A Study on the Effect of a Person when Subjected to Designed Cognitive

[1]Dr. V. G. Sangam, [2]Sushrutha Bharadwaj M, [3]Lakshmi A S, [3]Mohammed Faizan, [3]Prerana Ananda Murthy, [3] Sahana Sundar Raman

[1]Professor and Head of Department, [2]Associate Professor, [3]Students
[1]Department of Medical Electronics,
[1]Dayananda Sagar College of Engineering, Bengaluru, India.

Abstract: Brainwaves are produced by the large mass of neurons communicating with each other through synchronised electrical pulses. Slow brain waves such as theta are predominant in causing slow, sluggish, or sleepy nature. Fast brainwaves like gamma are cardinally present during thinking, concentration and processing of data. Stimuli or tasks given to a subject stimulate the different brain waves and also the brain lobes. The agenda of this study was to obtain a correlation of how a subject was affected when the designed tasks were provided. The stimuli chosen for this study was principally designed by us to trigger the pre-frontal or frontal lobe and the effect was noted in correlation with age, gender and behaviour.

Index Terms **- Brainwaves, Stimuli, Memory tasks, Colour Ranking, Tray game, Hyperventilation.**

I. INTRODUCTION

Neurons transmit signals carrying information to one another by means of impulses. These impulses give rise to waves known as Brainwaves. Pragmatically the brain has found to have different kinds of brainwaves such as alpha, beta, delta, gamma, infra low and theta waves. These waves are segregated based on their bandwidths of occurrence during a certain activity. [1] Brainwave activity is quantified Hertz (cycles per second) and they are split into bands precisely slow, moderate, and fast waves.

A. *Infra-Low (<.5HZ)*

Slow Cortical potential or Infra-Low brainwaves are the cortical rhythms that are the fundamental basis of cognition and behavior. Owing to the fact that these waves are slow in nature it is problematic in detecting and measuring them accurately. They are majorly responsible in timing and network function.

B. *Delta Waves (0.5 To 3 Hz)*

These are the slow, loud brainwaves that are initiated during the deepest sleep or meditations. Delta waves trigger regeneration and healing which is why deep reviving sleep is crucial in the healing process.

C. *Theta Waves (3 To 8 Hz)*

Theta activity that is the gateway to learning, memory, and intuition is habitually seen in sleep and pre-eminently in deep meditation. It is that downturn state which one generally experiences momentarily as we wake or drift off to sleep. It is this state one experiences fears, nightmares and troubled histories.

D. *Alpha Waves (8 To 12 Hz)*

Alpha brainwaves also known as ‘the power of now’ deals with the state of presence, predominantly aids in calmness, learning, alertness, mental coordination and mind/body integration during quietly flowing thoughts, and in certain meditative states.

E. *Beta Waves (12 To 38 Hz)*

Beta which is the fastest amongst the brainwaves present after the gamma waves, is actively responsible for alertness, attentiveness, engagement in problem solving, judgment, decision making, or focused mental activity. Beta activity is further split up into three bands:

i. Low Beta: This state also known as the Beta1 is considered as the 'fast idle' or musing and occurs between 12-15 Hz.

ii. Beta: This state also called the Beta 2 is the active state of puzzling out or high involvement of a certain work and materializes within the range 15-22 Hz.

iii. High Beta: This state also designated as Beta 3 is responsible for high consternation, complex thoughts and incorporation of escapades.

F. *Gamma Waves (38 To 42 Hz)*

Gamma waves i.e. the fastest amongst the brainwaves is accountable for the synchronous refinement of information from the all the regions of the brain.

II. METHODS

A. EEG Recording

The experimental set up consisted of subjects aged above 50 (> 50 years) who were considered for the acquisition of EEG before and during the conduction of the task.

B. EEG Selection

The selection of EEG was based on the device used therefore single channel recordings were considered. The single channel recording was taken from the pre-frontal lobe with one reference electrode on the left earlobe. [2]

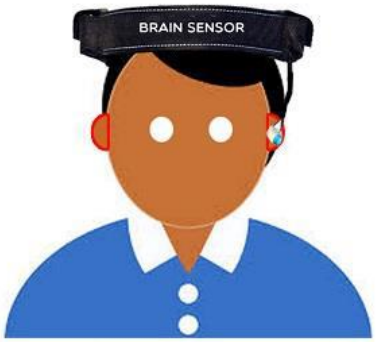

Figure 1: The subject wearing the BRAINSENSE with reference electrode clipped to left earlobe [2]

C. Tasks Selection

The tasks chosen and designed were used to trigger the pre frontal lobe. The stimuli maybe of any form: a visual video or picture, audio, decision making tasks etc. The stimuli adopted are ones that set off the lobes individually. Tasks or stimuli that are contemplated in our experimental interpretation are ones that set off the Frontal lobe, the Pre-frontal lobe to be more specific. These tasks were chosen and given under the guidance of a doctor.

i. Closed eyes/ Calm state/ meditation (0-30 sec)

It is has been observed that during this task a subject showed high theta activity in the frontal lobe. Stress can be relieved by meditation or slow breathing. The hormone disquieted with stress is cortisol administered by the adrenal glands. The state of stress in a subject is depicted by the levels of cortisol: Low levels imply stress free condition and High levels implies stressful conditions. Higher levels of cortisol cause memory loss which affects a patient's neurological condition. A subject may be

advised to stay calm by closing their eyes or by meditating. Doing this in turn helps to anneal the theta waves, nonetheless preventing neurological disorders like Parkinson's disease, Alzheimer's disease and dementia.

Studies have also analyzed that subjects who meditated often had greater quantities of gray matter than subjects who didn't. Thinning of gray matter led to gradual depiction of bipolar disorder in subjects. [3]

ii. Video (30-60 sec)

Laughter is the key emotion that enhances and triggers and parts of the brain, and it is well known that gamma is the only brainwave that influences all the parts or lobes of the brain. Due to this well known fact it can be noted that happiness evoking tasks would show predominant gamma activity.

Videos or short clips that triggered happy emotions or laughter were proved significant in Parkinson's subjects to beat depression and anxiety. Prevalence of Alzheimer's disease in a subject could be anticipated by laughter therapy. Anger issues habitually found in Borderline personality disorder can be diminished by keeping oneself occupied with joy. [4]

Post stroke depression caused by direct damage to emotional centers of the brain and frustration showed a gradual reduction. Anxiety, panic attacks, flat effect, apathy, lethargy, sleep disturbances and irritability are the ones overcome by laughter therapy in subjects suffering from stroke.

iii. Audio (60-120 sec)

Audio maybe of any form the radio, songs or news updates. The respective audio considered must stimulate emotions in a subject. In the conducted experiment audio taken was a song or music. Music has said to invoke emotions which improve motor functions cognitive functions (memory, attention, executive function) and most importantly gait balance in Parkinson's subjects. [5] Furtherance in cognitive, psychological, and behavioral alterations was seen in patients with Alzheimer disease. Blending music therapy along with dance therapy showed betterment in motor and functional impairment. [6]

Listening to music or any audio will depict theta activity and alpha activity in the orbito-frontal lobe. On the contrary listening to alpha music i.e. the waves that have been hypothesized to make one concentrate and be active. Hence audio tasks may show high alpha activity and theta activity.

iv. Tray game (120-300 sec)

This task is primarily based on the principle in which the subject is manifested with a certain quantity of objects. [7] The subject analyses and memorizes those objects for about 2 minutes. For the succeeding 1 minute the subject endeavors to name as many as possible objects he/she can remember. This is completely a memory based game. [8]

All Parkinson's subjects, Alzheimer's subjects and those suffering from dementia suffer substantially loss of memory. [9]Hence, one suffering from any of the three stated disorders may find it difficult to recall the objects manifested in front of them. Memory is highly apprehended with theta and gamma waves. To be more specific, means memory related tasks show large numbers of theta and gamma activity. [10][11]

Since the subject tries to memorize, store information and recollect the stored information, there will be presence of alpha and beta activity.

Figure 2: The objects exhibited in front of the subjects

v. Colour Ranking game (300-360 sec)

This game is completely based on the principle of decision making and judgment. The subject is presented a poster which enlists names of colors in different font colors. The subject is briefed to read out the color of the font aloud. [12] The tendency of the subject is that they begin to read the font color and sooner or later calls out the name of the color. A subject with critical skills shall make a mistake 1-2 times or absolutely no mistakes, whereas one with a neurological disorder may face difficulty in interpersonal skills. [12] [13] During this patient the EEG recorded for a particular subject will show large theta and beta activity. Nonetheless a subject with disorders will show abnormal levels of theta activity than a normal subject. [14]

Figure 3: Color ranking game

vi. Hyperventilation (HV)(360-390 sec)

It was primarily utilized as a provocative or activation to enhance antecedent activities, if not to persuade the normal brain activity. [15] [16] It also affects the alpha rhythms by increasing its amplitude as well. Hypertension has been observed to trigger epileptic seizures. [17] Studies have proven that HV elicits Abnormal EEG Patterns in EEGs of epileptic patients and normal subjects, consequently escalating the yield of EEG recordings. [18]

Hyperventilation is frequently used to reduce elevated intracranial pressure (ICP) or relax a tense brain specifically in subjects with neurological disorders. [19]

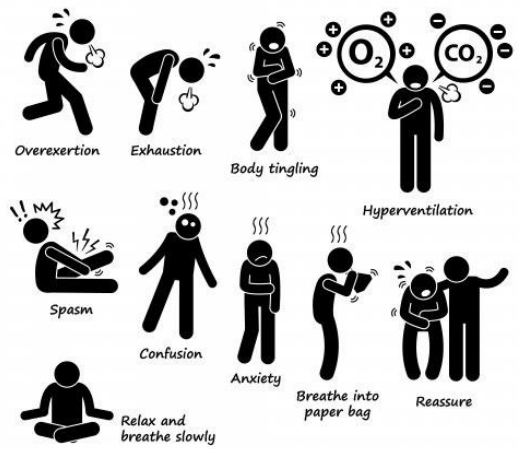

Figure 4: Representation of hyperventilation (Image courtesy [15])

III. RESULTS

The results tabulated from the study conducted were tabulated as below (table 1). The column tabulated as colour ranking was done in order to obtain the ability of a subject to correlate font name with font colour. Based on a subject's IQ and thinking ability one would read out with or without mistakes. The values shown under this column describes the number of mistakes one made out of the 28 words depicted to them.

The values under the tray game indicate a person's memory to remember and name the objects without looking. One who named the maximum number i.e. named 17 and above out of 20 had good memory. And it is a well known fact that one's memory reduces with disorders and with age.

Hyperventilation was conducted as test to check if a subject was suffering from epilepsy, those with epilepsy showed symptoms of focal seizures when subject to hyperventilation (HV). Hence the subjects 16, 18, 19 and 20 showed such symptoms.

Table 1: Tabulation of Age, Gender, Memory tasks and Hyperventilation

Subject	Age	Gender	Color Ranking	Tray Game	HV
1	61	M	3	18	No
2	55	F	3	17	No
3	68	F	4	16	No
4	59	M	4	17	No
5	53	F	2	17	No
6	66	F	1	16	No
7	80	F	2	12	No
8	67	M	4	19	No
9	57	M	2	20	No
10	56	F	2	17	No
11	76	F	4	19	No
12	56	M	4	18	No
13	62	F	3	17	No
14	69	F	3	20	No
15	63	F	3	16	No
16	58	F	6	20	Yes
17	64	F	5	18	No
18	71	M	3	16	Yes
19	65	M	3	17	Yes
20	72	F	2	17	Yes

IV. CONCLUSION

It was concluded that the tasks given above showed that the ability to store information in the brain varied subject to subject i.e. a normal subject could store or memorize and remember larger amount of information whereas one with a disorder couldn't.

The study conducted showed a variation of EEGs based on age as well as gender. It could be taken into account that one's age is inversely related to memory. Hence, as one ages, they tend lose their ability to remember things leading to a reduction in their memory span.

It was also deduced that in group of subjects (5 years age gap) that female subjects had a better memory and capacity to remember things than the male subjects in that particular group i.e. a female subject aged 72 years could name 17 objects out of 20 whereas a male subject aged 71 years could name only 16 out of 20 in the tray game.

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