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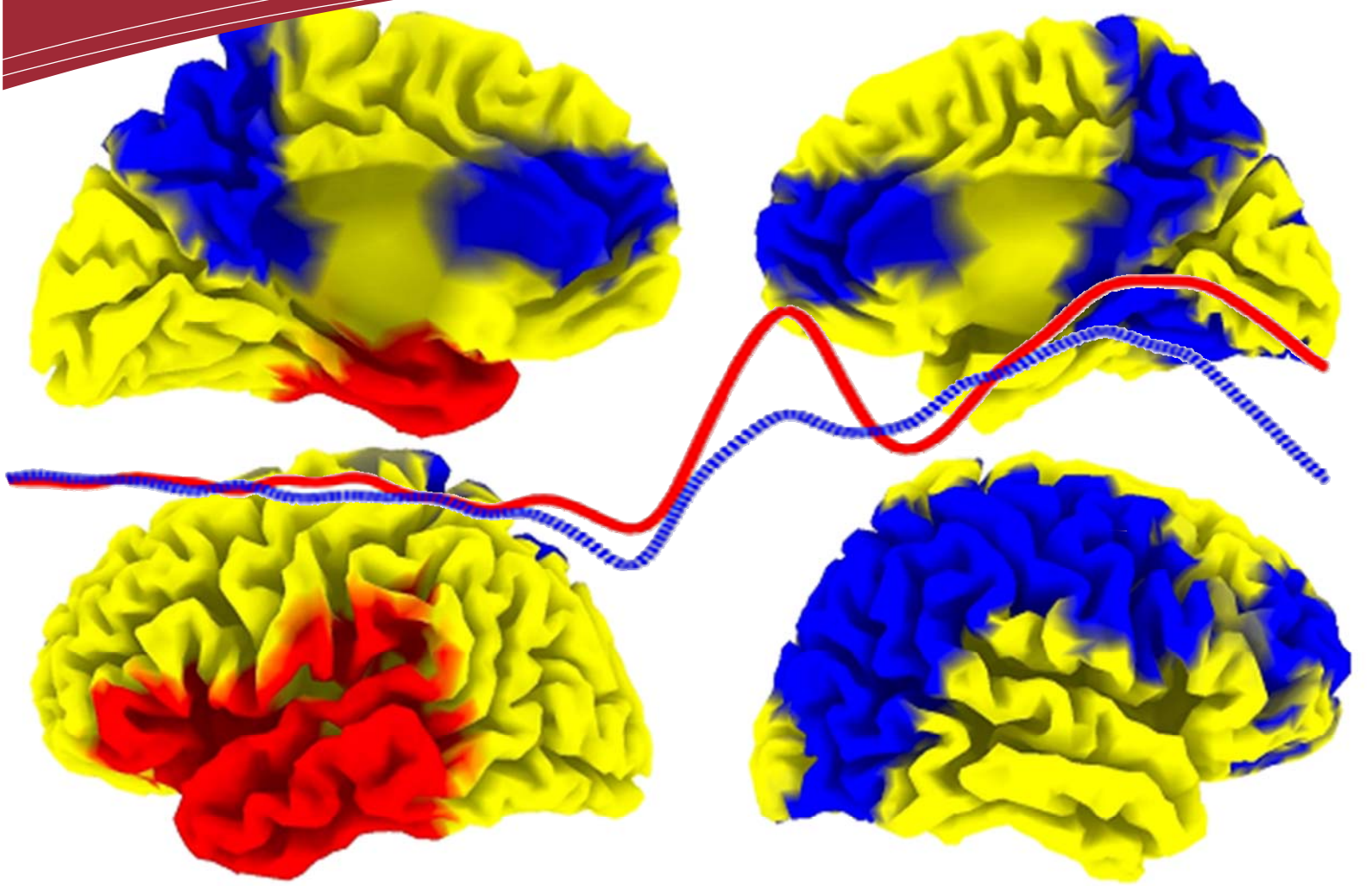

this issue

"Curing Migraine type headaches with Neurofeedback"

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Neuro-Eastern

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EDITOR-IN-CHIEF'S NOTE

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This is the 8th issue of NeuroEastern. The frequency of the newsletter is revised to bi-annual. Thus, the 8th issue is for January and June 2017. To start with, I would like to remind that Neuro-Eastern is a free platform to share your research and/or clinical experience and your current research projects with other researchers. Therefore, I would like to invite all interested readers of the Neuro-Eastern newsletter to share your expertise in neurofeedback or related current projects by writing a short article, which can be included in the next issue, and explore new tools for data analysis, especially EEG analysis.

The two articles in this issue are on 'Brain decoding' and 'Curing Migraine type headache with Neurofeedback'. The fundamentals of decoding human brain activity with different brain imaging techniques, such as EEG, fMRI and MEG, is explained by Mr. Raheel Zafar.

"Decoding of Human Brain Activity"

Relevant references are cited in this article. In the second article, Miss Soyaba Javed briefly highlights the basics of migraine, its various factors, standard treatment and the use of neurofeedback for migraine.

"Curing Migraine type headaches with Neurofeedback"

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 to 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 health care research, and the clinical applications of neurofeedback and biofeedback for serving society. There is a growing number of professional clinicians, and biomedical and computing engineers, who have expertise in medicine, psychology, therapy, engineering, and the development of new advanced computing solutions to biomedical problems.

These diverse experts started sharing their expertise, joint research collaborations, organizing joint events, and developing their professional networks, 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

Decoding of human brain activity

By Raheel Zafar
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Introduction

The primary goal of research in neuroscience is to understand the working of the human brain. For this purpose, different non-invasive functional neuroimaging techniques are used; the most common are functional magnetic resonance imaging (fMRI), electroencephalography (EEG) and magnetoencephalography (MEG). All of these techniques are able to record concurrent brain activity, directly or indirectly against the stimulus presented to the subjects. The underlying mental process can be extracted through a relation between the category of the stimulus and the pattern of recorded signal. There are different approaches to analyze the relation between stimuli and brain activity, but the one based on predicting the stimulus from the concurrent brain recording is called brain decoding.

Brain decoding started more than a decade ago [1], when neuroscientist began to understand that there was a lot of untapped information in brain scans. These brain scans were taken through fMRI. After that, a lot of research was done in fMRI, and it became the best modality in this field as it has very good spatial resolution. However in recent years, other modalities like EEG and MEG are also used in this field.

Why decoding of human brain activity is important

With the decoding of human brain activity, neuroscientists have hope that in the future two brain can communicate directly with each other, or one can read the mind of the other person. There are many potential applications of brain decoding, for example if such a decoding device was available then it could be used in court cases, detective work, dream decoding and diagnosis of diseases.

Decoding using fMRI

In fMRI, decoding of brain activity is quite mature and popular since many research groups related to decoding are working with fMRI. In fMRI, the pioneer work was done by Haxby [1]; after that, there were many significant studies available in this area [2-4]. In fMRI, the neural activity is not measured directly; it measures blood oxygen level dependent (BOLD) signals using a MRI scanner which is associated with the neural activity. Since there is a linear relationship between the BOLD signal and neural activity, the BOLD signal can give significant information during neural activity. The amplitude of the BOLD signal increases with neural activity and vice versa. The spatial resolution of fMRI makes it popular in neuroscience as exact localized information can be extracted, which is enough to decode the brain activity between different categories. In neuroscience, it is common to complete the difference between the task and the baseline, and in case of fMRI, different tools are available to compare and extract the significant information. The common tools in fMRI are Statistical parametric mapping (SPM), FMRIB Software Library (FSL), FreeSurfer, AFNI and Brain voyager. The most popular is SPM, as it is freely available and matlab based, with a lot of available help. In SPM, the neural activity can directly be seen on a glass brain in SPM. The glass brain is a 3D brain visualization that displays source activity and connectivity. The sagittal, coronal and transverse views are known as the glass brain. The glass brain view provides the visualization of analysis [5] as shown in Figure1. also gives a table which explains the degree of freedom, full width at half maximum (FWHM), voxel size, position of voxels, z-values, number of clusters, number of significant voxels in each cluster and the other information found during the analysis of the condition as shown in Table1.

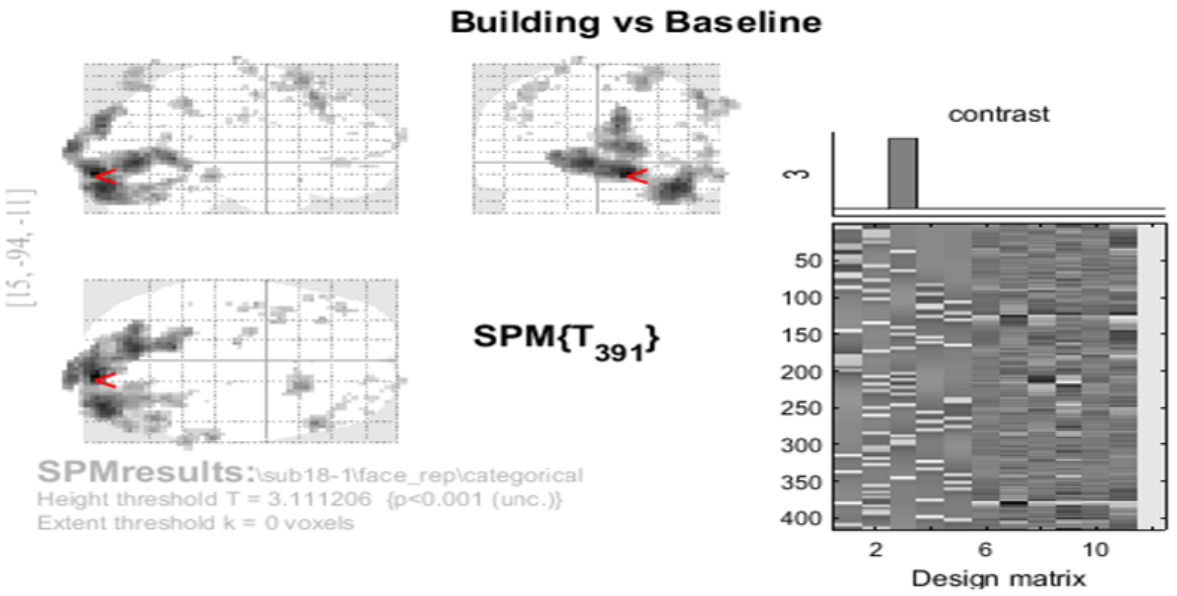

Figure 1: First level analysis: Building vs baseline.

Table 1: Statistic Table which shows the degree of freedom, FWHM, voxel size, position of voxels, z-values, cluster and other details.

Statistics: *p-values adjusted for search volume*

set-level		cluster-level				peak-level					mm mm mm		
p	c	$p_{FWE\text{-}corr}$	$q_{FDR\text{-}corr}$	k_E	p_{uncorr}	$p_{FWE\text{-}corr}$	$q_{FDR\text{-}corr}$	T	$(Z_=)$	p_{uncorr}			
0.006	43	0.000	0.000	1822	0.000	0.000	0.000	7.44	7.19	0.000	15	-94	-11
						0.000	0.000	6.43	6.26	0.000	39	-91	-23
						0.000	0.000	6.24	6.09	0.000	-6	-73	-2
		0.000	0.000	63	0.000	0.031	0.011	4.95	4.87	0.000	54	26	52
						0.422	0.068	4.38	4.32	0.000	57	29	43
						0.985	0.277	3.80	3.77	0.000	57	35	37
		0.000	0.000	92	0.000	0.166	0.041	4.59	4.52	0.000	24	17	67
						0.999	0.392	3.64	3.60	0.000	9	14	67
		0.016	0.004	31	0.001	0.195	0.041	4.55	4.49	0.000	66	-31	-14
		0.000	0.000	56	0.000	0.413	0.068	4.38	4.33	0.000	69	-46	49
						0.974	0.254	3.85	3.81	0.000	63	-43	40
		0.000	0.000	87	0.000	0.666	0.105	4.21	4.16	0.000	24	-76	64
						0.738	0.118	4.15	4.10	0.000	33	-76	73
		0.830	0.191	7	0.062	0.678	0.105	4.20	4.15	0.000	-12	-19	85
		0.487	0.078	11	0.023	0.791	0.131	4.11	4.06	0.000	-45	-7	55
		0.101	0.020	20	0.004	0.839	0.146	4.06	4.02	0.000	-21	-10	76
		0.144	0.023	18	0.005	0.933	0.193	3.94	3.90	0.000	-42	41	52
		0.902	0.195	6	0.082	0.933	0.193	3.94	3.90	0.000	-33	29	64
		1.000	0.468	1	0.468	0.983	0.277	3.81	3.78	0.000	18	17	-17
		0.026	0.006	28	0.001	0.985	0.277	3.80	3.77	0.000	-33	5	58
						0.997	0.345	3.70	3.67	0.000	-39	11	58

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
Expected voxels per cluster, <k> = 2.012
Expected number of clusters, <c> = 28.41
FWEp: 4.846, FDRp: 4.552, FWEc: 28, FDRc: 18

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

Decoding using EEG and MEG

Decoding of brain activity using EEG and MEG is quite new compared to fMRI, so extensive research is required in this field for these two modalities. The advantage of using EEG and MEG is that, unlike fMRI, they measure the brain activity directly and have very high temporal resolution. The main limitation of EEG is its poor spatial resolution. EEG is an old technique and has been used in brains studies for a long time [6,7]. However, it is not mature in the field of decoding, and has only been used in a few, recent studies [8, 9]. MEG is one of the best techniques to study brain activity, since it has good spatial and temporal resolution. So it is often used in recent studies [10, 11] for the application of decoding.

The current common available tools for the analysis of EEG data are EEGLAB, BESA, Net station, Brainstorm and SPM, while MEG data can also be analyzed using the same tools i.e. EEGLAB, BESA, Brainstorm and SPM.

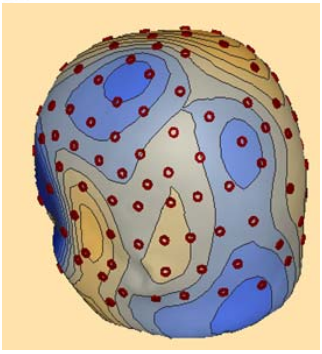

Figure 2: (a) Activity of brain before the task.

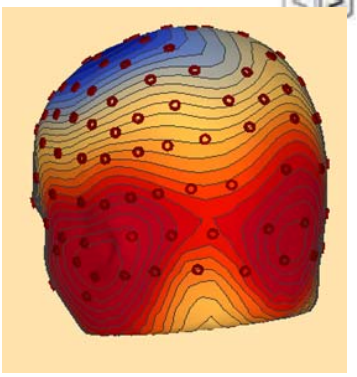

Figure 2: (b) Activity of brain after the task.

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Curing Migraine type headaches with Neurofeedback

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Introduction:

Migraine is a type of headache, in which the patient experiences throbbing pain on one side of the brain, accompanied by the symptoms, such as flashes of light, blind spots, tingling in the arms and legs, nausea and disturbed vision. Many people also experience migraine with aura. It is inferred that it is due to abnormal brain activity causing alternation in nerve signal chemicals and blood flow in the brain, but the exact cause behind the migraine is still unknown. In more technical terms, it is defined as a disorder due to an increased excitability occurring in the central nervous system [1,2].

Commonalities of Migraine:

According to statistics 3% of people in USA are suffering from chronic migraine [3]. It is more common in women during their productive years [4]. Approximately 18% of women and 6 % of men, aged between 25 to 55 suffer from it [5]. The national headache foundation states that health care providers have properly diagnosed fewer than half of all migraine sufferers [6].

Factors that contribute towards Migraine:

Migraines can be triggered by many factors; ranging from hormonal imbalance, light sensitivity, allergies, dehydration and neuro-metabolic issues.

Migraine leaves one's brain in a high state of stress and imbalance, which results in a variety of symptoms that take their toll on a person's life, including the inability to focus, mood swings and throbbing pain.

Migraines cause an increase in sympathetic response and a decrease in parasympathetic response. In simple words, it's a brainwave imbalance which can negatively impact normal brainwave function. If the stressful trigger of a migraine continues, the response becomes chronic making it harder for brain to re-regulate.

Standard treatment for migraine:

The standard protocol treatment for those suffering from migraines is medication. According to research studies, up to 84% of those taking migraine medications reported being unsatisfied; stating medications did not alleviate the pain [3]. Medications offer temporary pain relief by blocking pain receptor sites, but do not address the brainwave imbalance which is the main cause of the pain. Medications offer great short-term relief, but are not a long-term viable solution as they offer no correction to brain wave imbalance and come with a high potential risk for addiction.

Neurofeedback for migraine:

Neurofeedback is a form of biofeedback training which uses EEG as a signal to control feedback. The sensors are placed on the scalp to record brainwaves giving visual, sound or tactile feedback to the brain, to change the brainwaves through operant conditioning. Figure 1 explains the idea of neurofeedback training.

Neurofeedback can be used for pain management. Hence, it can be used to treat migraine. The popular methods of treating migraine using neurofeedback is: 1) blood-volume-pulse and electromyography feedback, and 2) peripheral skin temperature biofeedback [5]. The above-mentioned method is proven effective by clinical studies on patients suffering from migraines not triggered by traumatic event [6]. Still, there is not a sufficient amount of controlled studies conducted on neurofeedback based method to treat migraine type headache [7-13] [15].

Talking about neurofeedback, also known as EEG biofeedback, is a frequency based biofeedback which uses EEG signals to give a person inside information about their brain waves, and teaches them to train their brain waves in a way that it can be altered. Sensors are attached to the scalp, and EEG signals are recorded and amplified using amplifier, and selected components are displayed using some interface, for example, a video game. The clinical applications of neurofeedback have proven to be very effective for physical, cognitive, and emotional problems, as well as migraine [14,15].

A certain level of abnormalities is observed during brain waves analysis of migraine patients [6, 18]. Increased values of theta frequencies are observed in migraine patients [16].

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Studies show that using a certain type of protocol helps improve the migraine. For instance, one popular neurofeedback protocol is rewarding temporal lobes T3 and T4 at 12-15 Hz [17]. A drastic decrease in migraine patients is observed after ten neurofeedback sessions, focusing on central areas and midline frontal areas. The idea is to teach the patients to control cortical reactivity and cortical sensitivity [7]. A study was conducted on four migraine patients for treating migraine using neurofeedback training, in which the central and midline frontal areas with lower frequencies were trained to make them less dominant and augmented with higher frequencies [8]. Introducing hemoencephalography targeting the frontal lobe has also proven useful for migraine, as the thermal output of the frontal lobe is used for treating migraine [10,19].

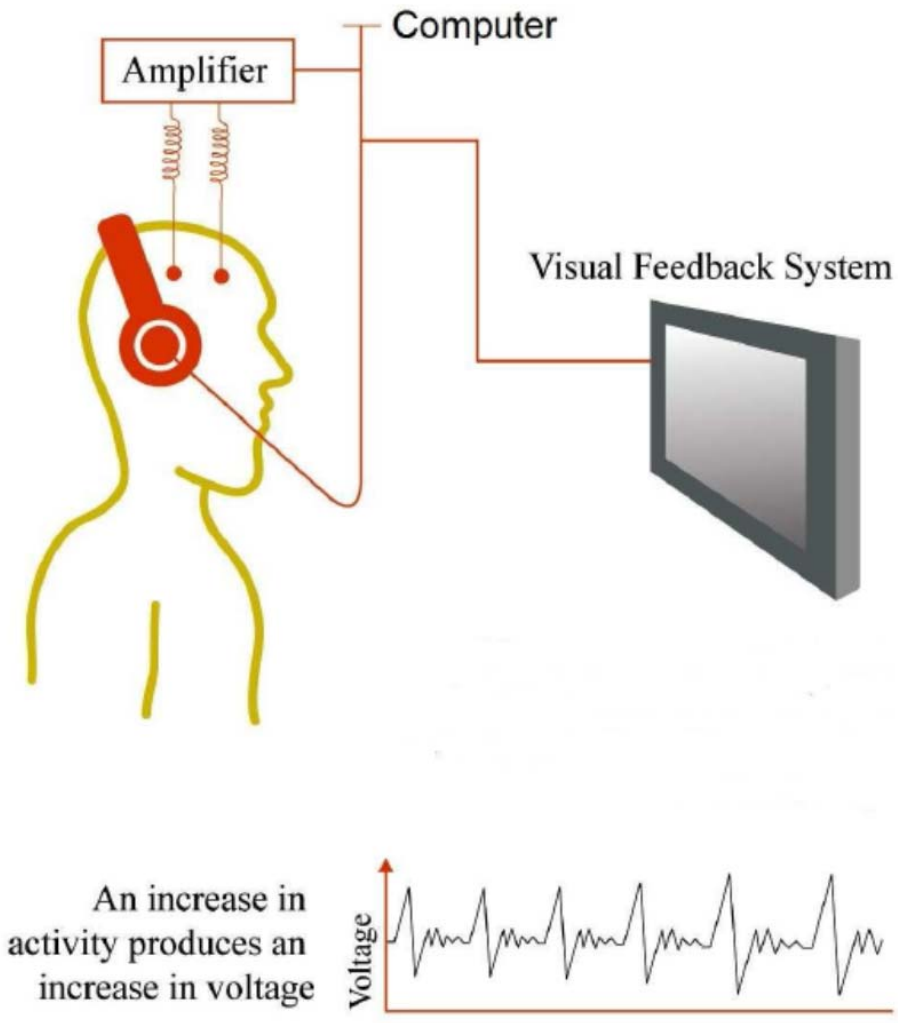

Figure 1: Neurofeedback training to improve brain function and regulate behaviour

Another study was conducted on 37 migraineurs in a clinical outstanding setting. For this study, two techniques i.e. EEG biofeedback and hemoencephalography biofeedback were combined with handwarming biofeedback to treat the patients. All these patients had tried at least one medication for migraine. The record of each of patient is maintained, recording everything including frequency, symptoms, severity of pain and medication used. The treatment is continued for six months and headache diaries are examined after this timespan. After an average of 14 months, the interview is also conducted for getting feedback from patients on treatment.

The results from all above-mentioned studies shows remarkable improvement in patients suffering from migraine, after treating with neurofeedback. After the treatment, the frequency of headache is decreased to 50% in 70% of the patients, keeping its sustainability for 14 months. People who are treated with biofeedback show 70% reduction in their migraines, as compared to the people who are treated using only medication. These non-invasive interventions not only reduce the migraine headaches, but they also prevent the progression from episodic to chronic migraine.

Conclusion:

Despite the limitation of non-existing control group studies on migraine treatment using neurofeedback. Neurofeedback is still a scientifically proven system that retrains the brain to create new patterns and responses to incoming triggers and stressors. This new response improves brainwave activity and function. The result is a calmer, happier, healthier brain that has fewer symptoms and flare-ups. Studies have shown a more than 54% rate of total cessation of pain and symptoms and 99% of patients reported a decrease in pain and symptoms [20,21]. When balance and function are restored, the outcomes are optimized and health is improved.

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