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**The Coordinated Allocation of Resource (CAR) Model Intervention for Reading Problems in two clinics**

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**Abstract**

Attaining the ability to read is a fundamental goal of the educational system. However, the attainment of this goal has been problematic and fraught with problems. Over the past several decades the special education roles have been rising along with the increased cost to federal government, state and county budgets, with no real end in sight. The problem is further compounded with the lack of an effective, cost effective intervention program. This article presents the data on an alternate approach, activation database guided EEG biofeedback, for several individual cases. Pre and post reading memory performance data is also presented for 7 children with a history of learning/reading problems. The initial average memory performance for the group was -1.39 standard deviations (SD) below the norm. Following the treatment the group's performance reflected an average SD gain of 2.40 (or 334%) and was -.27 SD below the norm. The reading time for the material decreased from 100 to 72 seconds. Thus the results present an encouraging alternative to the intervention methodologies currently employed.

**Background**

Special education costs and remediation effectiveness has been a growing concern of the educational and political environment due to the rising costs and prevalence.

In 2000, Center for Special Education Finance (CSEF) reported that "In per pupil terms, the total spending used to educate the average student with a disability amounts to \$12,639. This figure includes \$8,080 per pupil on special education services; \$4,394 per pupil on regular education services.... Thus, total spending to educate all special education students amounted to \$78.3 billion." More than half (63%) of the disabled students had a specific learning disability (attention, reasoning, processing, memory, communication, reading, writing, spelling, calculation, coordination, social competence and emotional maturity). Altarac & Saroha (2007) estimated the life time prevalence of a person having a learning disability is 9.7%.

The \$14 million National Adult Literacy Survey of 1993 (National Adult Literacy) found that even though most adults in the survey had finished high school, 96

percent of them could not read, write, and figure well enough to go to college. Even more to the point, 25 percent “were plainly unable to read,” period (Baughman, 1994).

Special education costs have been on the rise in recent years in (Chicago Special Education1, Massachusetts special education) as the roles of students requiring these services have risen. In Chicago Public Schools, the percentage of ninth grade students receiving special education services nearly doubled from 1994 to 2002, rising from around 11 percent to nearly 20 percent (Chicago Special Education2).

The ability to read has long been the focus of remediation efforts in the educational arena, albeit with limited success. It has been estimated that the average effect size across 26 different intervention strategies is .42 standard deviations (SD) (Thornton, 2006). The popular Orton-Gillingham method has two control research studies examining its effect size (Guyer, & Sabatino, 1989; Oakland, Black, Stanford, Nussbaum, & Balise, 1998). The Oakland et al. (1989) article reported a .34 SD improvement on employed measures after 350 intervention sessions, a result matched by merely providing the student with the Orton-Gillingham video tape. Using confidence interval and sample size statistics two of the measures employed by the Oakland study were examined for significance. Neither of the measures examined demonstrated statistical significance. The preferred intervention method for the Chicago and New York Public school system is the Orton-Gillingham method. Chicago’s special education program is at a cost of \$850 million (45,000 students), while New York City spends \$1.2 billion dollars on special education services at non Department of Education contract schools (NYC Special Education). The popular FastForWord program has in house research documenting its effectiveness (Thornton, 2006). However, three independent studies (Rouse & Krueger, 2004; Borman & Benson, 2005; Hook et al., 2001) showed no effect.

Specific research into specific improvements in reading ability have also not been impressive. Klingner, Vaughn, Hughes, Schumm, & Elbaum (1998) reported that 80% of students with disabilities read below grade level at the end of the intervention (45-90 minutes a day for a school year with a coteaching model). Foorman, Francis, Winikates, Mehta, Schatschneider, & Fletcher (1997) reported that 78% of the students who received the reading intervention showed an inadequate response rate. The intervention consisted of three forms of reading intervention with extensive professional development and coaching of the resource room teachers. Torgesen, Alexander, Wagner, Rashotte, Voeller, & Conway (2001) provided the students with reading scores in the 6<sup>th</sup> percentile with intense, research-based interventions. Thirty percent of the students did not read in the average range (word reading criteria) at the end of intervention. However, if a fluency benchmark was utilized, the number of non-responders was well over half the sample. Employing a resource room approach results in reduced scores on reading and IQ measures (Orlando & Rivera, 2004).

### **Discussion of the activation guided QEEG biofeedback approach**

The CAR model (Thornton & Carmody, 2009) states that performance on any particular cognitive skill (auditory memory, reading memory, problem solving, etc.) is a function of the use of different electrophysiological variables (relative power, coherence measures, etc.) and locations. While different cognitive skills may employ similar quantitative EEG (QEEG) variables and locations as other skills, each skill operates

somewhat differently than another skill. This model is somewhat implicit in fMRI and PET studies which report location activation during cognitive tasks. A model of brain functioning which asserts not just what the brain does in response to a task but elucidates the necessary variables and their directions is a critical step in any theory of brain functioning. The CAR model is an initial attempt to provide the identification of these functions in terms of QEEG variables. This article will address the implementation and success of the model in two different clinics to demonstrate that the model's effectiveness is not confined to a specific clinical location.

Successful reading memory works differently for children (ages 10-14) than for adults (age greater than 14) in the database developed by one of the authors (Thornton, 2001). Thornton (2002) established the positive relationship between Spectral Correlation Coefficients (SCC) beta (13-64 Hz) values from F7 and SCC alpha from T5 and reading memory in adults. For children (ages 10-14) the QEEG positive correlates of reading memory involve the relative power of beta1 (13-32 Hz) values at the T5, P3, O1, O2 & T6, relative power of beta2 (32-64 Hz) values at T5, T6 & Fz and occipital (O1-O2) values of beta1 (13-32 Hz) & beta2 (32-64 Hz) (peak amplitudes and microvolts) (unpublished). With development the effective predictors of reading memory change from the right posterior to the left posterior locations, although the relative power values remain approximately the same (unpublished). For this reason interventions in the following case 2 & 3 focused on increasing left posterior beta1 values and decreasing the theta and delta values.

Case #1

A previously reported case (Thornton, Carroll, & Cea, 2007) documented the QEEG problems in an individual who showed a failure to suppress alpha when he opened his eyes and engaged in cognitive tasks. He had received 12 years of specialized instruction, as in a specialized school for learning disabled students, and had received extensive private remediation attempts with well known programs (Orton-Gillingham, Lindamood- Bell) prior to the CAR intervention. The 1/2007 scores on the Wechsler Individual Achievement Test (WIAT) in Table 1 reflect the cumulative results of these interventions.

Table 1

WIAT Test	Date	Standard Score	Percentile	Grade
Word Reading	1/2007	40	<.1	3
	11/2007	83	13	7
	7/2010	80	9	8.5
Pseudoword Decoding	1/2007	73	4	3
	11/2007	92	30	8
	7/2010	92	30	8.2

There has been no further remediation interventions since 11/2007. After the treatment, he attended a year-long intensive film school and completed it on time successfully. He is currently working free lance on film sets, writing a screen play, and

looking for full-time work in the industry.

**Case #2**

A 10 year old male was brought to our clinic with a diagnosis of Attention Deficit Disorder. The initial evaluation revealed the standard problem of excessive theta relative power and decreased beta1 relative power. Fifty sessions were employed between 3/2002 and 3/2003. The changes on the Terra Nova (NJ state administered tests) are noted in Figure 1. Of some interest to note is the continued improvement on the other areas (science, math computation, math composite) following the initial dramatic improvements in reading, vocabulary, reading composite, social studies & word analysis. There were intermittent follow up sessions (about 20) during 2004 & 2005. The primary focus of the treatment was on the left posterior beta1 and theta relative power issues.

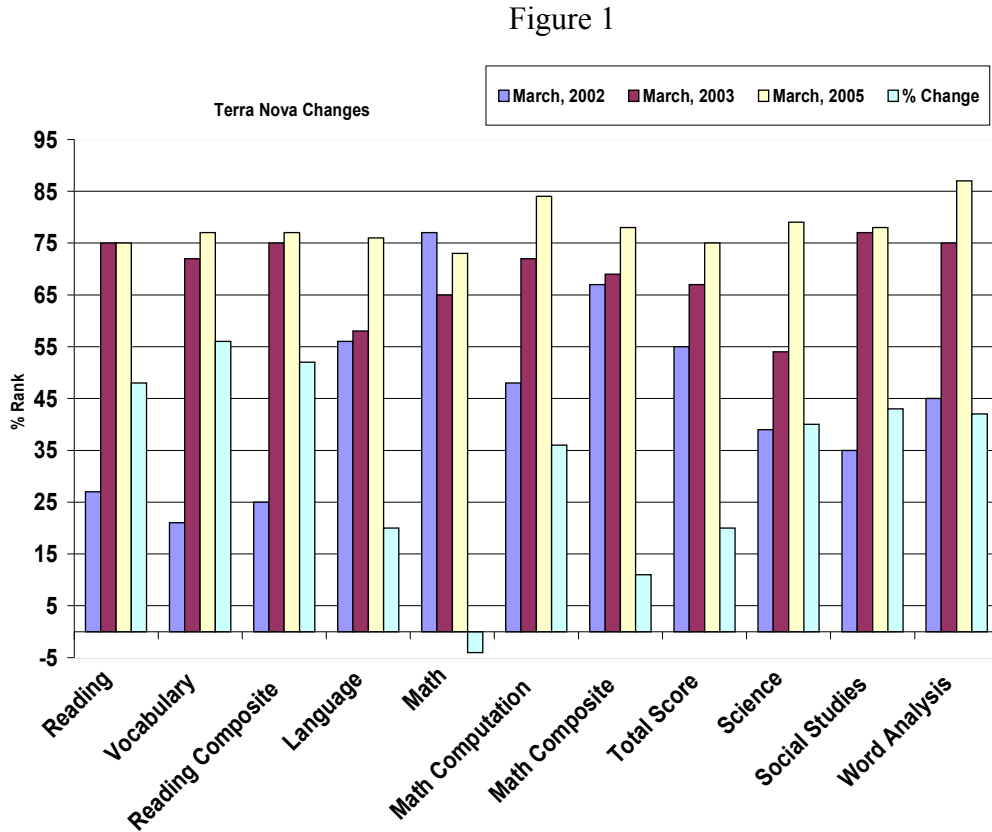
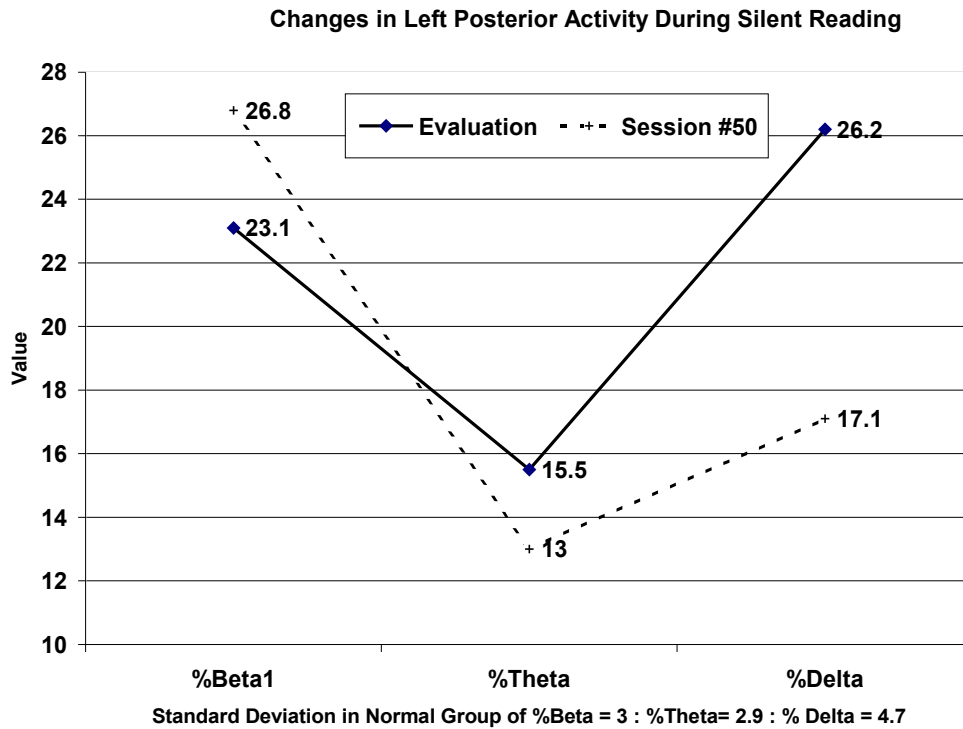


Figure 2 presents the changes in delta, theta and beta1 relative power values from the initial evaluation to session #50 during the reading task. As the figure indicates changes in the desired direction (decreased delta and theta & increased beta1) were obtained.

Figure 2



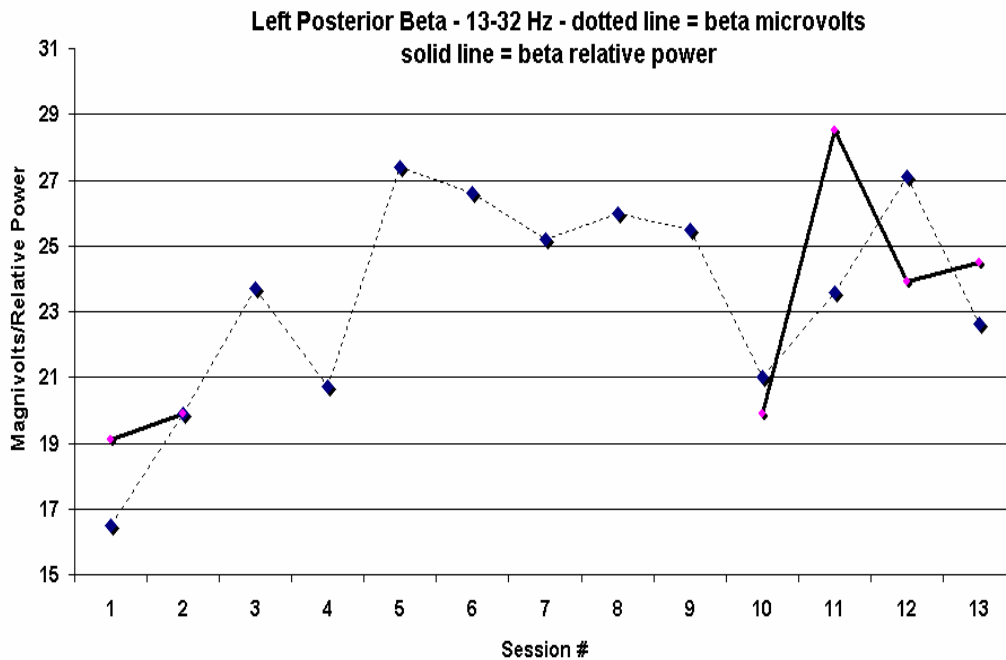
Case #3

The following case involves an 11 year old female with a history of learning problems as reported by her mother. She underwent 30 sessions of EEG biofeedback focused on the left posterior locations (T5, P3, O1). Table 2 presents the changes on the National California Achievement test which was administered 9 months after the treatment was ended. Figure 3 presents the changes in left posterior beta1 relative power and microvolt values.

Table 2  
National California Achievement test score changes (case #3)

	Local	Percentile	Ranking
	May-96	May-97	Change
Vocabulary	31	88	57
Comprehension	28	60	32
Total Reading	34	74	40
Language Mechanics	99	93	-06
Language Expression	34	83	49
Total Language	73	90	17
Math Computation	83	98	15
Math Concepts & App	58	88	30
Total Mathematics	73	98	25
Total Battery	58	98	40
Word Analysis	91	93	02
Spelling	47	84	37
Study Skills	41	50	09

Figure 2



Reading memory scores were obtained on seven subjects which do not include the cases which have been discussed in this article. The baseline reading memory score was obtained during the activation QEEG evaluation during which the subject had 100 seconds to read a story presented on a laminated paper. The reading period was followed by a 40 second silent recall period (eyes closed) and then the subject told the evaluator as much as they could recall of the story. Twenty minutes later the subject was to recall the story again (delayed recall). Periodically during the treatment period the subject's would be reevaluated on their reading memory abilities by having them read a story quietly to themselves, immediately tell the story back to the evaluator and then at the end of the session (33 minutes later) recall the story again. Scores were obtained for both immediate and delayed recall and then summed. The approximate Flesch-Kincaid reading level for the stories was 5<sup>th</sup> grade. The average age of the subjects was 12.88 years. An example of a story is provided below. The information between the slash marks represent a recall section, which would be scored 1 if all the information was correctly recalled and ½ point if partially recalled.

John Smith / lived on an old dirty barge/ in New York harbor/. One day he left the boat/ to go shopping/ for some milk,/ potatoes/ and hamburger/. He entered an alley/ to save time,/ but as he began to exit the alley/ a tall, large man / came over to him / and demanded his money/. John gave the man / the \$10 that he had/, as he was afraid/. The man left./ John continued to the store/ in the hope of getting credit./ He found a \$20 bill/ on the ground /near a fire hydrant /as he approached the store.

Total Score possible=24 Flesch-Kincaid Reading Grade Level=5.4

The following section presents data on 7 children (under the age of 14) and 7 adults (over the age of 14) whose initial evaluation reading memory values were about or below 1 standard deviation below the norm for their respective group (children or adults). Each group was composed of 4 males and 3 females. The amount of time allotted for evaluation reading task was 100 seconds. The reading memory reassessment times were recorded for 9 of the 14 subjects (4 children & 5 adults). The 4 children averaged 72 seconds for the reassessment stories while the adults averaged 78 seconds. Thus both groups took less time to read the material while improving their memory scores. The data used to determine the final memory score employed the average of the last 2-3 assessments or in one case a complete reevaluation conducted over a year later. The SD change for the subjects employed the SD of the initial evaluation and the final set of data. The calculation for the SD difference from the normative group employed the SD of the normal group. Each of these cases presented a different pattern of problems which, by and large, were addressed successfully.

Table 3  
Reading Memory Changes in Child and Adult Sample

	Child Norm Value (SD) N=37	Pre-Treatment Value – N=7	Post-Treatment Value	SD Change	% Change	Initial SD Difference From Norm	SD Difference from Norm at end of Treatment
Short Term Memory	12.3 (7.6)	3.07	11.2	<b>2.45</b>	<b>265%</b>	-1.21	- .14
Long Term Memory	12.7(7.6)	1.79	9.9	<b>2.25</b>	<b>454%</b>	-1.44	- .37
Total Memory	25(14.5)	4.86	21.1	<b>2.40</b>	<b>334%</b>	-1.39	- .27
	Adult Norm Value (SD) N=45	Pre-Treatment Value – N=7	Post-Treatment Value	SD Change	% Change	Initial SD Difference From Norm	SD Difference from Norm at end of Treatment
Short Term Memory	17.9(9.2)	6.28	11.8	<b>1.79</b>	<b>88%</b>	-1.46	- .82
Long Term Memory	18.7(10.8)	5.6	11.08	<b>1.87</b>	<b>99%</b>	-1.36	- .85
Total Memory	36.9(19.8)	11.86	23.4	<b>1.94</b>	<b>97%</b>	-1.43	- .86

### Conclusion

The CAR model of intervention for reading problems has shown promise in these three clinical examples and the reading memory data from 14 subjects. Each subject presented their unique pattern of difficulties. One of the values of the CAR model is its adaptability to individual differences. The limitations of the CAR model is its confinement to cortically generated electrophysiological patterns and its inability to define subcortical or cerebellum patterns which are contributing to task performance or measure the effect of the cortical interventions upon the subcortical functional involvement. The Low Resolution Brain Electromagnetic Tomography (LORETA) method could possibly address this limitation.

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