

BENIGN CHILDHOOD EPILEPSY WITH CENTROTEMPORAL SPIKES

Word and pseudoword discrimination

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Abstract – In the active phase of benign childhood epilepsy with centro-temporal spikes (BCECTS) there may be a fall in scholastic performance. **Objective:** To study lexical decision in children with BCECTS. **Method:** 42 children with BCECTS were compared with a control group with respect to their hits and response time in a visual discrimination of words and pseudowords task (DWPT). **Results:** The children with BCECTS had a lower percentage of hits for words and pseudowords and showed longer response times for pseudowords. They also frequently showed inferior reading and writing performance in the school performance test. The percentage of hits for pseudowords was lower when there was bilateral, asynchronous epileptiform activity. **Conclusions:** The DWPT provided contributions for reading assessments in children with BCECTS. The results indicated the need for attention in detecting reading difficulties in children with BCECTS.

KEY WORDS: benign childhood epilepsy with centrotemporal spikes, rolandic epilepsy, EEG, epileptiform activity, reading, cognition.

Epilepsia benigna da infância com pontas centro-temporais: discriminação entre palavras e pseudopalavras

Resumo – Na fase ativa da epilepsia benigna da infância com pontas centrotemporais (EBICT) pode ocorrer queda de desempenho escolar. **Objetivo:** Estudar a decisão lexical em crianças com EBICT. **Método:** 42 crianças com EBICT foram comparadas a grupo controle quanto a acertos e tempo de resposta em tarefa de discriminação visual entre palavras e pseudopalavras (DVPPS). **Resultados:** As crianças com EBICT tiveram percentual menor de acertos para palavras e pseudopalavras e maior tempo de resposta para pseudopalavras e tiveram, mais frequentemente, desempenho inferior em escrita e leitura em teste de desempenho escolar. Houve relação significativa entre os resultados do DVPPS e o teste de desempenho escolar. A percentagem de acerto de pseudopalavras foi menor quando havia atividade epileptiforme bilateral e assincronia no eletrencefalograma. **Conclusão:** O DVPPS mostrou contribuições na avaliação da leitura em crianças com EBICT. Os resultados apontam para a necessidade de atenção na detecção de dificuldades de leitura em crianças com EBICT.

PALAVRAS-CHAVE: epilepsia benigna da infância com pontas centrotemporais, epilepsia rolândica, EEG, atividade epileptiforme, leitura, decisão lexical, cognição.

Benign childhood epilepsy with centrotemporal spikes (BCECTS) is a type of focal idiopathic epilepsy more common in childhood. The interictal electroencephalogram (EEG) shows normal base activity and epileptiform activity, characterized by high amplitude spikes mainly in the central or mid-temporal regions (centrotemporal spikes or rolandic spikes – RS). There is no cerebral lesion or in-

tellectual deficit and the prognosis is good, with seizure remission by up to 15 years of age.

However, in the active phase of the epilepsy, discreet deficits may occur in various cognitive functions, with consequent learning difficulties and fall in scholastic performance¹⁻⁸, and reading difficulties are amongst those reported in children with BCECTS^{7,9-11}.

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Compromise in the various aspects of language and reading is to be expected due to the superimposition of the cortical areas for language with those of the RS, which concentrate in the lower part of the rolandic area and in the sylvian region, with an eventual extension into the temporal cortex and adjacent parietal region^{2,3,12,13}.

Transitory cognitive impairment¹⁴ could be one of the reasons for the genesis of cognitive deficits during the RS.

In recent research, a lexical decision task in which the participant was requested to determine if a series of letters was a word or non-word (discrimination of words and pseudowords task – DWPT) was used to assess the occurrence of transitory cognitive impairment. It was shown that during the RS¹⁵ a great reduction in the number of RS occurred, and that transitory cognitive impairment only was observed in 2 (15.4%) of the 13 children in which the RS persisted in sufficient numbers to analyze. These two children showed no impairment in their scholastic performance.

While carrying out the DWPT, the functional neuroimaging studies showed evidence of involvement of the left fusiform gyrus, posterior temporal cortex, pars opercularis and the bilateral insulae. There was also increased activation for pseudowords as compared to words, greater in the right inferior frontal region¹⁶. These areas could also be involved in BCECTS discharges^{2,12,13}.

Another possible physiopathological mechanism for the genesis of the cognitive deficits could be that the repetition of the RS caused alterations in the base functioning in the corresponding cerebral regions^{4,12}.

Nevertheless, in research on the relationship between the number of RS and neuropsychological difficulties, there was frequently no statistical significance² or detailed assessment of the neuropsychological aspects⁴.

The influence of RS lateralization in cognitive deficit has been the object of controversy, since studies exist showing greater compromise with respect to attention and visuospatial tests for RS in the right hemisphere¹⁷ and with respect to language for RS on the left^{12,13}, and other studies showing no such correlation^{1,10,18, 19}.

Another aspect concerning the relationship between cognitive alterations and RS is that the latter could be associated with greater impulsivity, since in continued performance tasks the reaction time observed was shorter for the incorrect responses. Evidence of impulsivity was observed in children with the attention deficit/hyperactivity disorder with RS²⁰ and with benign focal childhood epilepsy²¹.

In the present study with BECTS, the objective was to evaluate the performance in discriminating between words and pseudowords, with respect to hits and response time and their relationships with the school performance test (SPT), with the characteristics of the epileptic manifestations (onset age, number of seizures, time since the last seizure) and with laterality and the number of RS on the EEG.

METHOD

Participants

Forty-two children (mean age 9.6±1.0 years, range 8–11 years) diagnosed with BECTS according to the international classification of epilepsies and epileptic syndromes²², referred by the outpatients department in child neurology and the EEG service of the Celso Pierro Hospital and Maternity Hospital of PUC, Campinas, SP.

A control group (CG) was also formed with 42 children from the municipal school network in Campinas, SP, all considered normal with no neurological compromise and showing normal EEG, paired with the test group with respect to age, gender and scholastic level of their parents. The Ethics Commission for Research with Human Beings of PUC-Campinas approved the project, and the subjects signed an informed consent form.

With respect to school grade, the numbers of patients were as follows: 2nd grade – 8 patients; 3rd grade – 15; 4th grade – 9; 5th grade – 9; and 6th grade – 1 case.

The average onset age of the epilepsy was 6.8 years (SD=2.1) and the average seizure number was 4.2 (SD=2.9). The mean time since the last seizure was 15.7 months (SD=17.7). Nineteen used no medication at the time of the assessment, and 23 were on antiepileptic drugs (carbamazepine, n=16; valproate, n=4; phenytoin, n=2; phenobarbital, n=1). They had normal or corrected-to-normal vision. The average full-scale IQ (Wechsler Intelligence Scale for Children – WISC III) was 104.7 (SD=22.2). Five children were left handed as confirmed by the Edinburgh Handedness Inventory. There were no serious behavioural or cognitive complaints. No children were mentally retarded (IQ< 70), as determined by the WISC-III

Procedures

School Performance Test (SPT)²³: A standardized psychometric instrument, favorably considered by the Psychological Tests Evaluation System (Brazilian Federal Council Of Psychology), which offers an evaluation of the fundamental capacities for school performance in writing, reading, arithmetic and overall ability, per school year, classifying the performance as superior, average or inferior.

Discrimination of Words and Pseudowords Task (DWPT): A program especially developed for this study in collaboration with *EMSA Equipamentos Médicos* allowed for the visual presentation of the stimuli and recording of the response type (hit or miss) and the response reaction time.

100 words (W) and 100 pseudowords (PW), disyllables paired with respect to the number of letters and consonant and vowel compositions, were presented in a random manner. High frequency words were used, taken from the *Pinheiro* child first readers²⁵. A pseudoword was considered to be a group of letters forming a pronounceable unit, but with no meaning, and they were obtained by exchanging graphemes or making other alterations to real words. The letters of the words and pseudowords were white on a black background, the presentation time was

one second and the interval between stimuli, 4 seconds. During the activity there were short pauses (1 to 3 s) for resting.

To carry out the procedure, the child was instructed to press a previously determined key (INS or space) with one hand if the stimulus was a word, or another key (space or INS, respectively) with the other hand if it was a pseudoword. The number of cases was balanced for each type of response laterality.

The child remained seated in a darkened environment during the test and was submitted to prior training to check for adequate understanding of the instructions. The program used generated a file containing the type of reaction and time taken for each response.

For each child, the percentages of hits and misses were determined, as also the mean reaction time for correct responses to the words and pseudowords.

In most cases the DWPT and SPT were carried out on the same day as the EEG and clinical assessment.

Assessment of lateral dominance using the Edinburgh Handedness Inventory.

Wechsler Intelligence Scale for Children – WISC III: Used to determine the cognitive performance of the subjects in qualitative and quantitative terms.

Digital Electroencephalogram: Brain electrical activity was recorded using the Braintech 3.0 equipment (*EMSA Equipamentos Médicos*), with a resolution of 12 bits, 0.5 and 35 Hz filters, analyzing 200 samples per second. Impedance was maintained below 10 kΩ. The electrodes were placed according to the 10–20 international system and the reference consisted of interconnected auricular electrodes. The recording was carried out while resting, hyperventilation for three minutes and, when possible, during spontaneous sleep.

The RS were evaluated with respect to their location and side, and counted for 5 minutes to calculate the mean per minute.

Data analysis

The results for DWPT and SPT were compared between the BECTS and control groups and between the results for the discrimination of W and PW in the BCECTS group.

The relationship between the percent hits for W and PW and performance in the SPT was evaluated, and also the relationship between the characteristics of the epilepsy and the RS with performance in the DWPT.

Non-parametric statistical tests were used and values for $p < 0.05$ were considered statistically significant.

RESULTS

Electroencephalogram

RS were observed on the current EEG in 35 (83.3%) of the children with BECTS. With respect to the laterality of the RS, it was restricted or predominantly on the right in 17 cases and on the left also in 17 cases. In 8 cases the RS were bilateral and independent.

Discrimination of Words and Pseudowords Task (DWPT)

Table 1 shows that the children with BECTS presented a lower percentage of hits for the words and pseudowords than the control group, and a higher percentage of misses (Mann-Whitney, $p < 0.01$).

The response time for hits was greater in the BECTS group than in the control group for both words and pseudowords, but the difference was only statistically significant for PW (Mann-Whitney, $p < 0.001$), whereas the response time for misses was statistically greater for pseudowords in the BCECTS group ($p = 0.021$).

The response times for hits were statistically smaller for words in both the BECTS and control groups, where-

Table 1. Means for the hits, misses and response times for the discriminatory words and pseudowords trial, for the BCECTS and control groups.

	BCECTS	Control	Value for p
Words			
Percent hits	84.8%	94.7%	0.000*
Response times (ms) for hits	1195.2 ¹	1102.8 ²	0.234
Percent misses	12.0%	4.15%	0.000*
Response times (ms) for misses	1321.7 ¹	1137.3 ²	0.1997
Non-responses (stimulus without response)	3.19%	1.1%	0.254
Pseudowords			
Percent hits	67.37%	93.1%	0.000*
Response times (ms) for hits	1534.3 ³	1130.1 ⁴	0.003*
Percent misses	27.26%	5.49%	0.000*
Response times (ms) for misses	1303.3 ³	1042.5 ⁴	0.021*
Non-responses (stimulus without response)	5.48%	0.95%	0.001*
Total hits (words plus pseudowords)	76%	94.11%	0.000*
Total misses (words plus pseudowords)	19.53%	4.91%	0.000*

*Mann-Whitney, $p < 0.05$; ^{1,2}Wilcoxon, $p < 0.05$; ³Wilcoxon, $p < 0.01$; ⁴Wilcoxon, $p = 0.46$.

Table 2. Results in the school performance test for the BCECTS and control groups.

SPT	Group	Superior/average	Inferior
Writing*	BCECTS	19 (45.2%)	23 (54.8%)
	CG	36 (85.7%)	6 (14.3%)
Arithmetic	BCECTS	22 (52.4%)	20 (47.6%)
	CG	31 (73.8%)	11 (26.2%)
Reading*	BCECTS	19 (45.2%)	23 (57.8%)
	CG	33 (78.6%)	9 (21.4%)

*Chi-squared, $p < 0.01$

as the response times for misses were statistically smaller than for hits in the BCECTS group but not in the control group (Wilcoxon, $p < 0.05$) (Table 1).

The percentages of non-responses were statistically greater in the BCECTS group.

In both groups, the children presented greater percentages of hits for W than for PW and lower response times for W than for PW.

School Performance Test (SPT)

Table 2 shows the distribution of the cases with respect to their classification in the SPT, as superior, average or inferior.

The children with BCECTS showed inferior performance in reading and writing more frequently than those in the control group (Chi-squared, $p < 0.01$).

Comparison between W and PW discrimination and the SPT results

Table 3 shows the comparison between the SPT and the discrimination between W and PW in relation to the number of hits in the BCECTS group.

The children with BCECTS showing superior or average performance in the reading and writing tests showed greater percentages of hits for W (Mann-Whitney, $p < 0.05$) than those showing inferior performance.

There were no statistically significant differences between the BCECTS and CG groups for the reaction times according to their performance in arithmetic.

Comparison between W and PW discrimination and aspects of the epilepsy and epileptiform activity

There were no statistically significant correlations between the DWPT results and the onset age of the epilepsy, time since the last seizure, number of seizures and use of anti-epileptic medication.

Table 4 shows there were no statistically significant differences between the children with RS predominantly

Table 3. Comparison between the percent hits in the discrimination of words and pseudowords according to the results of the SPT for the BCECTS group.

	SPT	% hits W	p value	% hits PW	p value
Writing	Superior and average	89.9	0.006 *	74.0	0.058
	Inferior	80.6		61.6	
Reading	Superior and average	85.9	0.043*	67.9	0.471
	Inferior	83.8		66.7	
Arithmetic	Superior and average	85.4	0.306	70.8	0.110
	Inferior	84.0		63.3	

*Mann-Whitney, $p < 0.05$ **Table 4. Means for the results for hits and response times in the DWPT and p values (Mann-Whitney test) in the comparison between the laterality of the RS.**

Laterality	% hits W	% hits PW	Response time W	Response time PW
Right	85.2	70.58	1282.1	1610.3
Left	83.8	65.55	1107.2	1426.3
p value	0.683	0.973	0.563	0.540

Table 5. Correlation between the number of RS on the EEG and the percent hits for W and PW and the respective response times.

	% hits W	% hits PW	Response time W	Response time PW
Independent lateral RS	82.5	44.5*	1026.1	1216.0
Unilateral or synchronous bilateral RS	85.3	72.6*	1235.0	1609.2

*Mann-Whitney, $p < 0.05$

on the left and on the right with respect to percent hits and response times for W and PW (Mann-Whitney test). There was also no statistically significant correlation between the number of RS and the results for the W and PW discrimination (Spearman correlation coefficient).

The children with bilateral and asynchronous RS showed inferior performance in the discrimination of pseudowords (Mann-Whitney, $p=0.022$) (Table 5).

DISCUSSION

General aspects concerning the DWPT results

It is known that when learning to read, the ability to identify words initially occurs via decodification of the words into their component letters, letter by letter and in groupings. With the advance in scholastic level, the ability to read changes, and becomes based on an understanding of the meaning of the words by way of a repertory of categories present in the cognitive structure, denominated as mental or lexical representation, without the need for the previous step. Thus the response time is dependent on this cerebral processing, which is different for each individual²⁴.

In this study, the children in both groups, with BECTS and control, discriminated W more frequently than PW and presented smaller response times for W, which was expected for this age range, since, as from repetitions of the exposition, these become familiar with a much better established recognition system²⁴.

With respect to the discrimination of PW, a lower percentage of hits is understandable since, not being well constituted in a lexical system, some pseudowords could be confounded with W or be labeled as such, due to a lack of certainty in the limits of their lexical system.

Thus the longer response times for PW can also be explained by the activation, in addition to the cerebral areas involved more directly in processing W, of other areas that participate in the discrimination of PW, according to neurophysiological and functional imaging findings^{16,25}.

DWPT and BECTS

The children with BECTS had a lower percentage of hits for W than those in the control group, showing that the recognition processes for W were still not as well structured as expected for their age range.

With respect to PW, the level of hits was lower and the response time longer, indicating greater difficulty in processing due to a less mature lexical system.

The response time for misses for W was greater than for hits for both the BECTS and control groups, although the response time for misses was inferior to that for hits for PW, but only reaching statistical significance in the case of children with BECTS (Table 1).

It is possible that the children with BECTS responded quicker for misses due to the mechanism of impulsivi-

ty, as already suggested in the literature^{20,21}, although the shorter response time may also have resulted from the fact that the child confounded a PW with a W and hence responded quicker.

The objective of the only other study about BECTS and DWPT¹⁵ that included part of the present casuistry was to evaluate the presence of transitory cognitive impairment during RS, but it did not present the results for overall performance in the test. No studies were found on performance in a lexical decision task for children with BECTS.

Staden et al.² studied 20 children with BECTS and found language disorders in 13 of them. These disorders were characterized by performance inferior to the standard deviation in at least two speech and language subtests. On the other hand, Northcott et al.¹⁰ found normal language ability, but reported difficulties in phonological awareness and memory which could affect the reading and writing ability (literacy) and academic performance.

Using the dual-task procedure to assess language lateralization and studying children with RS on the left, Piccirilli et al.¹² found data suggesting modifications in the pattern of functional language representation. Such a finding was not confirmed by Lundberg et al.²⁶. According to Bulgheroni et al.²⁷ there was a tendency for bilateral representation of the phonological processing of auditory and verbal stimuli.

The inferior performance observed for the children in the DWPT in this study, could be related to the processing difficulties indicated by Northcott et al.¹⁰ and Bulgheroni et al.,²⁷.

School performance test and DWPT

Children with BECTS with difficulties at school have been the object of various studies reported in the literature^{3,8,11,13}.

In an earlier study it was observed that children with BECTS frequently showed inferior performance in the school performance test (SPT), especially in reading, as compared with normal children, which was confirmed in the present study and by Piccinelli et al.⁸ for both reading and writing. Some children with BECTS suffer a delay of one academic year or more¹¹.

In the present study a correlation was observed between the results for the SPT and for the DWPT, since the percent hits for W and PW were lower in children with an inferior result in writing, whereas for reading, the difference only occurred for W. Such inferior results for hits with W and inferior performance in reading and writing must occur as a result of the less developed lexical system in these children.

DWPT and aspects of epilepsy and RS

No relationship was found between performance in

the DWPT and the total number of epileptic seizures and use of antiepileptic medication, which is in agreement with the studies in relation to these aspects and neuropsychological alterations^{1,3,5,9,11,18,25}.

The onset age for epilepsy was not a significant factor for performance in the DWPT, and was also found to be non-significant in language tests and school performance in other studies^{5,28}. Nevertheless, Piccinelli et al.⁸ reported that children with BCECTS presented specific learning disabilities more frequently when the onset was before the age of 8. This study differed from the present one since it presented lower casuistry and an elevated level of learning disabilities.

With respect to the EEG, the number of RS had no significant correlation with performance in the DWPT, in agreement with various other authors who evaluated memory and language aspects, such as phonological consciousness^{10,19,27}.

RS in the left hemisphere could eventually cause interference in the hemispheric specialization of language processing and phonemic fluency^{12,19}, but in the present study, the side of the RS was not associated with differences in performance in the DWPT, and also had no relationship with performance in other neuropsychological evaluations^{10,11}.

In the present research, an independent and bilateral location of the RS correlated with the worst results in the DWPT, which could be related to the participation of both hemispheres in the lexical decision task¹⁶. Associations were also encountered between multi-focal RS and alterations in the Wide Range Assessment of Memory and Learning¹⁰, in verbal fluency and in the Peabody Picture Vocabulary Test¹⁹.

Various factors could contribute to the different neuropsychological findings and their relationships with RS, such as the different types of neuropsychological trials used, the time lapse between the evaluations and the carrying out of the EEG, and the variation in the location of the RS with time.

The inferior performance by children with BECTS in the DWPT is in agreement with one of the hypotheses for its explication and momentary interference of the RS in cerebral functioning, leading to transitory cognitive impairment¹⁴. Nevertheless, in a recent article reporting on an evaluation of children with BCECTS using DWPT, evidence was found showing a small percentage of the children with transitory cognitive impairment, but they did not show relevant cognitive impairment¹⁵.

On the other hand, the RS indicated cortical hyperexcitability which could vary in its extent and localization with time, but which tended to be ample and not exclusively focal. The repetition of the RS could be a factor in the genesis of neuropsychological difficulties by interfering with cerebral functioning in a chronic way^{2,12,13,19}, although it is difficult to document any direct relationship

between the RS and cognitive impairment. According to the hypothesis of Doose et al.²⁹, another possible factor could be concomitant cerebral immaturity.

In conclusion, the findings of this study suggest that tasks involving lexical decision allied with other clinical parameters, could be useful in the comprehension of aspects of cognitive development, and also that there is a need for attention in detecting reading difficulties in children with BCECTS.

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