Biofeedback and Self-Regulation, Vol. 8, No. 1, 1983

EMG and EEG Biofeedback Training in the Treatment of a 10-Year-Old Hyperactive Boy with a Developmental Reading Disorder

Michael A. Tansey[1]
Union, New Jersey

Richard L. Bruner
Hightstown, New Jersey

The serial application of electromyographic (EMG) and sensorimotor (SMR) biofeedback training was attempted with a 10-year-old boy presenting a triad of symptoms: an attention deficit disorder with hyperactivity, developmental reading disorder, and ocular instability. Symptom elimination was achieved, for all three aspects of the triad, following the procedure of first conditioning a decrease in EMG-monitored muscle tension and then conditioning increases in the amplitude of sensorimotor rhythm over the Rolandic cortex. The learned reduction of monitored EMG levels was accompanied by a reduction in the child's motoric activity level to below that which had been achieved by past administration of Ritalin. In addition, the attention deficit disorder with hyperactivity was no longer diagnosable following the EMG biofeedback training. The learned increase in the amplitude of monitored SMR was accompanied by remediation of the developmental reading disorder and the ocular instability. These results remained unchanged, as ascertained by follow-ups conducted over a 24-month period subsequent to the termination of biofeedback training.

[1]Address all correspondence to Dr. Michael A. Tansey, 2810 Morris Avenue, Union, New Jersey 07083.

0363-3586/83/0300-0025$03.00/0

The understanding of hyperactivity and the clinical approaches utilized in treating it have undergone an evolution—from a physiochemical to a cerebral-cognitive viewpoint—which, in turn, is reflected in the progression of the descriptive diagnoses assigned to this condition. These descriptive diagnoses, which reflect changing clinical approaches, have identified hyperactivity as minimal brain damage, minimal brain dysfunction, minimal cerebral dysfunction, a hyperkinetic reaction of childhood, a hyperkinetic syndrome, a hyperkinetic child syndrome, and, currently, an attention deficit disorder with hyperactivity (American Psychiatric Association, 1980). The present descriptive diagnosis recognizes the attentional difficulties that are the most persistent of symptoms for the hyperactive child. Other, overt, behavioral symptomology associated with this diagnosis may include motoric overactivity, impulsivity, distractibility, short attention span, low frustration tolerance, emotionality, and aggressive behavior.

Historically, there have been two different theoretical traditions concerned with the treatment of the hyperactive child: medical and physiological. In the medical model, the predominant treatment for the hyperactive child was to place him on stimulant drug therapy. Stimulant drug therapy, usually relying upon the administration of Ritalin (methylphenidate), often had a substantive effect on motor function, while being relatively ineffective in treating attentional deficits, information processing, low frustration tolerance, high distractibility, and emotional lability. In addition, it has been noted that stimulant drug therapy benefits only 45 to 60% of those hyperactive children so treated (Safer & Allen, 1976; Hampstead, 1979).

An alternative orientation, developed by psychologists, has been the utilization of behavior modification and operant conditioning techniques, as a source of learned self-control for the hyperactive individual. These techniques have been broadly applied when treating undesirable behaviors, especially when coupled with attentional training and relaxation procedures. While behaviors such as sitting (Pihl, 1967; Twardoz & Sajiraj, 1972; Braud & Holiday, 1974), being more attentive to immediate tasks, and the completion of assigned work (Allen, Henkel, Harris, Baer, & Reynolds, 1967; Toffler, 1972; Pigeon & Enger, 1972) have yielded to operant conditioning procedures, low frustration tolerance, impulsivity, distractibility, information processing, and emotional lability have continued to be resistant to behavior modification techniques. More recently, psychologists have been utilizing biofeedback training as a potent source of learned self-control for the hyperactive child. Biofeedback training has been found to have significant impact on hyperactivity and its behavioral concomitants through self-regulation of both attentional and physiologic process. This utilization of biofeedback training is very much in keeping with the current understanding of hyperactivity and is a continuation of the psychological orientation toward its treatment.

Biofeedback training has been applied to the treatment of hyperactivity along two major lines: the reduction of muscle tension levels through electromyographic (EMG) feedback, and the operant conditioning of brain-wave activity through electroencephalographic (EEG) feedback. Learned reduction of muscle tension levels, monitored over the central forehead, has been reported to have been efficacious in the treatment of hyperactivity (Braud, Lupin, & Braud, 1974, 1975; Braud, 1978; Hampstead, 1979). Electroencephalographically monitored cerebral activity has been reported to be amenable to operant conditioning. In addition, it has been shown that such conditioning is associated with clear reductions in hyperkinetic behavior (Lubar & Shouse, 1976; Shouse & Lubar, 1979). With respect to EEG biofeedback training, conditioned increases in the sensorimotor rhythm (SMR), monitored as a 12-Hz to 14-Hz brain wave over the Rolandic cortex, resulted in clear reductions in hyperkinetic behavior, when hyperactivity rather than distractibility was the principal symptom. While both EMG and SMR biofeedback training have been reported to be treatment alternatives to stimulant drug therapy, neither procedure has been reported to have been used in conjunction with the other in the treatment of hyperactivity.

In this report, the authors describe an attempt to differentiate the treatment effects of EMG and SMR biofeedback training. The results are presented in the context of a single-case study wherein a 10-year-old hyperactive boy is treated with a serial application of EMG and SMR biofeedback training.

BACKGROUND AND HISTORY

John,[2] a 10-year-old Caucasian male, was brought for biofeedback training by his mother. Background information was obtained from the mother and school records. In bringing her son, the mother stated: "My son is hyperactive and I would like you to teach him to calm down and do better in school." John's mother scheduled his intake evaluation subsequent to her being informed that John would be retained in the fourth grade the following year.

[2]The child's name has been changed in order to preserve confidentiality.

In grade 2, at the age of 7½ years, John was classified by the school's child study team as perceptually impaired. That evaluation, and subsequent classification, was prompted by the findings that John reversed letter and numbers from left to right, horizontally as well as vertically, was possessed of above-average intellectual potential, exhibited a high degree of anxiety, engaged in an unusual amount of physical activity within the classroom, and had maintained a history of behavioral and academic difficulties since entering first grade. As of his 3rd month in second grade, John was placed in a class for the perceptually impaired. After 2 months in the special education setting, he was diagnosed as hyperactive. Ritalin was prescribed for the hyperactivity and was continued throughout John's subsequent second-, third-, and fourth-grade experiences in classes for the perceptually impaired. Due to ongoing hyperactive behavior and academic underachievement, John was scheduled to repeat the fourth grade in a class for the perceptually impaired.

EXAMINATION AND FINDINGS

A week previous to John's intake session, his pediatrician had taken him off the Ritalin to assess the efficacy of biofeedback training. The therapist[3] found John to exhibit motoric overactivity, extreme impulsivity, a short attention span, low frustration tolerance, high distractibility, and a rigid approach to the handling of his daily routine. In addition, his reading comprehension and word study skills (as measured by his school's child study team) were found to be lagging more than 1 year behind expected levels. John also evidenced difficulties with saccadic fixation and ocular pursuit movements. Specifically, he was unable to move his eyes smoothly along a horizontal axis with his head in a stationary position. In addition, he could not move his head from side to side while keeping his eyes fixated on an object held before him. For John, reading entailed his moving his head from side to side in order to track the words across a line of print. This visual approach style was evidenced by John's skipping words, not noticing his missing the commas and periods, and a consistent inability to retain an understanding of what he had just "read."

On intake, John's baseline EMG was 60 microvolts (peak to peak). The reading was taken from the central forehead area. GSR readings were an identical 110 K on the second and third fingers of each hand. Thermal readings for both hands were in the low 90s. These measurements plus

[3]Michael A. Tansey, Ph.D., was the therapist.

previously obtained data were used to establish the provisional diagnoses of (1) attention deficit disorder with hyperactivity, 314.01; DSM III (American Psychiatric Association, 1980); (2) developmental reading disorder, 315.00, DSM III (American Psychiatric Association, 1980); and (3) ocular instability characterized by inadequate saccadic fixation and ocular pursuit movements.

John was accepted for biofeedback training for his attention deficit disorder with hyperactivity. It was recommended that he be examined by an opthalmologist for his ocular instability.

METHOD

Apparatus and Procedure

For the first three 40-minute once-weekly biofeedback training sessions, a Nova Systems[4] (Model A3) electromyometer was utilized in assisting John to reduce muscle tension levels, as monitored over the central forehead area. This unit is able to provide visual feedback in the form of a meter needle deflection. The position of the pointer of the peak-to-peak microvolt meter provides one mode of visual feedback. A higher EMG level produced a meter pointer movement to the right; a lower EMG level produced a meter pointer movement to the left. Additional visual feedback was provided by a Nova Systems Light Box. In the light box's light bar mode (used exclusively for this case), 10 LEDs turn on in sequence, forming a bar of red lights. A lower EMG causes the lighted LEDs to go out sequentially from right to left. The higher EMG level causes increasing numbers of LEDs to light up sequentially from left to right.

Procedure

Instructions to the child before the EMG training were as follows: "You're going to let the needle come down and the lights go out; as you do, let yourself become hollow and heavy." Immediately after the electrodes were attached, the child was given a visual image to facilitate the learning process. He was told: "It will be easier to let go and let the needle come down, and the lights go out, if you just let yourself be a hollow, heavy rock; quiet, hollow, and heavy—let go and let the lights go out and the needle go down." The child was trained with eyes open for 40 minutes each session.

[4]Nova Systems, 97 North Chatsworth Avenue, Larchmont, New York 10538.

Intermittent positive verbal reinforcement (verbal praise for meter and LED change) was provided every few minutes. Every 10 minutes, the visual imagery-laden instructions were repeated. In monitoring the EMG, three saline electrodes were used. The active electrode was placed so that its 6.5 cm × 1.3 cm contact surface lay vertically along the center of the forehead. The reference and ground electrodes were placed on opposite ears via earclips.

Immediately following John's three EMG training sessions, EEG biofeedback training of the sensorimotor rhythm (SMR) commenced. For the 20 once-weekly 40-minute SMR training sessions, a Nova Systems (Model A3) electroencephalograph was used to assist John in emitting the 14 ± .7-Hz brain wave over the Rolandic cortex. Specifically, the 3 dB points for the EEG's 14-Hz band-pass filter were at 13.3 Hz and 14.7 Hz. In operation, with an 8-microvolt threshold setting (peak-to-peak), the filtered 14-Hz signal is protected from contamination by alpha (down 27 dB at 10 Hz) and by low-amplitude scalp EMG (down 27 dB at 20 Hz) up through their attaining amplitude levels of approximately 160 microvolts (peak to peak).

In monitoring SMR, as in monitoring the EMG, three saline electrodes were used (impedance level in saline of 1 Kohm). Electrode contact with the skin/scalp surface was accepted as adequate upon obtaining impedance readings of less than 20 Kohms. The active electrode was placed so that its 6.5 cm × 1.3 cm contact surface lay lengthwise along the midline of the top of the skull (overlying the cerebral longitudinal fissure), centering about 2.6 cm behind Cz. In this position, the length of the active electrode centers over the Rolandic cortex (pre- and postcentral gyri) of both the right and left hemispheres. The reference and ground electrodes were placed on opposite ears via earclips (see Figure 1).

The monitored SMR was then transmitted to the electroencephalograph for signal processing and subsequent auditory feedback. The unit provided both amplitude and frequency-modulated audio feedback. The feedback tone is modulated so that the larger the amplitude of the SMR signal, the louder the tone. In addition, the repetition rate of the tone (the number of beats per second) accords with the rate of occurrence of the monitored brain wave. An EEG frequency-modulated Sonalert was attached to the electroencephalograph to transform the usual muted clicks of the unit's auditory tone into more pleasant beeps. The phase shift capability of the unit is set for 225°. This seems to have a brain-wave driving effect. This phase shift setting seems to adjust the audio feedback signals so that they become synchronous with the brain waves monitored. The authors have seen much more rapid acquisition of EEG biofeedback training when this phase shift setting is used.

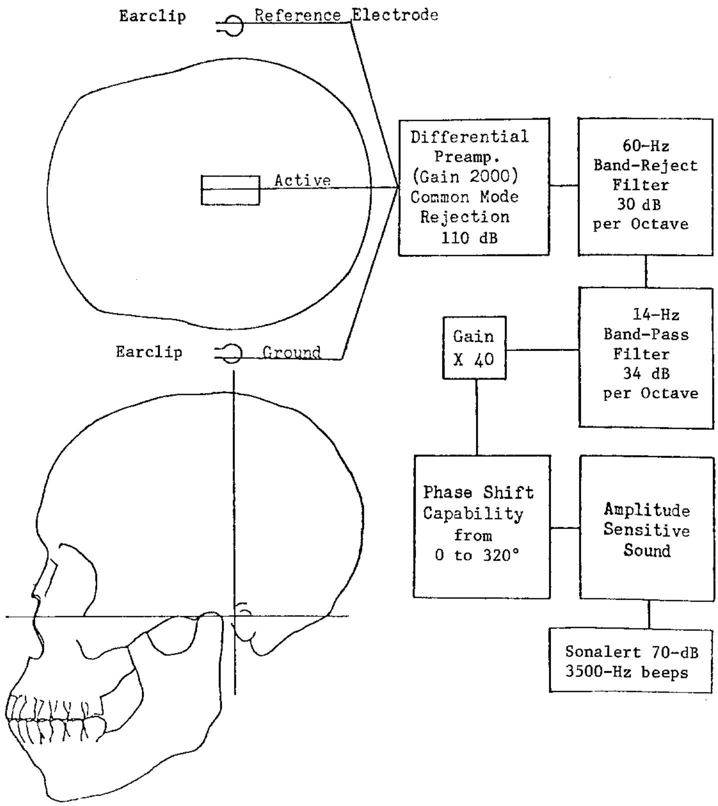

Fig. 1. Diagram and flow chart depicting EEG electrode placement and subsequent signal processing.

Instructions to the child during SMR training were as follows: "Just let yourself be a hollow, heavy rock; quiet, hollow, and heavy—let go and let the beeps come out." He was trained with his eyes closed for a 40-minute period each session. Sessions were scheduled once weekly. Intermittent positive reinforcement (verbal praise for "beep" production) was provided every few minutes. Every 10 minutes, the visual imagery-laden instructions were repeated.

The child's mother was requested to provide a weekly record of her son's overall behavior, including academic performance, and to report her findings at the beginning of each session (both EMG and SMR). In addition, at the end of each session, the child was instructed to practice being a hollow, heavy rock at home at least once a day. A contract was made with the child to provide a tangible reward, in the form of a matchbox car, at the end of each EMG and SMR training session, contingent upon "letting a lot of beeps come out," or "letting that needle and those lights go down even more."

RESULTS

This 10-year-old boy showed specific and positive responses to both EMG and SMR biofeedback training. The initial three EMG training sessions enabled John to reduce his central forehead tension levels from a baseline of 60 (peak-to-peak) microvolts to 5 microvolts (see Table I). During these 3 weeks, John's motoric activity level, as observed by his mother and the therapist, was seen to become increasingly under control. He was no longer "hyperactive." His behavior was marked by the absence of overactivity, distractibility, and poor self-control. By the end of the week, following his third EMG training session, the behavioral manifestations of hyperactivity were no longer in evidence. He was noted to be, in all situations, more calm and under control than when he had been prescribed Ritalin. The ocular instability, as well as the developmental reading disorder with information-processing deficits (inability to understand nor retain visually derived information as transmitted by a line of print), was still unchanged.

As a result of John's 20 SMR biofeedback training sessions, he acquired the ability to produce SMR in greater frequency and amplitude (see Table II). Concurrent with this change in monitored SMR, specific

Table I. EMG (Central Forehead Placement) Muscle Tension Levels[a] for the First Three Training Sessions

	Training sessions		
Duration of training[b]	1	2	3
Baseline	60	50	5
5	60	25	5
10	60	20	5
15	60	5	6
20	45	5	5
25	45	6	5
30	20	5	5
35	45	4	5
40	10	4	4

[a]Muscle tension levels in peak-to-peak microvolts.
[b]Numbers in the column indicate minutes of training.

Table II. Acquisition of Sensorimotor Rhythm

Training session	Acquisition of sensorimotor rhythm[a]
Baseline	10
1	10
2	10
3	10
4	10
5	10
6	12
7	12
8	12
9	16
10	16
11	16
12	16
13	16
14	24
15	24
16	24
17	24
18	24
19	24
20	24

[a]Sensorimotor rhythm measured in peak-to-peak microvolts.

remediation was noted in his remaining symptomology. His ability to read and comprehend what it was that he had just read improved significantly. Prior to his SMR training, John could not read a line of print smoothly and be aware of skipping some words, commas, and periods. In addition, at that time he was unable to accurately recall the line he had just read. As of his fourth SMR training session, he tracked smoothly, skipped no words, stopped at all the commas and periods, and was able to relate, in his own words, what he had just read.

At intake, a recommendation was made for John to be evaluated and, if possible, treated by an ophthalmologist for his ocular instability. This recommendation was not acted upon. The therapist was not notified of this lack of follow-through on the ocular examination and subsequent treatment until John's 18th SMR training session. When John showed a significant improvement in his reading ability, as of the 4th SMR training session, it was assumed to be more a function of his recommended ocular therapy than of the SMR training. As such, a reexamination of his ocular and reading functioning was not performed at that time. When, after 14 SMR training sessions, it was ascertained that no ocular therapy was initiated, a reexamination of John's ocular and reading functioning was performed. He was found to be able to track smoothly along a horizontal axis while keeping his head stationary. He was also now able to move his head from side to side while keeping his eyes fixated upon an object in front of him. His reading style was now characterized by eye rather than head movement, in order to track along a horizontal line of print.

The ongoing and positive transitions—from hyperactive to self-controlled, from reading-disabled with ocular anomalies to reading-able without ocular anomalies—were accompanied by decreases in EMG and increases in amplitude of SMR, respectively. Prior to biofeedback training, John was scheduled to be retained in a fourth-grade class for the perceptually impaired, because of insufficient academic progress. His first biofeedback training session coincided with the end of the school year, wherein he was recommended for retention. As of John's eighth SMR training session, he was enrolled in a normal fourth-grade class. The termination of John's biofeedback training coincided with the conclusion of the first academic quarter within his normal class setting. He had achieved better than passing grades in all academic areas (see Table III).

Three months following the cessation of John's biofeedback training, we received this note from his mother: "Thought you would be interested in [John's] latest report card. Spelling A. Reading B. Not bad for someone who couldn't read or spell last year." Throughout the academic year, John maintained and improved his academic performance. Follow-ups, conducted during a period of 24 months posttermination, revealed that John was continuing to maintain the attentional, behavioral, neuromuscular, information-processing, and academic progress that accompanied his biofeedback training.

Table III. Academic Progress in a Regular Fourth-Grade Class Placement

	Academic quarter			
School subject	1[a]	2[b]	3	4
Reading	C	B	B	B
Spelling	B	A	B	A
Mathematics	A	A	A	B
Language	B	B	B	B
Science	C	B	B	C
Social studies	C	C	A	B
Art	B	B	A	A
Music	A	C	B	B
Physical education	A	A	A	A
Handwriting	C	C	C	C
Total number of A's	3	3	4	3
Total number of B's	3	4	5	5
Total number of C's	4	3	1	2

[a]Biofeedback training was initiated prior to the start of the first academic quarter.
[b]Biofeedback training had terminated prior to the beginning of the second academic quarter.

DISCUSSION

The results clearly show differential effects for EMG and SMR biofeedback training, as utilized in this case study. The recipient of the serial application of EMG and SMR biofeedback training presented a triad of symptoms: attention deficit disorder with hyperactivity, developmental reading disorder, and ocular instability. While the initial treatment objective was to treat the hyperactivity, symptom elimination was successfully achieved for all three aspects of the triad, following the procedure of first lowering EMG-monitored muscle tension and then conditioning increases in the frequency and amplitude of SMR as monitored over the Rolandic cortex.

Operant conditioning of lower EMG levels was adopted as the initial treatment modality due to the child's very high baseline EMG. The EMG biofeedback training resulted in significant reductions of monitored EMG levels. Such lowering of EMG levels, over the central forehead area, was directly followed by a reduction in motoric activity levels to below that which had been achieved by past administration of Ritalin. In addition, the remaining behavioral manifestations of his attention deficit disorder with hyperactivity were noted by their absence. These results were maintained throughout subsequent SMR biofeedback training, as well as on follow-ups conducted during a period of 24 months following his termination from biofeedback training.

In reporting our findings with respect to the responsivity of the child, his developmental reading disorder, and his ocular instability to SMR biofeedback training, we are mindful of treating each as a separate clinical entity. It is also important to differentiate between the SMR biofeedback training received and the EMG biofeedback training preceding it. While both SMR and EMG biofeedback training have been mentioned as treatments for hyperactivity, they differ in the process monitored and subsequently conditioned, EMG having as its referent the conditioning of the amounts of electrical discharge in muscle fibers, while SMR has as its referent the conditioning of neural discharge over the Rolandic cortex. Noting that SMR has been monitored over the Rolandic cortex of the right hemisphere (Kaplan, 1975) and of the left hemisphere (Finley, Smith, & Etherton, 1975; Kuhlman & Allison, 1977; Sterman, 1973), and from both right and left hemispheres (Lubar & Shouse, 1976; Shouse & Lubar, 1979), the authors utilized the previously detailed electrode placement to maximize the monitoring and subsequent conditioning of SMR via a single-channel electroencephalograph.

While there is little argument as to the discomfort and fatigue that ocular anomalies lend to a reading task, there is a growing and significant literature concluding that reading disorders stem from deficits in information processing, in essence a symbolic learning disorder rooted in cerebral dysfunction, rather than being caused by oculomotor dysfunction. At very best, the literature shows oculomotor anomalies to be a concurrent dysfunction whose manifestation is determined by deficits of volitional control and internal coordination of the eye muscles. Developmental reading disorders are then viewed in terms of the efficacy of cerebral mechanisms that store visually derived information and its selective retrieval (Benton, 1975; Critchley, 1970; Fox, Orr, & Rourke, 1975; Lawson, 1968). In this context, we may entertain the possibility that the SMR training procedure, which was accompanied by both increased amplitude of SMR and the remediation of the developmental reading disorder, may have had some effect on the efficacy of the cerebral processing mechanisms involved with reading tasks. In addition, we may also entertain the possibility that the SMR training procedure, which was concurrent with the cessation of this child's ocular anomalies, may have had some effect on the volitational control and coordination of the muscles involved in such ocular function.

Even though remediation of the presenting symptoms was clearly linked with a learned reduction of EMG and a learned increase in amplitude of SMR, the generalizability of our findings is limited by their being based on a single-case study. Further research into the effects of the procedures described in this study needs to be performed. One avenue of additional investigation may be to assess whether the serial ordering of the EMG and SMR biofeedback training had a substantial effect on the results obtained. It is our hope that this single-case study may serve as a useful pilot for studies with larger numbers of subjects and thereby further our knowledge of the utility of biofeedback training.

Allen, E. K., Henkel, L. B., Harris, F. R., Baer, D. M., & Reynolds, N. J. Control of hyperactivity by social reinforcement of attending behavior. *Journal of Educational Psychology,* 1967, *58,* 231-237.

American Psychiatric Association. *Diagnostic and statistical manual of mental disorders* (3rd ed.), *DSM-III.* Washington, D.C.: Author, 1980.

Benton, A. L. Developmental dyslexia: Neurological aspects. In W. J. Friedlander (Ed.), *Advances in neurology* (Vol. 7). New York: Raven Press, 1975.

Braud, L. W. The effects of EMG biofeedback and progressive relaxation upon hyperactivity and its behavioral concomitants. *Biofeedback and Self-Regulation,* 1978, *3,* 69-89.

Braud, L. W., & Holiday, E. E. *The effects of reinforcement on sitting behavior in a hyperactive girl.* Unpublished manuscript, 1974.

Braud, L. W., Lupin, M. N., & Braud, W. G. *The use of EMG (electromyographic) biofeedback in the control of hyperactivity.* Paper presented at the 11th Annual International Convention for Learning Disabilities, Houston, February 1974.

Bradu, L. W., Lupin, M. N., & Braud, W. G. The use of EMG (electromyographic) biofeedback in the control of hyperactivity. *Journal of Learning Disabilities,* 1975, *8*(7), 21-26.

Critchley, M. *The dyslexic child.* Springfield, Illinois: Charles C Thomas, 1970.

Findley, W. W., Smith, H. A., & Etherton, M. D. Reduction of seizures and normalization of the EEG in a severe epileptic following sensorimotor biofeedback training: Preliminary study. *Biological Psychology,* 1975, *2,* 189-203.

Fox, F. J., Orr, R. R., & Rourke, B. P. Short-comings of the standard optometric visual analysis for the diagnosis of reading problems. *Canadian Journal of Optometry,* 1975, *37,* 57-61.

Hampstead, W. J. The effects of EMG-assisted relaxation training with hyperkinetic children: A behavioral alternative. *Biofeedback and Self-Regulation,* 1979, *4,* 113-125.

Kaplan, B. J. Biofeedback in epileptics: Equivocal relationship of reinforced EEG frequency frequency to seizure reduction. *Epilepsia,* 1975, *16,* 477-485.

Kuhlman, W. N., & Allison, T. EEG biofeedback training in the treatment of epilepsy: Some questions and some answers. *Pavlovian Journal of Biological Science,* 1977, *12,* 112-122.

Lawson, L. Opthalmological factors in learning disabilities. In H. R. Myklebust (Ed.), *Progress in learning disabilities* (Vol. 1). New York: Grune and Stratton, 1968.

Lubar, J. F., & Shouse, M. N. EEG and behavioral changes in a hyperkinetic child concurrent with training of the sensorimotor rhythm (SMR). *Biofeedback and Self-Regulation,* 1976, *3,* 293-306.

Pigeon, G., & Enger, A. Increasing assignment completion and accuracy in a hyperactive first grade student. *School Application of Learning Theory,* 1972, *4,* 24-30.

Pihl, R. D. Conditioning procedures with hyperactive children. *Neurology,* 1967, *17,* 421-423.

Safer, D., & Allen, R. *Hyperactive children.* Baltimore: University Park Press, 1976.

Shouse, M. N., & Lubar, J. F. Operant conditioning of EEG rhythms and Ritalin in the treatment of hyperkinesis. *Biofeedback and Self-Regulation,* 1979, *4,* 299-312.

Sterman, M. B. Neurophysiologic and clinical studies of sensorimotor EEG biofeedback training: Some effects on epilepsy. In L. Birk (Ed.), *Biofeedback: Behavioral Medicine.* New York: Grune and Stratton, 1973.

Toffler, A. E. The effect of intervention on children classified as minimal brain damaged by psychological testing which has been confirmed or disconfirmed by EEG evaluation. *Dissertation Abstracts International,* 1972, *32*(10-B), 6062-6063.

Twardosz, S., & Sajiraj, T. Multiple effects of a procedure to increase sitting in a hyperactive, retarded boy. *Journal of Applied Behavioral Analysis,* 1972, *5,* 73-78.