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Cognitive Behavioral Therapy on Frontal EEG Asymmetry among Students with Higher Levels of Test Anxiety

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Abstract- Individuals with more anxiety reveal more right frontal activity and they respond towards negative emotions and the individuals with left frontal activity exhibit more positive emotions. The present study aims to investigate the impact of CBT on frontal asymmetry on the students having more levels of test anxiety and EEG activity was measured in 16 higher secondary students with higher levels of test anxiety before and after cognitive behavioral therapy (CBT).After CBT students shifted towards greater relative left frontal brain activity. Students with greater left frontal activity were having lower levels of test anxiety and the results indicated that CBT reduced test anxiety and brought out the changes in frontal asymmetry. It is concluded that CBT has an impact on frontal asymmetry and test anxiety levels of students.

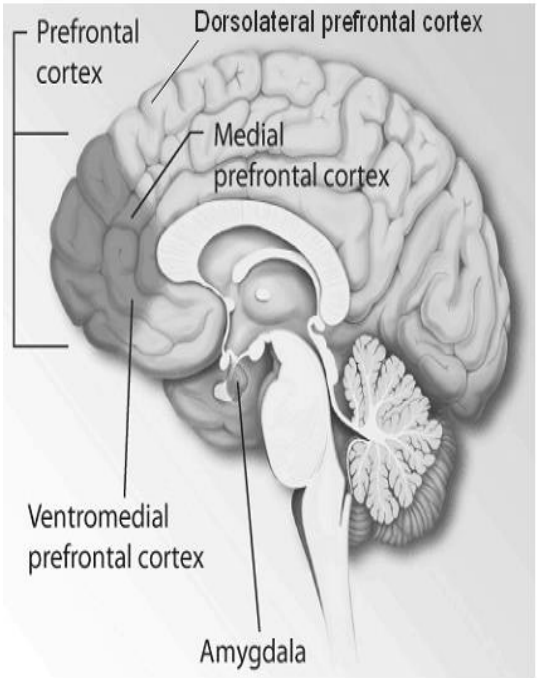
Index Terms- cognitive behavioral therapy, electroencephalogram, frontal asymmetry, test anxiety

I. INTRODUCTION

Motivated by a range of possible applications in the field of human-computer interaction, research on emotion recognition from facial expressions, speech and physiological signals receives increasing attention. Many application areas can benefit from emotion recognition systems, ranging from applications that track the user's affective states and give corresponding feedback (e.g., automatic tutoring applications) to personalized photo or music selection applications. Furthermore, they can be useful in exploring reactions to advertisements, for monitoring emotional states in the healthcare area or in detecting which product aspects cause frustration. The correlates of emotion in human EEG have been discovered more than two decades ago. In particular, the phenomenon of"frontal EEG asymmetry" has played a prominent role in the emotion research. According to Davidson's influential approach/withdraw motivational model of emotion [2003] left frontal activity indicates a positive or approach-related emotion, whereas higher right frontal activity indicates a negative or withdrawal-related emotion. The degree of activation is inferred from the spectral power in the alpha band (8-12 Hz), with lower values in alpha power being associated with a higher degree of activity.

The role of hemispheric laterality in emotion has been a source of debate for decades. Contrary to more simplistic notions of right hemisphere superiority across all domains of emotion, recent conceptualizations of hemispheric asymmetries have taken into account the variety of psychological experiences that fall under the broad rubric of emotion. For example, Davidson (1993) has proposed that while right posterior regions specialize in the perception of affective stimuli of both positive and negative valence, both Cognition and emotion. The left frontal regions may be more active during the experience of approach-related (i.e. positive) emotions and the right frontal regions may be more active during the experience of withdrawal-related (i.e. negative) emotions. Indeed, these Findings suggest that frontal EEG asymmetry may represent a predisposition that underlies individual differences in reactivity to valence stimuli. More specifically, individuals who exhibit hypo activation of the left frontal region and who, therefore also demonstrate elevated responsively to negative stimuli, may be at increased risk for experiencing episodes of depression. This formulation is consistent with the results of a wide range of studies examining biobehavioural aspects of depression (Ian Gotlib, 1998). For example, Robinson and his colleagues (e.g. Robinson, Kubos, Starr, Rao, & Price, 1984; Robinson & Price, 1982) have presented data supporting an association between left frontal lesions and subsequent depression (for a review, see Robinson & Downhill, 1995). Furthermore, several investigations utilizing positron emission tomography (PET) have similarly found left frontal hypo activation in depressed subjects (e.g. Bench et al., 1993; Martinot et al., 1990; but see also Drevets et al., 1992). in reviewing the literature, one will variously encounter references to frontal EEG activity and frontal EEG activation. At first blush, insistence upon this distinction may appear pedantic, but in fact, strict attention here can significantly enhance understanding of research in this area, and is relevant to making inferences concerning the distinction between frontal EEG asymmetry as a moderator or a mediator. For the purposes of this article, and as a general recommendation, activity will refer to a tonic recording of cortical processes as measured by EEG, while activation will refer to the change in EEG activity in response to a provocation, such as the presentation of an emotional stimulus. For example, one may be interested in measuring an individual's asymmetry in frontal EEG activity at rest as well as that same individual's asymmetrical frontal EEG activation in response to an experimental manipulation, such as the presentation of an image of a venomous snake. While this implies that activity refers only to resting or baseline measures, this is not necessarily the case. Indeed, one could measure an individual's resting activity both at baseline and following a stimulus presentation. The difference between those post-stimulus and baseline activity measures, however, would represent that individual's inferred activation in

response to the stimulus. This distinction is important for maintaining conceptual clarity when reviewing the literature on frontal EEG asymmetry. Thus, in reviewing the literature, one of the functions of this article will be to make clear this distinction in past literature as well as in the arguments and data presented here.



II. OBJECTIVES

- to study the impact of CBT on frontal EEG activity among the students having higher levels of test anxiety
- to improve the quality of academic life of the students

Frontal Asymmetry: ln (right) - ln(left)

1.2 Research question

Does Cognitive Behavior Therapy bring out changes in the frontal asymmetry scores of the brain waves among students having higher levels of test anxiety?

III. DATA ACQUISITION

200 students (age range 17–19 yr.) were selected and they were given speilberger's Test Anxiety questionnaire and scores were tabulated to select 16 students with higher levels of Test anxiety and they were divided into two groups and in each group 8 girls and 8 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 normal EEG pattern was recorded. Experimental group was given cognitive behavior therapy for about three weeks. Then their post test scores of EEG activity, and test anxiety were recorded. Pre test and post test scores of experimental group were statistically analyzed to tabulate the data. It is concluded that CBT has an impact on frontal asymmetry and test anxiety among students.

IV. DATA ANALYSIS

Absolute Power: The actual power (voltage) in the patient's EEG database. (Power is microvolt's squared.) Squaring the microvolt's we get the power of that brain region

Interhemispheric and Intrahemispheric Coherence: Interhemispheric (between left and right hemisphere sites) and intrahemispheric coherence (between sites in the same hemisphere) measures the similarity or correlation of the EEG signal between regions

Table-1 Mean scores of Different electrodes of FP1,F3, F8, FP2, F4, Fz, and F7 of Boys and Girls of the total sample

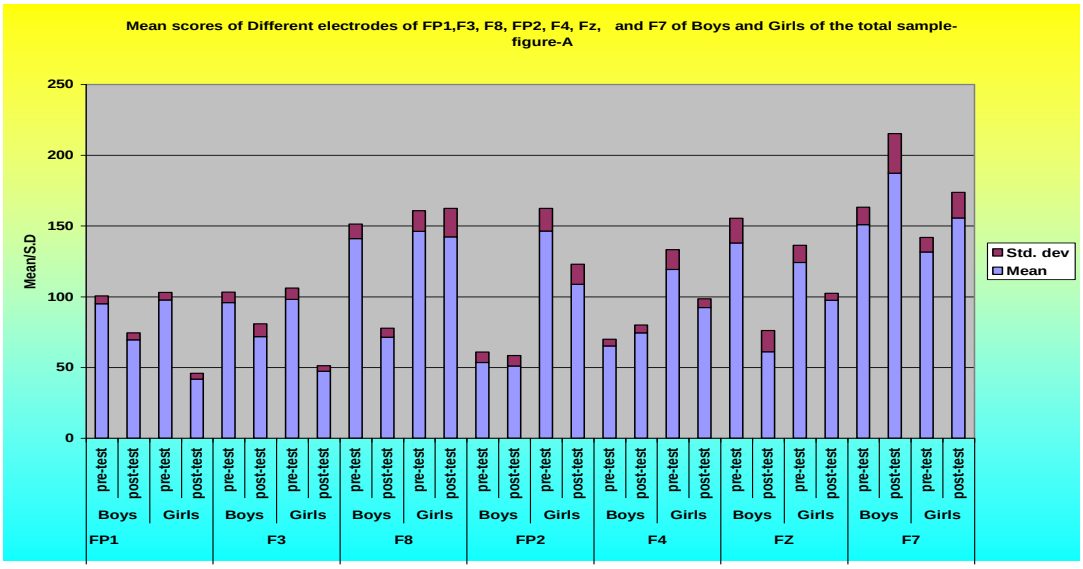
brain regions	electrode	Boys				Girls			
		pre-test		post-test		pre-test		post-test	
		mean	S.D	mean	S.D	mean	S.D	mean	S.D
frontal	FP1	94.99	5.46	69.50***	4.89	97.58	5.522	41.69***	4.06
	F3	95.83	7.40	71.82***	8.91	98.16	7.90	47.35***	3.93
	F8	140.99	10.4	71.34***	6.37	146.2	14.63	142.20*	20.23
	FP2	53.36	7.52	50.91**	7.52	146.36	15.99	108.85***	14.06
	F4	65.18	4.67	74.46***	5.41	119.17	14.07	92.36***	6.22
	FZ	137.96	17.5	61.14***	14.9	124.1	12.13	97.48***	4.93
	F7	150.86	12.3	187.36***	27.81	131.58	10.32	155.68***	18.00

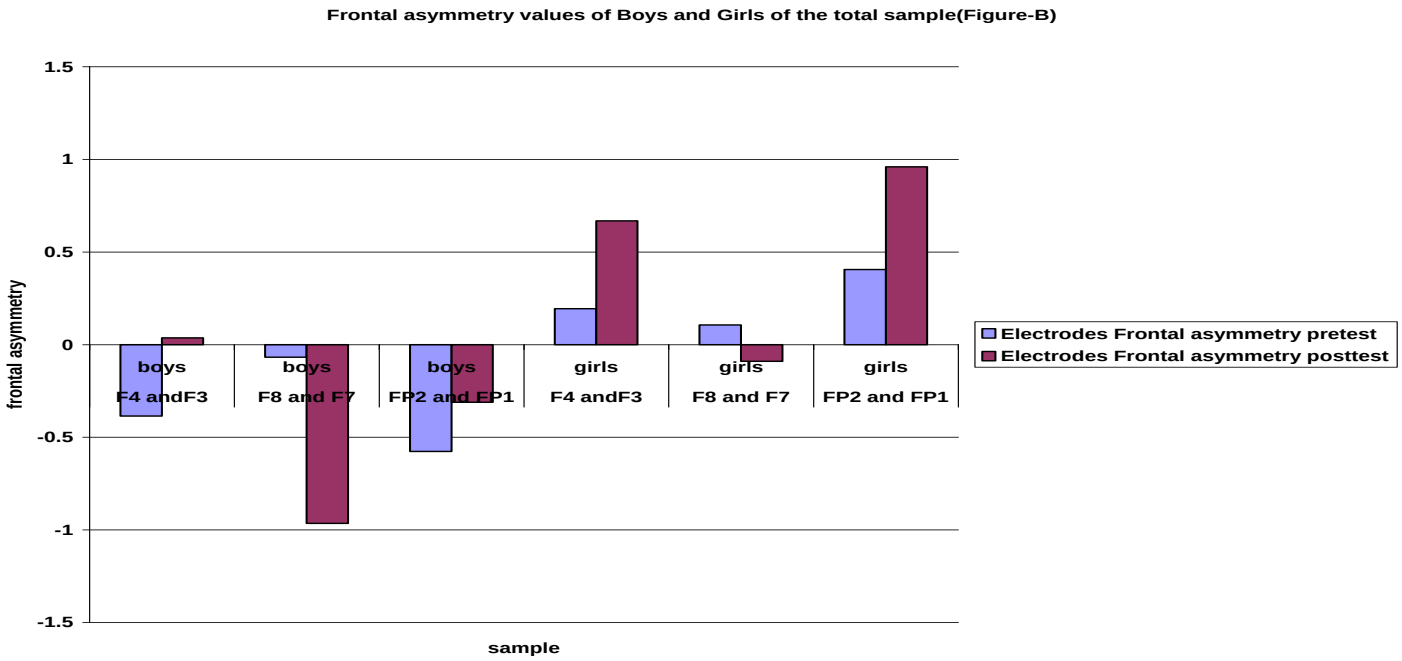
***P< 0.05, **P < 0.01, ***P< 0.001, N.S= Not Significant**

Table-2 Frontal asymmetry values of Boys and Girls of the total sample

Variables	Gender	Electrodes	No	Frontal asymmetry	
				pretest	posttest
absolute powers of Right frontal and left frontal brain regions	Boys	F4 andF3	8	-0.3854	0.0360
		F8 and F7	8	-0.0676	-0.9655
		FP2 and FP1	8	-0.5767	-0.3112
	Girls	F4 andF3	8	0.1939	0.6681
		F8 and F7	8	0.1053	-0.09
		FP2 and FP1	8	0.4050	0.9597

***P< 0.05, **P < 0.01, ***P< 0.001, N.S= Not Significant**





It is clear from the table 1 and 2 also from figures A and B that there are significant differences between pretest 'mean' scores and post test ' mean ' scores of right and left sides of the brain from the boys and girls sample. Significant changes are due to the application of Cognitive behavior therapy. This study is in line with the following studies.

. Davidson et al. (2003) examined changes in brain electrical asymmetry and immune function after a meditation program. They found that the meditation group showed significant larger increases in left-sided anterior activation (during baseline and positive, negative emotion induction) compared with a Wait-list group. EEG alpha power is inversely related to scalp-recorded cortical activity, positive asymmetry scores are thought to reflect greater relative left EEG cortical activity (Allen et al., 2004a; Davidson, 1988). Additionally, Craig (2005) has described a likely anatomical basis for autonomic nervous system lateralization. The right anteriorinsula (located deep to T4) receives ascending projections originating from afferent nerves that mediate sympathetic nervous system functions, whereas the left anterior insula (located deep to T3) receives Projections from afferent nerves that mediate parasympathetic nervous system functions. Our results are consistent with a report of functional brain changes due to CBT in patients with spider phobia (*Paquette V,* et al, 2003). Frontal EEG activity and ocular parameters may be used to monitor and predict changes in neurobehavioral performance associated with sleep loss and circadian misalignment. This global increase in slow EEG activity was less pronounced in the occipital derivation (Pz-Oz,), and the late evening decrease was more pronounced compared with the frontal derivation Brainwave Optimization. We propose that a wider range of human behaviors may be fundamentally motivated by the brain's intention to regulate itself. Indeed, we believe that the brain's impetus to self-regulate may eventually explain pathological behaviors more convincingly than can conventional psychological, sociological or genetic theories. Greater self-regulation by the human brain is necessary because the brain is our central command center for our biology at a global level. The brain is the central control center for all human experience and functioning. So to improve any aspect of our well-being, we should ultimately aim to facilitate better functioning of the brain. Peter Sterling's model of allostasis (2004) provides a theoretical elaboration of the centrality of the brain for human self-regulation. In the past, the physiological and medical sciences have been based on the model of homeostasis, or stability through constancy. Homeostasis considers various systems in terms of their requirement to maintain various set points at constant values. Deviations from these set-points are treated as disease states. The cause of these deviations is understood to bodys functionality of local mechanisms in the system. That is to say, dysfunctional local mechanisms are seen to interfere with preservation of the set-points. The aim of medical therapy is to correct the local mechanisms which are associated with set-point deviations, e.g., disease. In contrast, the allostasis model emphasizes that systems maintain stability through change. They shift their set-points based on the changing demands their environments. With regard to models of brain asymmetry and emotion increased alpha positive predictor for treatment outcome (Ulrich et al., 1984; Bruder et al 2001) in a refinement of their theory Heller, Nitschke, Etienne, and Miller (1997) proposed a distinction between subtypes of anxiety related to different patterns of brain activation. Anxious arousal (e.g. panic, state anxiety, and sympathetic nervous system hyper reactivity) should be associated with greater right parietal-temporal activation, while anxious apprehension (e.g. worry, rumination, anticipation of future threat) should be associated with greater left anterior activity since it involves linguistic processing (Heller et al., 2003; Heller et al., 2002; Nitschke et al., 2000). Partial support for their assumptions comes from studies examining regional EEG asymmetry in self-reported anxious arousal (Nitschke et al., 1999) and during experimentally manipulated anxious-arousal (Heller et al., 1997) the different models of brain asymmetry and emotion each are strong in

explaining different components of emotion (e.g. perception, experience, expression, and arousal). The right-hemisphere model emphasizes emotional perception and expression. The valence model, which is mainly focusing on experience of emotion, was subsumed by the AAE model of emotion which has probably the most empirical support. The AAE model is probably the most elaborated allowing clear predictions (e.g. about trait asymmetry as diathesis variable) and thus enables good empirical evaluation. The integrative model of Heller and colleagues confines the valence hypothesis to anterior brain regions and in part the 50 right-hemisphere hypothesis to posterior regions. Its strength is the integration of seemingly discrepant findings regarding different types of anxiety and comorbidity of anxiety and depression. Relative left frontal hemisphere activation has been proposed to be associated with a self enhancing regulatory style inhibiting negative affective responses (Tomarken & Davidson, 1994). Since CBT leads to a decrease of PTSD symptoms and anxiety we hypothesized that participants receiving CBT would exhibit a greater decrease in right anterior and posterior activation during exposure to a trauma-related accident. Specifically, there was an increase in the activation of the left medial temporal gyrus in response to the paradigm of empathy. The same process occurred with the posterior cingulate gyrus, which had its activation increased in response to the condition of forgiveness after the treatment. From this study Farrow et al. 2005 concluded that CBT can promote changes in the brain area. Schwartz et al, 1996 replicated the previous findings of significant decrease of the activity of the right caudate nucleus in those who responded to therapy. CBT favors the restructuring of thought, modification of feelings and behaviors, and promotes new learning. Consequently it involves synaptic changes (2006) and this may be responsible for significant changes of mean scores of absolute powers of Different electrodes of EEG of the sample.

Table-3 Inter Hemispheric Coherence of FP1 and FP2 of the brain in the total sample

Variables	Gender	Test	No	'r'	't'
FP1 vs FP2	Boys	Pre Test	8	0.2317 N.S	1.14
		Post Test	8	0.2870 N.S	1.43
	Girls	Pre Test	8	0.3175 N.S	1.6
		Post Test	8	0.7212***	4.99

***P< 0.05, **P < 0.01, ***P< 0.001, N.S= Not Significant**

It is clear from the table 3that the calculated correlation coefficient values were significantly lesser than that of table correlation coefficient values in the case of Boys (p< 0.01, N=8,) in pre-test and in the post test. Hence the hypothesis was accepted and proved that there are no significant Inter Hemispheric Coherence between Pre Test scores of FP1 vs. FP2 and Post Test scores of FP1 vs. FP2 before and after applying Cognitive Behavior Therapy.

In case of Girls (p< 0.01, N=8) the calculated correlation coefficient values were significantly lesser than the table correlation coefficient values in pre-test and in the post test it is greater than the table correlation coefficient values. Hence the hypothesis was rejected and proved that there are significant Inter Hemispheric Coherence between Pre Test and post test scores of FP1 vs. FP2 before and after applying Cognitive Behavior Therapy.

A model that might explain some inconsistencies in the study of brain asymmetries in relation to emotion and psychopathology has been suggested by Heller and colleagues (Heller, 1990, 1993; Heller & Nitschke, 1997), and subsequently refined (Heller et al., 2003; Heller & Nitschke, 1998; Heller et al., 1997; Heller, Schmidtke, Nitschke, Koven, & Miller, 2002; 48 Nitschke, Heller, & Miller, 2000; Nitschke, Heller, Palmieri, & Miller, 1999). This neuropsychological model of emotion integrates in part the competing right hemisphere hypothesis (Gainotti et al., 1993) and the valence hypothesis (Davidson, 1992). Based on and psycho physiological data the model incorporates psychological theories of emotion decomposing emotional states into two components, valence and arousal. The model proposes that the valence dimension (pleasant, unpleasant) is dependent on functions of anterior regions of the cortex. When the left frontal region is active relative to the right, affective valence is pleasant, whereas relative right-frontal activity is associated with negative affect. Furthermore, the model posits that the arousal dimension depends on right posterior regions of the brain. Nitschke et al. (2000) proposed that the right posterior anxious arousal system promotes sympathetic nervous system activity, spatial attention, visual scanning of the environment, and sensitivity to meaningful nonverbal cues. According to the model, anxiety and depression are associated with different patterns of brain activity in right posterior regions, with anxiety to be associated with increased and depression with decreased activity. The neuropsychological model of emotion by Heller and colleagues. This model explained some inconsistencies of prior EEG asymmetry research in depression and anxiety (Bruder et al., 1997; Kentgen et al., 2000; Metzger et al., 2004). Empirical evidence for the model comes from two studies investigating depressed patients (Keller et al., 2000) and students with high and low levels of depression (Heller, Etienne and Miller, 1995; Keller et al., 2000) using a neuropsychological task measuring a hemispheric correlation.

Table-4 Inter Hemispheric Coherence of F3 and F4 of the brain in the total sample

variables	Gender	Test	No	'r'	't'
F3 vs F4	Boys	Pre Test	8	0.347 N.S	1.77
		Post Test	8	0.4258**	2.25
	Girls	Pre Test	8	0.285 N.S	1.42
		Post Test	8	0.7505***	5.44

***P< 0.05, **P < 0.01, ***P< 0.001, N.S= Not Significant**

It is clear from the table 4 that the calculated correlation coefficient values were significantly lesser than that of table correlation coefficient values in the case of Boys ($p< 0.01$, N=8,) in pre-test and in the post test. Hence the hypothesis was rejected and proved that there are no significant Inter Hemispheric Coherence between Pre Test scores of F3 vs. F4 and Post Test scores of F3 vs. F4 before and after applying Cognitive Behavior Therapy.

In case of Girls ($p< 0.01$, N=8) the calculated correlation coefficient values were significantly greater than the table correlation coefficient values in pre-test and in the post test it is lesser than the table correlation coefficient values. Hence the hypothesis was rejected and proved that there are significant Inter Hemispheric Coherence between Pre Test and post test scores of F3 vs. F4 before and after applying Cognitive Behavior Therapy.

Cognitive restructuring taken place during CBT differs from student to student and at the same time CBT keeps on refining day by day that will cause changes differently in students' brain and it has been proved in the present investigation through changes in their frontal asymmetric values, which is not uniform in all the cases. Moscovitch et al (2011) noted that higher activity in the left frontal brain pretreatment correlated with lower social anxiety and depression scores post treatment. These findings suggest that the effects of CBT can be measure biologically. The absence of activation in the dorsolateral prefrontal cortex (BA 10) and parahippocampal gyrus, after CBT,provides strong support to the view that CBT reduces phobic avoidance by deconditioning contextual fear learned at the level of the hippocampus/parahippocampal region, and by decreasing cognitive misattributions and catastrophic thinking at the level of the prefrontal cortex (Gorman et al., 2000). This deconditioning process would prevent the reactivation of the traumatic memories by allowing the phobic subjects to modify their perception of the fear-evoking stimuli. Once this perception has been reframed, the phobogenic stimuli would not constitute a threat anymore. Such cognitive restructuring would render obsolete the activation of the brain regions previously associated with the phobic reaction. The lack of an association between EEG asymmetry and attention bias is also consistent with results obtained recently by Sutton, Davidson, and colleagues (1997), who suggest that attention bias on the emotion Stroop task may be related to alpha asymmetry in the anterior temporal region, rather than at the midfrontal sites .Considered collectively, these findings suggest that frontal EEG asymmetry is not related to cognitive bias in depression. Although it is possible that our sample size did not afford sufficient statistical power to detect a relation between frontal asymmetry and cognitive functioning, the fact that neither self-report nor behavioral measures of cognitive bias were found to be related to asymmetry raises questions concerning the association between frontal EEG asymmetry and cognitive vulnerability to depression. Moreover, given the finding in the present study that vulnerability to test anxiety may be associated with a loss of frontal EEG asymmetry, investigators in this area might profitably begin to examine the relation between frontal asymmetry and positive illusions (e.g. Taylor & Brown, 1988; Tomarken & Davidson, 1994).

V. EDUCATIONAL IMPLICATIONS

Overall, students who received the CBT treatment programme reported lower levels of anxiety at post treatment, although data analysis also confirmed this conclusion. The support for this explanation on the discrepancy between students and parent measures can be found in research findings suggesting that a low level of agreement between children' student's self-report and other informants, such as parents, is fairly typical.(Meehan BT et al ,2003, and Youngstrom,2000) This current review focuses specifically on the role of interventions based on the techniques of cognitive behavioral therapy (CBT) in secondary schools for preventing and reducing suicidality, depression and anxiety in students. A central aim of these interventions is to improve the social skills and problem-solving-abilities students require to cope with life and its many challenges, and thereby decreasing the likelihood of depressive symptoms developing when the student is faced with biological or environmental stressors. As these interventions can be delivered and implemented at different levels we chose to evaluate the relative effectiveness of the following approaches. Students with conduct disorders are more likely to be living in lone parent families, with parents who have no educational qualifications, in families where neither parents are employed, in low-income households or in social sector housing Meltzer, H et al, (2000). Obviously, this does not mean that students from these backgrounds are all conduct disordered, even if the proportion is larger than in other groups. As the name implies, this therapy addresses both cognition - thoughts, feelings, emotions - and behaviors, attempting to change dysfunctional ways of thinking or misguided thought patterns that often lead to dysfunctional and sometimes harmful behaviors. The therapy focuses on the present, current thought patterns, identifying distortions, and applying interventions that specifically target those errant thoughts. These interventions and techniques are problem-solving solutions, first guiding individuals in how to evaluate and modify beliefs, and then, how to change correspondingly unhealthy behaviors and interactions. Metaphorically, CBT interventions resemble a step-by-step "how-to" manual, giving instructions, and then empowering the students to follow the steps, observe how they feel, and report back to the therapist the successes or challenges encountered. Typically, this type of therapy is short-term and goal-oriented, with occasional "checkups" to gauge progress and help in correcting any missteps. Clinical psychology research is as important to the nation's health and well being as medical research. In the same way that medical scientists work to understand the prevention, genesis, and spread of various genetic and infectious diseases, scientists conduct rigorous psychological research studies to understand, prevent, and treat the human condition as it applies psychologically to individuals, couples, families, cultures, and diverse communities. However, cognitive-behavioral therapy is focused on "getting better" rather than "feeling better". So while we are encouraged that students improve their symptoms with cognitive-behavioral therapy, we are more interested in helping them with the underlying thoughts and core beliefs that caused their emotional distress, helping them rid themselves of problematic, inaccurate thoughts, and replacing them with thoughts that are healthy and accurate. An approach to therapy that emphasizes the pursuit of evidence on

which to base its theory and techniques, as well as encourages its students or clients to consider evidence before taking action; or an approach to therapy is supported by research findings, and those findings provide evidence that it is effective. Because cognitive behavioral therapists base their applications on evidence-based research, the amount of CBT research surpasses the amount of psychotherapeutic research in nearly all other areas. Beyond its efficacy in treating acute depression, it has prophylactic effects and is acceptable to various populations in a range of settings. Good theoretical accounts of the emergence of depression in adolescence are forthcoming; to date, however, attempts at primary prevention are unconvincing. Our understanding of factors contributing to positive outcomes is growing, allowing CBT to be tailored to individual client needs.

VI. CONCLUSIONS

In conclusion, the present results provide support for the association between abnormal frontal EEG asymmetry and vulnerability to anxiety and depression. Results of recent studies suggest that attachment models of anxiety and depression may provide an explanatory mechanism for the association between left frontal hypo activation and depression (cf. Dawson, 1994). Future investigations might continue to explore the relation between frontal EEG asymmetry and attachment, as well as the specificity of frontal EEG abnormality to anxiety and depression. Further examination of these areas will no doubt force a reconceptualisation of the nature of the associations among cognition, emotion, and psychopathology.

VII. FUTURE DIRECTIONS

As a sub-field of emotion and motivation, the study of frontal EEG asymmetry holds substantial promise. In terms of basic science, this sub-field promises to inform us regarding the fundamental properties of emotion, both in terms of how emotions occur and what properties they entail. In more applied settings, the possibility yet remains that frontal EEG asymmetry may serve as a useful liability marker for test anxiety. Regardless of the application of this measure, it is increasingly important that theoretical predictions surrounding frontal EEG asymmetry are put to more rigorous tests, especially those provided by testing explicit meditational and mode rational models. In the absence of such explicit tests, the field will remain a collection of studies merely suggestive of moderating and mediating influences, around which much exciting and potentially important speculation and theory is generated. It is possible to more explicitly test that speculation and theory with models that more adequately can support or refute such inferences. The results of these explicit tests will guide the field in investigating whether and how frontal EEG asymmetry may serve as a risk marker for psychopathology, and in investigating what underlying physiological systems influence and are influenced by emotion. Gaining a deeper understanding of the fundamental properties of emotion will require clear thinking in terms of how the various components of emotion and emotional experience are related. It is in this spirit that the present remarks are offered.

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