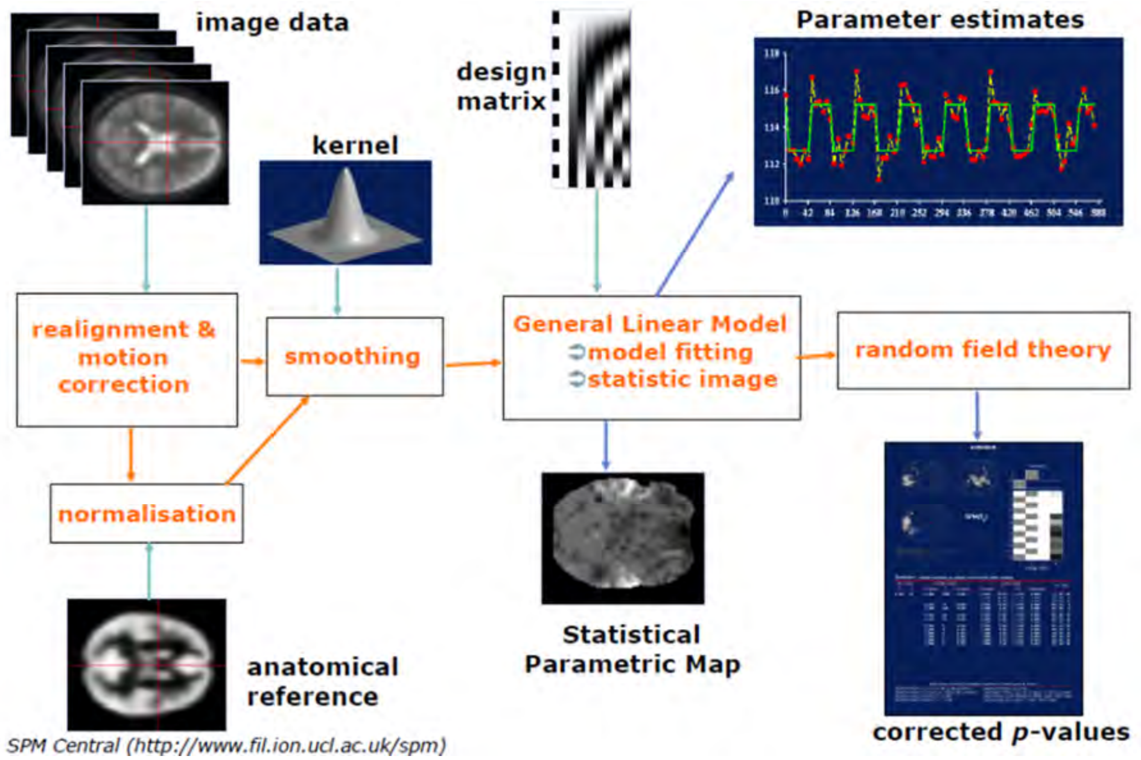

Figure 4: SPM transformations/processing steps in fMRI.

SPM for M/EEG:

There are three main parts of analysing M/EEG data using SPM.

• ***Statistical analysis.***

For statistical analysis, the same procedure is used as SPM for fMRI. These are robust and validated functions based on the General Linear Model (GLM) and Random Field Theory (RFT).

• ***Source Reconstruction***

Bayesian approaches are established to reconstruct the sources of M/EEG data. It is a very important step because normally it is very difficult to relate sensor data to neuroanatomy.

• ***Dynamic Causal Modelling (DCM)***

DCM is a model which is used to estimate the effective connectivity in a network of sources. For M/EEG, DCM is a powerful technique, because the data are highly resolved in time and this makes the identifiability of neurobiologically inspired network models feasible.

There are a lot of tools implemented for the full analysis of data. These start with raw data from EEG, fMRI and MEG machines and make it possible for the users to prepare their data for SPM analyses.

SPM development has focused on specific methods which were pioneered by the UCL group because they made it straightforward for the users to combine data processing in SPM and other software packages.

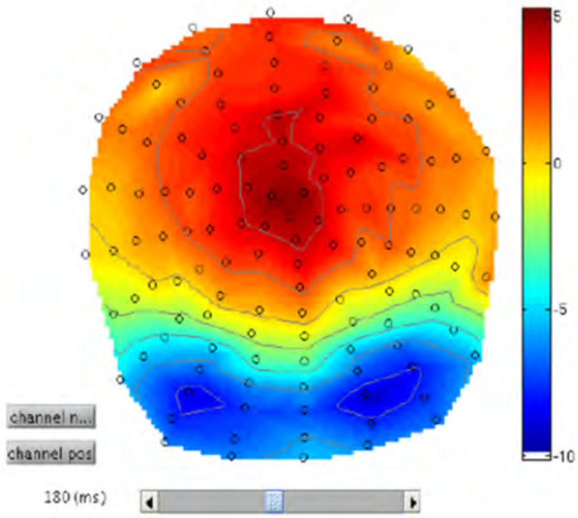

Figure 5: 2D topography map between two conditions in SPM [5]

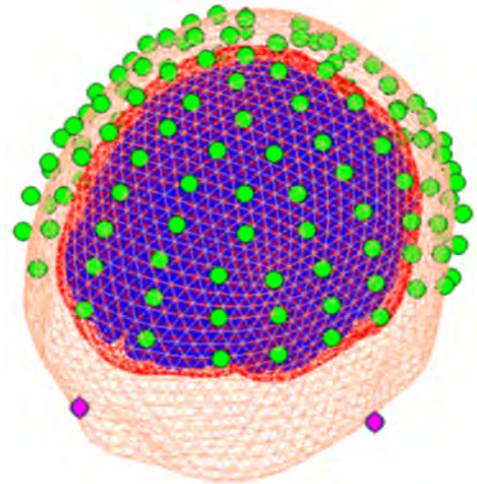

Figure 6: Complete channel detail in SPM [5].

SPM and Neurofeedback:

Neurofeedback is the direct training of brain function. In neurofeedback, the brain learns about the functions in a more appropriate and efficient way. In this process, brain observations take place from moment to moment and feedback is given to the person. As a result, the brain is changing its own activity into more appropriate patterns. Both EEG and fMRI data is used for neurofeedback. In fMRI, it is called real-time fMRI (rtfMRI), and in EEG, it is known as EEG Biofeedback.

SPM can be used for neurofeedback analysis. In Fig 7, an example of neurofeedback is presented. In this example, decoding of brain activity patterns is presented in real time. The subject is viewing letters on a visual display. Those letters are encoded in the brain, and at the same time, those letters are decoding in real time from Spatio-temporal activation patterns of the brain. This experiment is done on fMRI data, and the fMRI response for different letters can also be seen in real time.

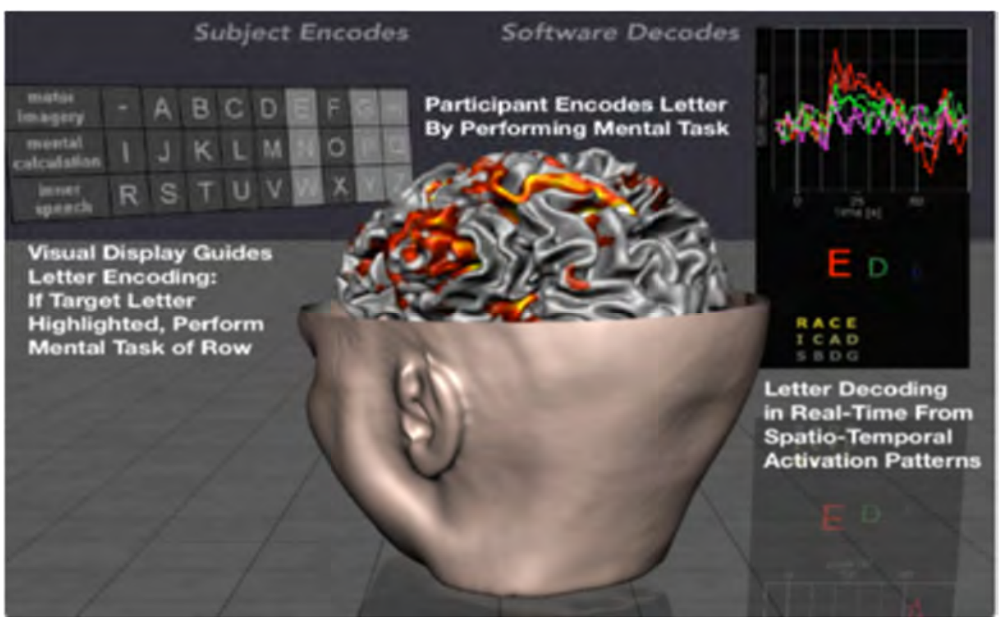

Figure 7: Decoding of brain activity patterns [4].

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