

Journal of Neurotherapy: Investigations in Neuromodulation, Neurofeedback and Applied Neuroscience

Single Case Study of EEG Asymmetry Biofeedback for Depression

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Published online: 20 Oct 2008.

To cite this article: Carolyn Earnest MSN, RN, CS (1999) Single Case Study of EEG Asymmetry Biofeedback for Depression, *Journal of Neurotherapy: Investigations in Neuromodulation, Neurofeedback and Applied Neuroscience*, 3:2, 28-35, DOI: [10.1300/J184v03n02_04](https://doi.org/10.1300/J184v03n02_04)

To link to this article: http://dx.doi.org/10.1300/J184v03n02_04

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Single Case Study of EEG Asymmetry Biofeedback for Depression: An Independent Replication in an Adolescent

Carolyn Earnest, MSN, RN, CS

Previous case studies are presented which demonstrate the effectiveness of Alpha Asymmetry EEG biofeedback training in the treatment of depression. The results of these studies suggest that this form of biofeedback training may be an effective adjunct in the treatment of depression. To date, these case studies have been conducted on adults. This is the first attempt to replicate and extend the adult studies using an adolescent client.

In a study by Baehr and Baehr (1997), clinical data were presented on three private clients, two with a diagnosis of Adjustment Disorder with Depression and one with a diagnosis of Dysthymic Disorder. All three clients learned to increase the difference in cortical alpha magnitude, right minus left, during biofeedback training. Additionally, the clients demonstrated measurable changes in a positive direction in their depressive symptomology. In the study by Baehr, Rosenfeld & Baehr (1997), clinical data were presented on two clients with a diagnosis of Major Depressive Disorder. Both clients learned to increase the difference in cortical alpha magnitude, right-minus-left, during biofeedback training. Both clients demonstrated measurable changes in a positive direction in their depressive symptomology and in other aspects of personality organization. The results of these studies suggest that Alpha Asymmetry EEG biofeedback training may be an effective adjunct to psychotherapy in the treatment of certain types of mood disorders. The present study was undertaken in an attempt to replicate and extend the findings of Baehr, E. & Baehr, R. (1997), and Baehr, Rosenfeld, & Baehr. (1997)

Davidson (1992) hypothesized that the left frontal region is involved in approach-related behavior and the right frontal region is involved in withdrawal-related behavior, and

also, that a predisposition to exhibit a particular frontal activation asymmetry contributes to vulnerability of individuals to positive and negative emotions in response to the requisite environmental elicitors. Wheeler, Davidson & Tomarken (1993) proposed that individual differences in frontal activation asymmetry are indicative of a trait model of affect and offer promise in understanding the variability of individuals' responses to emotionally provocative stimuli. The trait model of vulnerability to depression has been supported and discussed by various researchers. (Tomarken, Davidson & Henriques, 1990; Henriques, & Davidson, 1990, 1991; Tomarken, Davidson, Wheeler & Doss, 1992; Ketter, George, Ring, Pazzaglia, Marangell, Kimbrell & Post, 1994, Gotlib, Ranganath, & Rosenfeld, 1998) These studies demonstrate a correlation between frontal activation asymmetry and affect.

Davidson states that his asymmetry/valence model (1998) is not intended as a model for depression. Rather he proposes that the differences in prefrontal asymmetry bias a person's affective style and modulate an individual's vulnerability to develop depression. Additionally, he proposes that the two major forms of motivation and emotion are represented in separate neural circuits. Certain areas of the brain participate in both hypothesized circuits and that

lateralization for valence exists in some components of this circuitry. He suggests that decreased activation in both the left and right prefrontal region is predicted to be associated with deficits in both approach and withdrawal systems, respectively.

It has been suggested that there are specific electrophysiological profiles typical of individuals who are currently depressed or previously depressed when compared to never depressed individuals. These patterns involve decreased activation of the left frontal area of the brain (increased alpha) and increased activation of the right frontal area of the brain (decreased alpha). Henriques & Davidson, (1997) reported on previous studies of EEGs taken mostly during rest in depressed and non-depressed individuals. The studies have shown left frontal hypoactivation both in the depressed state and following remission in a normothymic state. Similar results were found by Rosenfeld, Baehr, Baehr & Earnest (in-press), Baehr & Baehr, 1997, Baehr et al, 1997, Rosenfeld, Baehr, Baehr, Gotlib & Ranganath, 1996, Henriques & Davidson, 1990, 1991. Pathological asymmetry may indicate a trait marker of vulnerability to depression, but it does not rule out that this pattern may also represent a state marker of depression. (Davidson, 1992; Tomarken et al., 1990; Wheeler et al., 1993; Henriques & Davidson, 1990, 1991; Tomarken et al., 1992)

Although there has been a significant number of studies on adult subjects, there are fewer studies on adolescents or children. Of the studies that have been conducted, the same asymmetry patterns are being found in younger individuals with depression and in infants of mothers with depression. (Graae et al, 1996; Dawson, et al 1997 & 1995)

This is the first attempt to treat an adolescent patient with an affective disorder

using the alpha asymmetry protocol developed by Rosenfeld¹. At issue was whether or not EEG biofeedback training would be beneficial in alleviating her depressive symptomatology. She had been in treatment with her psychotherapist for two years and there had been no change in her symptoms. She had not been on medication and did not try any new treatment modalities during the EEG biofeedback regimen.

Procedures

A QEEG was collected from this case on a Lexicor Neurosearch 24 and submitted for comparison to the Thatcher Lifespan Database. The QEEG was within normal limits. She was also administered the MMPI-A and the Beck Depression Inventory initially and at the end of treatment. Additionally, the patient was evaluated using Rosenfeld's asymmetry protocol¹. Asymmetry was defined by the formula $[(R-L)/(R+L)] \times 100 = \text{ALAY score}$. Her initial ALAY score was -0.9 with a percentage score (PCT) of 36%. Percentage score is the amount of time alpha is dominant in the right frontal side of the brain. She was seen twice a week for neurofeedback (see below) after school. Each training session was fifty minutes in length. The client was seated in a recliner with eyes closed during the session. The therapist remained neutral and silent during the training sessions. The EEG data for ALAY training was also recorded on a Lexicor Neurosearch 24. Electrodes with impedances reduced to 5000 ohms or less (as measured by an EIM electrode impedance meter) were applied to F3 and F4, referenced to Cz. The threshold for reinforcement was set to zero so that scores below zero

¹ A patented asymmetry protocol was used under license in this study. For information contact Dr. Peter Rosenfeld, Dept. of Psychology, Northwestern University, Evanston, IL 60208.

represented greater left than right alpha magnitude, and scores above zero represented reverse asymmetry. A bell tone was used as a reinforcement when the asymmetry score exceeded zero.

Case Study

Clinical data are presented on a private adolescent patient who participated in EEG biofeedback training. There was a clear understanding from the outset that any issues relating to psychotherapy would be dealt with by the patient's psychotherapist. The sessions discussed here were purely neurofeedback sessions.

Eve is a fourteen-year old single, Caucasian adolescent. She is in the eighth grade. Her parents were recently divorced. She lives with her mother and has regularly scheduled visitations with her father. Eve has one older brother.

Eve has experienced Dysthymic Disorder all of her life, and in March, 1995 had an episode of Major Depression. She began psychotherapy at that time. When referred for EEG biofeedback in June of 1997, her therapist stated that she had a poor prognosis with Major Depression, Single Episode and Specific Phobias (fear of school, fear of losing her mother and an avoidance fear related to her father). Following the onset of the episode of Major Depression in March of 1995, Eve did not see her father again until April of 1996.

When Eve was five years old, her mother was diagnosed with a life threatening illness and was not expected to live more than three months following the diagnosis. At that time, Eve began sleeping on the floor beside her mother's bed. Her mother was hospitalized and close to death a number of times during the first year. Her mother's illness appears

currently to be in remission but she is totally disabled. Her health is poor, and she suffers from frequent opportunistic infections.

Eve's older brother has been away from home most of this time. The family intended to send Eve to a private boarding school in 1997, but were unable to do so because of her depression. Eve's parents separated in November of 1994. Her father reportedly has problems with alcohol, and there had been some alleged sexually inappropriate behavior with Eve by her father during his periods of being inebriated. These allegations came to light with the onset of the Major Depressive Episode and Specific Phobias.

Eve was referred to Carolyn Earnest, MSN, by her mother in June, 1997 for evaluation and treatment with EEG biofeedback. She continued to see her psychotherapist for psychotherapy. She was given an Axis I diagnosis of 296.23, Major Depressive Disorder, Single Episode, Chronic. She met all of the criteria for Major Depressive Disorder. These criteria require that the disturbance be a single major depressive episode with depressed mood most of the day, nearly every day; markedly diminished interest or pleasure in all, or almost all, activities most of the day, nearly every day; failure to make expected weight gains; insomnia or hypersomnia nearly every day; psychomotor retardation nearly every day, fatigue or loss of energy nearly every day; feelings of worthlessness or excessive or inappropriate guilt nearly every day; diminished ability to think or concentrate or indecisiveness nearly every day; and recurrent thoughts of death. The symptoms do not meet criteria for a mixed episode; the symptoms cause clinically significant impairment in many areas of functioning; the symptoms are not due to the direct physiological effect of a substance; and the symptoms are not better accounted for by

bereavement. Additionally, the criteria require that the episode is not better accounted for by Schizoaffective Disorder and is not superimposed on Schizophrenia, Schizophreniform Disorder, Delusional Disorder, or Psychotic Disorder. There has never been a Manic Episode, a Mixed Episode or a Hypomanic Episode. Eve also met the criteria for Chronic in that the full criteria for a Major Depressive Episode have been met continuously for at least the past two years.

RESULTS

Eve's first EEG biofeedback session was on 7/28/97 and her last session on 5/13/98. She completed a total of 67 sessions. The sessions were interrupted after the first session for seven weeks due to the client's vacation and summer camp. Thereafter, the sessions were held a minimum of once a week and at times, twice a week. Her psychotherapist met with her once a week except for the interruption for the client's vacation and summer camp. The Beck Depression Inventory scores were 11 initially and 3 at the conclusion of treatment (see Figures 1 & 2).

Figure 1
Summary of Objective Test Results

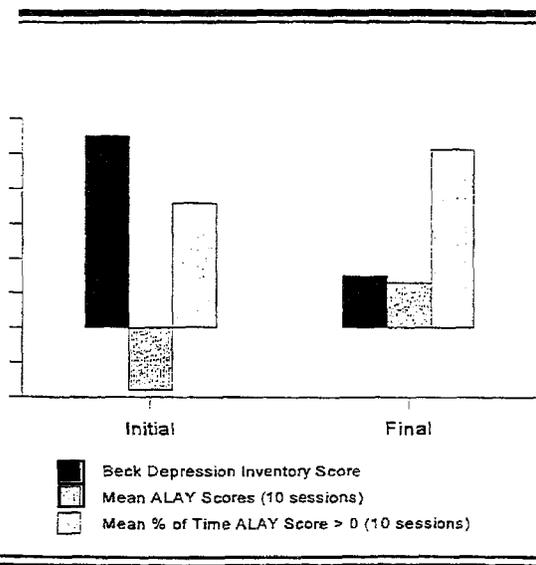
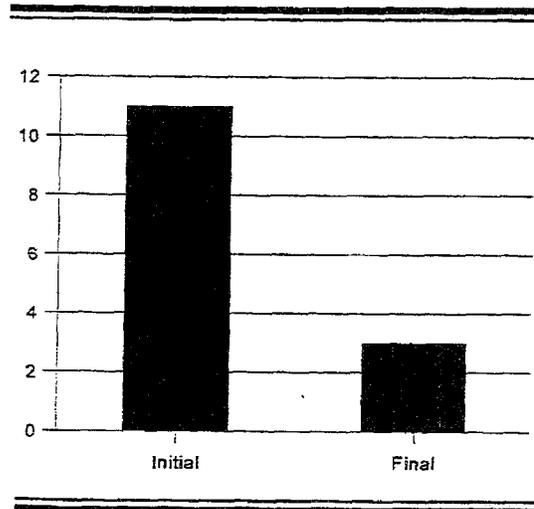
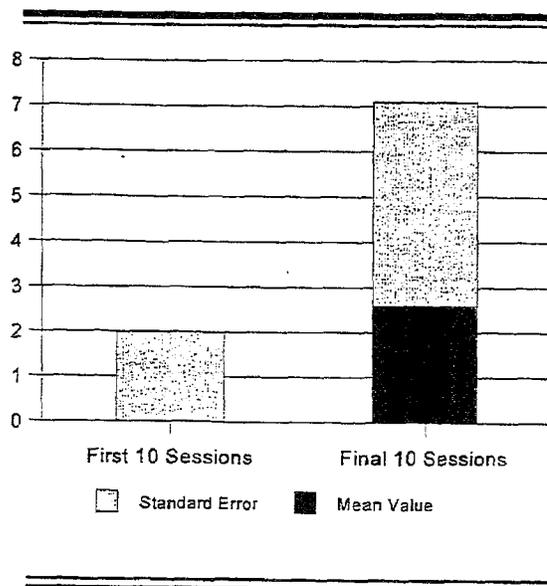


Figure 2
Beck Depression Inventory Scores



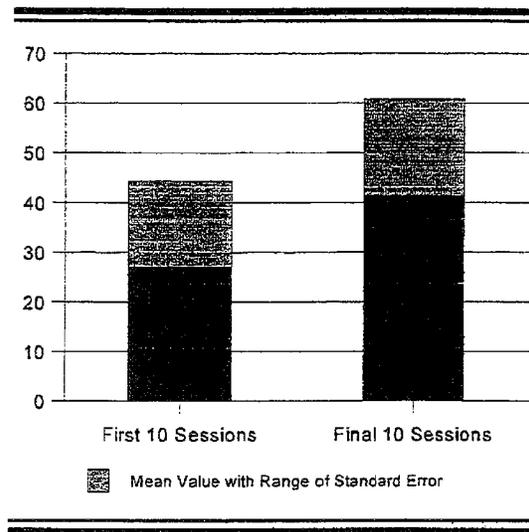
The MMPI-A was within normal limits on both occasions. Eve learned to increase the difference in activation between right and left frontal cortices. Her mean ALAY score for the first ten sessions = $-3.6(+/-5.6)$ contrast with the mean ALAY score for the last ten sessions = $+2.6(+/-4.5)$, $t=2.69$, $df=18$, $p<.02$ (see Figures 1 & 3).

Figure 3
Mean ALAY Scores



Her mean percentage time of ALAY score >0 for the first ten sessions = 35.7(+/-8.7) compared to the mean percentage time of ALAY score >0 for the last ten sessions = 51.2 (+/-9.7), $t=3.781$, $df=18$, $p<.002$ (see Figures 1 & 4).

Figure 4
Mean % of Time ALAY Scores > 0



There was a regression of ALAY scores and percentage of time scores midway through the treatment. These changes directly correlated with negative events in her life as related by her mother. The ALAY scores were more highly variable than the PCT scores. This is consistent with a study conducted by Baehr, Rosenfeld, Baehr, & Earnest (in press) in which the ALAY score was demonstrated to be more variable than PCT. This study found that the percentage of time alpha is produced by left versus right hemisphere is a more reliable index of depression than the ALAY score.

At the conclusion of EEG biofeedback therapy, Eve's psychotherapist commented that the EEG biofeedback "saved her from early mental illness. A year ago she was headed in

the direction of isolation and detachment from everyone. In the past year she has made new friends at school and is going through normal adolescent separation issues as she prepares to go away to school. She is sleeping in her own bed. Her ups and downs over the past year have been directly related to perceived concerns about her mother's health and rejection from her father. Those issues no longer affect her as much."

Discussion

For the first time, a case study was presented of an adolescent who had been treated with 67 sessions of EEG biofeedback using an asymmetry protocol designed to increase the activation of the left hemisphere and decrease the activation of the right hemisphere. Psychotherapy in the past failed to make any change in her depression. She did not try medication. She is currently not depressed even though problems between the parents continue. She is attending a private boarding school at this time.

The variability in Eve's ALAY scores was directly related to exterior events. Negative scores always correlated with some external event that was upsetting. Usually those events were related to perceived concerns regarding her mother's health and perceived rejection by her father.

There are other possible explanations for the variability exhibited. Adolescence, more than any other period of life, is a time of potentially vast mood swings and turmoil. Additionally, an adolescent is largely dependent on parents meeting most of their hierarchy of needs and defining the meaning of home and family. They are therefore subjected to the upheaval of the lives of the parents as well as the issues within their own peer group. This turmoil is compounded in a family with

substance abuse problems due to the dysfunctional interactions that develop within the family unit. Also, in this case, the divorce of the parents, their continued lack of agreement over issues related to parenting and their ongoing legal property cases prevent closure on many components involved. The mother's chronic and life threatening illness has also profoundly affected everyone in this family unit.

Another factor that can certainly influence the world of an adolescent in particular is psychological type. (Jung, 1921; Myers & McCaulley, 1985) Eve's mother interacts with the outer world using an extroverted preference. Eve, on the other hand, expresses an introverted preference, as does her father and her brother.

Wilson & Languis (1989; 1990) propose that individual differences in psychological type seem to be at the core of differences in both approaching and reacting to the world. They examined the effect of psychological type on the electrophysiology of the brain and found general patterns of higher cortical arousal states for introverted adults specifically at C3, CZ, C4, T5, P3, PZ, O1, Oz and O2. These results support the findings of earlier studies by Gale & Edwards. (1983; 1986) Various researchers have examined the role of temperament or psychological type on response tendencies. (Harmon-Jones & Allen, 1997; Ranganath, 1996; Sutton & Davidson, 1997) Baehr & Baehr (1997), proposed that we need to examine the changes that occur with overall personality and cognitive functioning and other EEG variables (coherence and phase). Additionally, gender should be a consideration.

On the basis of our findings in this study, EEG asymmetry training appears to be an effective adjunct to psychotherapy in the treatment of Major Depressive Disorder. This

was the first adolescent to be treated with the asymmetry protocol. As psychotherapy was conducted with this client by another new therapist and no other treatments tried during the course of the biofeedback, the positive results obtained may be a result of the biofeedback training. However the effect could have been due to the specific therapist-client interaction. More work, involving controls, needs to be done.

References

- Baehr, E., Rosenfeld, J.P. & Baehr, R. (1997). The clinical use of an alpha asymmetry protocol in the neurofeedback treatment of depression: Two case studies. *Journal of Neurotherapy*, 2, (3), 10-23.
- Baehr, E. & Baehr, R. (1997). The use of biofeedback as an adjunctive therapeutic treatment for depression: Three case studies. *Biofeedback*, 25, (1), 10-11.
- Baehr, E., Rosenfeld, J. P. Baehr, R. & Earnest, C. (in press). Comparison of two eeg asymmetry indices in depressed patients vs. Normal controls, *International Journal of Psychophysiology*.
- Davidson, R. J. (1992). Anterior cerebral asymmetry and the nature of emotion. *Brain and Cognition*, 20, 125-151.
- Davidson, R. J. (1998). Anterior electrophysiological asymmetries, emotion, and depression: Conceptual and methodological conundrums. *Cognition & Emotion*, 12, (3), 307-330.
- Dawson, G., Frey, K., Panagiotides, H., Osterling, J., & Hessler, D. (1997). Infants of depressed mothers exhibit atypical frontal brain activity. A replication and extension of previous

- findings. *Journal of Child Psychology & Psychiatry*, **38**, 179-186.
- Dawson, G., Grofer Klinger, L., Panagiotides, H., Hill, D. & Speiker, S. (1992). Frontal lobe activity and affective behavior of infants of mothers with depressive symptoms. *Child Development*, **63**, 725-737.
- Gale, A. & Edwards, J.A. (1986). Individual differences. In: M.G. Coles, E. Donchin, and S.W. Porges. *Psychophysiology: Systems, Processes, and Applications*. New York: Guilford Press, 431-507.
- Gale, A. & Edwards, J.A. (1983). Physiological correlates of human behavior. *Vol. III: Individual Differences and Psychopathology*, New York: Academic Press.
- Graae, F., Tenke, C., Bruder, G., Rotheram, M-J, Piacentini, J., Castro-Blanco, D., Leite, P. & Towey, J. (1996). Abnormality of EEG alpha asymmetry in female adolescent suicide attempters. *Biological Psychiatry*, **40**, 706.
- Harmon-Jones, E. & Allen, J.B. (1997). Behavioral activation sensitivity and resting frontal eeg asymmetry: covariation of putative indicators related to risk for mood disorders. *Journal of Abnormal Psychology*, **106**, (1), 159-163.
- Henriques, J. B. & Davidson, R. J. (1990). Regional brain electrical asymmetries discriminate between previously depressed and health control subjects. *Journal of Abnormal Psychology*, **99**, 22-31.
- Henriques, J. B. & Davidson, R. J. (1991). Left frontal hypoactivation in depression. *Journal of Abnormal Psychology*, **100**, 535-545.
- Henriques, JB & Davidson, RJ (1997). Brain electrical asymmetries during cognitive task performance in depressed and nondepressed subjects. *Biological Psychiatry*, **42**, (11), 1039-1050.
- Jung, C. G. (1921). *Psychological types*. London, England: Routledge and Kegan Paul.
- Ketter, A., G., M., Ring, H., Pazzaglia, P., Marangell, L. Kimbrell, T., and Post, R. (1944). Primary mood disorders: Structural and resting functional studies. *Psychiatry Annals*, **24**, (12), 637-647.
- Ranganath, C. (1996). Anterior EEG asymmetry, personality and depression, Northwestern University. Submitted to the Graduate School in fulfillment of the Second Year Research Project, 1-25.
- Rosenfeld, J. P., Baehr, E., Baehr, R., Gotlib, I. H. & Ranganath, C. (1996). Preliminary evidence that daily changes in frontal alpha asymmetry correlate with changes in affect in therapy sessions. *International Journal of Psychophysiology*, **23**, 137-141.
- Sutton, S. K., & Davidson, R. J. (1997). Prefrontal brain asymmetry: A biological substrate of the behavioral approach and inhibition systems. *Psychological Science*, **8**, 204-210.
- Tomarken, A. J., Davidson, T. J. & Henriques, J. B. (1990). Resting frontal brain asymmetry predicts affective responses to films. *Journal of Personality and Social Psychology*, **59**, 791-801.
- Tomarken, A. J., Davidson, R. J., Wheeler, R. E. & Doss, R. (1992). Individual differences in interior brain asymmetry and fundamental dimensions of emotion. *Journal of Personality and Social Psychology*, **62**, 676-687.

Wheeler, R. E., Davidson, R. J., & Tomarken, A. J. (1993). Frontal brain asymmetry and emotional reactivity: A biological substrate of affective style. *Psychophysiology*, **30**, 82-89.

Wilson, M. A. & Languis, M. L. (1990). A Topographic Study of Differences in the P300

Between Introverts and Extroverts. *Brain Topography*, **2**, (4), 269-274.

Wilson, M. A. and Languis, M. L. (1989) Differences in brain electrical activity patterns between introverted and extroverted adults. *Journal of Psychological Type*, **18**, 14-23.

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