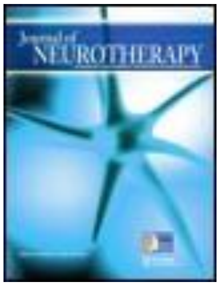

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Visual-motor Integration and its Relation to EEG Neurofeedback Brain Wave Patterns, Reading, Spelling, and Arithmetic Achievement in Attention Deficit Disordered and Learning Disabled Students

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Studies examining EEG neurofeedback treatment for Attention Deficit Disorders (ADD) and Learning Disabilities (LD) have shown relationships between Theta/Beta ratios (TBR's) and enhanced attention, and measures of cognitive functioning including visual-motor integration. Thirty-eight children, ages 8 to 18, received neurofeedback where Beta was rewarded while Theta and EMG were inhibited and demonstrated significant reductions in TBR's after an average of 46 sessions. They also demonstrated significant improvements in measures of visual-motor integration, and academic achievement. Though the changes in TBR's were not correlated with all outcome measures, post-treatment TBR's were correlated to post-treatment visual-motor integration scores. The possible intervening variable relationship of visual-motor integration with TBR's and achievement changes is discussed.

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Muehl, Knott, and Benton (1965) reported that 63% of children with LD had EEG abnormalities, as compared with 20% for controls matched on age and intelligence. Winkler, Dixon, and Parker (1970) discovered a slow brain wave pattern (Theta 4-8 Hz) dominated in children exhibiting behavior and academic problems. Lubar, Bianchini, Calhoun, Lambert, Brody, and Shabsin (1985) assessed a larger number of LD children and a group of normal control children. They found that LD children exhibited slower brain wave patterns than the controls and it was possible to predict LD or normal group membership within the sample with greater than 95% accuracy using discriminant analysis on the frequency of the brain wave pattern. Mann et all (1992) showed significantly higher Theta and lower Beta differences between ADD/LD children and normal controls. Other studies have confirmed the relationship of slow brain wave patterns and ADD (Satterfield and Braley, 1977; Linden, 1991).

Lubar and Shouse (1976) conducted a study employing EEG Biofeedback to modify Beta and Theta frequencies for ADD and LD children. Their protocol consisted of teaching children to increase Beta and sensorimotor rhythm (SMR) frequencies (12-20 Hz) while concurrently decreasing their abnormally high Theta frequencies. They treated S's where reading, arithmetic, and spatial tasks were employed simultaneously with feeding back the occurrence of SMR and Beta (16-20 Hz) frequencies. They showed that EEG biofeedback resulted in increased 12-15 Hz during the functional activities. Associated with the improved brain wave patterns were increased grades and achievement test scores. The importance of visual-motor elements in learning disabilities has been documented (Tucker, 1976; Haring and Bateman, 1977).

Tansey and Bruner (1983) and Tansey (1985) reported the successful use of EEG neurofeedback to increase SMR amplitudes in the treatment of LD. Several other studies have indicated that EEG neurofeedback assisted ADD and LD S's speed-up their brain wave pattern while cognitive skills, academic performance and other measures of intellectual functioning improved (Lubar, & Lubar, 1984; Tansey, 1990; Lubar, 1991). Postneurofeedback S's showed decreased Theta and enhanced Beta amplitudes such that the ratio between these wave frequencies is lowered. Academic and behavioral improvements were attributed to this change. Other studies have reported neurofeedback protocols used in connection with positive academic and attention or motor outcomes but do not report brain wave changes (Othmer, Othmer, and Marks, 1991; Linden, Habib, Radojevic, 1996). Othmer et al. attribute the positive outcomes to some unspecified "cortical regulation or stabilization in individuals where that is manifestly deficient."(p. 18) Linden et al. attribute the improvement in IQ scores to the "treatment group having an increased ability to attend and concentrate"(p. 23) - another reported outcome of the study. Their study also employed behavioral rewards such as baseball cards and stickers given on the basis of cooperation, effort and performance. They report a brain wave shaping protocol but cite no evidence that the EEG patterns of their S's had any particular characteristics either pre- or post-treatment. They recognize that "Attentional training through behavioral methods cannot be ruled out based on the current design."(p. 23)

The present study attempted to replicate the findings of lowered TBR's resulting from neurofeedback with people with ADD and LD who also improve on measures of academic achievement. This study also adds a dimension to these evaluations such that brain wave patterns would be measured concurrent with the performance of an objective test of visual-motor integration to demonstrate a possible relationship of changed brain wave ratios and changes in visual-motor integration, reading, spelling, and arithmetic achievement test scores.

Method

Participants

Children and adolescents ages 8 to 18 were accepted into the study if they were referred for academic problems and/or attentional deficits. Forty-three S's were included in the evaluation and treatment sequence. Each except two was diagnosed ADD by the psychologist author according to DSM-III-R criteria (DSM-IV had not been published at the time of the study during 1991-2). Two were diagnosed with a developmental visual-motor integration disorder. These behavioral diagnoses coincided with microvolt TBR's of greater than two to one. The ADD S's had greater than two to one TBRs while reading, listening, and drawing, while the developmental visual-motor integration disorder LD S's had a greater than two to one TBR during drawing only. (Lubar considers a three to one TBR or greater in children ages 8 to 12, and two to one in older ages indicative of abnormal brain wave activity - personal communication, June 1, 1991.) Four did not complete the minimum 40 treatment session requirement and the final evaluation. One was on Ritalin medication and was changed to other medications and doses during the time of treatment and was removed from the study because of a question of appropriate similarity to the other members of the study group. Eight females and 30 males participated. Ages included one age 8, two age 9, three age 10, four age 11, six age 12, seven age 13, six age 14, six age 15, and one each ages 16, 17 and 18. Thus 38 S's are included in this study.

Design and Procedure

The training protocol employed 16-20 Hz augmentation training, with concurrent inhibition of excessive 4-8 Hz amplitudes.

Reward and inhibit filters were set such that rewards were given approximately 70% of the time on the Beta band, and the reward was inhibited 20% of the time on the Theta band. Thus approximately 60 rewards were given per minute for most S's with a range of 50 to 100. After 30 sessions the reward percentage was incrementally reduced to 40 to 50% and the number of rewards to 40 to 60 per minute at the conclusion of training. The criterion for termination of training and administration of the final evaluation was the achievement of TBRs that were within 0.2 across activities for five or more sessions.

Electrode placement was bipolar at FZ and PZ per the International 10-20 system. An ear ground on the left side was also used. Choice of electrode placement was a copy of the work of Lubar (1992). All electrode skin contact was below 10 kohms impedance.

During the initial evaluation session, the S's appropriateness for the training was determined by an evaluation of school problems and attention characteristics. The S's willingness to undergo the evaluation was determined. TBR's were determined by measuring a baseline, eyes closed, reading, listening, drawing, and concentration TBR. During the reading activity, a portion of a book at appropriate reading level was read silently by the S. During the listening activity, a further portion of the same book was read to the S. During the drawing portion, the Beery test of Visual-Motor Integration (BVM) was administered. During the concentration portion, the S was asked to concentrate on the fish display to maximize rewards. Each condition lasted three minutes. Often the BVM administration took longer than the three minute EEG period. Following the administration of the EEG and BVM the Jaztac Wide Range reading (WRR), spelling (WRS) and arithmetic (WRA) was administered.

Following the initial evaluation, the results were discussed with the child and parent(s), appropriateness of the treatment was determined, and the S was asked to commit to a minimum of 40 sessions of training at a frequency of twice a week with the possibility of more training to be determined. Training was conducted for an average of 46 sessions. During the summer months some S's trained up to five times per week. Median time in treatment was 18 weeks.

Instrumentation was by a two channel EEG amplifier from Stolting Autogenics (A620). After setting the thresholds for Beta reward (70%), Theta inhibition (20%), and EMG inhibition (2%), the S is taught to maximize rewards by attending to one of three displays: a light bulb that increases in size, a fish that follows a course, and a wheel that fills with colors while playing a two octave musical scale. Concurrent with the video display which counted the rewards, an auditory display presented sounds to announce the rewards. A second visible display shows red when the inhibit threshold is exceeded. The 45 minute training time was divided into three 15 minute sessions. Following each session the number of rewards were reviewed. Differences were discussed to determine S's awareness of less or more attention during the training. The S was encouraged to increase the number of rewards through attention. This protocol was followed for five sessions. Thereafter each fifteen minute condition constituted a different activity: reading silently, reading aloud, and working on visual-motor activities such as mazes, hidden figures, copying written material, or working on jig-saw puzzles. The activities could be completed in any order. Sometimes the reading was from school material and at other times from story books appropriate to the reading level of the S. During the reading aloud condition, any mistake was corrected and repeated correctly by the S.

Results and Discussion

Tables 1 ("EEG TBR's Pre vs. Post Results") and 2 ("Pre-vs. Post-test BVM and Achievement Test Results") show that all TBR's and performance measures changed significantly from pre- to post-testing, and in the desired directions: TBR's declined and performance scores increased. None of the TBR means declined below the 2.0 level. The average reduction is 15%. (Figure 1) This reduction was accompanied by a 15 point increase in BVM standard scores, a 7 point standard score increase in WRR, and a 4 point standard score increase in WRS and WRA. (Figure 2).

Table 1
EEG TBR's Pre- vs. Post- Results, N=38

Variable	Mean TBR	S Dev	S Error	Dif Mean	S Dev	S Error	t value	2 Tail Prob
prebase line	3.256	1.244	.202					
post	2.700	.627	.102	-.5553	.977	.158	-3.50	.001
pre eyes closed	3.199	1.139	.185					
post	2.659	.668	.108	-.5403	.923	.150	-3.61	.001
pre reading	3.276	1.223	.198					
post	2.797	.646	.105	-.4787	.901	.146	-3.28	.002
pre listening	3.213	1.115	.181					
post	2.627	.620	.101	-.5863	.838	.136	-4.31	.000
pre drawing	3.555	1.295	.210					
post	2.932	.597	.097	-.6237	1.08	.175	-3.56	.001
pre con-centration	3.163	1.212	.197					
post	2.678	.625	.101	-.4853	.943	.153	-3.17	.003

note: t tests are correlated

Table 2
Pre- vs. Post-test BVM Standard Scores (SS) and Achievement Test Results Standard Scores, N=38

Variable	Mean SS	S Dev	S Error	Dif Mean	S Dev	S Error	t value	2 Tail Prob
pre BVM	88.316	11.20	1.816					
post	103.290	14.71	2.386	14.974	13.01	2.11	7.10	.000
pre WRR	99.553	15.60	2.531					
post	106.579	15.33	2.487	7.026	5.59	.91	7.75	.000
pre WRS	96.368	15.71	2.549					
post	100.316	16.38	2.657	3.947	5.48	.89	4.43	.000
pre WRA	96.342	16.49	2.674					
post	100.526	16.37	2.655	4.184	10.75	1.74	2.40	.022

note: t tests are correlated

Figure 1
Pre- vs. Post-test TBR's for Reading, Listening, Drawing, & Concentration

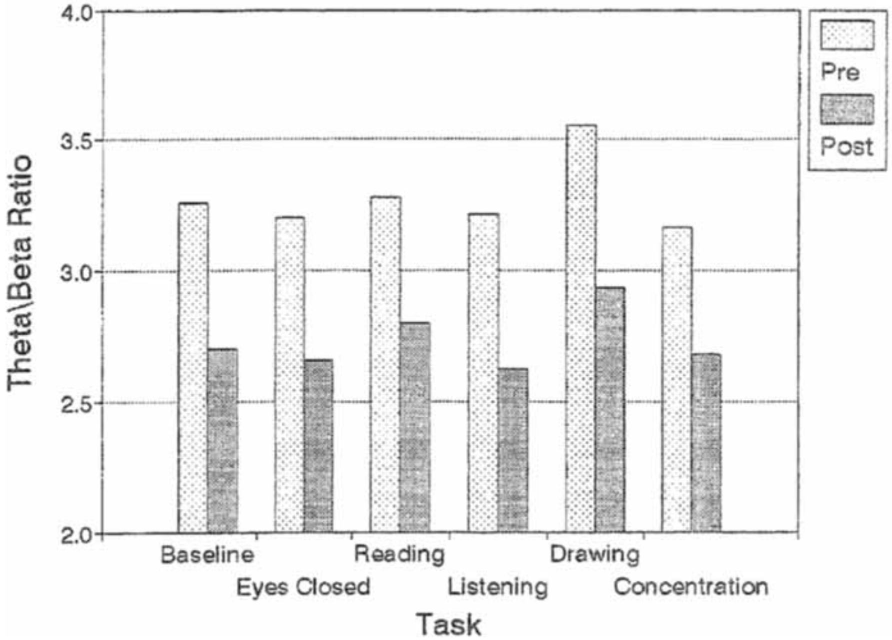
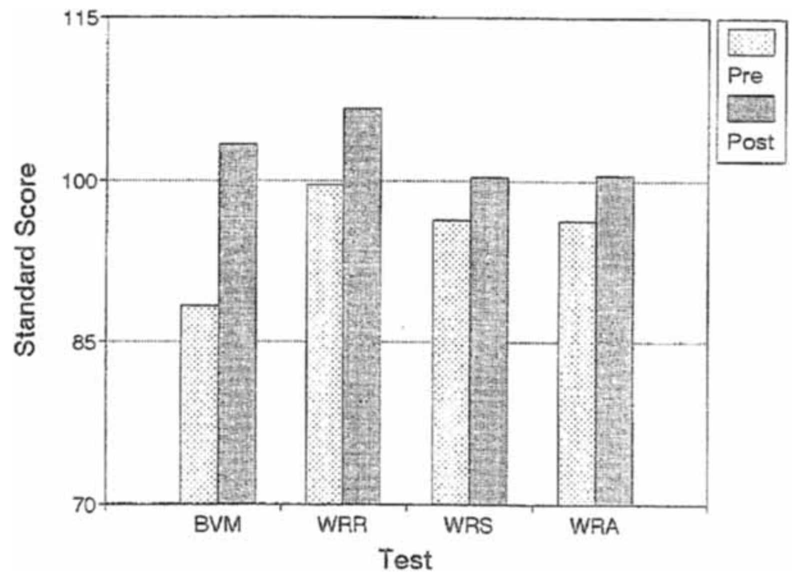


Figure 2
Pre- vs. Post-test Standard Score Changes for BVM, WRR, WRS, and WRA



The S's were measured during a trial where they were rewarded for a concentration task. The primary problem of attention deficit is the ability to concentrate appropriately. The concentration task of this evaluation was to make a fish figure advance as rapidly as possible. The increased production of Beta, associated with attention, and the reduced production of Theta, associated with internal thought processes, were the conditions that allowed reward and were the factors that reduced the TBR's. The decreases in TBR's were accompanied by increases in performance measures. Are the two related? During the pretest they were not (see table 3). But they were in the proper direction, that is, the lower the TBR, the higher the tested score. However they did not change following the neurofeedback. Why? The lack of change may stem from the difference in the two tasks. Concentrating on producing significant Beta amplitudes and low TBR's may not be the same attention task as concentrating on achievement tasks. Reading, spelling, and arithmetic are indeed different tasks than watching a fish figure advance. There is considerably more Theta (associated with thinking) involved in the achievement tasks than required in the concentration exercise.

The same relationship would be assumed for the reading TBR. If the reading TBR improves (i.e. lowers), it would be assumed that reading ability would also improve. However, the relationship was not shown. Perhaps this is due to the difference between the two reading tasks during the two measurements: the reading during the EEG measurement was of a continuous story, the reading during the WRR is more correctly described as a word recognition and pronunciation task. Also, the two measurements are taken at different times and the time difference in itself may be a factor limiting the relationship between the two measures. Simultaneous measurement might reveal significant relationships. The lack of relationship between the TBR's and concentration and reading measures may also stem from the fact that changes in brainwave frequency amplitudes have no immediate direct relationship with school skill functioning. What then might be a possible relationship between the TBR's and achievement tasks? The drawing task as measured by the visual-motor integration test may point to an answer.

The drawing task is different from the concentration and reading task. The drawing task is the same during evaluation and treatment and the EEG and drawing scores are measured simultaneously. Table 3 shows the drawing TBR and the BVM are not related during pre-testing but are significantly related during post-testing. The lower the TBR becomes, the higher the score on the BVM. The concurrence of the measurements during pre- and post-testing may account for the presence of the significance of this correlation while the other outcome measures show none. On the other hand, the correlation may demonstrate the actual influence of the brain wave changes on the visual-motor capabilities of the S's. As the relationship does not exist prior to treatment but exists following treatment, a causal relationship between the change in TBR and BVM scores might exist.

Table 3
Correlations Between EEG TBR's and Test Results, N=38

	BVM	WRR	WRS	WRA
Pre-treatment				
Concentration TBR	-.15	-.19	-.28	-.16
Reading TBR		-.29		
Drawing TBR	-.13			
Post-treatment				
Concentration TBR	-.19	-.16	-.28	-.19
Reading TBR		-.12		
Drawing TBR	-.39 $p<.01$			

note: other cells were calculated, no relationships were hypothesized nor significance found

Table 4 shows test-retest correlations of concentration and reading TBR's, BVM and achievement standard scores. All are significant, but there are differences in the levels of their significance. The achievement WRR, WRS, and WRA pre- and post-test correlations are very similar to stability coefficients published by Wilkinson (1993, p. 173) for these measures. The concentration and reading TBR stability coefficients are lower than the achievement coefficients. Unfortunately, there are no published norms of test-retest reliabilities for EEG TBR's for any age group. This is a lack in the current literature and their documentation would assist our knowledge of the stability of these measures over time. Thus we cannot infer if these correlations indicate some possible treatment influence lowering TBR stability. However, all of these stability coefficients are higher than that of the BVM. The BVM pre- and post-test correlation is less than the published test-retest reliabilities cited in the BVM manual (Beery, 1989, p. 13) as .81 (a median of several time periods from two weeks to seven months). The lower score in this study is perhaps related to a possible treatment effect from the increased TBR's.

Table 5 shows the significant changes from pre- to post-treatment in the relationships between the BVM and the achievement tests. There was no significance in their relationships pre-treatment while they are all significant in post-treatment and in the expected direction. That is, the higher the BVM score the higher the achievement results. Table 3 shows that there are no significant relationships between TBR's and achievement measures pre-treatment. It does, however, show there is a significant relationship between the post-treatment TBR and the BVM. This relationship may indicate a possible mechanism as to how the TBR effects achievement: faster TBR's may improve visual-motor functioning which in turn improves achievement.

Table 4
Pre- vs. Post-test Correlations: TBR's, BVM, and Achievement Tests, N=38

Post / Pre	Concen TBR	Read TBR	BVM	WRR	WRS	WRA
Concen TBR	.64*					
Read TBR		.70*				
BVM			.52*			
WRR				.94*		
WRS					.94*	
WRA						.79*

*p<.001

This interpretation is supported by further analysis of the present data. During the pre-test the drawing TBR is positively related to each of the achievement scores. (table 5). During post-test (table 5) the relationship is reversed and while the relationships are not statistically significant, the reading, spelling, and arithmetic correlations change a total of .43, .50, and .16 respectively and the relationships are reversed as would be expected. That is, a reduction of the TBR is related to an increase in the achievement score. This relationship does not exist with the other TBR's. It is significant that the drawing TBR demonstrates changes in the positive direction while the others showed no directionality. The drawing TBR is related to visual-motor functioning. It is the visual-motor function that is effected by the drawing TBR and it is the visual-motor function that has been demonstrated to improve while the drawing TBR decreases. (The significance of the pre-treatment drawing TBR with the spelling test is likely a function of the necessity of the student to increase thinking associated with Theta activity in order to succeed in the spelling test.)

The fact that the significant relationships between achievement and TBR changes are limited to the drawing TBR and BVM score may be related to the role of the visual-motor process in learning. Piaget and Inhelder (1969, p. 44) assert the role of visual-motor functions as fundamental in learning: "...the role of action with its sensori-motor schematism [mechanism]...may constitute...the basis for the later operations of thought". Others have studied the relationship between visual-motor development and higher learning and confirmed the fundamental role of visual-motor development as crucial to thinking (Bruner, 1964), psycholinguistic variables (Bannatyne, 1969), general academic success (Duffy, Ritter, and Fedner, 1976), school achievement (Tucker, 1976; Klein, 1978), and language (Halloway, 1971). Thus the relationship between TBR's and achievement may hinge upon TBR's allowing greater attention to visual-motor functioning which in turn allows increased assimilation of school achievement skills.

It should be noted that all of the correlations calculated for this study were performed on Theta and Beta amplitudes singly but no relationships were demonstrated between them and BVM or achievement scores. These relationships only appeared statistically when TBR's were calculated. This statistical relationship may indicate that increasing Beta attention by itself or attenuating Theta internal thought processes individually by themselves are not sufficient to increase attention and academic progress. Rather a combination of the two processes must constitute the therapeutic intervention.

On the basis of the present design it cannot be determined if the brain wave changes caused the visual-motor changes or vice versa, though the lack of relationship between TBR's and BVM previous to treatment and the presence of that relationship following treatment, points to the former. That change in relationship suggests studying an experimental group where the visual-motor activities and achievement measures are studied in the absence of neurofeedback. Other studies have shown the efficacy of neurofeedback and the influence of changed brain wave patterns in effecting intellectual change (Lubar, 1991). This study supports those findings. This study, additonally, shows the possible importance of visual-motor activities in the development of intellectual skills. This study suggests visual-motor integration as a possible "cortical regulation" mechanism posited by Othmer et all (1991) cited above. The relationships between brain wave TBRs and achievement tasks were shown to be present when the EEG was taken concurrent with the achievement test. It is possible that the ranges of the outcome variables are increased with neurofeedback so that the relationships can emerge statistically. Perhaps better relationships can be demonstrated between academic achievement and brain waves if the two are measured concurrently. This study also suggests increasing the number, kind and/or time allotted to visual-motor activities during neurofeedback as a possible means of increasing neurofeedback's effectiveness.

Table 5
Correlations of BVM Standard Scores and Drawing TBR's with Achievement Test Standard Scores, N=38

Pre-treatment			
	WRR	WRS	WRA
BVM	.06	.24	.23
Drawing TBR	.24	.37 p<.02	.11
Post-treatment			
	WRR	WRS	WRA
BVM	.40 p<.01	.51 p<.001	.35 p<.02
Drawing TBR	-.19	-.13	-.05

Note: other TBR relationships were calculated and none were larger than +/- .04

References

Bannatyne, A. (1969). A comparison of visuo-spatial and visuo-motor memory for designs and their relationship to other sensori-motor and psycholinguistic variables. *Journal of Learning Disabilities, 19*, 328-30

Beery, K. (1989). *Developmental Test of Visual-Motor Integration, Administration, Scoring, and Teaching Manual.* 3rd Edition, Cleveland, Ohio, Modern Curriculum Press.

Bruner, J. (1964). The course of cognitive growth. *American Psychologist, 19,* 1-15

Duffey, F., Ritter, D., & Fedner, M. (1976). Developmental test of visual-motor integration and the Goodenough Draw-A-Man test as predictors of academic success. *Perceptual and Motor Skills, 43,* 543-46

Halloway, G. (1971). Auditory-visual integration in language delayed children. *Journal of Learning Disabilities, 4,* 107-13

Haring, N. & Bateman, B. (1975). *Teaching the learning disabled child.* Englewood Cliffs, N.J.: Prentice-Hall.

Klein, A. (1978). The validity of the Beery test of visual-motor integration in predicting achievement in Kindergarten, first and second grades. *Educational and Psychological Measurement, 38,* 457-61

Linden, M. (1991). Event related potentials of subgroups of attention deficit disorder children and implications for EEG biofeedback. *California Biofeedback, 7 (1),* 7-12

Linden, M., Habib, T., & Radojevic, V. (1996). A controlled study of the effects of EEG biofeedback on cognition and behavior of children with attention deficit disorders and learning disabilities. *Biofeedback and Self-Regulation, 21*

Lubar, J.F. (1991). Discourse on the development of EEG diagnostics and biofeedback for attention-deficit/hyperactivity disorders. *Biofeedback and Self-Regulation, 16* (3), 201-225

Lubar, J.F., Bianchini, K., Calhoun, W., Lambert, E., Brody, Z. and Shabsin, H. (1985). Spectral analysis of EEG differences between children with and without learning disabilities. *Journal of Learning Disabilities, 18,* 403-408

Lubar, J.F. & Lubar, J.O. (1984). Electroencephalographic biofeedback of SMR and beta for treatment of attention deficit disorders in a clinical setting. *Biofeedback and Self-Regulation, 9* (1), 1-23

Lubar, J.F., Mann, C.A., Gross, D.M. & Shively, M.S. (1992). Differences in semantic event related potentials in learning disabled, normal, and gifted children. *Biofeedback and Self-Regulation, 17* 41-57

Lubar, J.F., & Shouse, M. (1976). EEG behavioral changes in a hyperactive child concurrent with training of the sensorimotor rhythm (SMR). A preliminary report. *Biofeedback and Self Regulation, 1,* 293-306

Mann, C.A., Lubar, J.F., Zimmerman, A.W., Miller, C.A., & Muenchen, R.A. (1992): Quantitative Analysis of EEG in Boys with Attention-deficit-hyperactivity Disorder: Controlled Study with Clinical Implications, *Pediatric Neurology 8* (1), 30-36

Muehl, S., Knott, J., & Benton, A. (1965). EEG abnormality and psychological test performance in reading disability. *Cortex, 1,* 434-439

Othmer, S., Othmer, S.F., & Marks, C. (1991). EEG biofeedback training for attention deficit disorder, specific learning disabilities, and associated conduct problems. EEG Spectrum, 16100 Ventura Blvd, suite 10, Encino, CA 91316

Piaget, J. & Inhelder, B. (1969). *The Psychology of the Child.* New York, Basic Books

Satterfield, J. & Braley, B. (1977). Evoked potentials and brain maturation in hyperactive and normal children. *EEG and Clinical Neurophysiology, 43,* 43-51

Tansey, M. & Bruner, R. (1983). EMG and EEG biofeedback training in the treatment of a 10 year old hyperactive boy with a developmental reading disorder. *Biofeedback and Self-Regulation, 4,* 299-311

Tansey, M. (1985). Brain wave signatures: An index reflective of the brain's functional neuroanatomy: Further findings on the effect of EEG sensorimotor rhythm biofeedback training on the neurologic precursors of learning disabilities. *International Journal of Psychophysiology, 3,* 85-99

Tansey, M. (1990). Righting the rhythms of reason: EEG biofeedback training as a therapeutic modality in a clinical office setting. *Medical Psychotherapy, 3,* 57-68

Tucker, R. (1976). The relationship between perceptual-motor development and academic achievement. Doctoral dissertation, University of Alabama.

Wilkinson, G. (1993). *Wide Range Achievement Test Administration Manual,* 3rd Edition. Wilmington, Delaware, Wide Range, Inc.

Winkler, A., Dixon, J. & Parker, J. (1970). Brain function in problem children and controls: psychometric, neurological, electroencephalogic comparisons. *American Journal of Psychiatry, 127,* 94-105

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