Explaining Discrepant Math Performance in Children with Epilepsy: Relative Contribution of Cognitive and Attentional Factors

Chad P. Johnson[1], Rob Collins[2], & Mary Lynn Chapieski[3]
[1]Department of Psychology, University of Houston
[2]?
[3]?Blue Bird Circle Clinic for Pediatric Neurology, Baylor College of Medicine, Texas Children's Hospital

OBJECTIVE

Problems with attention are common in children with epilepsy. Additionally, academic problems common to epilepsy, including mathematic ability, is greater than in children with other seizure disorders than other chronic illnesses, suggesting additional factors beyond classroom discomfort and multiple absences. Inattention has been implicated in mathematics underachievement reported in Tourette's syndrome. Similarly, due to the lack of a specific learning impairment in children with epilepsy, factors of attention have been suggested as difficulty associated with both seizure disorders and as a common side effect of anti-epileptic medications.

The current study investigated the impact of variables of attention on math performance in a group of children with intractable epilepsy. In particular, focus was placed on the possibility of variations from the population between more structured assessment of mathematical skills and unstructured assessment which may be more susceptible to the effects of attentional deficits.

METHODS

Participants

Participants included 87 children with intractable focal seizures. All children in the study were being evaluated for surgical candidacy at the time of testing. 8 children were excluded for failure to meet the minimum WAIS-IV FSIQ score of 70 for inclusion in the study. 14 participants were excluded for a pre-existing diagnosis of ADHD. Finally, 4 participants were excluded for failure to complete all necessary measures associated with the current study. This left a sample of 63 children between the ages of 6 and 19.

Age at testing in years, age of onset in months, gender, and number of current anti-epileptic medications at the time of testing are summarized below in table 1. Variables characterizing the seizure focus are summarized in table 2, including hemisphere and lobe of focus as characterized by EEG and whether or not consistent MRI lesion findings coincided with the EEG localized region.

Variable	Value	Range
Gender [M/F]	33/32	N/A
Age (Years) [M(SD)]	12.2(3.2)	6-19
Age of Onset (Months) [M(SD)]	78.2(50.5)	1-180
Number of Medications [M(SD)]	1.8(0.7)	1-4

Table 1. Demographic variables for included participants. Gender is separated as male/female. Remaining variables include both means and standrad deviations.

Hemisphere		
Left	**Right**	**Bilateral**
37	26	2

Lobe		
Frontal	**Temporal**	**Other**
20	31	14

MRI Comparison to EEG Findings	
Consistent	**Inconsistent**
43	22

Table 2.Localized focus of seizure activity characterized by EEG. Other category for lobe focus includes occipital foci, parietal foci, and foci localized across multiple lobes. Inconsistent MRI findings include both failure to identify a lesion as well as lesions in positions inconsistent with EEG findings.

Procedure

Measures included the Conners' Continuous Performance Test-II (CPT-II), Achenbach Child Behavior Checklist (CBCL), and the Kaufman Test of Educational Achievement-II (KTEA-II). All measures were administered as part of a larger pre-surgical neuropsychological battery. Attention variables included omission errors, commission errors, response time, and response time variability scores from the CPT as well as the Attention Problems scale from the CBCL. Math performance was assessed using the Math Applications and Concepts and Math Computation subtests from the KTEA-II. The contributions of age of seizure onset and number of medications were also assessed.

Measure	Mean	SD	Range
WISC-IV			
Full Scale IQ	92.31	14.04	72-136
KTEA-II			
Math Applications and Concepts	96.00	16.95	61-151
Math Computations	97.63	16.41	67-157
CPT-II			
Omission Errors	56.07	16.48	42-132
Comission Errors	50.07	11.26	18-68
Hit Response Time	48.32	10.28	27-78
Hit Response Time Variability	55.79	10.20	38-80
CBCL			
Attention Scale	61.76	10.89	50-83

Table 3.Means, Standard Deviations, and Ranges for study measure variables. Note that WISC-IV, and KTEA-II means are presented as standard scores (M = 100, SD = 15) while CPT-II and CBCL scores are presented as t-scores (M = 50, SD = 10).

RESULTS

Stepwise regression models were estimated for attention and seizure variables predicting both Math Computation performance (table 4) and Math Applications and Concepts (table 5). Neither age of onset nor number of medications predicted performance on either measure. Additionally, CBCL Attention did not predict performance on either math scale. However, Math Computation performance was predicted by Full Scale IQ, CPT Hit Response Time, and number of CPT Commission Errors. Conversely, only Full Scale IQ predicted Math Applications and Concepts performance. General linear modeling of seizure variables as predictors of attentional deficits associated with poor performance on Math Computations revealed that age of onset did not predict CPT Hit Response Time ($F(1, 62) = 0.32$, $p = 0.57$) or CPT Commission Errors ($F(1, 62) = 0.54$, $p = 0.47$). Similarly, number of medications did not predict CPT Hit Response Time ($F(1, 62) = 0.05$, $p = 0.83$) or CPT Commission Errors ($F(1, 62) = 0.05$, $p = 0.82$)

Predictor	ΔR^2	F	*p*
Step 1			
WISC-IV Full Scale IQ	**0.466**	**44.42**	**< 0.001**
Step 2			
CPT Hit Response Time	**0.078**	**8.59**	**0.005**
Step 3			
CPT Commission Errors	**0.057**	**7.00**	**0.011**
Total R^2	**0.601**	**24.60**	**< 0.001**

Table 3. Stepwise Regression for Math Computations subtest.

Predictor	ΔR^2	F	*p*
Step 1			
WISC-IV Full Scale IQ	**0.592**	**75.49**	**< 0.001**
Total R^2	**0.592**	**75.49**	**< 0.001**

Table 4. Stepwise Regression for Math Concepts and Applications subtest.

CONCLUSIONS

Math performance in children with epilepsy is primarily determined by general level of intellectual functioning, but attentional variables are an additional factor that may account for the discrepancy between mathematical skill level and performance in the classroom. The unstructured format of the Math Computations subtest may make it susceptible to impulsive errors captured by the impulsive indices of commission errors and faster response times as measured by the CPT-II. Differences in performance between math applications and computations probably reflect a difference in the amount of structure inherent in the two tasks.