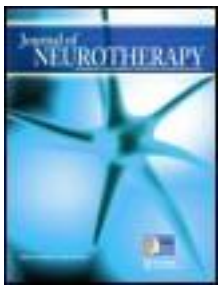

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LENS Neurofeedback Treatment of Anger: Preliminary Reports

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ABSTRACT. There has been no neurofeedback outcome research on anger control. Problems with anger cut across numerous diagnostic categories and represent a serious societal problem. Two case reports are presented involving significant traumatic brain injuries and histories of chronic anger and violent behavior. The Low Energy Neurofeedback System (LENS) was used as sole treatment in both cases. Significant improvements were reported in a variety of symptoms and changes in anger were evaluated with the State-Trait Anger Expression Inventory–2. Although the case reports are uncontrolled and represent only very preliminary evidence, the results support the potential of LENS neurofeedback to produce significant improvements in anger control, which has implications with many diagnoses, including traumatic brain injury, juvenile and adult correctional populations, and domestic violence. Clinicians and researchers need to begin using objective pre- and posttreatment outcome measures of anger and aggressiveness.

KEYWORDS. Anger, EEG biofeedback, Low Energy Neurofeedback System, neurofeedback, STAI–2

INTRODUCTION

Anger is a symptom that is a component of many different diagnostic conditions including attention deficit/hyperactivity disorder (ADHD), postconcussion syndrome, depression, bipolar disorder, schizophrenia, addictions, and posttraumatic stress disorder among others. It is common opinion that we live in an increasingly impulsive and violent society, with anger apparent in incidents ranging from road rage to domestic abuse.

Although neurofeedback has been applied to many of these conditions, no study has directly focused on the effects of neurofeedback on anger, and only one article (Hammond, 2001) has even speculated on the implications for anger control of EEG research. The author, therefore, took four cases where anger and explosiveness was rated by the patient during the intake history interview as one of their most prominent symptoms. Rather than simply obtaining regular patient ratings of this symptom as the author regularly does, each patient was administered the State-Trait Anger Expression Inventory–2 (STAI–2; Spielberger, 1999). This article reports on two of those cases. Two other cases that showed significant improvement in session symptom ratings of anger were lost to follow-up before STAI–2 posttreatment testing could be completed.

The STAI–2 is a 57-item, 4-point rating scale, self-report psychological test that takes 12 to 15 min to complete (Spielberger, 1999). It has been used extensively in research for more than 20 years. The inventory has been

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used in research evaluating anger management programs and treatments and posttraumatic stress disorder; in headache and chronic pain patients; in evaluating the relationship of anger and the development of hypertension, coronary heart disease, and cancer; and relationships between anger, depression, and violence. There are 12 subscales on the STAI–2 with both percentile and *T*-score norms for normal adults age 16 and older; for normal males and females in age ranges of 16 to 19, 20 to 29, and age 30 and older; and for male and female psychiatric patients ages 18 and older.

State Anger

As measured by the STAI–2, the State Anger (S-Ang) scale evaluates the intensity of angry feelings and the extent to which the person feels like expressing anger at a particular time, whereas the Feeling Angry (S-Ang/F) scale displays the intensity of anger the person is currently experiencing. The Feel Like Expressing Anger Verbally (S-Ang/V) scale is the intensity of current feelings related to the verbal expression of anger, whereas Feel Like Expressing Anger Physically (S-Ang/P) scale measures intensity of current feelings related to the physical expression of anger.

Trait Anger

The Trait Anger (T-Ang) scale measures how often angry feelings are experienced over time. The Angry Temperament (F-Ang/T) subscale measures the disposition to experience anger when there is no specific provocation. The Angry Reaction (T-Ang/R) subscale evaluates the frequency with which angry feelings are experienced in situations involving frustration and/or negative evaluations.

Anger Expression

The Anger Expression–Out (AX-O) subscale measures how often angry feelings are expressed in verbally or physically aggressive behavior, whereas the Anger Expression–In (AX-I) scale measures how frequently angry feelings are experienced but are suppressed rather than expressed.

Anger Control

The Anger Control-Out (AC-O) subscale measures how frequently a person controls the outward expression of angry feelings, whereas the Anger Control–In (AC-I) subscale measures how often someone attempts to control angry feelings by calming down or cooling off.

Anger Expression Index

When the AX Index is high, it is anticipated that the person experiences intense angry feelings. These feelings may be suppressed, expressed in aggressive behavior, or both.

In the two cases that are presented in this article, the only treatment intervention consisted of the Low Energy Neurofeedback System (LENS). LENS (Hammond, 2007; Larsen, 2006; Ochs, 2006) is a passive form of neurofeedback that produces its effects through feedback that involves a very tiny electromagnetic field, which has a field strength of 10^{-18} watts/cm^2, which is less than the output of a watch battery. The feedback is delivered in 1-sec intervals down electrode wires while the patient remains motionless, with the feedback being adjusted 16/sec to remain a certain number of cycles per second faster than the dominant EEG frequency.

THE CASE OF DAVID

David was an 18-year-old male who had been diagnosed with ADHD in third grade. His history included three mild head injuries, two of which resulted in loss of consciousness. His symptoms at intake were rated by the patient on a 0-to-10 scale where 0 represents an absence of a problem and 10 represents the most severe level of the problem that they can imagine. His initial symptoms

and their ratings were as follows: problems concentrating, 7; anger, 7.5; forgetfulness and problems with short-term memory, 9.5; anxiety, 4.5; and impulsiveness, 9. He also had daily headaches. He had been a discipline problem in school, obtained average grades, and had been arrested once for assault and battery. A quantitative EEG evaluation was done on David, which showed a low power record with a very significant deficit in absolute power across all frequency bands. In relative power there was an excess in frontal beta (centering on Fz-F3), an excess in relative power theta (in more posterior and frontotemporal areas), and an excess in posterior delta. Frontal hypocoherence was apparent in the NxLink database in alpha, theta, and delta. The NeuroGuide traumatic brain injury discriminant analysis made a 97.5% prediction that he suffered with postconcussion syndrome of moderate severity.

His aunt described his history in these words:

> When he was a freshman in high school the school system finally tested him for and diagnosed learning disabilities in writing and math. If you knew David and his struggles you certainly were not surprised by these findings. School was just baffling to him. Throughout his time in school, he was also disruptive and exhibited behavioral issues in the classroom. Socially he was somewhat of an outcast and had very few friends. He also did not possess the capability to nurture relationships. I often said that he was a difficult kid to like. This was unfortunately true. He was extremely angry and impulsive. This led to outbursts of the worst kind at inopportune times. It was also very difficult to get him up and going in the morning. This led to attendance problems at both school and at jobs. Anxiety was also a large issue in his life. David also had a great deal of difficulty focusing on anything. He had been on medication for ADHD since his diagnosis. As can often be the case with regard to medication, he really took it when he wanted, and sometimes went weeks without it. It was always obvious when he wasn't taking the medication.
>
> David attended an alternative high school in the small town that we live in. The smaller classrooms and stricter structure were much more amenable to his success. He graduated from high school in June 2009. The last two months of high school were some of the most tested times we experienced with him. He was being heavily influenced by a peer group that was less than desirable by my terms. He barely achieved the necessary qualifications for graduation.

Treatment consisted of 28 sessions with the LENS utilizing a program that focused feedback a few cycles per second faster than the dominant frequency in the 1–8 Hz range. After only 3 sessions he was reporting improvements in reading. The amount of feedback he was given was gradually increased, and because he never experienced even a transient side effect in the last 10 sessions he was receiving feedback at seven electrode sites per session with a total of 140 sec of feedback. At the time of his last treatment session David's symptom ratings had declined from 7 to 0 on problems concentrating, 7.5 to 0 on anger, 9.5 to 1 on forgetfulness and short-term memory problems, 4.5 to 1 on anxiety, and from 9 to 0 on impulsiveness. He was no longer experiencing regular headaches.

Before presenting the objective testing data on anger, it is instructive to hear the external report of changes provided by David's aunt:

> During the first 2 weeks of treatment I asked David if he noticed a difference. He responded that he didn't get mad as quickly. This was entirely evident as he hadn't blown a gasket that morning when he couldn't find his iPod prior to leaving for the treatment. The lost iPod usually caused a complete meltdown. On this particular day, he simply responded that he would look for it when he returned home. I asked him if

there was anything else that he had noticed. He indicated that he had read a chapter in a book the night before. I inquired about what was different about that. His response was that he had read an entire chapter and never lost his place while reading. This was entirely new to him and he explained to me that he could not read even a paragraph without losing his place multiple times. He was definitely feeling the positive effects of the therapy. He was also sleeping better and was easier to get up and get going in the morning. We progressed through some 28 sessions with Dr. Hammond and David continued to respond. With two weeks left in the treatment regimen, he told his grandma that he had never felt better in his life. As we walked out of Dr. Hammond's office after the last treatment, he told me that he was so calm it was almost scary to him.

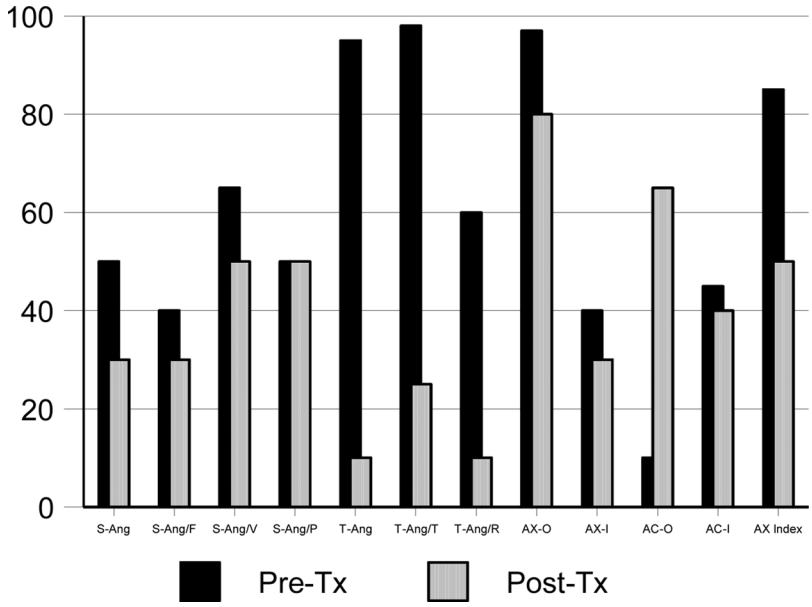
As I write this information some 4 months after the end of neurofeedback sessions, I would like to offer that David is doing very well. He has not been medicated since he quit taking his medication in April 2009. He is working with a recruiter from the Air Force on joining the military and would like to be a pilot. He is a typical 19-year-old now—he has been able to more successfully make and retain friends. He is also much more social in various settings. His confidence in himself has grown tremendously. He was willing and able to help take care of his mom when she had knee surgery that left her laid up totally for 2 months. I haven't had a hysterical telephone call from either David or his mom since we began the neurofeedback sessions. He gets angry at what people his age normally get angry at and assesses his response to his anger. He reads much better and will read for enjoyment. He has developed coping skills that he has never had. And he doesn't run on anxiety—he is comfortable in his skin for the first time in his life. For me, it is great to see these changes as now I think he has a fighting chance in this world.

> For my nephew, neurofeedback therapy was simply priceless. We really could not have asked for better outcomes from the therapy sessions. It was totally worth our investment of time. It was also very worth the cost that we incurred. It is wonderful to see him grow, change, and have great hope for what he can do in life. We were happy to find this option and lucky to be able to take advantage of it. We will be forever grateful.... Neurofeedback therapy allows David to have great dreams about doing great things in life. He feels as though the barriers to his success have been removed.

David's responses to the STAI were compared to normative data for normal males ages 16 to 19 years, which was a sample obtained on from 271 to 268 males on various scales. Figure 1 displays pre- and posttreatment STAI–2 results for David. It may be observed visually that before treatment measures of state anger were only in the average to mildly elevated range, but nonetheless, after treatment his state anger declined to the 30th percentile. His one state anger pretreatment elevation (S-Ang/V) declined from the 65th percentile to the 50th percentile, reflecting a decrease in tending to express anger through yelling, shouting or screaming.

Prior to treatment (see Figure 1) trait anger was extremely high indicating that he frequently experienced angry feelings and often felt treated unfairly by others. This declined from the 95th percentile to the 10th percentile following LENS treatment. Initially he also scored extremely high on Angry Temperament (T-Ang/T), which reflected him being very quick-tempered and ready to express his anger with very little provocation. He was extremely lacking in anger and impulse control. He also showed some elevation (60th percentile) in being oversensitive to criticism, perceived affronts, and negative evaluation by others. Dramatic decreases were seen in all trait anger measures, with trait anger declining from the

FIGURE 1. David pre- and posttreatment State-Trait Anger Expression Inventory–2 (STAI-2).



95th percentile to the 10th percentile, angry temperament (impulsive, quick-tempered expression with little provocation) decreasing from the 98th percentile to the 25th percentile, and Angry Reaction (T-Ang/R) reduced from the 60th percentile to the 10th percentile. He was no longer highly sensitive to perceived negative evaluations by others.

With regard to anger expression, David scored exceptionally high (97th percentile) on the AX-O scale before treatment, reflecting how he would frequently express his anger in aggressive behavior toward others (e.g., fights or verbal assaults) or objects (e.g., hitting walls). This declined to the 80th percentile but was still elevated. However, prior to treatment he scored very low (10th percentile) on the Anger Control-Out (AC-O) scale, reflecting the fact that he expended very little energy in monitoring or seeking to prevent the outward expression of anger. But this increased very significantly after treatment to the 65th percentile. Therefore, it appears that despite continuing to have strong tendencies to outwardly express his anger, he was nonetheless now expending considerable effort in monitoring and preventing his long-lived habits to outwardly express anger when he did experience it—which, as reflected in the tremendous declines in trait anger, is much, much less often. This is congruent with the external validation of his changes by his aunt.

The Anger Control-In (AC-I) scale was within normal limits before and after treatment, meaning that he tended to expends about as much energy in calming down and reducing anger as most normal males of his age. David's Anger Expression Index (AX Index) was extremely elevated (85th percentile) before treatment but decreased to the 50th percentile after treatment. This measure reflects that before treatment he experienced intensely angry feelings, but no more so than an average young man following treatment.

A 4-month follow-up with the patient's aunt, who continues to see him almost daily, validated that treatment improvements are being maintained. She said,

> I will tell you that it was worth every penny and minute of time we spent during the 14 weeks. We couldn't have hoped for a better outcome for David. He continues to do well. He is still incredibly comfortable in his skin. The

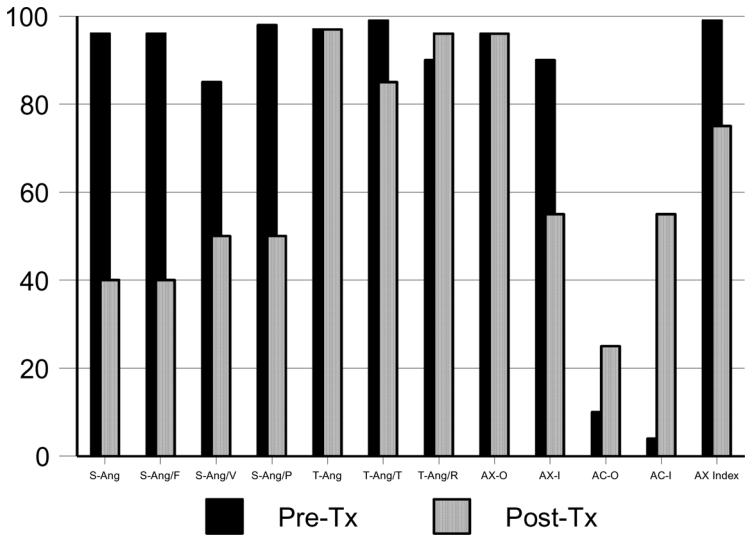
change in him is nothing short of remarkable. He has further developed a sense of humor and is socially flourishing. He is also more defined in his thinking.

THE CASE OF ALAN

Alan was a 30-year-old patient whose history included multiple head injuries including head banging when angry as a child, fights, football concussions, and rolling a four-wheel ATV over his head, which resulted in a loss of consciousness for 10 min. He had abused alcohol (experiencing numerous blackouts), methamphetamines daily for 6 to 7 years, opium, mushrooms, marijuana, and opiates. There was a family history of alcoholism and depression, and he indicated that he had been depressed for as long as he could remember. He stated that even as a child he had a problem with anger. He had lost numerous jobs due to his anger, and he was in his third marriage. He would unpredictably become explosive and said that little frustrations would send him ''on the rampage, screaming, hitting walls, and throwing things.'' He was born 6 weeks premature, was in special education classes throughout elementary school, and still could not read when he entered high school. His initial symptom ratings (0–10) were anger, 9; depression, 7; sleep problems, 8; short-term memory problems, 8; fatigue, 8; and impulsiveness, 6.

Alan's anger profile was different from that of David. As displayed in Figure 2, Alan scored exceptionally high in state anger (96th percentile) and all of the state anger subscales prior to treatment. Those scores are congruent with someone who is experiencing intensely angry feelings, and given the fact that his trait anger was also extremely elevated (97th percentile) as well as his AX-I subscale (90th percentile), the test indicates that he is someone with chronic anger. These scores predict someone who is intensely angry a good deal of the time and who will verbally (S-Ang/F) and physically express this intense anger (S-Ang/P). His trait anger scores predict accurately predicted someone who feels unfairly treated by other people, who is quick-tempered and likely to impulsively express his anger with little provocation, and who is highly sensitive to criticism. His pretreatment AX-O score (96th percentile) typifies someone who will frequently express his anger through aggressive behavior, whether by shouting or assaulting people or objects, and yet he also seeks to suppress these

FIGURE 2. Alan pre- and posttreatment State-Trait Anger Expression Inventory–2 (STAI-2).



feelings as well (AX-I). Prior to treatment his AC-O score at only the 10th percentile indicates that he expended very little energy in either monitoring or trying to prevent the expression of anger. His AC-I score also indicates that before treatment he also made very little effort to calm himself down or reduce his anger. His pretreatment AX Index at the 99th percentile once again verifies that he was experiencing very intense angry feelings. The combination of his AX Index and AS-O and AX-I scores predicts someone who will have great difficulty in interpersonal relationships (as witnessed in his vocational and marital history), as well as someone who may be at greater risk for developing medical disorders.

Alan's treatment consisted exclusively of 26 sessions of LENS neurofeedback, which was gradually increased from 1 sec of feedback at each of four electrode sites to 5 sec of feedback at each of 7 electrode sites in his last 5 sessions. No side effects were ever reported in his treatment. After the very first session he reported feeling calmer and less fatigued for 2 days. At the conclusion of treatment his mean symptom average had declined from 7.7 to 1.2, and his rating of anger and explosiveness had declined from 9 to 1 and had been at a basically negligible level after his 16th session. Ratings on his other symptoms found that depression had declined from 7 to 1, impulsiveness from 6 to 0, sleep problems from 8 to 1, short-term memory problems from 8 to 1, and fatigue from 8 to 1.

Alan's STAI–2 pre- and posttreatment scores (see Figure 2) show that his state anger had declined from the 96th percentile to the 40th percentile, and his other state anger measures were in the 40 to 50th percentile range. These changes are congruent with someone who does not currently feel angry and who does not impulsively express anger verbally or physically. Of interest, his trait anger remained very elevated. The AX-O scale remained at the 96th percentile, which would, contrary to his self-reports and along with his trait anger scores, suggest that he certainly continues to have the potential to aggressively express anger. However, his AX-I scale declined from the 90th percentile to the 55th percentile, suggesting that although he may still experience angry feelings, he no longer suppresses them as much. The AC-O scale declined from the 25th percentile to the 10th percentile, suggesting that after treatment he seemed to be expending even less conscious energy in monitoring anger expression.

The AC-I scale increased from the 4th percentile to the 55th percentile. This would indicate that following neurofeedback he was expending a great deal more energy as soon as possible in calming himself down and reducing his trait anger. It is anticipated that this is the reason that his state anger scores have declined so substantially. His overall AX Index improved somewhat from the 99th percentile to the 75th percentile, suggesting an improvement in the intensity of angry feelings, although it remains elevated.

Alan's overall results are clearly more complicated to interpret than David's. This may be due to his lengthier, chronic, and violent past history, as well as perhaps less self-awareness than was the case with David. Alan is certainly still very prone to feeling angry, criticized, and unfairly treated, and he could undoubtedly benefit from further treatment. Yet he appears to be feeling less anger currently, to be suppressing these feelings less, and yet exerting much more effort in calming himself down and reducing anger when he does experience it. He reports and it seems that he is feeling less chronically angry, and he was reporting better relations at work. These improvements are certainly welcome in an individual with such an explosive and violent history.

SUMMARY AND CONCLUSIONS

Anger control has not previously been a focus of neurofeedback outcome research. Two case studies have been presented that involved chronic anger, violence, and impulsiveness. In each case there was a history of significant head injuries that had resulted in loss of consciousness.

LENS neurofeedback treatment resulted in self-reports of noteworthy improvement in a wide range of symptoms, including anger. Although these results are very preliminary and uncontrolled, they provide encouragement that neurofeedback has potential to produce significant improvements in anger problems. This has implications for a wide range of diagnostic populations including TBI, juvenile and adult correctional populations, and domestic violence. Clinicians and researchers need to begin using objective pre- and posttreatment outcome measures of anger and aggressiveness such as the STAI–2 and Aggression Questionnaire (Buss & Perry, 1992).

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