

The Clinical Use of An Alpha Asymmetry Protocol in the Neurofeedback Treatment of Depression: Two Case Studies

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In this study we are presenting case studies of two depressed women who were trained with more than 34 sessions each of EEG biofeedback (neurofeedback) using an Alpha Asymmetry protocol. The purpose of this training was to determine if depression could be alleviated when the subjects learned to increase the activation of the left hemisphere and/ or decrease the activation of the right hemisphere. The MMPI-2 was administered before and after training to measure changes in personality factors, including depression. The results suggest that Alpha Asymmetry neurofeedback training may be an effective adjunct to psychotherapy in the treatment of certain types of mood disorders.

Positive preliminary results were obtained in our development of an EEG biofeedback modality (called ALAY for Alpha Asymmetry), in which five persons were trained to increase the difference in activation between right and left frontal cortices. We also found that prior to successful training, day to day fluctuations in EEG asymmetry predicted the direction of change in affective responses to EEG training during a session. (Rosenfeld, Baehr, Baehr, Gotlib, & Ranganath, 1996). This study was based on the work done by Davidson, Tomarken and colleagues (e.g., Davidson, 1992; Tomarken, Davidson & Henriques, 1990; Wheeler, Davidson & Tomarken, 1993) who have shown that frontal activation asymmetry correlates with affect. Rosenfeld, Cha, & Blair, (1993) demonstrated that it was possible to train nine of thirteen normal individuals to increase the difference in activation between right and left frontal cortices. Allen & Cavender (1966) independently replicated and extended the work of Rosenfeld et al. (1995), by showing that normal persons could also decrease the activation difference, and that the expected effects of bidirectional training on emotional reactivity were obtained.

Henriques and Davidson (1991) state that they, along with other researchers, (Ketter, George, Ring, Pazzaglia, Marangell, Kimbrell & Post,) (1994), believe that the anterior region of the left and right hemispheres are involved in the mediation of approach and withdrawal behavior, respectively. They state that there is a predictable bias toward negative emotional reactivity to stress when different asymmetrical patterns of activation occur in the brain. They propose a diathesis stress model in which anterior left activation is related to approach-related emotions and behavior, and anterior right activation is related to increased vulnerability to withdrawal related emotions and behavior. They hypothesize that sadness and depression are both related to "approach related deficits" and they address the possibility that projections from subcortical structures, such as the amygdala and the thalamus, may be part of the mechanisms which underlie frontal asymmetry differences. Gotlib, Ranganath and Rosenfeld (1996), replicating and extending the findings of Henriques and Davidson (1990, and 1991), found that the pattern of relative left frontal hypoactivation was evident not only in acutely depressed individuals but also in formerly depressed individuals. This was evidence that a pathological asymmetry is a trait marker of vulnerability to depression, but does not rule out that this pattern is also a state marker of depression (Rosenfeld et al., 1996).

In this paper we are presenting clinical data and case material on two private patients who participated in neurofeedback training as an adjunct to psychotherapy for depression. The first is a case study of a chronically depressed sixty-five year old woman who has had thirty-four asymmetry neurofeedback sessions ; the second is a case study of a dysthymic forty year old woman who has had thirty-six asymmetry neurofeedback sessions. The issue of whether they could benefit from asymmetry training designed to increase the difference in activation between right and left frontal hemispheres is addressed. Specifically we asked whether there would be measurable changes in their depressive symptomology and in other aspects of personality organization based on clinical impressions and comparisons of pre and post MMPI-2 test results.

Procedures

In addition to clinical impressions, the MMPI-2 was administered to assess emotional functioning before and after a series of training sessions. Adult Clinical Interpretations were computer-generated by the National Computer Center.

Prior to neurofeedback training the patients were trained to use diaphragmatic breathing exercises and autogenic suggestions such as "I feel quite relaxed", and "warmth is flowing down my arms into my hands and fingers" to promote relaxation and hand warming. Subjects were taught to meet a handwarming criteria of 90-95 degrees Fahrenheit. This technique serves to reduce artifact caused by muscle tension. The patients were also encouraged to focus their thoughts on pleasant, unemotional imagery during EEG training sessions. They sat in a reclining chair with their feet up, and were encouraged to maintain a relaxed state, closing their eyes and moving as little as possible.

The patients were seen once or twice a week for an hour long session which consisted of approximately 50% brainwave biofeedback followed by 50% psychotherapy. During biofeedback, F3 and F4, referenced to Cz, were recorded. Impedances were 5000 ohms or less, as measured by an EIM electrode impedance meter. The threshold was set at zero so that scores below zero

represented greater left than right alpha magnitude, and scores above zero represented reverse asymmetry. Alpha rhythm in this case reflects cortical hypoactivity, therefore an increase in left frontal activity corresponds to a positive change in the asymmetry score.

Asymmetry was derived by the formula $[(R-L)/(R+L)] \times 100$. The EEG data for ALAY training were recorded either on a 4 channel unit, or on a Neurosearch 24 channel unit (Both these units are from Lexicor Corp., and the software controlling the biofeedback was identical in both units). FFTs were derived on Blackman-Harris windowed analog signals over 1-second epochs (Harris, 1978). This device also outputs the mean value over the entire session each day as a mean Asymmetry score. A bell tone was used as a reinforcement when the Asymmetry score exceeded zero.

Case Study Number One

Ann Rose³ is a sixty-five year old woman who had a history of a Major Depressive Disorder with chronic depressive bouts which occurred every two or three years since she was in her twenties. She was first seen by a psychiatrist for treatment of depression when she was twenty-five years old. Her diagnosis at that time was Major Depressive Disorder, (DSM IV 296.32). She continued in supportive therapy on an intermittent basis for twenty-eight years. There was no significant change in her affective pattern. Her thinking was characterized by obsessiveness and indecision. She had been treated with medication during that time, with some improvement of symptoms, but she also suffered side effects and she elected to discontinue all medication. She was referred to Dr. Elsa Baehr twelve years ago by the psychiatrist she had been seeing, as he felt she might benefit by working with a female therapist. She was initially diagnosed by Dr. Baehr as having a recurrent Major Depressive Disorder of moderate severity, (DSM IV 296.32). On a daily basis she presented six of the nine criteria for a Major Depressive episode listed in DSM IV. Her symptoms included depressed mood during most of the day, a loss of interest and pleasure in activities, significant weight loss, insomnia, fatigue and loss of energy, and indecision and diminished ability to concentrate. Episodes generally lasted between two to six months, and then she would be in partial remission, with sleep disturbance being her only residually chronic symptom. Her depression was differentiated from a dysthymic disorder in that the depressed mood was present for most of the day, nearly every day, for a period of at least two weeks. In a Dysthymic Disorder the symptoms are present for more days than not, over at least a two year period. Another distinction between the two disorders is that discrete Major Depressive Episodes can be distinguished from the person's normal functioning, while the Dysthymic Disorder is characterized by less severe chronic depressive symptoms which may last for many years. Her depression was also differentiated from a Cyclothymic Disorder and a Bipolar Disorder due to the total lack of hypomanic symptoms.

At the time of the referral to Dr. B. she had been married for thirty years and had two children who were nearing college age. She was seen by Dr. B. in psychotherapy for a period of two years during which time she sufficiently recovered from her depression to allow her to continue her work as a librarian, and to function well socially.

She contacted Dr. Elsa Baehr every few years when she was again experiencing the same symptoms of depression and would typically stay in treatment just long enough to become functional, yet still mildly dysthymic. In the Spring of 1993 she called for an appointment. Ann

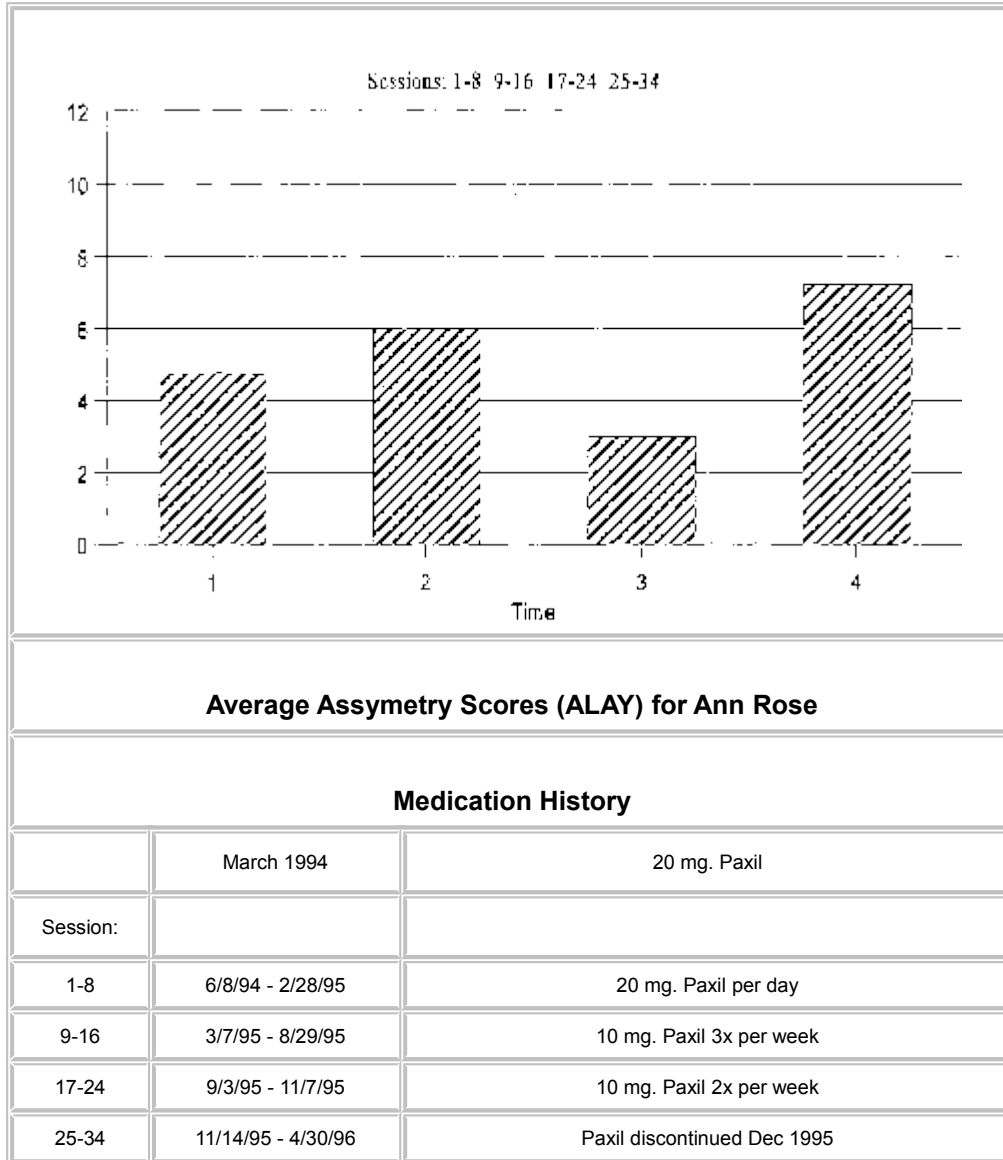
Rose was puzzled by the onset of this latest bout of depression. There were no stressors in her life to account for her feelings. To the contrary, she reported that things were going very well with her family and her job. Shortly after beginning therapy, however, stress increased when she was forced to make a decision about early retirement from her job. When she elected to retire, her depressive symptoms increased; she was insecure about the future, she ruminated a great deal about her decision, and worried obsessively about her health .

In the Fall of 1993, she was offered neurofeedback treatments for depression in addition to her psychotherapy sessions. She began the first of thirty-two Alpha-Theta training sessions.⁴ A portable EEG manufactured by Discovery Engineering Co. was used at that time. One electrode was placed at O1 and one electrode was placed on each ear were used for reference and ground. As mentioned above, diaphragmatic breathing and relaxation training preceded the sessions. All sessions were conducted with eyes closed to help increase the production of alpha /theta brain waves. During the first thirteen sessions the percentages of Beta and Theta exceeded Alpha. It was apparently difficult for her to stop "thinking" as she relaxed. By session fourteen she had successfully learned to use the relaxation techniques to reduce the percentage of Beta and increase Alpha. By session thirty-two she reported some improvement in her feelings after she left the office but complained that the depression would return, particularly when she awoke in the morning. She decided to try medication and in March of 1994 she began taking 20mg Paxil per day. After one month she began to feel less depressed, however she elected to try the neurofeedback because she did not want to rely on medication as a treatment for depression.

The first of a series of thirty-four neurofeedback sessions using the Alpha Asymmetry protocol was conducted on June 8, 1994, and the last on April 30,1996. While it appeared that asymmetry learning was occurring, the learning curve was not monotonic(Figure 1.)⁵ The asymmetry scores were related to life's vicissitudes. For example, during the course of therapy, her average asymmetry scores dropped during sessions seventeen to twenty-five. (Figure 1.).

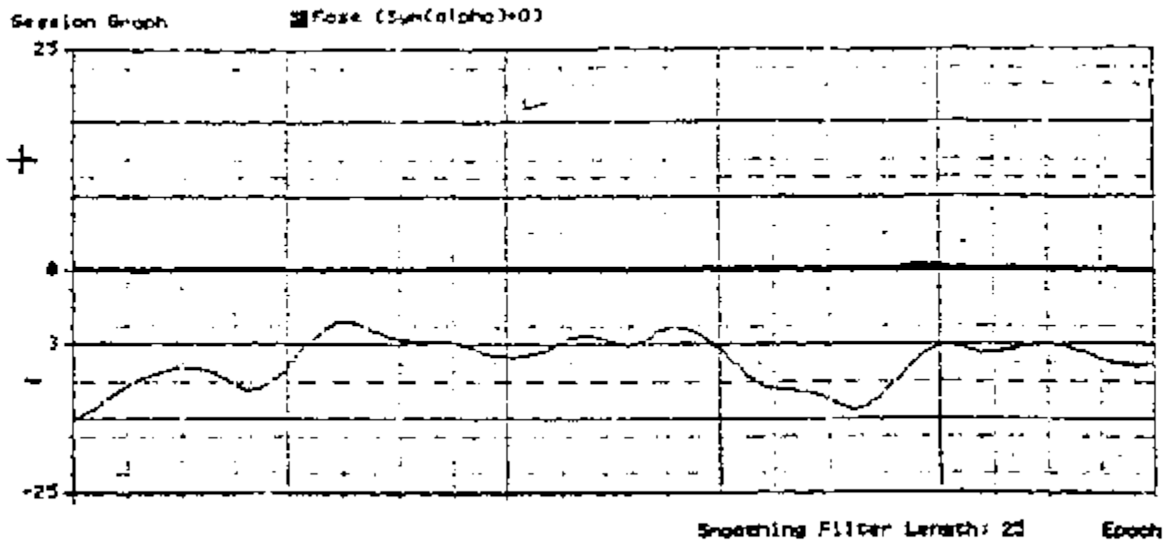


Figure 1



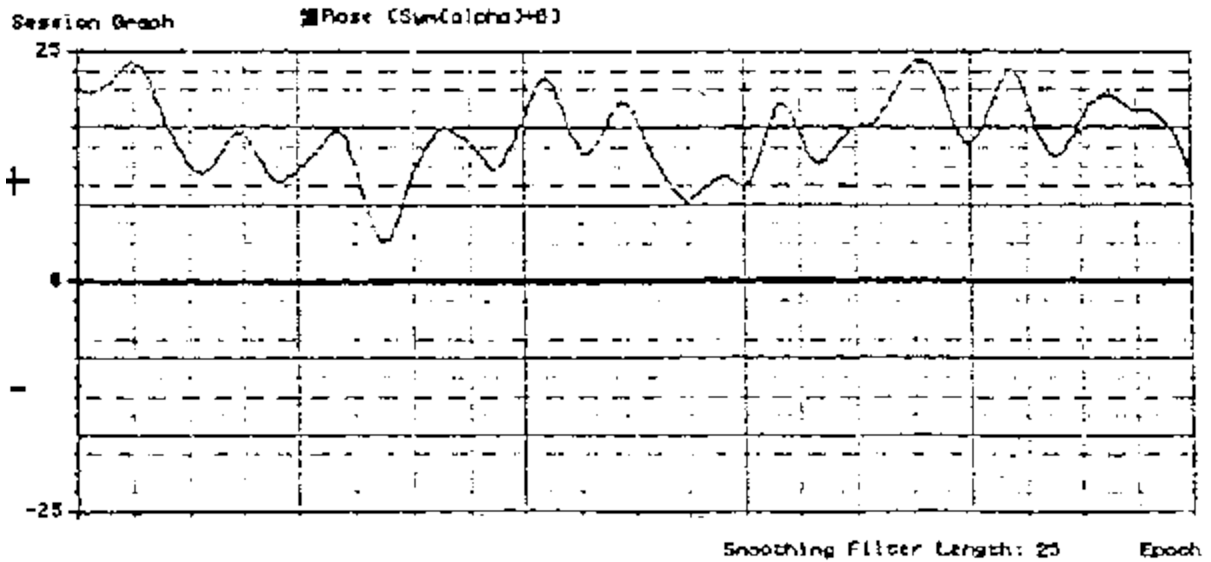
In that time period her daughter developed lung cancer, her sister in-law died, and a close family friend died. Scores varied with the news about her family; when reports were good her alpha asymmetry scores rose, and when she was worried, negative asymmetry scores occurred. (Figures 2A and 2b). The negative scores occurred when she was on full dosage of medication as well as when medication was reduced. It was characteristic of her to rebound with positive right frontal alpha asymmetry scores. After prolonged training, (twenty-five sessions), she claimed that she was no longer depressed, and that she could distinguish between the emotions generated by depression and those associated with appropriate worry or sadness evoked by situations in her life.

Figure 2a



Negative scores during a training session reflect emotional stress. These ALAY scores reflect possible hypoactivation of the left cortices as compared to the right cortices.

Figure 2b

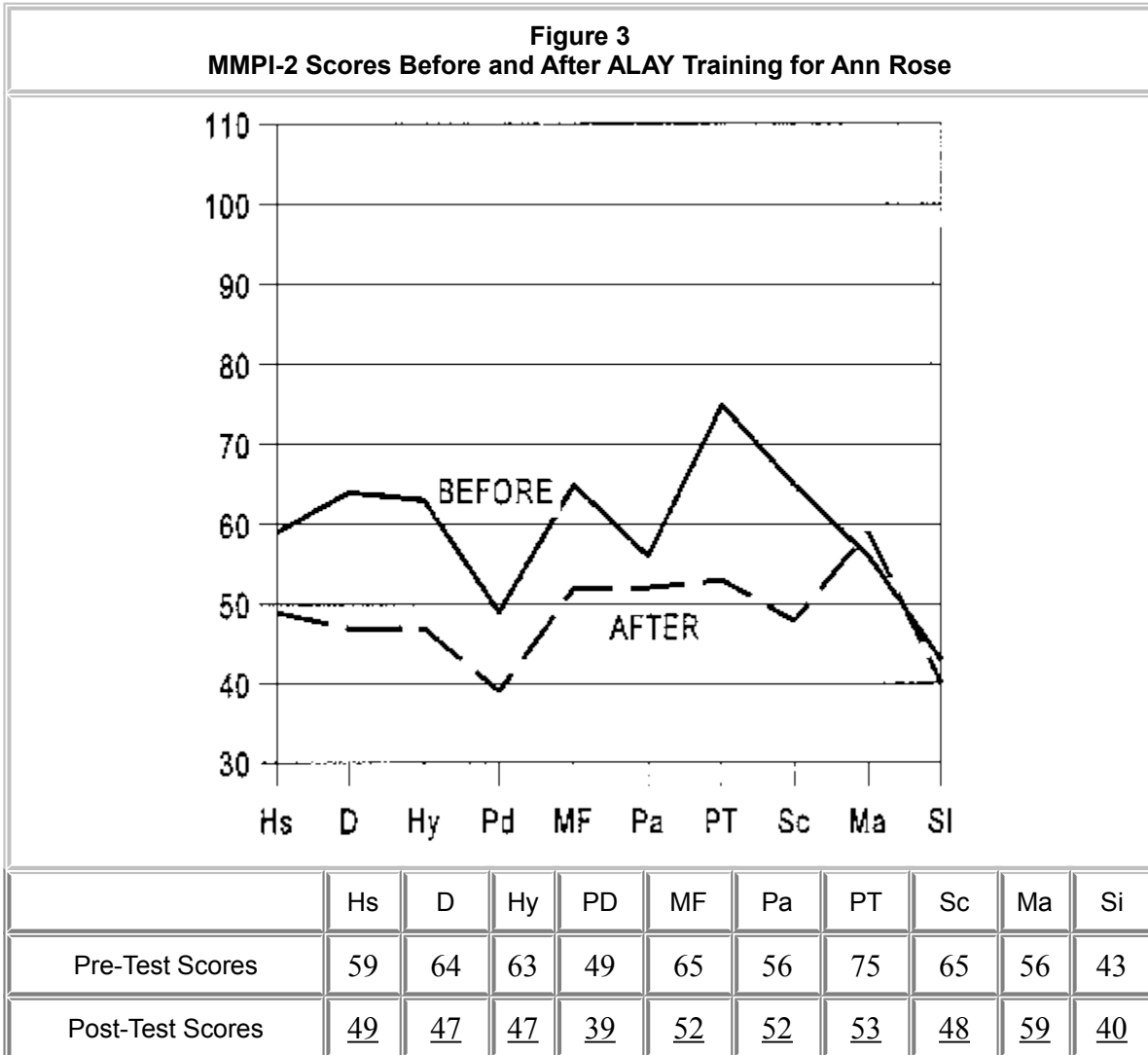


Positive scores during a training session reflect emotional stability. These ALAY scores reflect possible hypoactivation of the left cortices as compared to the right cortices.

Results

Ann Rose learned to increase the difference in activation between right and left frontal cortices during a series of 34 neurofeedback asymmetry training sessions. Five months post training retesting indicated that she was maintaining the asymmetry differences. At that time her ALAY score of 7 was equal to the average ALAY scores at the end of her training.

A comparison of the two computer generated MMPI-2 reports of tests taken before and after the series of EEG asymmetry training sessions revealed statistically significant differences in her personality profile. (Fig. 3). While it is expected that MMPI-2 profiles regress toward the mean on the second testing, the differences in pre and post subtests are significant only when they exceed the standard error of measurement (SE_m).



Difference	10	17	16	10	13	04	22	17	-03	03
Standard Deviation	4.2	4.9	4.5	4.4	3.9	2.9	6.8	6.8	4.2	9.3

According to James Butcher, a recognized authority on the MMPI, differences that are greater than two times the SEM are preferable for conservative personality appraisal. (Butcher, 1990). In the case of Ann Rose, three scales, Hypochondriasis, Psychasthenia and Masculinity-Femininity, yielded differences greater than three times the SEM. The Depression Scale yielded a difference of greater than four times the SEM. In the "pre" test MMPI-2 interpretative report she was described as follows:

"The client appears to be anxious and tense, and is having difficulty concentrating or making routine decisions. She ruminates a great deal and feels worried, guilty and depressed..."

In the post test MMPI-2 report she was described as follows:

"This MMPI-2 clinical profile is within normal limits. She appears to be a pleasant, friendly, and ambitious person who feels happy and effective in her life...She has a rather positive self image and is optimistic about the future."

Approximately six months after the beginning of asymmetry treatment, Ann Rose began reducing her medication to 20 mg. 3x per week, and then approximately 6 months later to 20 mg. 2x per week. She discontinued her medication entirely at the beginning of December 1995.

Ann Rose is no longer depressed. She is seen on an intermittent basis just to "keep in touch". She commented that at times she feels like she may be going into a depression again, but it doesn't materialize. She also commented that her mind seems to be functioning better. She no longer ruminates about things, and she finds that in games like Mah Jongg she is now able to recognize combinations much more quickly than she had ever been able to do in the past. Her diagnosis has been changed to "Major Depressive Disorder in Full Remission." DSM IV 296.6 .

Ann Rose has been known to her therapist, Dr. Elsa Baehr for a period of twelve years. Her recovery from depression on former occasions appears clinically to be qualitatively different than it is currently. She appears to be more energetic and outgoing than previously. While she admits to worrying when things go wrong, she is not as obsessive in her thinking as she was in the past.

Case Study 2

Catherine is a forty year old caucasian divorced woman. She has been a registered nurse for twelve years. She works full time in a hospital setting and is the head nurse in her department. Her job carries administrative responsibilities as well as nursing duties.

Catherine was married while in college. Her marriage lasted only three years. She has no children. She lives alone in a condominium she owns. She sought therapy in the Spring of 1993. She was diagnosed as having a single episode of a Major Depressive Disorder (DSM IV 296.2) at that time. Her symptoms included the presence of depression during most of day every day, psychomotor

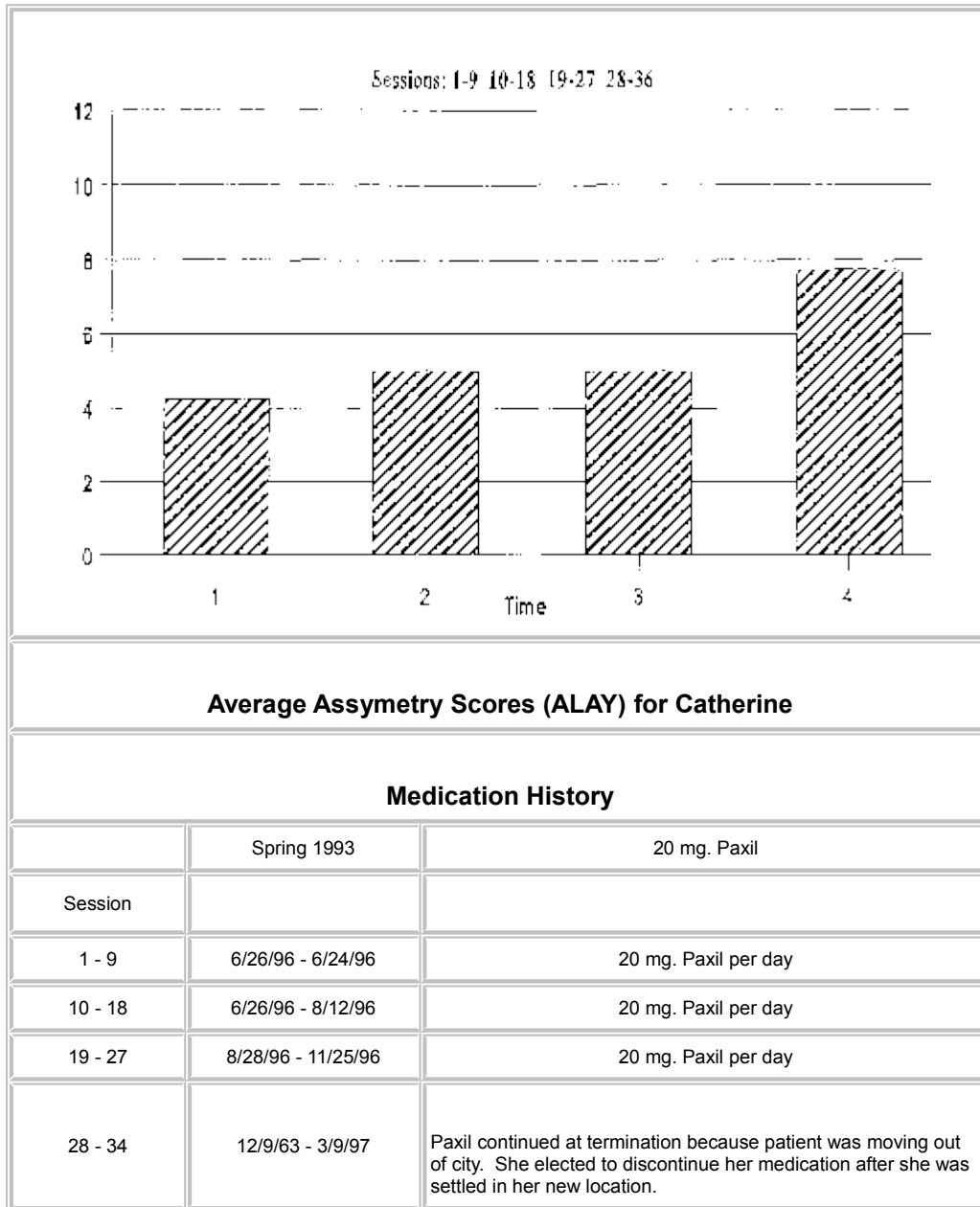
agitation, insomnia, weight loss, obsessive thinking and inability to concentrate. Catherine's family had a history of depression. When she was growing up her father suffered bouts of depression. Catherine's mother was often ill during the time her father was depressed, and both parents depended on her. Catherine tended to feel overwhelmed during those times.

The onset of her recent depression was related to feeling overextended when she was given the responsibility of presenting a program to the medical staff at her hospital. She was unable to meet her commitments, and took a brief leave of absence from her job. When she started in psychotherapy with Dr. Elsa Baehr, the emphasis in treatment was on understanding her dynamics and relating them to her present situation. She also began a course of medication for depression. (Paxil, 20 mg. per day). After three weeks she returned to work, and she remained reasonably stable for a period of a year. She continued the medication, and was seen in psychotherapy on a once a week basis. A second episode of depression occurred when her father became depressed, and a co-worker developed a serious illness. She was diagnosed at that time by her therapist, Dr. Baehr, as having a Dysthymic Depressive disorder, (DSM IV 300.4). Her depression was characterized by chronic, non-severe depressive symptoms such as feeling sad or down in the dumps, having low self esteem and low energy. She also gained weight because of overeating. In this disorder symptoms may be present for more days than not over at least a two year period. In some cases the disorder may last for many years. Although she understood the relationship between feelings she had as a child, and the feelings she was now experiencing, she was unable to fully recover. She continued working, but would retreat to her home and basically spend time by herself. This pattern continued for nearly a year, in spite of encouragement from friends and her therapist to become more socially active. Because neither medication nor psychotherapy was apparently helpful in relieving her depression, it was suggested that she try neurofeedback as an adjunct to her ongoing therapy.

Catherine began the first of a series of thirty-six neurofeedback sessions in June, 1996. Each session was an hour in duration and the time was divided nearly equally between neurotherapy and psychotherapy. She came for therapy twice a week for the remainder of the summer, and then continued on a once a week basis until the March 1997. After a brief learning period during the first two sessions, she demonstrated progress in increasing her asymmetry scores.(Fig.4).



Figure 4

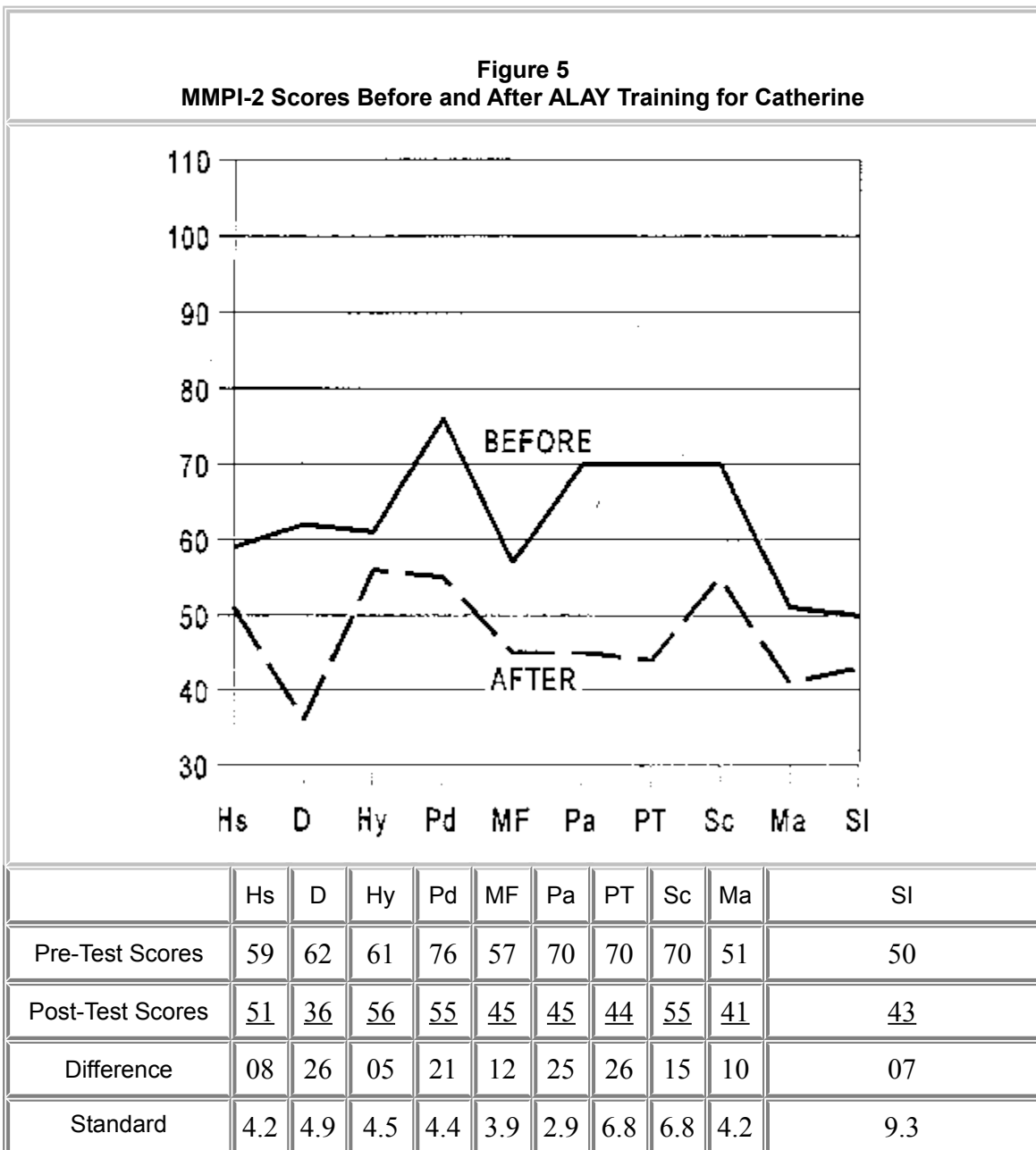


Occasional negative scores occurred after her training period, and these were generally associated with disappointments she had in relationships. As training progressed she reported feeling better, and she became interested in increasing her sphere of activities with friends. She joined a dating service, and began meeting men. She made the observation that she experienced herself as being more flexible and less oppositional. Her therapist concurred that she also noticed positive changes in her personality. Catherine began a serious relationship with a man during the winter. She also began to realize that she had many more career options than she had ever explored, and she began to think about finding a more suitable job. Her ALAY scores continued to increase. She is no longer depressed. Her self esteem has improved and she is optimistic about the future. Her current diagnosis is Dysthymic Disorder in full remission (300.46)

Results

Catherine learned to increase the difference in activation between the right and left frontal cortices over a period of 36 neurofeedback asymmetry sessions.

A comparison of the two computer generated MMPI-2 reports before and after the series of EEG asymmetry training revealed significant differences in her personality profile. (Figure 5).



Deviation.										
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In the pretest she was described as follows: "...Individuals with this MMPI-2 clinical profile tend to exhibit a pattern of chronic psychological maladjustment...She has endorsed a number of items suggesting that she is experiencing low morale and a depressed mood...She is likely to have difficult interpersonal relationships, often appearing sullen, resentful and quite uncompromising...marital breakup is relatively common."

In the post test she was described as follows: "Her MMPI-2 clinical and content scales are within normal limits. No clinical symptoms were reported... Quite outgoing and sociable, she has a strong need to be around others. She is gregarious and ...her social behavior is not likely to change if she is retested at a later time."

Differences in four of the basic scales, Depression, Psychopathic Deviate, Paranoia and Psychasthenia (Fig.6) were greater than three SE_m ,⁷ . As in the case of Ann Rose, these differences are statistically significant, and the changes they represent would not be expected to occur on retesting.

Discussion

We have presented two case studies of depressed women who have been treated with more than 34 sessions each of EEG biofeedback using an asymmetry protocol designed to increase the activation of the left hemisphere and decrease the activation of the right hemisphere. Ann Rose was treated for depression by a combination of techniques which included psychotherapy, medication and neurofeedback, (including alpha - theta and asymmetry protocols). Long term therapies and medication in the past failed to make any lasting change in her depression or her general personality functioning. She is currently not depressed, even though she has had to cope with serious medical problems in her family and in her- self. She has none of the six symptoms of major depression she showed when initially diagnosed. She still has occasional wakefulness during the night, however she is often able to fall back asleep rather than lie awake and ruminate as she had done in the past. Significant changes in her subtest scales on the MMPI-2 as well as subjective reports of well being, suggest that real changes in her emotional functioning have occurred. While medication may have helped improve her mood in the initial phase of the neurofeedback treatment, it cannot account for her present level of functioning, as she discontinued the Paxil one year ago. The observed changes may be all or in part be due to psychotherapy, although similar changes in her functioning did not occur when she was in psychotherapy alone over a period of thirty-two years. Catherine had been seen in psychotherapy for a period of 3 years prior to starting the neurofeedback sessions. Like Ann Rose, neither medication nor psychotherapy was effective in helping her overcome her depression. Catherine has made major gains in her functioning since she started neurotherapy. The two most conspicuous changes have been improvement in her affect, and flexibility in her thinking. Her diagnosis has been changed to Dysthymic Disorder in Full Remission, DSM IV 300.26. She is in the termination phase of therapy. She is planning to marry soon.

While both patients had been receiving a combination of psychotherapy and medication to treat their depression, neither had made significant progress until they added the alpha asymmetry protocol to their ongoing treatment. There were striking similarities in their response to the EEG biofeedback. They both felt subjectively better soon after therapy had begun. Both demonstrated learning curves, and both patients had occasions after they were trained when, due to life's vicissitudes, they exhibited negative ALAY scores. Negative scores always correlated with some event that was upsetting. Both patients demonstrated that they could recover quickly, and restore positive ALAY scores. Thus, the ALAY score is impacted by both life's stresses and biofeedback.

Some unexpected findings occurred in both patients. A comparison of the pre and post MMPI-2 patients showed that not only had depression significantly improved, but other factors in their personality structure seemed to normalize. In both cases differences that were greater than three times the standard error of the measure were found among their subtest scores. While on the first test each was diagnosed as having pathology that was unlikely to change, on the last test they both were diagnosed as normal. Each person demonstrated more flexibility in their thinking, and a positive outlook for the future. Since both of these women had been patients of Dr. Elsa Baehr before the neurotherapy began, it would appear that neither medication nor psychotherapy were producing the type of change that was observed after their Asymmetry training sessions. However, without appropriate control cases, this possibility is offered very tentatively.

We recognize that these studies are in their infancy, and that our impressions may change as more researchers contribute data in this important area of study. The results of control studies, now being conducted in other research facilities, are urgently needed. While we are encouraged by the positive results in these two patients, we need to evaluate the effectiveness of the asymmetry training on other types of mood disorders such as the bipolar and cyclothymic disorders. We also need to account for the positive changes which occur in overall personality and cognitive functioning. Factors such as gender differences should be evaluated. We also may profitably learn more about the impact of asymmetry training on other EEG variables, (e.g. coherence and phase), which are also reported to have functional correlates.

On the basis of our findings in this study EEG asymmetry training has appeared to be an effective adjunct to psychotherapy in the treatment of certain types of mood disorder. While we do not claim that EEG Asymmetry training is a "stand-alone" treatment for depression, we believe that it may be possible, with training to produce a brain state that is less vulnerable to depression.

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