



## Relationship between learning disabilities and the laterality of epileptic discharges in young patients with idiopathic focal epilepsy

Authors

Gharib Fawi<sup>1</sup>, Al-Amir Bassiouny Mohamed<sup>1</sup>, Alaaeldin Sedky<sup>1</sup> Ahmed Borai Hassan<sup>1</sup>,  
Sania Gamal Abdelhameed<sup>2</sup>, Ahmed Mahmoud Mosa<sup>2</sup>, Ghada Mohamed Hussein<sup>2</sup>

<sup>1</sup>Department of Neuropsychiatry, Faculty of Medicine, Sohag University, Egypt

<sup>2</sup>Department of Psychology, Faculty of Art, Sohag University, Egypt

### Abstract

**Background:** *Epilepsy is a common and serious neurological disorder. Children who suffer from epilepsy frequently exhibit learning difficulties (LDs) particularly marked in mathematics, reading, spelling and writing. These learning difficulties are different from mental retardation found in one third to one fourth of epileptic children. Conversely, up to half of epileptic patients have learning disabilities (LDs).*

**Method:** *This is a case-control study that included 56 patients (35 male and 21 female) and 36 Controls of healthy subjects (22 male and 14 female). Both patients and controls were age and sex matched. Included patients had focal epilepsy with age between 7 and 16 years and normal Intelligence quotient (IQ).*

**Results:** *The study included 56 patients with focal epilepsy and 36 healthy subjects with age and sex matched. LDs were present in 67.9 % of our participants. More than 50 % of patients had focal aware type of seizures and most of them were left focus (55.4%). LDs are significantly correlated with focal seizure semiology of temporal lobe (TL) origin. Laterality of epileptic focus is significantly related to learning difficulties, early age of onset, seizure frequency and semiology, long treatment duration and polytherapy but not an independent predictor of LDs. Specifically left temporal lobe epileptic focus was significantly associated with LDs.*

**Conclusion:** *There is a significant association between LDs and localization of epileptic focus in patients with idiopathic focal epilepsy.*

**Keywords:** *Learning difficulties, academic achievement, epileptic focus.*

### Introduction

Epilepsy is a common and serious neurological disorder with the lifetime prevalence about 7.60 per 1,000 persons and incidence rate about 61.44 per 100,000 person-years<sup>[1]</sup>.

Focal epilepsies (Previously called partial seizures) recently defined as seizures that start in an area or network of cells on one side of the brain including focal aware seizures; focal impaired awareness

seizures; focal motor seizures; focal non-motor seizures. Focal to bilateral tonic-clonic seizures (previously called a secondary generalized seizure) were defined as seizures that start in one side or part of the brain and spreads to both sides<sup>[2]</sup>.

Learning disability is a reduction in the capacity of learning of children or reduction in the intellectual ability of adults and this is different (at least in some countries) from mental retardation, or dementia. In most parts of the world, mental retardation was

defined as a situation involving an abnormal Intelligence quotient (IQ), and a learning disorder as one involving a normal IQ<sup>[3]</sup>. Recently DSM-5 considered specific Learning Disabilities (LDs) to be a type of Neurodevelopmental disorder that requires persistent difficulties in reading, writing; arithmetic; or mathematical reasoning skills during formal years of schooling. Symptoms may include inaccurate or slow and effortful reading, poor written expression that lacks clarity, difficulties remembering number facts, or inaccurate mathematical reasoning<sup>[4]</sup>.

Children who suffer from epilepsy frequently exhibit academic difficulties<sup>[5]</sup>, particularly marked in arithmetic, spelling, and reading<sup>[6]</sup>. The reason behind this is apparent failure to reach levels of attainment that should be within the intellectual capacities of these children<sup>[7]</sup>. An alternate possibility would be an underlying cognitive deficit directly related to the occurrence of the epilepsy per se, such as a deficit in reading process. This hypothesis is supported by findings showing that children with partial complex epilepsy had more important specific reading deficits compared to patients with generalized epilepsy<sup>[8]</sup>.

LDs are found approximately in one fourth up to one third of patients with epilepsy and conversely, up to half of all patients with LDs are said to have seizure disorders<sup>[9]</sup>.

There is a growing evidence of selective impairment of cognitive functioning is possible in some children with idiopathic focal epilepsy<sup>[10]</sup>. Hermann et al. found that the reading comprehension was more impaired in patients with left hemisphere language dominance and left temporal lobe epilepsy (TLE) than in those with right TLE<sup>[11]</sup>. The relation between specific learning disorders and TLE or other epilepsies remains uncertain, in part because researchers have used different definitions and measures of specific learning skills<sup>[12]</sup>. However, Piccirilli et al. reported learning or language impairments; attention deficit and hyperactivity in children affected by this type of epilepsy<sup>[13]</sup>. For idiopathic childhood epilepsy with occipital paroxysms (ICEOP) and idiopathic photosensitive

occipital lobe epilepsy (IPOLE), there are hardly any data on the cognitive and neuropsychological correlates, while ictal phenomenology and neurophysiological correlates are well described<sup>[14-18]</sup>. LDs in occipital epilepsy, explained by ictal dysfunction of occipital circuitries were to be present, visuoperceptual difficulties as the occipital lobes are involved in both low level and high-level visual processing, including object identification, face recognition, and object localization<sup>[19, 20]</sup>.

There is a crucial need for valid and reliable screening instruments to early detect children with or at risk for learning disabilities (LDs). The Quick Neurological Screening Test (QNST) contains aspects of neurological; neuropsychological and developmental examinations. This test is considered as an early screening tool that focuses on behavioral parameters associated with learning disorders and neurological dysfunctions<sup>[21]</sup>. A recent report of the international league against epilepsy (ILAE); Neuropsychology Task Force and Diagnostic Methods Commission recommended the use of neuropsychological assessment in the routine care of children and adults with epilepsy to provide a comprehensive and objective assessment of cognitive and psychological functioning<sup>[22]</sup>. This neuropsychological assessment should be done at the epilepsy onset in children and adults as the cognitive or behavioral difficulties may already be present at seizure onset, with a clinical history of problems or complaints preceding diagnosis<sup>[22]</sup>.

The objectives of this case-control study to examine the relationship between LDs at one arm and the origin and semiology of idiopathic focal epilepsy at the other arm.

### **Patients and Methods**

This is a case-control study that included 56 patients 35 male (62.5%) and 21 female (37.5%) who are following up at the Neurology outpatient Clinic, Sohag University Hospital between December 2016 to May 2017.

All children with focal epilepsy meeting the following criteria were invited to participate in the study: (1) normal mental and motor developmental

history; (2) focal epilepsy diagnosed on the basis of clinical semiology and interictal EEG; (3) a chronological age between 7 and 16 years, (4) IQ score  $\geq 70$  which indicate a problem in understanding the IQ; and (5) normal brain imaging.

Exclusion of patients was made according to the following criteria: (1) patients with major neurological deficits or overt behavioral disorders ; (2) patients having MRI abnormalities other than atrophic findings (e.g. hippocampal atrophy); (3) patients having additional comorbid neurological or developmental disorder; (4) patients taking antiepileptic drugs which are markedly affect the cognitive functions like phenytoin or topiramate and/or (5) patients with significant head injury, chronic physical conditions.

A total 36 Controls were healthy children 22 Male (61.1%) and 14 Female (38.9%) of age and sex matched randomly selected from primary; preliminary; and secondary school in Sohag Governorate during the same period. All patients were classified and managed using a standardized epilepsy protocol.

Each patient was subjected to the following: full medical and neurological evaluation including symptoms of birth trauma; developmental history; scholar performance; family history of epilepsy; manifestation of CNS infection; neurocutaneous syndromes or neurometabolic disorders. Educational stages were determined according to The UNESCO's International Bureau of Education which maintains a database of country-specific education systems and their stages<sup>[23]</sup>.

**Table (1)** Subtests of the Revised Quick Screening Test (QNST-R)

Subtest	Description
<b>1. Hand skill</b>	Subject is instructed to write his or her name and an age-appropriate six- to eight-word simple sentence.
<b>2. Figure recognition and production</b>	Present page containing a series of five geometric figures on the Recording form. Subject is instructed to name each one and then draw them.
<b>3. Palm form recognition</b>	Subject is instructed to identify, solely by touch, numerals drawn on the palm of his or her hands.
<b>4. Eye tracking</b>	Present a pencil or other appropriate object at Subject's eye level. Subject is instructed to follow it back and forth.
<b>5. Sound patterns</b>	Subject is instructed to reproduce sound patterns with the eyes closed manually and orally after the patterns are demonstrated by examiner.
<b>6. Finger to nose</b>	Subject is instructed to close both eyes and reach back and forth between examiner's hand and the tip of his or her own nose.
<b>7. Thumb and finger circle</b>	Subject is instructed to form successive circles by touching the thumb to each of the fingers.
<b>8. Double simultaneous</b>	Examiner observes whether S is able to feel the gentle simultaneous touch on hands,

Epilepsy types and epilepsy syndromes have been recently classified according to the International League Against Epilepsy who defined focal as "originating within networks limited to one hemisphere and it can be focal aware and focal with impaired awareness<sup>[2]</sup>. Focal epilepsy diagnosed on the basis of clinical semiology and interictal EEG. Idiopathic epilepsy is defined as epilepsy without any additional neurological impairments, such as cerebral palsy and MR<sup>[24]</sup>.

Informed written consent was obtained from the patients or their relative. The study was approved by local ethical committee in Faculty of Medicine, Sohag University in March 2015.

#### **A. Neuropsychological assessment**

1-The Revised Quick Neurological Screening Test (QNST-R)

The QNST-R is scored based on careful observation of performance and the total score for the test is obtained by tabulating the scores on the 15 subtests ranging from 0 to 149<sup>[21]</sup>. (Table 1)

A total score 25 or less is considered normal but the score exceeding 50 is considered high and the score between 25 and 50 is falling in the suspicious category<sup>[21]</sup>. A "High" score shows that a child is likely to have trouble learning in the regular classroom. A "Suspicious" score indicates that a child does not perform at the level predicted for his or her age. A child with a "Normal" score is very unlikely to have LDs<sup>[25]</sup>.

<b>stimulation of hand and cheek</b>	bilateral cheeks, and one hand and the contralateral cheek.
<b>9. Rapidly reversing repetitive hand movements</b>	Subject is instructed to turn his or her hands over rapidly and repetitively after these movements are demonstrated by examiner.
<b>10. Arm and leg extension</b>	Subject is instructed to extend his or her extremities in front of him or her as straight as possible in sitting position.
<b>11. Tandem walk</b>	Subject is instructed to walk a straight line for at least 10 feet, placing the heel of each shoe directly against the toe of the opposite foot. Subject then walk backward on the "line", heel-to-toe, and then repeats the tandem walk forward with his or her eyes closed.
<b>12. Stand on one leg</b>	Subject is instructed to balance him or herself with the eyes open and closed on each foot for a count of 10 seconds.
<b>13. Skip</b>	Subject is instructed to skip across the room.
<b>14. Left-right discrimination</b>	This section is scored from parts of three other subtests (6, 7, and 12). The left-right discrimination is determined by observing whether subjects hold up the right hand (leg) when he uses the right hand (leg) to demonstrate.
<b>15. Behavioral irregularities</b>	The final item requires general observation of subject's behavior (e.g., excessive talking, fidgeting, distractibility, defensiveness, Anxiety, etc.) During the entire test.

## 2-Wechsler Intelligence Scale for Arabic children

Given the range in age and level of ability, various intelligence tests were used to assess intellectual functioning. Among the eligible patients, IQ was assessed using the Arabic version of the Wechsler Intelligence Scale for Children fourth edition (WISC-IV)<sup>[26, 27]</sup>. A subject is defined as mentally normal and, accordingly, as having a normal intelligence level (IQ > 85). A subject is considered near-normal if the IQ is 71–85. Mentally normal and mentally near-normal are also called mentally non-retarded.<sup>[28]</sup>

### B. Electroencephalography (EEG)

They were advised to wash hair with shampoo with sleep deprivation an overnight before EEG. The EEG data were acquired by a computer-based system (Nihon Kohden Neurofax, SN: 00429) with minimal duration of 20–30 minutes and electrode positioned on scalp according to international 10–20 system. Recording was done in both awake and sleep state, except those who didn't sleep, only awakened state recording was taken. Provocative stimuli like hyperventilation, photic stimulation were given for three minutes each. The EEG was interpreted by consultant neurologist, trained and experienced in electro-physiologic studies. The abnormal EEG activity was also classified as generalized or focal.<sup>[29]</sup>

### Statistical Analysis

The statistical analysis was performed using the Statistical Package for the Social Sciences for window (SPSS 20.0, IBM Corp., Armonk, NY,

USA). All the patients' data were tabulated. Descriptive statistics were employed to investigate general characteristics of the epileptic patients. Continuous data were expressed as mean  $\pm$  SD, and categorical data were expressed as numbers and percentages. We used Student's t-test for the continuous data, Chi-square test for categorical data to compare between with right and left epileptic focus and patients with and without learning disabilities. Pearson's correlation was done to investigate the relationship between LD and epileptic focus values of less than 0.05 were considered significant.

### Results

The study included 56 patients with focal epilepsy and 36 healthy children with age and sex matched. The study included 35 males (62.5%) and 21 females (37.5%) of the patient in contrast to the control group the males were 22 (61.1 %) and the females were 14 (38.9%). Table (1) and (2)

Learning difficulty was present in 67.9 % of our participants. Table (2)

More than 50 % of the cases were focal aware type of seizures and most of them were left Focus (55.4%). The most frequent seizure semiology was focal with impaired awareness of TL origin (39.3%) then focal seizures with occipital spikes (28.6%). Table (2)

The most commonly used antiepileptic drugs in our study was carbamazepine with percentage 39.3%. Table (2)

Table (2) Patients Characteristic

	Mean (range)	No. of patients	Percent
Age (yr)	11.8±2.8	-	-
Sex	-		
Male	-	35	62.5%
Female	-	21	37.5%
<b>Educational Years</b>	-		
1- 3 years	-	13	23.2%
4-6 years	-	19	33.9%
4-9 years	-	9	16.1%
10-12 years	-	15	26.8%
<b>Age of Onset of epilepsy</b>	-		
<2 years	-	12	21.4%
2-10 years	-	29	51.8%
10-20 years	-	15	26.8%
<b>Seizure frequency</b>	-		
>=1 /year	-	24	42.9%
2-10 /year	-	8	14.3%
11-49/year	-	11	19.6%
>=50	-	13	23.2%
<b>Clinical Seizure Semiology</b>	-		
Focal aware	-	29	51.8%
Focal with impaired awareness	-	27	48.2%
<b>EEG Seizure semiology</b>			
Focal seizures with Centrotemporal spikes		13	23.2%
Focal seizures with occipital spikes		16	28.6%
Focal with impaired awareness of TL origin		22	39.3%
Focal with impaired awareness of FL origin		5	8.9%
<b>QNST-R</b>	-		
Mean ± SD	58.9±22.2		
Normal	-	18	32.1%
Abnormal (Learning Difficulty)	-	38	67.9%
<b>Antiepileptic drugs(AEDs)</b>	-		
Levitracetam	-	16	28.6%
Carbamazepine	-	22	39.3%
Valproate	-	18	32.1%
<b>Treatment Duration</b>	-		
1-5 Years	-	21	37.5%
6-10 years	-	20	35.7%
>10 years	-	15	26.8%
<b>Number of AEDs</b>	-		
Monotherapy	-	40	71.4%
polytherapy	-	16	28.6%
<b>EEG Focus</b>	-		
left Focus	-	31	55.4%
right Focus	-	25	44.6%
QNST-R =Revised Quick neurological screening test; EEG electroencephalogram; L			

**Table (3)** Different characteristics between patients and controls

	<b>Controls (N=36)</b>	<b>Patients (N=56)</b>	<b>P=</b> value
<b>Age (Mean±SD)</b>	12.4±2.7	11.8±2.8	0.37
<b>Sex</b>			0.89
Male	22(61.1%)	35(62.5%)	
Female	14(38.9%)	21(37.5%)	
<b>Educational years</b>			0.46
1- 3 years	4 (11.1%)	13 (23.2%)	
4-6 years	14 (38.9%)	19 (33.9%)	
4-9 years	5 (13.9%)	9 (16.1%)	
10-12 years	13 (36.1%)	15 (26.8%)	
<b>QNST-R (Mean ±SD)</b>	14.2±7.7	54.5±24.4	<b>&lt;0.001</b>
QNST-R =Revised Quick neurological screening test			

The mean age of epileptic patients with left and right epileptic focus was 11.09±2.8 versus 13.09±2.8 respectively (P value = 0.01). Table (4) Left epileptic focus is significantly related to learning difficulties, early age of onset, seizure

frequency and semiology, long treatment duration and polytherapy Table (4). Learning disability is significantly correlated to the left epileptic focus with (Table 4, 5).

**Table (4)** Different patient characteristics and learning disabilities

	<b>Left epileptic Focus (N=34)</b>	<b>Right epileptic Focus (N=22)</b>	<b>P-value</b>
<b>Age (year)</b>	11.09±2.896	13.09±2.448	<b>0.01</b>
<b>Sex</b>			0.6
Male	22 (64.7%)	13 (59.1%)	
Female	12 (35.3%)	9 (40.9%)	
<b>Educational Years</b>			0.077
1- 3 years	10 (29.4%)	3 (13.6%)	
4-6 years	14 (41.2%)	5 (22.7%)	
4-9 years	3 (8.8%)	6 (27.3%)	
10-12 years	7 (20.6%)	8 (36.4%)	
<b>Age of Onset</b>			<b>0.008</b>
<2 years	11 (32.4%)	1 (4.5%)	
2-10 years	18 (52.9%)	11 (50.0%)	
>10 years	5 (14.7%)	10 (45.5%)	
<b>Seizure duration</b>			0.620
1-5 (Years)	21 (61.8%)	13 (59.1%)	
6-10 (Years)	6 (17.6%)	6 (27.3%)	
>10 (Years)	7 (20.6%)	3 (13.6%)	
<b>Seizure Frequency</b>			<b>0.004</b>
≥1 /year	9 (26.5%)	15 (68.2%)	
2-10 /year	4 (11.8%)	4 (18.2%)	
11-49/year	9 (26.5%)	2 (9.1%)	
≥50	12 (35.3%)	1 (4.5%)	
<b>Clinical seizure Semiology</b>			<b>0.021</b>
Focal aware	14 (41.2%)	16 (72.7%)	
Focal with impaired awareness	20 (58.8%)	6 (27.3%)	
<b>EEG seizure Semiology</b>			<b>0.009</b>
Focal seizures with Centrottemporal spikes	6 (17.6%)	7 (31.8%)	
Focal seizures with occipital spike	8 (23.5%)	8 (36.4%)	

Focal with impaired awareness of TL origin	19 (55.9%)	3 (13.6%)	
Focal with impaired awareness of FL origin	1 (2.9%)	4 (18.2%)	
<b>Antiepileptic drugs</b>			0.07
Levitracetam	6 (17.6%)	10 (45.5%)	
Carbamazepine	15 (44.1%)	7 (31.8 %)	
Valproate	13 (38.2%)	5 (22.7%)	
<b>Treatment Duration</b>			<b>0.005</b>
1-5 Years	7 (20.6%)	14 (63.6%)	
6-10 years	16 (47.1%)	4 (18.2%)	
>10 years	11 (32.4%)	4 (18.2%)	
<b>Number AED</b>			
Monotherapy	20 (58.8%)	20 (90.9%)	<b>0.009</b>
Polytherapy	14 (41.2%)	2 (9.1%)	
<b>QNST-R</b>	()	()	<b>0.021</b>
Normal	7 (20.6%)	11 (50.0%)	
Abnormal (Learning Difficulty)	27 (79.4%)	11 (50.0%)	

EEG electroencephalogram; QNST-R =Revised Quick neurological screening test;TL = temporal lobe ;FL= frontal lobe

**Table (5)** Correlation between epileptic focus and learning disabilities

	QNST-R	
	r	P value
<b>Epileptic focus</b>	-0.318	0.017
<b>Focal with impaired awareness of TL origin</b>	0.273	0.042
<b>Focal with impaired awareness of FL origin</b>	-0.198	0.144
<b>Focal aware (BECTS)</b>	-0.320	0.016
<b>Focal aware (Occipital lobe)</b>	-0.015	0.912

QNST-R =Revised Quick neurological screening test; TLE = temporal lobe epilepsy ; TL = temporal lobe ;FL= frontal lobe ;BECTS= benign epilepsy with centrotemporal spikes

**Table (6)** Relationship between the origin and site of epileptic focus and learning disabilities

	Normal QNST-R	Abnormal QNST-R	P-value
<b>Focal with impaired awareness of TL origin</b>			
Left TLE	2 (11.1%)	17 (44.7%)	<b>0.011</b>
Right TLE	0 (0.0%)	3 (7.9%)	
<b>Focal with impaired awareness of FL origin</b>			0.238
Left FLE	1 (5.6%)	0 (0.0%)	
Right FLE	2 (11.1%)	2 (5.3%)	
<b>BECTS</b>			.055
Left BECTS	2 (11.1%)	4 (10.5%)	
Right BECTS	5 (27.8%)	2 (5.3%)	
<b>Occipital</b>			0.487
Left Occipital	2 (11.1%)	6 (15.8%)	
Right Occipital	4 (22.2%)	4 (10.5%)	

QNST-R =Revised Quick neurological screening test; TLE = temporal lobe epilepsy ; TL = temporal lobe ;FLE= frontal lobe epilepsy ;BECTS= benign epilepsy with centrotemporal spikes

**Table (7)** Multivariate logistic regression analysis of predictors of LD

	B	S.E.	P-value	Odds ratio	95% C.I.for EXP(B)	
					Lower	Upper
<b>Age of Onset</b>	-.138	1.384	0.920	0.871	0.058	13.120
<b>Seizure duration</b>	-0.247	1.072	0.818	0.781	0.096	6.381
<b>Seizure Frequency</b>	-2.828	1.947	0.146	0.059	0.001	2.684
<b>EEG Focus</b>	-0.425	0.860	0.621	0.653	0.121	3.528
<b>Seizure Semiology</b>	-0.628	0.803	0.434	0.534	0.111	2.576
<b>Treatment Duration</b>	2.737	1.467	0.062	15.442	0.872	273.529
<b>Number antiepileptic drugs</b>	1.508	1.258	0.230	4.519	0.384	53.166
<b>Constant</b>	1.256	1.263	0.320	3.512		

## Discussion

Epilepsy is one of the commonest neurological disorders affecting people of all ages, races and social classes with an estimated 50 million people suffering from epilepsy worldwide<sup>[30,31]</sup>. Patients with epilepsy are generally considered to be at a threefold risk for cognitive or other mental problems<sup>[32]</sup> and children with idiopathic epilepsy were at a higher risk of educational failure which may persist during adulthood<sup>[33]</sup>. Previous studies reported higher rates of learning problems in children with partial epilepsy compared to generalized epilepsy and in symptomatic (lesional) epilepsy syndromes compared to idiopathic or cryptogenic syndromes<sup>[8,28,34]</sup>. The main issue of these studies is that they included patients with both idiopathic and symptomatic focal epilepsy.<sup>[28, 35-37]</sup>

We found that LDs were present in 67.9% of epileptic children which is slightly similar to Sillanpaa et al. who documented that LDs occurred in 57% of subjects with an IQ greater than 85; in 67% of those with an IQ of 71–85; and self-evidently, in 100% of the mentally retarded.<sup>[28]</sup> The high prevalence of cognitive impairments at epilepsy onset suggests the intrinsic abnormalities attributable to genetics and the underlying abnormality of the brain in children with new onset epilepsy at baseline<sup>[38]</sup>.

This work highlighted the significant relationship between left epileptic focus and learning difficulties which was found in 79.4% of epileptic patients with left focus while present in 50% of those with right focus and this finding was in agreement with a study of Butterbaugh et al.<sup>[39]</sup> which indicates that more LDs in people who have seizures on the left side of their brains .

About half of the patients (52.6%) with focal epilepsy with impaired awareness of temporal lobe origin had learning disabilities which in agreement with the results of Chaix et al.<sup>[40]</sup> who showed that a significant differences between the right and left sided temporal lobe epilepsy in several disabilities in skills associated with learning to read and the performance of children with left TLE was significantly lower than in children with right TLE

on reading speed. In addition, Jambaqué et al.<sup>[41]</sup> reported that memory scores were statistically lower in epileptics than in controls with more severe degree in partial epilepsy especially in TLE.

Lastly Butterbaugh et al.<sup>[39]</sup> concluded that seizure onset in the language-dominant hemisphere, as compared with the non-dominant hemisphere, was associated with higher rates of specific learning disabilities.

In contrast, Vanasse et al.<sup>[42]</sup> found no statistical difference between children with TLE and their healthy peers on reading tasks administered and this difference in contrast to our results may be explained by using a different scale for learning disabilities.

The neuropsychological profile of the left TLE was similar to the profile encountered in developmental dyslexia. Recent studies using functional magnetic resonance imaging, gave evidence of dysfunction in left parietal-temporal and left occipital-temporal regions in developmental dyslexia<sup>[43]</sup>. Also, Attention and visuospatial impairments occur in children with partial epilepsy which interrupts the development of other cognitive functions, eg. working memory and executive functions<sup>[44]</sup>.

In addition, Children with TLE are more vulnerable to reading difficulties for two main reasons .First, pathology/seizure focus are often not restricted to the hippocampus, but also involve the temporal neocortex which is an integral part of the reading network<sup>[45, 46]</sup>. Second, seizures in TLE are often difficult to control with medication which can interfere with knowledge and skills acquisition; and reduce school attendance<sup>[47]</sup>. However, other studies have failed to demonstrate focus-specific memory deficits which also reported that memory problems were found in children with extra-temporal epilepsy<sup>[41]</sup>.

We did not find a statistically significant association between focal epilepsy with impaired awareness of frontal lobe origin and learning disability and this was in agreement with several studies<sup>[48-50]</sup>. It is possible that the functions of other areas connected to frontal lobe (including areas of the contralateral lobe) are simultaneously affected and this is

completely different from cognitive impairment and behavioral disturbances that is frequently encountered in structural lesions within the frontal lobes<sup>[51]</sup>.

We found that 15.8 % of epileptic children with benign epilepsy with centrotemporal spikes (BECTS) had learning disabilities. On the other hand, Vinayan et al. who observed that about 54% of the children with BECTS had educational problems<sup>[52]</sup>. Difference in this percentage may be due to different neuropsychological and EEG recording protocols. There are conflicting reports regarding laterality of spikes to dominant or non-dominant hemisphere and occurrence of specific neuropsychological impairments. Some studies documented that left sided discharges were earlier shown to be associated with impairment in verbal tasks and right-sided discharges were associated with nonverbal tasks<sup>[53]</sup>. While , other studies did not confirm this finding such an associatio<sup>[52, 54]</sup>.

There are several mechanisms about the pathogenesis of neuropsychological impairment in BECTS. Interictal epileptiform discharges can interfere with the learning process and thereby lead to scholastic problems<sup>[55]</sup>. Similarities between the syndromes of BECTS, Landau—Kleffner Syndrome and epilepsy with Continuous Spike and Wave activities during slow wave sleep (CSWS) were also highlighted previously<sup>[56]</sup> and some authors consider them to be part of a broad continuum of brain maturation disorders with a marked phenotypic variability, while others consider them to be fundamentally distinct entities<sup>[52]</sup>.

We did not find a significant correlation between focal aware seizure and LDs. In contrast to few studies<sup>[57,58]</sup> who suggested that children with idiopathic occipital epilepsy are at risk for lower intellectual performance; poor scholastic achievement and specific deficits in the visuo-perceptual functions. The authors interpreted these results cautiously because it was retrospective and based on a small sample of patients in whom learning and behavioral difficulties were among the reasons for referral. In multivariate analysis<sup>[40]</sup>, it was reported that after adjustment of age; age of

onset of epilepsy; seizure duration; semiology; frequency; the duration of antiepileptic drugs the difference between the TLE and BECTS patients was no longer significant in reading speed and reading comprehension. These results are in favor of the impact of these variables in relation to epileptic activity, independently of the epileptic syndrome, on certain aspects of academic achievement.

This study has some restrictions that should be brought into account in evaluating the results. First is the routine use of EEG and not recording during sleep to detect electrical status epilepticus during sleep and to investigate the impact of this phenomenon on LDs. Second, we did not follow up the patient to clarify the role of antiepileptic drugs in controlling seizure activity or education programs of parents and educators in LDs improvement. Third, a smaller number of focal epilepsy represented in each category. In spite of these limitations, the present study has shown that LDs which is not merely due to seizure variables is present in left focal epileptic children with seemingly normal development and IQ particularly of temporal lobe origin. Also, these LDs have significant functional consequences, through childhood and into adulthood, and should be considered in all children with epilepsy to avoid lower academic attainments and higher school drop-out rates. These results need to be confirmed in a larger and more elaborate study.

## References

1. Fiest KM, Sauro KM, Wiebe S, Patten SB, Kwon C-S, Dykeman J, et al. Prevalence and incidence of epilepsy: a systematic review and meta-analysis of international studies. *Neurology*. 2017;88(3):296-303.
2. Scheffer IE, Berkovic S, Capovilla G, Connolly MB, French J, Guilhoto L, et al. ILAE classification of the epilepsies: position paper of the ILAE Commission for Classification and Terminology. *Epilepsia*. 2017;58(4):512-21.

3. Cornaggia CM, Gobbi G. Learning disability in epilepsy: definitions and classification. *Epilepsia*. 2001;42:2-5.
4. Association AP. Diagnostic and statistical manual of mental disorders (DSM-5®): American Psychiatric Pub; 2013.
5. Mitchell WG, Chavez JM, Lee H, Guzman BL. Academic underachievement in children with epilepsy. *Journal of Child Neurology*. 1991;6(1):65-72.
6. Black KC, Hynd GW. Epilepsy in the school aged child: Cognitive-behavioral characteristics and effects on academic performance. *School Psychology Quarterly*. 1995;10(4):345.
7. Pulliainen V, Jokelainen M. Effects of phenytoin and carbamazepine on cognitive functions in newly diagnosed epileptic patients. *Acta neurologica scandinavica*. 1994;89(2):81-6.
8. Stores G, Hart J. Reading skills of children with generalised or focal epilepsy attending ordinary school. *Developmental Medicine & Child Neurology*. 1976;18(6):705-16.
9. Lhatoo S, Sander J. The epidemiology of epilepsy and learning disability. *Epilepsia*. 2001;42:6-9.
10. Metz-Lutz M-N, Kleitz C, de Saint Martin A, Massa R, Hirsch E, Marescaux C. Cognitive development in benign focal epilepsies of childhood. *Developmental neuroscience*. 1999;21(3-5):182-90.
11. Hermann BP, Wyler AR, Somes G. Language function following anterior temporal lobectomy. *Journal of Neurosurgery*. 1991;74(4):560-6.
12. Breier JI, Fletcher JM, Wheless JW, Clark A, Cass J, Constantinou JE. Profiles of cognitive performance associated with reading disability in temporal lobe epilepsy. *Journal of clinical and experimental neuropsychology*. 2000;22(6):804-16.
13. Piccirilli M, D'Alessandro P, Sciarma T, Cantoni C, Dioguardi MS, Giuglietti M, et al. Attention problems in epilepsy: possible significance of the epileptogenic focus. *Epilepsia*. 1994;35(5):1091-6.
14. Gastaut H. A new type of epilepsy: benign partial epilepsy of childhood with occipital spike-waves. *Clinical Electroencephalography*. 1982;13(1):13-22.
15. Panayiotopoulos CP. Benign childhood epileptic syndromes with occipital spikes: new classification proposed by the International League Against Epilepsy. *Journal of child neurology*. 2000;15(8):548-52.
16. Guerrini R, Dravet C, Genton P, Bureau M, Bonanni P, Ferrari AR, et al. Idiopathic photosensitive occipital lobe epilepsy. *Epilepsia*. 1995;36(9):883-91.
17. Porciatti V, Bonanni P, Fiorentini A, Guerrini R. Lack of cortical contrast gain control in human photosensitive epilepsy. *Nature neuroscience*. 2000;3(3):259.
18. Taylor I, Scheffer IE, Berkovic SF. Occipital epilepsies: identification of specific and newly recognized syndromes. *Brain*. 2003;126(4):753-69.
19. Braddick O, O'Brien J, Wattam-Bell J, Atkinson J, Turner R. Form and motion coherence activate independent, but not dorsal/ventral segregated, networks in the human brain. *Curr Biol*. 2000;10(12):731-4.
20. Morrone MC, Tosetti M, Montanaro D, Fiorentini A, Cioni G, Burr D. A cortical area that responds specifically to optic flow, revealed by fMRI. *Nature neuroscience*. 2000;3(12):1322.
21. Lin Y-hCK-c. The Quick Neurological Screening Test: Psychometric Considerations. 1998.
22. Wilson SJ, Baxendale S, Barr W, Hamed S, Langfitt J, Samson S, et al. Indications and expectations for neuropsychological assessment in routine epilepsy care: Report of the ILAE Neuropsychology Task Force, Diagnostic Methods Commission, 2013–2017. *Epilepsia*. 2015;56(5):674-81.

23. UNESCO. International Standard Classification of Education: ISCED2001.
24. Sillanpää M, Jalava M, Kaleva O, Shinnar S. Long-term prognosis of seizures with onset in childhood. *New England Journal of Medicine*. 1998;338(24):1715-22.
25. Mutti M, Sterling HM, Spalding NV, Crawford C. *Quick neurological screening test: Academic Therapy Publications* Novato, CA; 1978.
26. Wechsler D. *Wechsler Preschool and Primary Scale of Intelligence—Fourth Edition: Psychological Corporation* San Antonio, TX; 2012.
27. Bernstien, Ibrahim, Yeshel, Rotsheld, Hakeam S. *Arabic Version of Wechsler Intelligence Tests for Children (WISC-IVARB)*. PsychTech Ltd. Jerusalem 2012.
28. Sillanpää M. Learning disability: occurrence and long-term consequences in childhood-onset epilepsy. *Epilepsy & Behavior*. 2004;5(6):937-44.
29. Chowdhury RN, Hasan AH, Rahman KM, Mondol BA, Deb SR, Mohammad QD. Interictal EEG changes in patients with seizure disorder: experience in Bangladesh. *Springerplus*. 2013;2(1):27.
30. Meinardi H, Scott RA, Reis R, Sander JW. The treatment gap in epilepsy: the current situation and ways forward. *Epilepsia*. 2001;42(1):136-49.
31. Ngugi AK, Bottomley C, Kleinschmidt I, Sander JW, Newton CR. Estimation of the burden of active and life-time epilepsy: a meta-analytic approach. *Epilepsia*. 2010;51(5):883-90.
32. Dodson H. *The assessment of cognitive function in epilepsy*. New York: Demos; 1991.
33. Williams J. Learning and behavior in children with epilepsy. *Epilepsy & behavior* : E&B. 2003;4(2):107-11.
34. Zelnik N, Sa'adi L, Silman-Stolar Z, Goikhman I. Seizure control and educational outcome in childhood-onset epilepsy. *Journal of child neurology*. 2001.
35. Gordon N. REVIEW Cognitive functions and epileptic activity. *Seizure*. 2000;9(3):184-8.
36. Berroya AG, McIntyre J, Webster R, Lah S, Lawson J, Bleasel AF, et al. Speech and language deterioration in benign rolandic epilepsy. *Journal of child neurology*. 2004;19(1):53-8.
37. Dubois CM, Gianella D, Chaves-Vischer V, Haenggeli C-A, Deonna T, Perez ER. Speech delay due to a prelinguistic regression of epileptic origin. *Neuropediatrics*. 2004;35(01):50-3.
38. Bhise VV, Burack GD, Mandelbaum DE. Baseline cognition, behavior, and motor skills in children with new-onset, idiopathic epilepsy. *Developmental Medicine & Child Neurology*. 2010;52(1):22-6.
39. Butterbaugh G, Olejniczak P, Roques B, Costa R, Rose M, Fisch B, et al. Lateralization of temporal lobe epilepsy and learning disabilities, as defined by disability-related civil rights law. *Epilepsia*. 2004;45(8):963-70.
40. Chaix Y, Laguitton V, Lauwers-Cances V, Daquin G, Cances C, Démonet J-F, et al. Reading abilities and cognitive functions of children with epilepsy: influence of epileptic syndrome. *Brain and Development*. 2006;28(2):122-30.
41. Jambaqué I, Dellatolas G, Dulac O, Ponsot G, Signoret J-L. Verbal and visual memory impairment in children with epilepsy. *Neuropsychologia*. 1993;31(12):1321-37.
42. Vanasse C, Beland R, Carmant L, Lassonde M. Impact of childhood epilepsy on reading and phonological processing abilities. *Epilepsy & Behavior*. 2005;7(2):288-96.
43. Démonet J-F, Taylor MJ, Chaix Y. Developmental dyslexia. *The Lancet*. 2004;363(9419):1451-60.
44. Kolk A, Pölder A, Bachmann M, Parik C-K, Saard M. OP39-2489: Improving the

- fundamentals of learning: Cognitive neurorehabilitation for children with partial epilepsy. *European Journal of Paediatric Neurology*. 2015;19:S13.
45. Jambaqué I, Dellatolas G, Fohlen M, Bulteau C, Watier L, Dorfmüller G, et al. Memory functions following surgery for temporal lobe epilepsy in children. *Neuropsychologia*. 2007;45(12):2850-62.
46. Richlan F, Kronbichler M, Wimmer H. Functional abnormalities in the dyslexic brain: A quantitative meta-analysis of neuroimaging studies. *Human brain mapping*. 2009;30(10):3299-308.
47. Lah S, Castles A, Smith ML. Reading in children with temporal lobe epilepsy: A systematic review. *Epilepsy & Behavior*. 2017;68:84-94.
48. Helmstaedter C, Kemper B, Elger C. Neuropsychological aspects of frontal lobe epilepsy. *Neuropsychologia*. 1996;34(5):399-406.
49. Hernandez MT, Sauerwein HC, Jambaqué I, De Guise E, Lussier F, Lortie A, et al. Deficits in executive functions and motor coordination in children with frontal lobe epilepsy. *Neuropsychologia*. 2002;40(4):384-400.
50. Riva D, Avanzini G, Franceschetti S, Nichelli F, Saletti V, Vago C, et al. Unilateral frontal lobe epilepsy affects executive functions in children. *Neurological Sciences*. 2005;26(4):263-70.
51. Braakman HM, Vaessen MJ, Hofman PA, Debeij- van Hall MH, Backes WH, Vles JS, et al. Cognitive and behavioral complications of frontal lobe epilepsy in children: a review of the literature. *Epilepsia*. 2011;52(5):849-56.
52. Vinayan K, Biji V, Thomas SV. Educational problems with underlying neuropsychological impairment are common in children with benign epilepsy of childhood with centrotemporal spikes (BECTS). *Seizure*. 2005;14(3):207-12.
53. Binnie C, Marston D. Cognitive correlates of interictal discharges. *Epilepsia*. 1992;33: S11-7.
54. Drury I, Beydoun A. Benign partial epilepsy of childhood with monomorphic sharp waves in centrotemporal and other locations. *Epilepsia*. 1991;32(5):662-7.
55. Deonna T. Rolandic epilepsy: neuropsychology of the active epilepsy phase. *Epileptic disorders: international epilepsy journal with videotape*. 2000;2:S59-61.
56. Galanopoulou AS, Bojko A, Lado F, Moshé SL. The spectrum of neuropsychiatric abnormalities associated with electrical status epilepticus in sleep. *Brain and Development*. 2000;22(5):279-95.
57. Chilosi AM, Brovedani P, Moscatelli M, Bonanni P, Guerrini R. Neuropsychological findings in idiopathic occipital lobe epilepsies. *Epilepsia*. 2006;47:76-8.
58. Maher J, Ronen GM, Ogunyemi AO, Goulden KJ. Occipital paroxysmal discharges suppressed by eye opening: variability in clinical and seizure manifestations in childhood. *Epilepsia*. 1995;36(1):52-7.