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Cognitive Behaviour Therapy on EEG and Neurotransmitters Levels among the Students Having Higher Levels of Test Anxiety

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Abstract

The primary goal of cognitive behavior therapy is to identify and modify thoughts, feelings, and behavior that interfere with a desired outcome in life. Treatment may begin by addressing readiness issues or treatment interfering behaviors. New learning and planned steps to accomplish desired behavior change are developed with the students. Test anxiety management skills and behavioral skills are key components of treatment. With all these ideas in mind investigator had applied CBT to the sample. Primary aim of this investigation was to identify the impact of cognitive behavior therapy on Electro Encephalo Gram wave pattern of their brain and blood neurotransmitter levels of the students having higher levels of test anxiety. Higher secondary students are facing higher levels of test anxiety in INDIA, because higher secondary education is deciding their career life. Spielberger's Test anxiety questionnaire was given to the 200 higher secondary students.100 students with higher levels of test anxiety were selected and 50 students were treated as control students and 50 were treated for experimental study. Out of which 25 girls (mean age of 16.85±0.75) and 25 boys (mean age of 17.85±0.9) having higher levels of anxiety was chosen the study. Blood samples were drawn and sent to Ranbaxy laboratory for bio chemical estimation Electro Encephalo Gram recordings were done in neuro physician's clinic. Electro Encephalo Gram wave pattern, dopamine and acetylcholine levels of these students were measured before applying cognitive behavior therapy. Students were also photographed at the beginning of the experiment. These scores were recorded as pre test scores. Then the students were regularly given cognitive behavior therapy for about 6 weeks. Then their Electro Encephalo Gram wave pattern in the brain, dopamine and acetylcholine level of these students in the blood were estimated and recorded as Post Test scores. Critical Ratio, Correlation Coefficient and T test were the statistical techniques applied to analyze the pre test and post scores of the sample.

Key Words: *Acetylcholine, Cognitive Behavior Therapy, Dopamine Electro Encephalo Gram, Test anxiety*

Introduction

Neuroscience has developed several methods to analyze the cognitive function and potentate the understanding of the mental functioning of healthy and mentally disordered individuals. The recent advances in neuro imaging techniques have helped to increase the understanding of the neuronal correlates of mental disorders.

Psychological interventions can promote changes in the thoughts, feelings, and behaviors of students. Can we then say that the psychological treatment promotes brain changes? Unfortunately, the biological

mechanisms related to psychotherapy are little known. On the other hand, the arrival of neuroimaging techniques makes it possible to investigate the neurobiological consequences of psychological treatment. Such investigation is highly important, as a better understanding of the brain mechanisms underlying therapy can promote improvements in the therapeutic interventions as well as increase our knowledge on the formation and maintenance of symptoms. Elucidating the neural correlates associated with symptom reductions has been the subject of research aimed at the identification of the biological mechanisms of psychotherapy. The neuroscience of CBT is a novel area with important implications for our understanding of the mechanisms of maintenance of symptoms and of therapeutic change (Brenner et al., 2006; van der Gaag, 2006). A number of studies have already documented significant neural changes following psychological therapies for depression (Martin et al., 2001; Goldapple et al., 2004; Fu et al., 2008), obsessive compulsive disorder (Schwartz et al., 1996), panic disorder (Prasko et al., 2004) and social (Furmark et al., 2002) and animal phobias (Paquette et al., 2003; Straube et al., 2006; Schienle et al., 2009). The aim of the present study was to examine, for the first time to our knowledge in India what kind of functional brain changes, if any, might emerge following CBT for test anxiety in students.

Test anxiety is a common problem, affecting many students to the point that their grades suffer in spite of their performance in everyday class situations and on non-test academic activities. Many students become so overwhelmed by test anxiety that they perform poorly on tests no matter how much they study, and learning to cope with test anxiety is essential for optimum academic performance.

Cognitive-Behavioral Therapy (CBT) is a combination of cognitive and behavior therapies that are directive, time-limited, structured, and place great emphasis on homework exercises. While cognitive therapy emphasizes the role of cognitive processes in the origin and maintenance of psychological disorders, behavior therapy focuses on principles of learning theory and the role of reduced reinforcement in the creation and maintenance of these disorders. In cognitive therapy, individuals learn to identify and monitor distorted, negative thinking, to become aware of the relationship between such thoughts and negative assumptions about oneself—and of the association between thoughts and feelings. Individuals also learn to apply techniques to challenge these thoughts. In behavior therapy, individuals are taught to track the frequency of targeted behaviors and to understand the relationship between these behaviors and their antecedents and consequences. Furthermore, individuals learn techniques to increase or decrease particular events, and are taught skills such as problem solving, relaxation, and assertiveness. Both cognitive therapy and behavior therapy assume that psychological problems can be alleviated by teaching individuals new skills to identify negative thoughts, form adaptive thoughts, and alter maladaptive behavior patterns.

CBT acts on these perturbation and reduces the test anxiety and it also balances the Electrocardiography waves. (ECG) continues to be the most commonly used laboratory procedure for the diagnosis of heart disease Over the last several decades there has been an increasing realization that the evaluation of medical trainees must include measures that reflect the complex multidimensional activities physicians perform in real-world settings Performance should involve the integration of multiple capabilities; involve the observation of behaviors; be clinically relevant, linked to actual clinical tasks and cued only insofar as clinical tasks are cued in the real world. It is important to carefully think through how to conceptualize the sources of variation in ECG performance-based assessments(self handicapping) Cognitions also play a central role in self-handicapping. Urdan and Midgley (2001) claim that "(a) performance in an achievement situation can reveal information about ability; (b) more effort suggests less ability; and (c) it is possible to manipulate others' perceptions of one's ability by decreasing effort". Throughout this process, cognitive inaccuracies can influence a person's understanding of a situation and their resulting behaviour. Given the central role of inaccurate cognitive processes in developing and maintaining perfectionism and self-handicapping, one would expect cognitive based approaches to play a central role in attempts to modify perfectionistic beliefs and self handicapping behaviours CBT addresses the cognitive deficiency and cognitive distortions that cause a variety of communication and social difficulties, which may lead to feelings of anxiety. CBT attempts to help the individual identify and alter these faulty thought patterns regarding test situations to effect a constructive change in behaviour and emotion. Through CBT, individuals are provided with procedures to modify their

thoughts and beliefs, as well as requisite skills (e.g. problem-solving skills) to interact with others effectively and appropriately, thereby promoting self-regulation. Accordingly, cognitive–behavioural strategies with children and adolescents use enactive, performance-based procedures as well as cognitive interventions to produce changes in thinking, feeling and behaviour. So bearing all those in mind the investigator realizes the need for applying CBT on the individuals with higher levels of test anxiety, the investigator tried this technique among students. As there is no research based on EEG imaging after CBT in INDIA, it is necessary for the students to try this technique for reducing the test anxiety level and to improve the learning and academic performance. Since CBT modifies the thought pattern, it is not only qualifying academic life but also their personal, social and family life.

There are more research on EEG research in the western countries, it has been felt that Indians should also be benefited to modify the emotional and behavioural changes which can be read through EEG studies. Hence, the topic has been decided on Cognitive Behaviour therapy on EEG, ECG and Neurotransmitter level among the students having higher levels of Test anxiety.

Variables chosen for the present study

- Test anxiety
- CBT
- Dopamine
- Acetylcholine
- E.E.G

Objectives

1. To study the impact of CBT on EEG activity, acetyl choline levels and Dopamine and test anxiety levels of the students
2. To improve the quality of academic life of the students

Design of the study

Experimental design has been selected for the present study. 200 students (age range 17–19 yr.) were selected and they were given speilberger's test anxiety questionnaire and scores were tabulated to select 100 students with higher levels of test anxiety and they were divided into two groups such as control and experimental group.In each group 25 girls and 25 boys were present. Subjects were free from medical, psychiatric, and sleep disorders as determined by history, physical examination, biochemical screening tests, electrocardiograms, and psychological screening questionnaires. Their blood was collected and sent to ranbaxy lab for the estimation of acetyl choline and Dopamine. Their normal EEG pattern were recorded. Experimental group was given cognitive behaviour therapy for about three weeks. Then their post test scores of EEG activity, acetyl choline levels and Dopamine levels were recorded. Pre test and post test scores of experimental group were statistically analysed to tabulate the data. Based on these findings, the authors hypothesized as follows.

Hypotheses

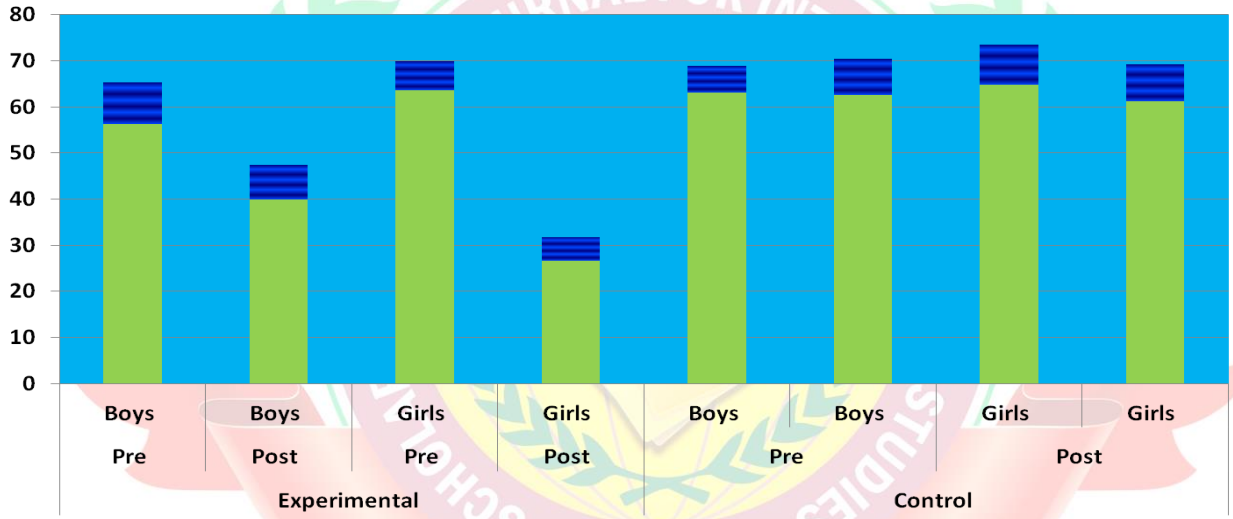
1. There are no significant differences) between pre test and post test scores of test anxiety, Electro Encephalo Gram waves pattern, dopamine and acetylcholine levels
2. CBT has not influenced the levels of alpha and delta waves of Electro Encephalo Gram wave pattern in the brain
3. Neurotransmitter levels (acetylcholine and dopamine) have not increased among the sample.

Table – 1 Differentiation of Test Anxiety Scores of the Sample

Psychological variable	Type of group	Type of Test	Gender	Mean	S.D
		Pre	Boys	56.23	9.15
		Post	Boys	39.93***	7.52

Test Anxiety	**Experimental**	**Pre**	**Girls**	**63.60**	**6.38**
		Post	**Girls**	**26.54*** **	**5.14**
	Control	**Pre**	**Boys**	**63.03**	**5.91**
		Post	**Boys**	**62.49** $^{N.S}$	**7.93**
		Pre	**Girls**	**64.78**	**8.75**
		Post	**Girls**	**61.13** $^{N.S}$	**8.15**

p* < 0.05, p < 0.01, p*** < 0.001**



It is clear from the table 1 and also from Figure - B, that the calculated 't' values were significantly greater than that of table 't' values in the case of Boys ($p< 0.001$, N=25) and Girls ($p< 0.001$, N=25). Hence hypothesis was rejected and proved there are significant differences between Pre Test and Post Test scores of Test Anxiety before and after applying Cognitive Behaviour Therapy. But this significant difference was more in the case of Girls than Boys. This indicates Girls responded more than that of Boys. In control group test anxiety scores are not reduced significantly in post test.

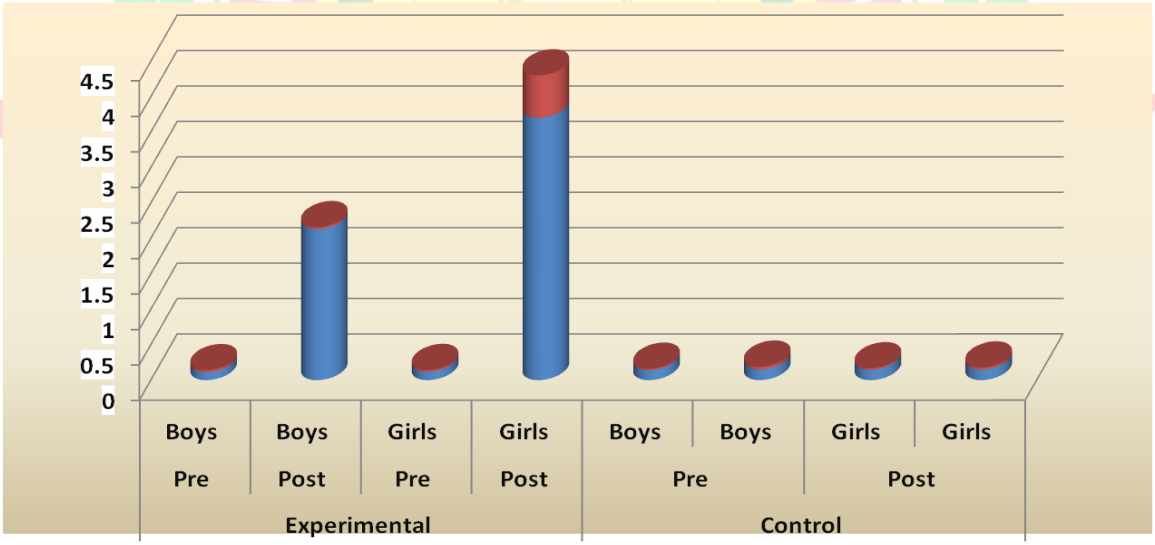
Our results are consistent with those of studies on the effect of cognitive therapy and relaxation in reducing anxiety, (Barlow DH, et al 1984) the effect of cognitive reconstruction, thought control and relaxation in reducing anxiety, and the effect of cognitive-behavioral therapy in reducing anxiety. Daniel J. Benor, MD et al (2009) in their study, they investigated that in the pre-test, these students showed an elevated score on the Test Anxiety Inventory (TAI). Compared to the control group, the CBT group showed significant reduction in test anxiety on the TAI, as well as improvement in study skills and academic self-esteem, as measured by the Survey of Study Habits and Attitudes, and the school scale of the Coopersmith Self-Esteem inventory. These results, already demonstrated in several studies of younger students, show that this method holds up for older students. They also suggest that relief from test anxiety can be expected fairly quickly when cognitive-behavioral methods are used. The results of these studies show the effectiveness of cognitive-behavioral therapy (cognitive reconstruction, thought control, relaxation, etc.) in reducing students test anxiety. Based on

our findings, we conclude that cognitive-behavioral therapy is an appropriate treatment strategy for reducing anxiety in students Among the desirable outcomes of these techniques - relaxation in particular, mention can be made of their physiological and neurological effects, which can reduce muscle activity, delay spinal reflexes and consequently reduce the excitability of the autonomous nervous system and brain cortex activity; the activity of the sympathetic nervous system decreases and the activity of the parasympathetic nervous system increases (Yousefy et al, 2006).

Table – 2 Differentiation of Acetyl Choline Scores of the Sample

Psychological variable	Type of group	Type of Test	Gender	Mean	S.D
Acetyl Choline	Experimental	Pre	Boys	0.11	0.03
		Post	Boys	2.13***	0.028
		Pre	Girls	0.118	0.024
		Post	Girls	3.7***	0.6
	Control	Pre	Boys	0.14	0.02
		Post	Boys	0.15 N.S	0.04
		Pre	Girls	0.146	0.021
		Post	Girls	0.148 N.S	0.03

p* < 0.05, p < 0.01, p*** < 0.001**



It is clear from the table 2 and also from Figure-C, that the calculated 't' values were significantly greater than that of table 't' values in the case of Boys ($p < 0.001$, N=25, t=36.59 and Girls ($p < 0.001$, N=25, t=28.77). Hence hypothesis was rejected and proved there are significant differences between Pre Test and Post Test scores of Acetylcholine before and after applying Cognitive Behaviour Therapy. But this significant difference were more in the case of Boys than in the case of Girls. In control group acetyl choline scores are not increased significantly in post test.

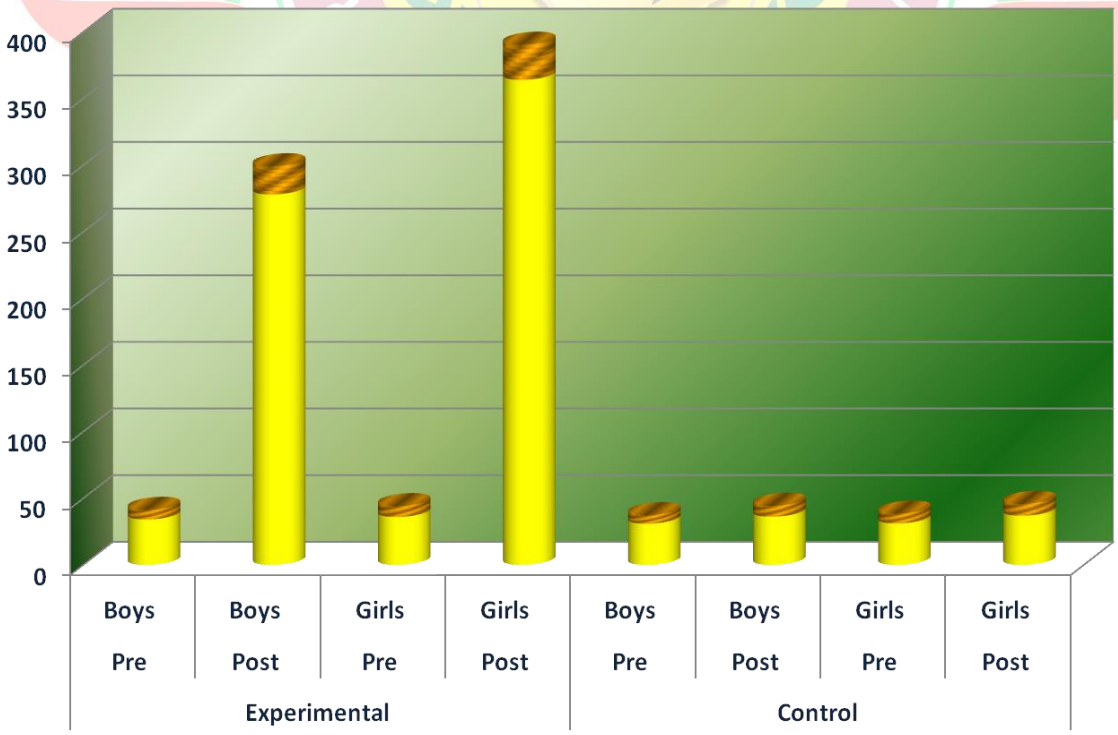
The above study was supported by the study of Acetylcholine is released in cortex when animals are performing a task requiring sustained attention (Arnold, H.M. et al 2002) and a recent study showed that ACh can be released in frontal cortex in a transient and spatially specific manner and that this transient release of ACh increases the probability of stimulus detection (Parikh, V. et al ,2007). These results demonstrate the

possibility of enhancing the beneficial cognitive effects of the cholinergic system, even in a young, healthy population and increases the specificity of perceptual learning suggests that ACh may augment plasticity and tuning in populations of neurons that encode task-relevant stimulus features. Cholinergic receptors (receptors binding acetylcholine) also are found in the sympathetic system (as well as the parasympathetic system). Nicotinic cholinergic receptors cause sympathetic postganglionic neurons, adrenal chromaffin cells, and parasympathetic postganglionic neurons to fire and release their chemicals. Muscarinic receptors are associated mainly with parasympathetic functions and are located in peripheral tissues (e.g., glands, smooth muscle).

Table – 3 Differentiation of Dopamine Scores of the Sample

Psychological variable	Type of group	Type of Test	Gender	Mean	S.D
Dopamine	Experimental	Pre	Boys	34.12	7.20
		Post	Boys	278.0***	21.17
		Pre	Girls	35.97	8.13
		Post	Girls	364.0***	26.34
	Control	Pre	Boys	30.91	6.43
		Post	Boys	36.2 N.S	8.21
		Pre	Girls	31.14	7.37
		Post	Girls	36.92 N.S	8.95

p* < 0.05, p < 0.01, p*** < 0.001**



It is clear from the table 3 and also from Figure-D, that the calculated 't' values were significantly greater than that of table 't' values in the case of Boys (p< 0.01, N=25, t=40.21 and Girls (p< 0.01, N=25,

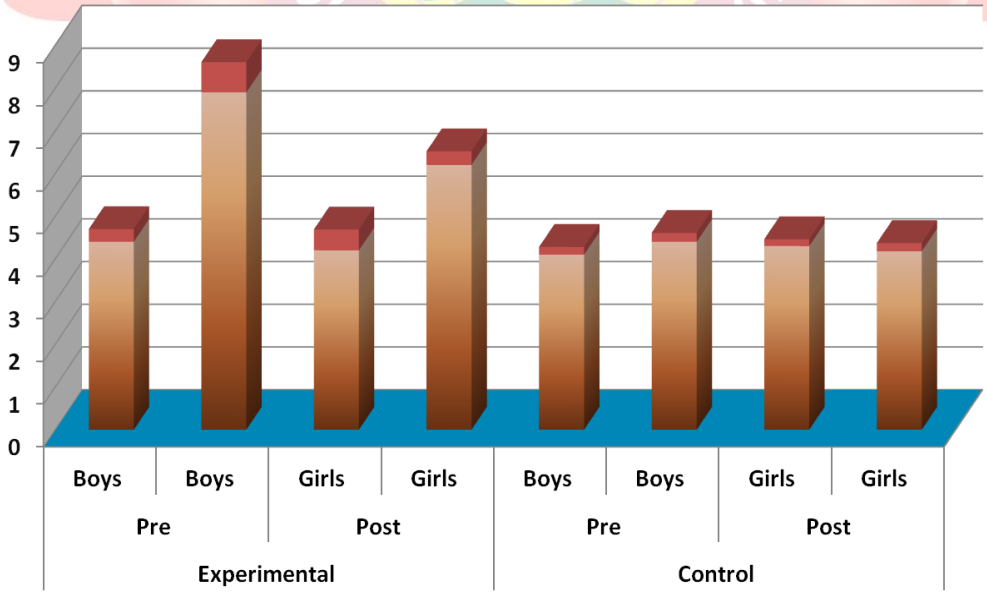
t=49.71). Hence hypothesis was rejected and proved there are significant differences between Pre Test and Post Test scores of Dopamine before and after applying Cognitive Behaviour Therapy. But this significant difference was more in the case of Girls than in the case of Boys. In control group dopamine scores are not increased significantly in post test.

Cognitive-behavioral therapy (CBT), primarily training in problem solving and social skills, has not been shown to provide clinically important changes in behavior and academic performance of children (Pelham et al., 1998). The neurotransmitter dopamine plays a key role in initiating purposive movement, increasing motivation and alertness, reducing appetite, and inducing insomnia, effects that are often seen when a child responds well to CBT. However, CBT might be helpful in treating symptoms of accompanying disorders such as oppositional defiant disorder, depression, or anxiety disorders (Abikoff, 1985; Hinshaw & Ehardt, 1991; Lochman, 1992).

Table – 4 Differentiation of Alpha waves of the Sample

Psychological variable	Type of group	Type of Test	Gender	Mean	S.D
Alpha waves	Experimental	Pre	Boys	4.4	0.30
		Post	Boys	7.9***	0.71
		Pre	Girls	4.2	0.49
		Post	Girls	6.2***	0.32
	Control	Pre	Boys	4.1	0.18
		Post	Boys	4.4 N.S	0.21
		Pre	Girls	4.3	0.16
		Post	Girls	4.18 N.S	0.19

p* < 0.05, p < 0.01, p*** < 0.001**



It is clear from the table 6 and also from Figure -G , that the calculated 't' values were significantly greater than that of table 't' values in the case of Boys (p< 0.01, N=25, t=26.11 and Girls (p< 0.01, N=25,

t=20.62). Hence hypothesis was rejected and proved there are significant differences between Pre Test and Post Test scores of Alpha waves before and after applying Cognitive Behaviour Therapy. But this significant difference was more in the case of Boys than in the case of Girls. In control group alpha scores are not increased significantly in post test.

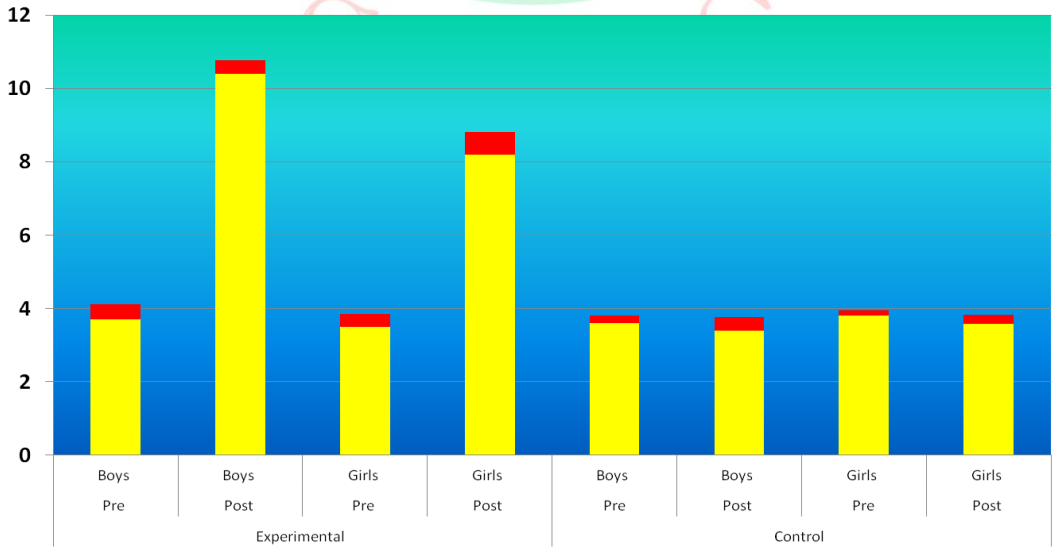
Alpha wave biofeedback has gained interest for having some successes in humans for seizure suppression and for treatment of depression. Alpha enhancements were correlated to primary sensory processing in several experiments using cross-modality stimulation in cats and humans (Ba_sar, 1980; Ba_sar et al., 1992; Ba_sar and Schurmann, 1996).

Another study by Rice, Blanchard, and Purcell (1993), comparing frontal EMG biofeedback to EEG biofeedback (training either to increase or decrease alpha activity), researchers found that, although all three training methods worked in reducing anxiety, "only alpha-increase biofeedback subjects showed significant reductions in heart rate reactivity to stressors at a separate psycho physiological testing session" (Rice et al., 1993,) Cade and Coxhead (1979) describe a two factor theory of arousal in which the alpha rhythm is indicative of relaxed cortical arousal. Other physiological measures such as skin resistance reflect peripheral or somatic arousal. In their model cortical and peripheral arousal interacts but may vary independently. From this it is clearly stated that mind tools do have significant impact on alpha waves.

Table – 5 Differentiation of Delta waves of the Sample

Psychological variable	Type of group	Type of Test	Gender	Mean	S.D
Delta waves	Experimental	Pre	Boys	3.7	0.42
		Post	Boys	10.4***	0.38
		Pre	Girls	3.5	0.36
		Post	Girls	8.2***	0.62
	Control	Pre	Boys	3.6	0.21
		Post	Boys	3.4 N.S	0.37
		Pre	Girls	3.8	0.16
		Post	Girls	3.58 N.S	0.24

p* < 0.05, p < 0.01, p*** < 0.001**



It is clear from the table 5 and also from Figure - F, that the calculated 't' values were significantly greater than that of table 't' values in the case of Boys ($p< 0.01$, N=25, t=26.11 and Girls ($p< 0.01$, N=25, t=20.62). Hence hypothesis was rejected and proved there are significant differences between Pre Test and Post Test scores of Delta waves before and after applying Cognitive Behaviour Therapy. But these significant differences were more in the case of Boys than in the case of Girls. In control group delta scores are not increased significantly in post test.

Delta enhancements were correlated with cognitive processes like signal matching or decision making by using auditory and visual oddball paradigms (Stampfer and Ba sar, 1985; Basar-Eroglu et al., 1992; Schurmann et al., 1995; Demiralp et al.,1999) . The effects can be beneficial by directly affecting behaviour and performance and well as physical and emotional well-being. The intervention is non-invasive and evidence based.It involves sensors being placed on the scalp and referred to non-cephalic sites such as the ears or mastoids. During brain training (i.e. neurofeedback) computers are used to feedback information in real time to the client about brain activity, in the form of auditory cues and visual images. For children, this feedback is often in the form of games. These can include the extensive thalamocortical networks that induce both the idling rhythms of the brain (alpha 1 rhythms) as well as processes critical to attentional filtering (selection), involving parietal cortical regions, the superior colliculus, and the intralaminar and reticular nuclei of the thalamus; and that lead to the activation of semantic memories related to extant working memories (alpha 2 rhythms). They also include the limbic-cortical networks (theta), involving the hippocampi, enthorhinal cortex, anterior and posterior cingulates, the amygdalae, and the perirhinal and parahippocampal cortices, which drive critical function related to a self-preservating evaluation of the significance of stimuli, their relationship to ongoing plans and goals, the targeting of related events for attention, the monitoring and correction of subsequent behavioural response, the storage and activation of episodic memories related to extant working memory, and control of the flight and flight responses associated with stimulus-related affect. And they include intracortical and corticocortical activity reflecting the information analysis and preparatory activities of this structure Dysregulation in any of these systems or their network components disrupts effective psychological function. Importantly, such dysregulation is not directly amenable to stabilisation through talking therapy (e.g. CBT and other psychotherapies), since the difficulties lie with the carrier systems rather than with system content, though the latter will obviously be affected as a consequence.

Conclusion

1. There are significant differences ($p <0.0001$) between pre test and post test scores of test anxiety, Electro Encephalo Gram waves pattern, dopamine and acetylcholine levels
2. CBT had significantly influenced (p, <0.0001) the levels of alpha and delta waves of Electro Encephalo Gram wave pattern in the brain
3. Neurotransmitter levels (acetylcholine and dopamine) had significantly ($p<0.0001$) increased among 25 boys and 25 girls in the test group.
4. CBT has remarkably changed facial features of students under investigation.
5. Quality of their Academic life was increased.
6. There was no change in the case of control group.

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