

ANTERIOR AND POSTERIOR REGIONS OF THE BRAIN IN RELATION TO TEST ANXIETY

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Abstract

Left hemispheric anterior and posterior activities are related to positive affect and inversely right-sided anterior and posterior brain activity is associated with negative affect. In this present study the anterior and posterior regions of the brain were analysed using Electro Encephalogram (EEG) with relaxation therapy intervention. The study was framed as quasi experimental design with pre-test and post-test having sample (N=5) of five high achievers with the mean age of 16.2 ± 1.64 was selected for the study. Initially the pre-test values of brain regions of all the students were recorded and test anxiety scores were also measured using test anxiety inventory by Charles D. Spielberger (1980). Relaxation therapy intervention programme was conducted for all the students for about a month in order to reduce the adverse emotions. At the end of the intervention programme post-test was recorded on brain regions and test anxiety scores. Significant differences were observed in absolute powers of pre and post-test scores of anterior and posterior regions and also in alpha and delta waves. Differences were noticed in pre and post-test asymmetries of anterior and posterior regions. Findings suggested that left sided brain activity is responsible for reduction in test anxiety. Relaxation therapy acts as a useful tool to reduce test anxiety by increasing the positive affect and the changes occurred are not only functional and it can be structural too to produce long term effects.

Key Words: Alpha wave, Delta wave, Anterior region, Posterior region, Relaxation therapy, Test anxiety.

Introduction:

Anterior cortical activity has been associated with emotional and self-regulatory processes in connection with anxiety and depression.^[1,2] Research assessing electroencephalographic (EEG) activity, particularly in the alpha band (8-13 Hz), has supported the idea that the left and right anterior regions of the cortex are differentially involved in emotional and motivational processes.^[3] During meditation increase in alpha power is observed which is associated with relaxation.^[4] Researcher hypothesizes that relaxation has the potential to reduce anxiety by increasing the alpha power and study shows that it is related with relaxation.^[5] Delta brain wave (1 Hz-4Hz/Sec) which is the slowest in frequency and highest in amplitude plays a role in processing of the mind and to connect with the in-depth conscious level. Delta wave can be correlated to deep relaxation condition. Research findings show that relaxing activities can increase left sided activation of anterior and posterior regions of the brain. Changes in brain electrical asymmetry and immune function after a meditation program was found between meditation group and wait-list group.^[6] Test anxiety incorporates cognitive and emotional facets acts in specific situations and can be called as a situation specific anxiety trait.^[7] Anxiety, a negative emotion that is associated with right sided brain activation and it is proved in previous researches that increased posterior cingulated activation has previously been associated with increased negative affect and anxiety symptom intensity.^[8] An increased activity in the left and even more in the right posterior sites by displaying a hemispheric asymmetry in favor of the right hemisphere during negative emotions.^[9] Based on the previous studies it is hypothesized that right sided anterior and posterior brain activation is responsible for

test anxiety and relaxation therapy can lead a way to activate left brain activity to reduce negative affect.

Objectives of the study:

- To study the impact of relaxation therapy on absolute powers of Anterior and Posterior regions of the brain with respect to test anxiety among high achievers.
- To discuss the impact of relaxation therapy on Anterior and Posterior Asymmetry.
- To measure the impact of relaxation therapy on Alpha and Delta waves.
- To improve the quality of academic life of high achievers.

Research questions:

- Does relaxation therapy change the absolute powers of Anterior and Posterior Regions of brain with respect to test anxiety of high achievers?
- Do asymmetric indices of anterior and posterior regions change after relaxation therapy?
- Does relaxation therapy bring changes in alpha and delta brain waves of high achievers?
- Is there any significant difference between pre and post test scores of test anxiety?

Materials and Method:

Design of the study:

The experimental design chosen for the study is quasi-Experimental having pre-test and post-test categories. Stratified Random Sampling Technique was adopted for sample selection. Out of 40 high Achievers, highly test anxious five students (N=5) with the mean age of (16.2±1.64 years) were selected for the experiment. Spielberger's test anxiety inventory^[10] was used to measure the test anxiety. After obtaining permission, electroencephalogram was taken down for all the students, in-order to know their earliest brain activation before intervention and these values were considered as pre-test values. The selected students were taught relaxation therapy individually for one week before the beginning of the experiment. The therapy included Visualisation, Progressive Muscle Relaxation and Breathing Techniques. After making the students to get familiarize with the techniques, group 'Relaxation therapy' was given to the students with a mixture of all the three techniques each fifteen minutes for about one hour everyday as an intervention programme for one month. At the end of the intervention period, post-test was recorded on brain waves by electroencephalogram while doing relaxation therapy for the experimental cases in-order to minimize the intervening factors and Test Anxiety scores were also noted down.

Before the beginning of the experiment, permission was obtained orally from the school, from the students and their parents. The samples were screened by neurophysician and confirmed that they are free from other disorders.

Electroencephalogram (EEG) recording:

The electroencephalogram (EEG) is a recording of the electrical activity of the brain from the scalp. The recorded waveforms reflect the cortical electrical activity. EEG was recorded with the help of EEG technician. The odd numbers are used as subscript for points over the left hemisphere and even numbers over the right. For the present study the anterior region electrodes (Fp1, F7, F3, Fp2, F8, F4), posterior region electrodes (T5, P3, O1, T6, P4, O2) were considered for the analyses.

Test anxiety inventory:

Spielberger's Test Anxiety Inventory^[10] was used to measure the test anxiety among students which has reliability of 0.97 and validity of 0.98. Out of 20 total statements in this inventory, 8

statements are made for worry factor, 8 for emotionality factor and 4 for negativity factor with 4-point scale.

Asymmetry:

Asymmetry measures were calculated by subtracting left-sided power density from right-sided power density at homologous sites [$\ln(\text{right}) - \ln(\text{left})$]. Greater the left-sided activation is marked by observing higher scores on asymmetric index^[11] and the power of EEG is inversely related to brain activity which results in greater relative right hemisphere activity due to its negative values.^[12]

Results:

Table 1: Differentiation of pre and post-test absolute power of Left and Right Anterior and Posterior Regions of the brain of High Achievers

Brain Regions	N	Pre-test Mean	Post-test Mean	't'	'P'
Left Anterior	5	62.40	383.69	5.05	0.007
Right Anterior		71.03	608.40	12.52	0.000
Left Posterior		153.10	1699.96	7.70	0.002
Right Posterior		329.06	3002.99	9.93	0.001

It is found from table 1 that the calculated 't' values of high achievers are significantly greater than that of the table 't' values ($p < 0.007$, $N=5$, for left anterior; $p < 0.000$, $N=5$, for right anterior; $p < 0.002$, $N=5$, for left posterior; $p < 0.001$, $N=5$, for right posterior). It is proved that there exists a significant difference between Pre-test and post-test scores of left and right anterior and posterior regions of the brains of high achievers before and after applying Relaxation Therapy. Studies have suggested that greater left-sided anterior activation, indexed by decreased alpha activity on the left hemisphere, is associated with reduction in anxiety, higher levels of positive affect, and feeling of well-being.^[13,14] Studies on Triarchic Body-pathway Relaxation Technique (TBRT) and music were both associated with significant increases in left-sided anterior activation, with increased positive emotions.^[15] These results are also in line with findings from previous studies that demonstrated the therapeutic effects of meditation^[16] and music^[17,18]. Qigong meditation type having Rest and meditation group showed increased alpha power in their states.^[19] There was a significant increase in alpha power in the meditation condition compared to the rest condition, when averaged across all brain regions, and it was found that alpha was significantly greater in the posterior region as compared to the frontal region.^[20]

Table 2: Pre and Post-test Scores of Anterior and Posterior Asymmetry

S.No	Anterior Asymmetry		Posterior Asymmetry	
	Pre-test	Post-test	Pre-test	Post-test
1.	0.07	0.19	1.48	0.41
2.	0.63	0.77	-2.44	0.51
3.	0.29	0.84	-0.57	0.69
4.	0.25	0.15	2.14	0.97
5.	-2.57	0.48	3.14	0.29

From Table 2 it is observed that, balanced level of brain activity is achieved in Anterior and Posterior asymmetry of high achievers after relaxation therapy. Some cases had negative brain asymmetry value before intervention programme. It has been changed to positive asymmetry after relaxation therapy that is an indication of increased left brain activity. Resting anterior EEG asymmetry has been found to relate to individual differences in dispositional positive and negative affect such that individuals with extreme and stable relative left-anterior cortical activity report increased positive affect and decreased negative affect relative to individuals with extreme and stable right anterior cortical activity.^[21] The resting asymmetry has also been found to predict affective responses to stimuli such that individuals with stable and extreme relative left-anterior activity report more intense positive affect to positive films and individuals with stable and extreme relative right-anterior activity report more intense negative affect to negative films.^[22] Moderation of right-posterior asymmetry by anxiety is consistent with the hypothesized role of the posterior right hemisphere in arousal, vigilance, and other aspects of adaptive threat response.^[23,24] Increased posterior right hemisphere activity as measured by fMRI has also been demonstrated in normal individuals in response to high-arousal negative words during an emotional stroop task.^[25]

Table 3: Differentiation of pre and post-test absolute power of left and right alpha and delta brain waves of High Achievers

Brain Waves	N	Pre-test Mean	Post-test Mean	't'	'P'
Left Alpha	5	48.92	181.18	4.74	0.009
Right Alpha		49.02	333.46	5.81	0.004
Left Delta		125.11	1333.61	7.04	0.002

Right Delta		298.86	2240.95	7.86	0.001
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It is noted from the table 3 that the calculated 't' values of high achievers are significantly greater than that of the table 't' values ($p < 0.009$, $N=5$, for left alpha; $p < 0.004$, $N=5$, for right alpha; $p < 0.002$, $N=5$, for left delta; $p < 0.001$, $N=5$ for right delta). Significant differences are observed between pre-test and post-test scores of left and right alpha and delta waves of the brains of high achievers before and after applying Relaxation Therapy. Alpha power increase is one of the more consistent findings about meditation state effects and alpha is generally associated with relaxation.^[5] A study on Raj yoga meditation type having the experimental design of rest versus meditation showed that increased alpha power during Samadhi in meditation state.^[25] Transcendental Meditation (TM) type having Long Transcendental Meditation and Short Transcendental Meditation design showed that increased alpha power in their meditation traits.^[26] Increased delta power was observed in a 15 min of massage therapy among adults^[27] and it is associated with relaxation and alertness^[28].

Table 4: Differentiation of Pre and post-test Test Anxiety Scores of High Achievers

Test Anxiety	N	Pre-test Mean	Post-test Mean	't'	'P'
	5	53.80	41.60	3.28	0.031

From table 4, it is clear that the calculated 't' value of total test anxiety scores are significantly greater than the table 't' value ($p < 0.031$, $N=5$) and it is proved that there is significant difference between pre-test and post-test test anxiety scores of high achievers before and after applying relaxation therapy. Relaxation techniques showed significant decrease in test anxiety after 5 weeks among third grade elementary school students.^[29]

Discussion:

Higher level of anxiety leads to low performances in cognitive tests^[30] and so, the main aim of the test anxiety interventions should be on the cognitive or emotional facets^[31]. The present study analyzed test anxiety in connection with emotional activities of anterior and posterior brain regions. Relaxation intervention programme has been given to reduce the anxiety related symptoms and alpha waves were analyzed to study the effects of relaxation. Studies investigating developmental changes in topography have found that the increase in alpha power starts at posterior derivations and ends at more anterior recording sites.^[32,33] In this study the increased alpha power is observed among the sample after relaxation. Mindfulness based Triarchic Body-Pathway Relaxation technique (TBRT) and music were both associated with significant increases in left-sided anterior activation, and found that TBRT is associated with increased positive emotions.^[34] These results are also in line with findings from previous studies that demonstrated the therapeutic effects of meditation^[6] and music.^[35,18] Based on the objectives of this research, relaxation therapy increased the alpha power and it has connection with increase of left sided anterior activation that is an outcome of increased positive emotions.

Alpha oscillations are known to arise from an increase of internal attention^[36] which of course does not only occur due to meditation. Various studies showed an increase of alpha power^[5,25,37] related to internally driven mental operations, like the imagery of tones.^[36,38,39] As it is derived in

previous researches that the increase in alpha power is responsible for internal focus and relaxed mental operations, which can be associated with the results of the present study. Greater self-awareness of errors and difficulties in social behaviour appears to be an anterior cortical function that is related to anxiety.^[40,41]

Anxiety and related constructs are usually associated with right anterior asymmetry in research with adults, which is greater in individuals who are threat sensitive or exhibiting an anxiety disorder.^[2] Recent studies have suggested that greater left-sided anterior activation, indexed by decreased alpha activity on the left hemisphere, is associated with reduction in anxiety, higher levels of positive affect, and feeling of well-being.^[13,14] It is developed from the previous study and our research results that left-sided anterior activation decreases alpha activity on the left hemisphere and thereby it reduces test anxiety among samples after relaxation. Increased frontal and posterior right hemisphere activity as measured by fMRI has also been demonstrated in normal individuals in response to high-arousal negative words during an emotional stroop task.^[23] Right-posterior activation was complicated by an interaction of anxious arousal and anhedonic depression, supporting predictions that this region of the brain would be modulated by arousal effects of anxiety.^[42] Slow wave EEG activity (delta power) is associated with lower arousal and relaxation^[28], as were decreased in heart rate.^[43]

From the previous research supports it is proved in the present study that increased activity in the right posterior region of the brain is accountable for anxious arousal, the negative emotion and in our present study, the left sided posterior activity is observed among the samples in the post-test with delta activity which is responsible for lower arousal and relaxed state. It is concluded that relaxation increased positive affect by increasing the left sided activity in anterior and posterior regions of the brain.

Based on the present research outcomes test anxiety can be reduced through relaxation therapy by increasing the positive emotional stimuli. According to Zbornik (as cited in^[45]), students who suffer from test anxiety tend to be consumed with feelings of anxiousness, worthlessness, and/or absolute dread in regard to their academic achievement. As a result, today's students are associating a greater sense of consequence with the prospect of being tested, resulting in feelings of pressure to perform and fear of not performing adequately.^[46] Based on these subjective outcomes, after the intervention programme it was observed among high achievers that they expressed positive emotions through their bodily symptoms. And it is proved with their brain wave recordings.

Richard Davidson, a neuroscientist at the University of Wisconsin, had led experiments in cooperation with the Dalai Lama on effects of meditation on the brain. His results suggested that long-term or short-term practice of meditation results in different levels of activity in brain regions associated with such qualities as attention, anxiety, depression, fear, anger, the ability of the body to heal itself, and so on.^[47] Teachers in the classrooms can easily identify the test anxious students and they can modify their mood and the brain by applying intervention programmes used by the investigator. These functional changes may be caused by changes in the physical structure of the brain^[47,48,49] and we can conclude that the changes occurred because of relaxation therapy on the brain regions of the high achievers are not only functional and also it can be structural and it can give long term effects. Academicians can admit relaxation techniques in curriculum to bring out better cognitive and behavioural outcomes.

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