Relaxation Therapy on Prefrontal Cortex Activity in Relation to Psychological and Biological Variables

Abstract:

Apprehension of test affects the working memory of the brain which is processed at the prefrontal cortex area. If the person develops test anxiety, the brain power becomes low and it is exhibited on the performance of the test. For better cognitive performance relaxation must be necessary for humans. In this present study Relaxation therapy was used to reduce test anxiety among school level students. Quasi-Experimental design with pre test and post test (without control group) was used for the study. Initially Stratified Random Sampling Technique was adopted for samples selection. Out of 112 average learners five students were selected randomly with the mean age of 16.2±0.84 years. Out of 40 above average learners, highly test anxious five students with the mean age of 16.2±1.64 years were selected for the experiment. Pre test values were measured on test anxiety, working memory and pre frontal cortex area of the brain using Electroencephalogram and after five minutes their heart rate was also recorded using electrocardiogram. Test Anxiety Inventory by Charles D. Spielberger (1980) was used in order to measure the attitude towards test of average and above average learners and working memory scores were noted by using the working memory scale developed by Nithiya Amirtham .S and Saraladevi .K (2013). Relaxation therapy as an intervention programme was given to average and above average learners separately for one month. At the end of the intervention programme all the above mentioned tests were taken during post test while doing relaxation therapy. Prefrontal asymmetry of the samples is interpreted with the emotional states. Relaxed mental state can smooth the cognitive functions and it can be interpreted with the possibility of structural changes in prefrontal cortex. It is concluded that Relaxation therapy is beneficial for reduction in worry, test anxiety and improving the working memory functioning by increasing the prefrontal cortex brain power in both the groups.

Key Words:

Heart Rate, Prefrontal Cortex, Relaxation Therapy, Test Anxiety, Working Memory, Worry.

Introduction:

Test anxiety is a fear of facing exam situations which mainly affects cognitive performance. Nicaise (1995) also defined test anxiety as an individual's physiological, cognitive, and behavioral responses that stimulate negative feelings about an evaluation. Test anxiety directly impairs performance in test situations, at least high stakes ones (Rothman, 2004; Zatz & Chassin, 1985). Worry is a major component of test anxiety that leads to cognitive dissonance, physical tension and interruption at the performance level. Students with test anxiety typically experience worry about the exam result, tension or jitteriness, irrelevant thoughts, and bodily reactions like stomachaches or headaches (Sarason, 1984). (Borkovec et al., 2004) presented the theoretical rationale behind and empirical evidence for the possibility that worry functions as a cognitive avoidance of somatic and affective experience. It was confirmed in a number of studies that routine academic events may cause stress and produce temporary elevations in pulse, blood pressure, and that there is strong positive correlations between the self-rating anxiety score and the blood pressure and heart rate increase amplitudes (Conley & Lehman, 2012; Pramanik, Ghosh, & Chapagain, 2005; Zhang, Peng, Yang, & Cheng, 2011). In previous research study it is said that highly anxious learners have been shown to be less skillful in laboratory memory tasks (Mueller, 1980). Memory level of the students is affected by test anxiety which is a major blockage in performance situations. Information processing approaches (e.g. Benjamin et al., 1981; McKeachie, 1984) suggest that performance deficits of anxious students may result from problems in encoding the material, in organizing the material, or in retrieving the information during an exam. In our study it is assumed that the heart rate and increase in test anxiety may have relationship and it may affect the working memory of the students. Many researches showed that the working memory capacity decrease with the increase of the anxiety (Mayes & Calhoun, 2007; Wood, 2006). Prefrontal lateralization during encoding may depend on the material presented (Brewer et al., 1998; Wagner et al., 1998, 1999; Kirchhoff et al., 2000) as well as on the stage of memory processing studied (encoding versus retrieval; Tulving et al., 1994; Smith and Jonides, 1999; Haxby et al., 2000). Shackman, Pizzagalli, Lavric, and Davidson (2006) defended the idea that anxiety uses the resources of the prefrontal cortex normally allocated to working memory, therefore causing deficits in memory performance. Several studies have shown a specific relationship between the prefrontal cortex and both anxiety (Bechara, Damasio, & Damasio, 2000; Davidson, Pizzagalli, Nitschke, & Putnam, 2002) and working memory (Manoach et al., 2004). Alpha power increase is one of the more consistent findings about meditation state effects and alpha is generally associated with relaxation (Aftanas & Golocheikine, 2001). Meditation-related brain states at the beginner/student level were often found to correspond to an increased power and synchronization of low frequency activity, in particular, alpha activity (Juergen Fell, Nikolai Axmacher, Sven Haupt, 2010). Relaxation is used as an effective method to reduce anxiety and including two different techniques, i.e. deep breathing and muscle relaxation have proved to be effective in relieving anxiety and increasing concentration of children and adults on their tasks at hand (Zuercher-White, 1998; Paul, Elam, & Verhulst, 2007). Dendato & Diener (1986) conducted a study to measure the effectiveness of cognitive/relaxation therapy and study-skills in reducing self-reported anxiety and improving the academic performance of test-anxious students. In our study it is hypothesized that relaxation techniques have the ability to bring changes in worry and manage the test taking situations by relaxing the mind and body with increase in alpha power. It is postulated that significant differences may occur in prefrontal cortex functioning before and after relaxation therapy. Test anxiety plays a significant role in academic settings and may prevent some students from realizing their fullest academic potential (Betz, 1978; Chapell et al., 2005; McDonald, 2001; Powell, 2004a, 2004b; Seipp, 1991). Introducing relaxation therapy as an intervention programme to test anxious students has chances to reduce test anxiety and to produce better cognitive performance. It was identified that there is a link between asymmetry of frontal alpha activation and the valence of a subject's emotional state (Davidson, 1993). Negative affect is associated with relatively higher right frontal activation, whereas positive emotional states are associated with greater left frontal activation (Davidson, 1992; Tomarken, 1990; Wheeler et al., 1993). It is found in previous researches that reduction in self reported stress levels and decreased heart rate, the greatest shift towards left frontal EEG asymmetry for the moderate pressure massage group (Miguel A. Diego, 2004). Techniques such as meditation, relaxation, yoga and mindfulness therapy can boost activity in the left side of prefrontal cortex leading to increased wellbeing (Davidson, Kabat-Zinn, Schumacher, Rosenkranz, Muller, Santorelli, Urbanowski, Harrington, Bonus & Sheridan, 2003). It is presumed in this study that increase in left frontal alpha activity will lead to decrease in worry component with reduction in test anxiety and will increase working memory level of the students after relaxation therapy.

Objectives of the Study:

- To find out the impact of relaxation therapy on prefrontal cortex of the brain of average learners and above average learners with respect to test anxiety.
- To find out the significant difference between pre and post test of heart rate, worry, test anxiety and working memory before and after relaxation therapy among average learners and above average learners.
- To obtain the pre test and post test FP1 and FP2 asymmetric index values of average learners and above average learners.
- To improve the quality of academic life of average learners and above average learners.

Research Questions:

The research questions addressed in this research are:

- Does relaxation therapy change the absolute power of prefrontal cortex area of the brain of average learners and above average learners?
- Does relaxation therapy influence Worry and Test Anxiety?
- Is there any change in the working memory of the brain after relaxation therapy?
- Does relaxation therapy have any impact on heart rate?
- Is there any difference between the pre test and post test FP1/FP2 asymmetry?
- Are there any relationship between heart rate & worry, heart rate & test anxiety and heart rate and working memory?

Design of the study:

Quasi-Experimental design with pre test and post test (without control group) is used for the study. Randomly selected students were given Raven's advanced progression matrices test (1962) for classification of average and above average learners based on the IQ level. Stratified Random Sampling Technique was adopted for samples selection. The students were allotted under different strata using intelligence quotient values. Out of 112 average learners five students (N=5) who are highly test anxious were selected with the mean age of (16.2±0.84 years) and out of 40 above average learners, highly test anxious five students (N=5) with the mean age of (16.2±1.64 years) and were selected for the experiment. 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 permission, Electroencephalogram was recorded for all the students to measure their brain activation and electrocardiogram was also recorded to measure heart rate. Test Anxiety scores were measured using Charles D. Spielberger's test anxiety inventory (1980) and working memory values were noted down working memory scale developed by Nithiya Amirtham .S and Saraladevi .K (2013). These values were considered as pre test values. After that, Relaxation therapy was given to the selected five students in each group for one month. Post-test was recorded on brain waves while doing relaxation therapy for the experimental cases while doing relaxation therapy and after 10 minutes heart rate was measured through electrocardiogram. Test Anxiety scores and working memory values were also assessed at the end of the intervention programme through questionnaires.

Limitations:

- Obtaining permission from individuals, parents and school authorities for doing human brain research was a hard earned task and an ethical issue in the Indian context also limited the sample size.
- Since the design of the study is cost effective experiment, only five students in each groups were involved in the present study.
- Even though five students in each group were admitted in the experimentation, number of variables which were observed among the students was more in number including brain waves, different lobes and regions of the brain, bio-physical, bio-chemical and psychological variables.

Electroencephalogram (EEG) and Electrocardiogram Recordings:

Electrical activity of the brain from the scalp is recorded through electroencephalogram. The standardized placement of scalp electrodes for a classical EEG recording has become common since the adoption of the 10/20 system. An ECG is used to measure the heart's electrical conduction system (Walraven, 2011). In our study EEG and ECG was recorded with the help of technicians. For the present study the prefrontal cortex electrodes FP1 and FP2 are selected for analyses. FP1 covers Brodmann area 10 on the front left side of the frontal lobe. This is part of the prefrontal cortex that highly developed part of the brain which sets us apart from other mammals since it is responsible for the execution of cognitive tasks. Complex behaviors and simultaneous mental activities need a kind of working memory that keeps track of running tasks in either pending states or executive states. For most cognitive functions information needs to be retrieved after completion of another task. FP2 covers the right side of the prefrontal cortex (Christoph De Boeck, 2010). Heart rate is considered for the present study in order to connect the mind body relation.

Test Anxiety Inventory:

In this present study, Test Anxiety Inventory by Charles D. Spielberger (1980) was used in order to measure the attitude towards test of average and above 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-ponit scale. The reliability and validity of the questionnaire is 0.9752 and 0.9875 respectively.

Working Memory Scale:

For the present investigation, the working memory scale prepared by the authors of the present study Nithiya Amirtham .S and Saraladevi .K (2013) was used to measure the working memory of the average and above average learners. There are 9 questions in the scale. The alpha reliability of the test is 0.8270 and the validity of the test is 0.9093.

Frontal Asymmetry:

Asymmetry measures were computed by subtracting left-sided power density from right-sided power density at homologous sites (ln right minus ln left). Higher scores on this asymmetry index are interpreted to reflect greater left-sided activation (Sutton S.K & Davidson RJ, 1997). Because EEG power is inversely related to activity, resulting negative values reflect greater relative right hemisphere activity (Davidson & Tomarken, 1989).

Table: I

Differentiation of Pre and Post Test Absolute Power Scores of Fp1 and Fp2 Electrodes

Level of Learners	**Average Learners**		**Above Average Learners**	
Pre-Frontal Cortex Electrodes	***Fp1***	***Fp2***	***Fp1***	***Fp2***
N	5	5	5	5
Pre Test Mean (Micro Volts^2)	30.50	17.02	21.75	22.23
Post Test Mean (Micro Volts^2)	86.55	124.95	106.84	101.59
t-Value	2.58*	15.80**	5.28**	3.36*

Significance Level $^*p < 0.01$, $^{**}p < 0.00$

Table: II
Pre Test and Post Test Prefrontal Asymmetry (FP1/FP2)

Number of Cases	Average Learners Prefrontal (FP1/FP2) Asymmetry		Above Average Learners Prefrontal (FP1/FP2) Asymmetry	
	Pre Test	*Post Test*	*Pre Test*	*Post Test*
1.	-0.04	0.13	-0.58	-1.50
2.	-1.21	1.48	-1.06	0.51
3.	0.79	0.80	0.79	-0.02
4.	-1.08	0.05	0.76	-0.22
5.	-0.53	0.02	-6.86	0.33

Table: III
Differentiation of Pre Test and Post Test Scores of Alpha Absolute Power

	Learning Level	N	Pre Test Mean (Micro Volts^2)	Post Test Mean (Micro Volts^2)	t-Value
Absolute Power	***Average Learners***	5	194.12	270.74	4.565*
	Above Average Learners	5	97.94	514.65	6.566**

Significance Level $^{*}p<0.01$, $^{**}p < 0.00$

Table: IV
Differentiation of Pre Test and Post Test Scores of Heart Rate

	Learning Level	N	Pre Test Mean (bpm)	Post Test Mean (bpm)	t-Value
Heart Rate	***Average Learners***	5	80.00	63.00	7.410**
	Above Average Learners	5	72.40	71.00	0.551$^{N.S}$

Significance Level $^{**}p < 0.00$, N.S- Not Significant

Table: V
Differentiation of Pre Test and Post Test Scores of Worry, Test Anxiety and Working Memory

Learning Level Category	Average Learners			Above Average Learners		
Psychological Variables	***Worry***	***Test Anxiety***	***Working Memory***	***Worry***	***Test Anxiety***	***Working Memory***
N	5	5	5	5	5	5
Pre Test Mean	18.20	46.80	107.80	20.40	53.80	126.6
Post Test Mean	13.20	32.20	125.20	14.00	41.60	134.4
t-Value	3.84^{*}	13.56^{***}	4.25^{*}	3.78^{*}	3.28^{*}	5.10^{**}

Significance Level $^{*}p<0.01$, $^{**}p<0.00$, $^{***}p<0.000$

Table: VI
Pre Test and Post Test Correlation between Heart Rate (HR) and Psychological Variables

Level of Learners	Average Learners		Above Average Learners	
Correlation between HR and Psychological Variables	***Pre Test***	***Post Test***	***Pre Test***	***Post Test***
HR and Worry	-0.914^{*}	0.474	0.054	0.863
HR and Test Anxiety	-0.817	0.484	0.260	0.519
HR and Working Memory	0.571	-0.528	0.777	-0.931^{*}

Significance Level $^{*}p<0.05$

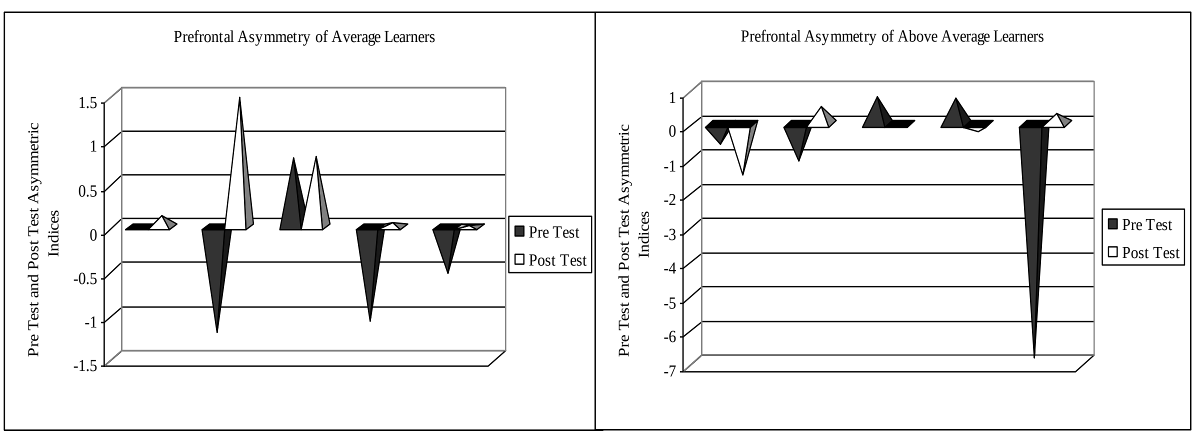

Figure I: Pre test and post test prefrontal asymmetries of average and above average learners

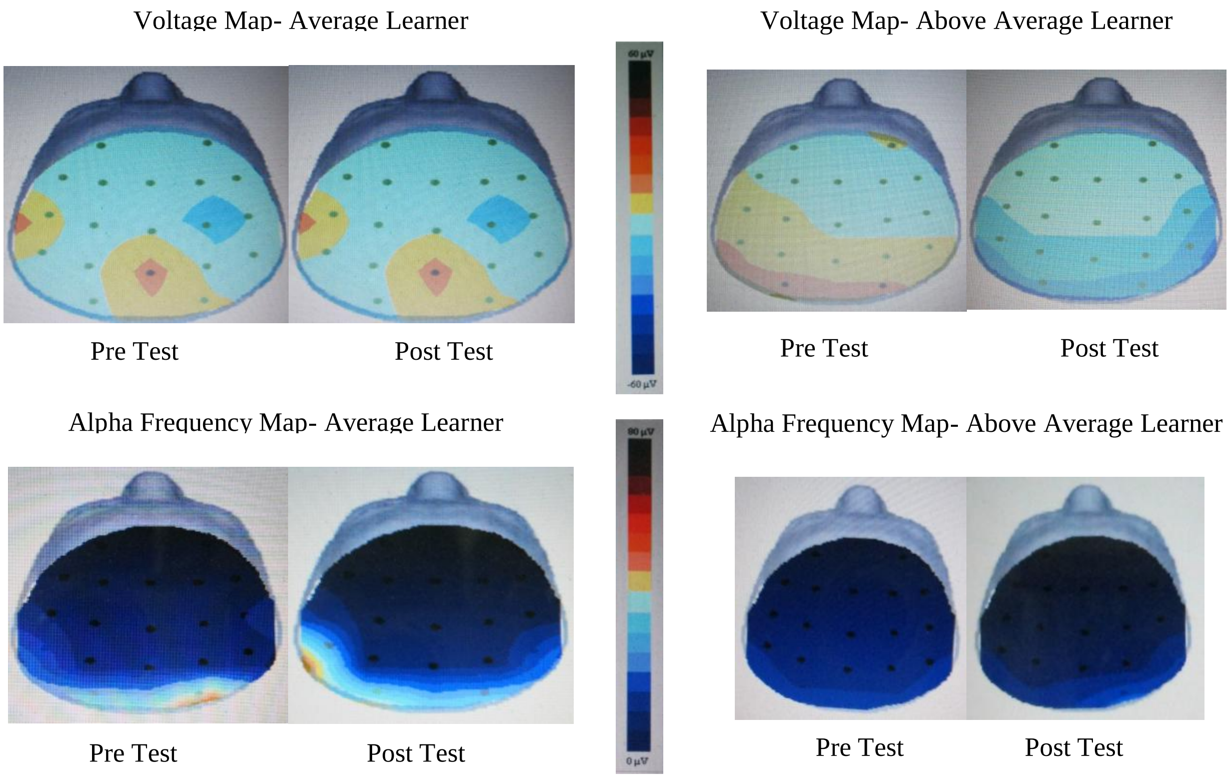

Figure II: Pre test and post test voltage map and alpha frequency map of an average and an above average learner

Results and Discussion:

It is clear from table I that there are significant differences between pre test and post test of prefrontal cortex electrodes fp1 ($p<0.01$, N=5) and fp2 ($p<0.01$, N=5) for average learners and fp1 ($p<0.00$, N=5) and fp2 ($p<0.01$, N=5) for above average learners. The same observation was made by Myoungjin Kwon et al., 2013, in their study the relative power of alpha waves from the prefrontal sites was significantly more in the experimental group compared to the control group after the group music therapy and Bruder et al. (1997) showed that prefrontal lobe activity was significantly high among patients with anxiety. The difference in absolute power before and after relaxation therapy in our study shows that changes occurred in FP1 and FP2 sites among both the groups. Heller et al. (1997) suggested previously that panic or anxiety were related to over activation of the prefrontal lobe, while Tucker (1981) related anxiety to a dysfunction of the forebrain hemisphere.

From table II we can understand the prefrontal asymmetry of average learners and above average learners. For average learners the result shows that except the third case all the others cases have, increased positive asymmetry values in post test than in pre test which is an indication of positive emotional state. In the case of above average learners case 2 and case 5 have positive asymmetry value. These findings are in line with the following studies. Prefrontal asymmetry has been found to reliably predict responses to emotion elicitors such as positive or negative film clips, pictures, and words (Coan and Allen 2004). Greater right frontal EEG asymmetry is manifested during the expression and regulation of negative/withdrawal emotions, while greater left frontal EEG alpha asymmetry is manifested during the expression of positive/approach emotions (Davidson, 1998; Davidson, 2000). The shift toward left frontal EEG asymmetry suggests that the moderate and light pressure massage, as well as the vibratory stimulation were perceived as being pleasant. This is consistent with the lower anxiety and stress levels reported across all groups (Miguel et al., 2004). Negative asymmetry is observed among some cases in above average learners group. Relaxation has less impact on FP1 and FP2 sites for these students. Peripheral biological correlates of individual differences in baseline functional prefrontal asymmetry where we have shown that individuals with more left prefrontal activity have lower levels of the stress hormone cortisol (Kalin et al., 1998). Subjects with greater relative baseline left-sided prefrontal activity recover more quickly following a negative event (Jackson et al., 2003) and report higher levels of psychological well-being (Urry et al., 2004), and they indicate the left-sided prefrontal activity is associated with a homological network that consists of effective coping with negative events and a resilient profile of peripheral neuro-endocrine and immune function. Bishop (2009) showed that processing inefficiency in high-anxious individuals often takes the form of deficient use of attentional control mechanisms based on the dorsolateral prefrontal cortex. Left prefrontal activity lowered test anxiety among the students those who have positive asymmetry value and it is proved that these students can easily manage test taking situations.

As per the results of table III there is a high level of significant differences is observed between pre and post test alpha absolute power values ($p<0.00$, $N=5$) among both the groups. It is supported by the studies of Anand et al., 1961. They worked with Raj yoga meditation type having the experimental design of (($N=6$) and Rest vs. meditation) showed that increased alpha power during Samadhi in meditation state (Anand et al., 1961). It is proved that alpha power increase is an indication of internal attention and relaxed condition. Relaxation induces a host of biochemical and physical changes in the body collectively referred to as the relaxation response (Benson, 1997). Some types of meditation might work by reducing activity in the sympathetic nervous system and increasing activity in the parasympathetic nervous system or equivalently, that meditation produces a reduction in arousal and increase in relaxation (National Center for Complementary and Alternative Medicine (NCCAM)). Alpha oscillations are known to arise from an increase of internal attention (Ray & Cole, 1985). Alpha power increase in relaxation state can improve attention and working memory functioning. An increase of alpha power related to internally driven mental operations, like the imagery of tones (Ray & Cole, 1985; Cooper et al., 2003; Cooper et al., 2006), or working memory retention and scanning (Jensen et al., 2002; Klimesch et al., 1999). The association between alpha changes and cortical activation had been assessed with combined EEG and fMRI–PET studies, with increased alpha power related to decreased blood flow in inferior frontal, cingulate, superior temporal and occipital cortices (Goldman, Stern, Engel, & Cohen, 2002; Sadato et al., 1998).

Table IV shows that significant differences exist between pre and post tests of heart rates of average learners ($p<0.00$, $N=5$) and in the case of above average learners it is not statistically significant.

These results are in agreement with the studies of Lindsey Dailey et al., 2012 and Miguel et al., 2004. (Lindsey Dailey et al., 2012) studied between control group who were in conversation with a lab technician sitting in a well lit room with average heart rate value (second and third minute recording) was approximately 74 beats per minute (bpm) and the average heart rate value for the second and third minute recording in the experimental group who were instructed to relax in supine position in a dark room for the duration of three minutes was approximately 67 (bpm) which showed statistically significant (P<0.04) difference between the two groups. Moderate massage group showed a significant decrease in heart rate during the massage, $t(11) = 5.89$, $p < .05$, which continued into the post session (Miguel et al., 2004). Among 15 college students, 30 minutes of Transcendental meditation (TM) practice caused a reduction in heart rate, breathing rate, and oxygen consumption and an increase in galvanic skin resistance suggesting a reduction in sympathetic arousal (Wallace, 1970) and also it had been showed that a similar trend of reduction in heart rate, total ventilation, and oxygen consumption and a greater stability of the electro-dermal response (Wallace, 1971). From the present study, among average learners it is obvious that significant differences are observed between pre and post test heart rate is an indication of reduction in sympathetic activity which is responsible for left prefrontal cortex activity compared to the above average learners group. (Telles, Nagarathna, & Nagendra, 1995) observed simultaneous reduction in heart rate (possibly related to increased vagal tone with reduced cardiac sympathetic activity) and finger plethysmogram amplitude (decreased sympathetic vasomotor activity) was observed during repeat meditation sessions among 7 experienced 'Om' meditators. As with the reduction in self reported stress levels and decreased heart rate, the greatest shift towards left frontal EEG asymmetry for the moderate pressure massage suggests that this modality was more pleasant and relaxing than either the light pressure massage or the vibratory stimulation (Miguel et al., 2004). (Rollin McCraty, 2009) observed alpha–ECG synchronization, this study found that a significant amount of lower frequency brain activity (< 8 Hz) was also synchronized to the cardiac cycle and proved that short-term (beat-to-beat) changes in heart rate are largely generated and amplified by the interaction between the heart and brain and also it was said that this interaction is mediated by the flow of neural signals through the efferent and afferent pathways of the sympathetic and para-sympathetic branches of the autonomic nervous system (ANS) (Rollin McCraty, 2009).

Significant differences are observed in table V between pre test and post test on psychological variables worry (p<0.01, N=5), test anxiety (p<0.000, N=5) and working memory (p<0.01, N=5) among average learners and worry (p<0.01, N=5), test anxiety (p<0.01, N=5) and working memory (p<0.00, N=5) among above average learners. The results are supported by the following research study. Paired t-tests across Cognitive Therapy (CT) group and Acceptance Based Behavior Therapy (ABBT) treatment groups showed a large overall reduction in test anxiety (TAI) from pre to post-intervention ($t(15)=2.45$, $p<.05$), and the test anxiety worry scale (TAI-W; ($t(15)=2.21$, $p<.05$)) (Lily et al., 2011). The results of the present research are similar with many studies that addressed the impact of relaxation on working memory (Hirokawa, 2004; Hudetz, Hedetz, & Reddy, 2004). (Rezaei Kargar et al., 2013) found that relaxation training and exercises have led to a significant increase of working memory capacity and its components (storage and processing) as well as academic achievement ($p < 0.05$). Chambers et al., (2008) examined the impact of a ten day Vipassana (mindfulness) meditation retreat on novice meditators' working memory capacity, measured by response time (RT) on a novel attention task that required participants to attend and update information between two categories, and five self-report measures of cognitive processes and affect. They found that meditation training increased mindfulness enhancement working memory, and reduced switch costs in the attention task. In addition, mindfulness training reduced anxiety, negative effect, and depression. Study results also suggest that improvements in working memory capacity may mitigate negative affect such as stress or anxiety (Jha et al., 2010). It is showed that in the present study relaxation therapy reduces worry which makes the person anxious about the test taking situation and leading to poor performance. (Sarason, 1975) demonstrated that test anxious students become preoccupied with the worry responses that are attentionally demanding and distracting from the task at hand during test-taking situations, which results in impairment in performance. Negative cognitions related to examinations, when such students under-estimate their own abilities, or overestimation the consequences related to their failure, are often accompanied by higher anxiety levels, and poor performance (Hancock, 2001; Hembree, 1988). Anxiety also amplifies the psychological and physiological reaction to aversive events (Ploghaus, Narain, et al., 2001; Epstein & Clarke, 1970). A functional account of anxiety emphasizes its role in avoidance of anticipated aversive events (Hofer, 2002; Gray & McNaughton, 2000). It is proved in the present study that alpha power increase during relaxation which helps the students in improvement of cognitive processing during working memory tasks. Experimental works focused on the role of brain oscillations in working memory, alpha band activity has been shown to increase with memory demands (Jensen et al., 2002; Klimesch et al., 1999; Krause et al., 1996). Klimesch et al. (1999) suggested that significant increase in these areas are not being used in processing and, in fact, are being inhibited by other active brain regions. Alpha band activity is directly involved in the neuronal mechanisms responsible for the maintenance of working memory (Jensen et al., 2002). There are findings of enhanced prefrontal alpha amplitude in a short-term memory task which is known to activate the prefrontal cortex (Goldman-Rakic, 1996). (Sauseng et al., 2005 a) study provides evidence that during top-down processing in a working memory task alpha power increase at prefrontal but decreases at occipital electrode sites. The dorsolateral prefrontal cortex is presumably a part of the explicit working memory network involved in establishing a novel association between visual cues and motor commands. Trained visuo-motor skills appear to increase specifically the left hemisphere activity (Halsband & Lange, 2006) and left M1dominance for motor imagery was also suggested in healthy subjects (Stinear, 2006).

The relationship between heart rate and psychological variables is observed clearly in table VI. Changes in relationship are observed between pre test and post test of heart rate and worry, heart rate and test anxiety, heart rate and working memory among average and above average learners. It is observed that there is a shift from negative relationship to positive relationship among average learners between HR and worry, HR and test anxiety. In the case of above average learners increase in positive relationship is observed. Between HR and working memory positive relationship has been changed into negative relationship in post test among average and above average learners. Significant negative relationship is observed between HR and worry ($p<0.05$, N=5) among average learners in pre test is observed and also negatively significant relationship is noticed between HR and working memory ($p<0.05$, N=5) in post test of above average learners. These findings are supported by the following previous researches. Peasley-Miklus & Vrana (2000) randomly assigned victimization-fearful or victimization- and speech-fearful participants to engage in 30 second periods of worrisome or relaxing thinking and to then imagine feared victimization or speech-giving scenes and it was noticed that there was greater heart rate suppression during fear imagery following a period of worry relative to a period of relaxation. Parameters for heart rate were assessed based on research published in the Journal of College Teaching and Learning, which shows a positive correlation between stress and heart rate. Reduction in stress via relaxing activities—yoga, humor, or reading for 30 minutes once a week for three weeks—reliably decreased heart rate by an average of 2-4 beats/min in students from a pre-study heart rate of 70-77 beats/min (Rizzolo et al., 2009). Depending on the nature of the heart’s input, it can either inhibit or facilitate working memory and attention, cortical processes, cognitive functions, and performance (Hansen, Johnsen, & Thayer, 2003; Lacey & Lacey, 1974; Rau, Pauli, Brody, Elbert, & Birbaumer, 1993; Sandman, Walker, & Berka, 1982; Van der Molen, Somsen, & Orlebeke, 1985). As discussed in previous researches, in our study heart rate reduction denotes that the subjects relaxed mental state and it can smooth the cognitive functions and it can be interpreted with the possibility of structural changes in frontal cortex. Short term stress inhibits prefrontal activities for emotional process and reduces working memory, mean while amygdala activity increases under prolonged stress. The chronic stress can lead to structural change in prefrontal cortex (Arnsten, 2009). (Luders et al., 2009) showed that an underlying biological basis for long-term meditation correlated with larger hippocampal and frontal volumes of gray matter. 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. These functional changes may be caused by changes in the physical structure of the brain (Lutz etal, 2004; Sharon Begley, 2007; Davidson & Lutz, 2008; Chris, 2007).

Conclusion:

The present study mainly focuses on the prefrontal cortex activity of average and above average learners. The electrode placements at FP1 and FP2 are analyzed with the relaxation therapy intervention programme and differences are found between pre tests and post tests. From the results it is observed that positive changes occurred in prefrontal cortex of average learners are effective comparing with the above average learners from the asymmetry indices. Among both the groups relaxed mental state is obvious from the alpha activity during relaxation therapy. Significant changes in heart rate are observed among average learners and it is not significant among above average learners group. Changes are visible in worry, test anxiety and working memory in both the groups. The connection between bodily reactions and the psychological variables such as worry, test anxiety and working memory are analyzed. Decrease in worry and test anxiety and increase in working memory are noticed with decrease in heart rate after the intervention programme. It is concluded that reduction in prefrontal cortex activity lowers the test anxiety with increase in alpha activity during relaxation which facilitate the improvement of working memory. Enhancement in parasympathetic nervous system activity leads to the left prefrontal activity which is an indication of increase of positive emotions. Though it is a short term period of the intervention programme the results of prefrontal cortex functional changes of average learners are better than the above average learners and also it can be structural and it can give long term effects.

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