

Mid-Frontal EEG Asymmetry and Relaxation Therapy: An Indicator of Emotional Brain Activity on Test Anxious Learners

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Abstract: Frontal brain asymmetry is an indicator of brain activity in emotion related behaviours. Left brain activity is responsible for positive emotions and right brain activity is responsible for negative emotions. From previous research studies, it is noticed that anxiety has connection with frontal asymmetry and therefore relationship between frontal asymmetry and test anxiety of school children has been linked in the present study. This study considered test anxiety as a negative emotion and the main focus of the brain area was mid-frontal region. Quasi-Experimental design with pre test and post test (without control group) was used for the study. Relaxation therapy as an intervention programme was given to the sample of average learners with the mean age ranges from (16.2±0.84) in order to find out the impact on mid-frontal asymmetry. It was found that mid-frontal EEG asymmetry and test anxiety have relationship with each other and relaxation therapy intervention programme can help the children to reduce test anxiety by increasing the left mid-frontal brain activity which is a sign of increase of positive emotions.

Key Words: Electroencephalogram (EEG), Mid-Frontal Asymmetry, Relaxation Therapy, Test Anxiety.

I. INTRODUCTION

Frontal brain asymmetry has been conceptualized as a biological substrate for the fundamental dimensions of emotion, approach and withdrawal [10], [11]. Positive affect and approach behaviours are correlated with a greater relatively left frontal activity [14], [16], whereas negative affect and withdrawal behaviours are related to a greater relatively right frontal activity [5]. In the extant literature, therefore, it is hypothesized that Frontal Asymmetry acts as an index of the basic emotional dimension of approach versus withdrawal [2]. On this basis individual difference in asymmetric frontal activity indicates individual differences in affective style [8]. The main aim of the present study is, focusing the left frontal activity of human brain. Frontal Asymmetry has been put forward as a biological marker for the risk for anxiety and depression [2], [8]. Frontal EEG asymmetry has been linked to anxiety [36] and researchers are investigating the role of frontal EEG asymmetry in anxiety disorders [9], [26]. Through these previous research studies, it is noticed that anxiety has connection with frontal asymmetry and therefore relationship between frontal asymmetry and test anxiety of school children has been linked in the present study. Test anxiety is conceptualized as a relatively stable trait triggered by threatening situations. It is a subtype of anxiety that is defined as a situation specific anxiety trait [33]. Libert & Morris construed test anxiety as comprised of cognitive (i.e. worry) and emotional (tension, bodily reactions, and perceived arousal) facets [33]. There are positive effects of relaxation training in children [27] in comparison to a control group that did not receive relaxation training [32]. It is found that progressive muscle relaxation, as well as systematic relaxation training, may reduce tension. Therefore, test anxiety interventions should focus on the cognitive or emotional facets [6]. With these ideas the objectives of the study are framed to analyze the impact of relaxation therapy on mid-frontal asymmetry with respect to test anxiety among average learners in adolescence age group ranges from (16.2±0.84) years.

II. OBJECTIVES OF THE STUDY

- ◆ To find out the impact of relaxation therapy on mid-frontal EEG asymmetry of the brain of average Learners.
- ◆ To measure the impact of relaxation therapy on Test Anxiety of the Average Learners.
- ◆ To interrelate the frontal EEG asymmetry and Test Anxiety of the Average Learners.
- ◆ To improve the quality of academic life of Average Learners.

III. RESEARCH QUESTIONS

- ◆ Does Relaxation Therapy change the mid-frontal EEG asymmetry of the brain of Average Learners?
- ◆ Does Relaxation Therapy influence the Test Anxiety of the Average Learners?
- ◆ Is there any relationship between mid-frontal EEG asymmetry and Test Anxiety of the Average Learners?

IV. DESIGN OF THE STUDY

Quasi-Experimental design with pre test and post test (without control group) is used for the study. Out of 112 average learners five students were selected randomly with the mean age of 16.2±0.84 years. Initially Stratified Random Sampling Technique was adopted for samples selection. Subjects were free from medical and sleep disorders as determined by history, physical examination, biochemical screening tests, electrocardiograms, and psychological screening questionnaires. In order to measure their brain waves permission had been requested from the individual students, class teachers, school authorities and parents of the selected students. After receiving the permission, Electro Encephalogram was recorded for all the students to measure their brain activation waves. Test Anxiety scores were measured using Charles D. Spielberger’s test anxiety questionnaire [41] and these values were considered as pre test values. After that, Relaxation therapy was given to the selected five students for about a month. Post-test was recorded on brain waves while doing relaxation therapy for the experimental cases and Test Anxiety scores were also measured at the end of the intervention programme.

A. Test Anxiety Questionnaire: In this present study, Test Anxiety Questionnaire by [41] was used in order to measure the test anxiety scores of the Average Learners. There are totally 20 statements in this questionnaire. It consists of 3 dimensions such as worry factor (8 Statements), Emotionality Factor (8 Statements) and Negativity (4 Statements) with 4-point scale. The reliability and validity of the Questionnaire is 0.9752 and 0.9875 respectively.

B. Mid-Frontal EEG Asymmetry: Mid-frontal EEG asymmetry is determined by subtracting the natural log (ln) of alpha power at the left electrode from the natural log (ln) of the alpha power at the right electrode (lnF4-lnF3). Brain activity is an inverse measure of alpha power activity, meaning less alpha power represents more brain activity and vice versa [38]. Thus, higher scores (scores greater than zero) on the left/right difference score indicate relatively less left alpha power and, it is assumed, relatively greater cortical activity. By contrast, lower scores (scores less than zero) on this scale indicate relatively less right frontal alpha power and relatively greater right frontal activity. Alpha power is assumed to represent the inverse of cortical activity [1]. Based on these ideas, from the individual EEG recording wave patterns, the mid-frontal region electrodes (F4 & F3) were extracted and asymmetry was calculated.

V. DELIMITATIONS OF THE STUDY

- Total number of sample is restricted to five average learners.
- The age group has been restricted between 15 and 17.
- In order to find out the mid-frontal EEG asymmetry only one psychological variable i.e., test anxiety has been chosen in the present study.
- Factors of test anxiety are not incorporated separately for the correlational studies, whereas total score of test anxiety has been considered.

TABLE: I
 PRE TEST AND POST TEST MID-FRONTAL ASYMMETRY OF AVERAGE LEARNERS

Case No.	Mid Frontal Region	N	Pre Test Asymmetry	Post Test Asymmetry
1.	F4 & F3	5	-0.59	1.33
2.			-0.10	0.20
3.			-1.60	-1.30
4.			0.45	0.11
5.			0.99	2.80

In cases 1, 2 and 5 the post test asymmetry values are increased because of relaxation therapy and it indicates that greater left brain activity relative to the right and it can be related to the experience of positive emotion during Relaxation therapy. In case 3, though the asymmetry value is negative in post test during relaxation therapy but it is lesser than the pre test value. In case 4, the impact of relaxation therapy is less but the individual experienced left brain activity and it is also an evidence of approach related behaviour.

Work by Tomarken and a colleague [43] suggests that differences in asymmetry observed across individuals are rooted in functional, not structural, differences in the brain. For example, individuals who show a pattern of left frontal asymmetry at rest may display right frontal asymmetry when presented with aversive film clips [18], [42]. Stable left asymmetry reported more intense positive emotion when presented with positive film clips [44].

10 month- old-infants were more likely to show left frontal asymmetry when viewing a person smiling than when presented with the same individual crying [12]. Infants of the same age also show shifts in EEG asymmetry in response to the approach of an unfamiliar adult [19] and maternal separation [20].

From these supporting studies it is interpreted that relaxation therapy has the potential of developing positive emotion in human brain as a result of that it increases the left frontal activity.

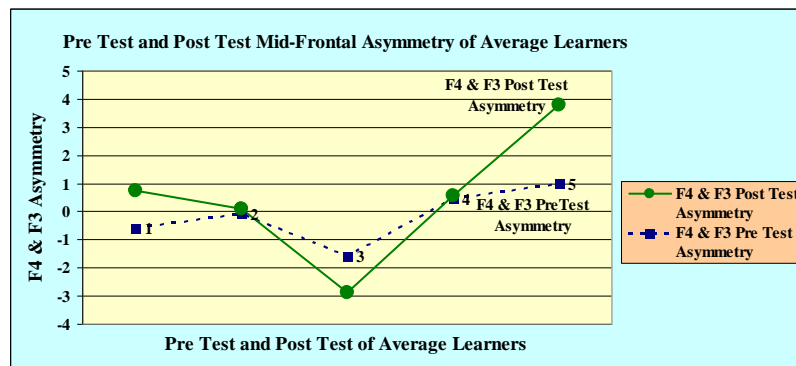


Fig.1 Pre test and post test mid-frontal asymmetry of average learners

TABLE: II
DIFFERENTIATION OF PRE TEST AND POST TEST TEST ANXIETY OF AVERAGE LEARNERS

Variable	N	Pre Test Mean	Post Test Mean	t-Value
Test Anxiety	8	46.8	32.2	2.516*

*p<0.05

It is clear from the table II that the calculated ‘t’ value of total test anxiety of Average Learners is significantly greater than the table ‘t’ value (p<0.05, N=5). Hence it is proved that there is significant difference between pre test and post test scores of Test Anxiety of Average Learners before and after applying Relaxation Therapy.

Relaxation therapy in the present study shows that decrease in test anxiety among average learners and it is supported by the following studies. To find out the effects of relaxation techniques on test anxiety in elementary school students of third-graders researchers selected two relaxation techniques and taught it to the students and proved that significant decrease in test anxiety among the experimental group after 5 weeks as compared to a group of their peers receiving no training [29]. 30 boys and girls participated in a 10 sessions group therapy that include training of muscle relaxation and dealing with stress, findings showed that in experimental groups test anxiety scores were lower than control group [25]. The evaluation of three methods namely cognitive therapy, training of reading skills, and control group was done by [40] that showed significant difference between control and main groups about test anxiety.

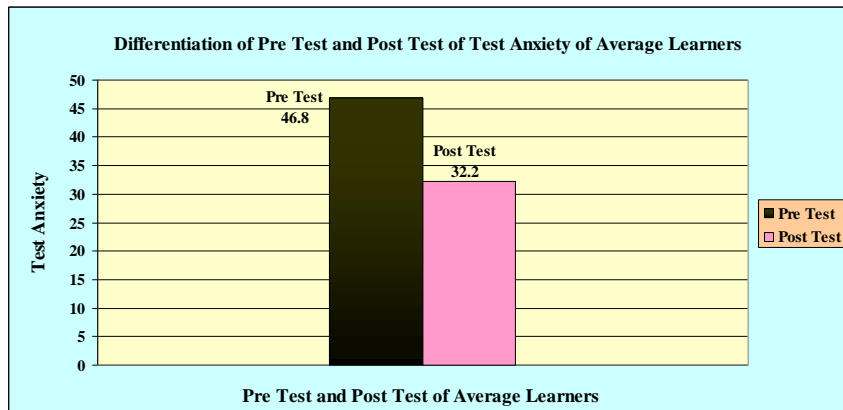


Fig.2 Differentiation of pre test and post test of test anxiety of average learners

To evaluate the lowering methods of anxiety with the aim of training of study skills and cognitive-behaviour technique and combination of Cognitive and regular desensitization technique [3] and control group, results showed that in ternate groups test anxiety scores were lower than control group. A new approach for test anxiety treatment academic achievement and meta-cognition with the design of pre-test and post-test with control group [34]. In that study all students of experimental group were given instruction methods training by 8 sections, every section, an hour with use of participatory learning and techniques such as lecture, disputation and question and answer and finally post Test was measured and the results of t-test showed that there were significant differences between test anxiety in pre-test and post-test. Test anxiety benefits of Wholistic Hybrid derived from Eye Movement Desensitization and Reprocessing (WHEE), Emotional Freedom Technique (EFT) and cognitive behavioural therapy (CBT) were explored [7]. Canadian university students with severe or moderate test anxiety participated in the research study. A controlled trial of WHEE (n = 5), EFT (n = 5), and CBT (n = 5) was conducted. Despite small sample size, significant reductions in test anxiety were found for all three treatments. In the present study, it is proved that relaxation therapy has the ability to reduce test anxiety among students.

TABLE: III
 CORRELATION BETWEEN MID FRONTAL ASYMMETRY AND TEST ANXIETY

Pre Test	Post Test
0.809*	0.952**

*p < 0.10; **p < 0.02

Positive correlations indicate that higher scores on the scale are associated with relatively greater left mid-frontal activity at rest. Negative correlations indicate that higher scores on the scale are associated with relatively greater right mid-frontal activity at rest [28].

It is obvious from the table that the correlation coefficient value (r=0.952) at the post test level is significantly greater than the table value at (p< 0.02, N=5). Hence it is proved that the high positively correlated score is associated with relatively greater left mid-frontal activity during relaxation therapy compare to the pre test value and it is concluded that the left mid-frontal activity during relaxation therapy is a result of reduction in test anxiety. The above result is supported by the similar research study with neuro-feedback intervention. Studies were done on neuro-feedback with phobic (test) anxiety [23]. It included random assignment, four alternative treatment control groups, and a wait- list control group. The group that received alpha EEG enhancement training produced 33% more alpha after treatment, and all three feedback groups (who received alpha enhancement biofeedback, electromyography (EMG) (muscle) biofeedback, and alpha plus EMG biofeedback) demonstrated significant reductions in test anxiety.

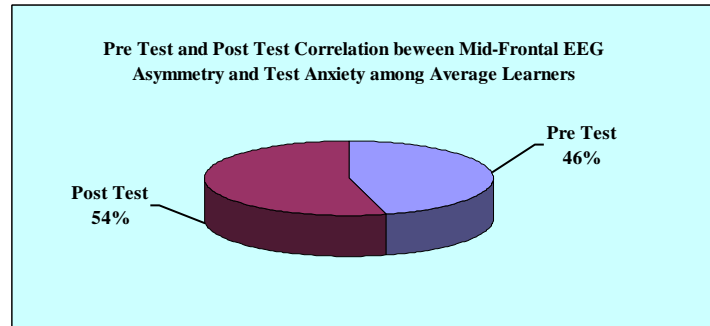


Fig. 3 Pre test and post test correlation between mid-frontal EEG asymmetry and test anxiety among average learners

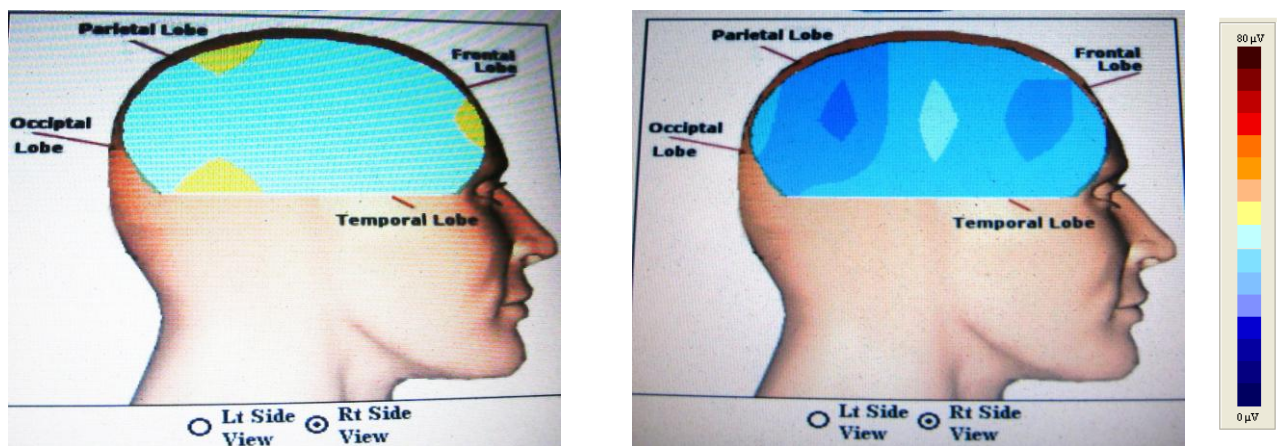


Fig. 4 Pre test and post test voltage maps of an average learner

VI. DISCUSSION

Davidson and Fox have theorized that the frontal lobes are differentially involved in positive versus negative affective states and corresponding motivated behaviours [13], with left frontal areas of the brain mediating the experience of positive emotions (e.g., joy, happiness, etc.) and approach behaviours, and right frontal areas of the brain mediating the experience of negative emotions (e.g., fear, sadness, etc.) and withdrawal behaviours. In the present study test anxiety has been considered as a negative emotion as it is found in the previous research studies. In previous studies it is proved that individuals with high test anxiety worry about not doing as well as they would like to do on a test [45]. Most people find examinations are stressful and may focus on expectations of failure and the undesirable consequences of personal inadequacy [39]. Moreover, patterns of frontal electroencephalogram (EEG) asymmetry may serve as an index of risk for a variety of emotion-related disorders, including depression and anxiety [35]. It is obvious from the correlation results of the present study that test anxiety has positive relationship with mid-frontal EEG asymmetry.

Anxiety had significant effect on right frontal EEG activation on trials with fearful faces of anxious participants displayed higher right frontal activation on fearful trials, in comparison to non-anxious participants. This effect was specific to the right hemisphere and fearful trials [30]. The results of the present study show that most of the cases have right frontal EEG activity and it proves that they have negative emotions in mid-frontal area of the brain. For example, a consistent pattern of relatively greater right mid-frontal activity compared to, left mid frontal activity characterizes those participants who later show larger negative and smaller positive affective responses to emotional film clips [44]. School-age children were asked to prepare a potentially embarrassing speech, a task designed to elicit social stress, showed increases in right frontal EEG asymmetry that paralleled increases in anxiety [37]. Studies were on EEG asymmetry in anxious children at ages 8 or 11 relative to non-anxious control groups and found that anxious girls showed more right frontal asymmetry [4].

In this study after the relaxation therapy intervention programme, maximum number of cases shows increase in left frontal activity, that is an indication of increase of positive emotion in mid-frontal area of the brain. The above interpretation is supported by table (I) and table (II). In table (II) it is observed that after the relaxation therapy programme, test anxiety has been reduced, that means as it is considered in the present study that the negative emotion, test anxiety is reduced by the relaxation therapy programme and that is evident from the results of table (I) which indicates left mid-frontal EEG activity at the post test level. Frontal EEG asymmetry appears to serve as an individual variable related to emotional response in emotional disorders like anxiety [15]. Regulatory skills and behaviours developed rapidly during childhood play a critical role in linking frontal EEG asymmetries to emotional reactivity in children [31]. In early childhood, children with right frontal asymmetry are also more likely to be behaviourally inhibited and show difficulty with social interactions [21], [22]. Individuals with high levels of anxiety tend to do worse on cognitive tests [24].

VII. CONCLUSION

It is concluded that mid-frontal EEG asymmetry and test anxiety have relationship with each other and relaxation therapy intervention programme can help the children to reduce test anxiety by increasing the left mid-frontal brain activity which is a sign of increase of positive emotions.

VIII. LIMITATIONS

- In Indian scenario, for experimental brain researches it is very difficult to get permission from individual, parents and school authorities for measuring EEG brain activity. Generally parents think that their children's resources are wasted for acquiring educational qualifications of the investigator instead they should feel that the research is submitted for the welfare of humanity.
- It is cost effective.

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