



Event-related EEG oscillations to semantically unrelated words in normal and learning disabled children

Thalía Fernández^{a,*}, Thalía Harmony^a, Omar Mendoza^b, Paula López-Alanís^a, José Luis Marroquín^b, Gloria Otero^c, Josefina Ricardo-Garcell^a

^a Departamento de Neurobiología Conductual y Cognitiva, Instituto de Neurobiología, UNAM Campus Juriquilla, Querétaro 76230, Mexico

^b Center for Research in Mathematics (CIMAT), Apartado Postal 402, Guanajuato, Gto., 36000, Mexico

^c Facultad de Medicina, Universidad Autónoma del Estado de México, Mexico

ARTICLE INFO

Article history:

Accepted 23 April 2012

Available online 25 May 2012

Keywords:

Time–frequency analysis
Learning disabled children
EEG oscillations
EEG theta
Event related EEG
EEG delta

ABSTRACT

Learning disabilities (LD) are one of the most frequent problems for elementary school-aged children. In this paper, event-related EEG oscillations to semantically related and unrelated pairs of words were studied in a group of 18 children with LD not otherwise specified (LD-NOS) and in 16 children with normal academic achievement. We propose that EEG oscillations may be different in LD NOS children versus normal control children that may explain some of the deficits observed in the LD-NOS group. The EEGs were recorded using the 10/20 system. EEG segments were edited by visual inspection 1000 ms before and after the stimulus, and only correct responses were considered in the analysis. Time–frequency (1–50 Hz) topographic maps were obtained for the increases and decreases of power after the event with respect to the pre-stimulus average values. Significant differences between groups were observed in the behavioral responses. LD-NOS children show less number of correct responses and more omissions and false alarms than the control group. The event-induced EEG responses showed significant differences between groups. The control group showed greater power increases in the frequencies 1–6 Hz than the LD-NOS group from 300 to 700 ms. These differences were mainly observed in frontal regions, both to related and non-related words. This was interpreted as a deficit in attention, both to internal and external events, deficits in activation of working memory and deficits in encoding and memory retrieval in the LD-NOS children. Differences between groups were also observed in the suppression of alpha and beta rhythms in the occipital regions to related words in frequencies between 8 and 17 Hz from 450 to 750 ms. LD-NOS children showed shorter durations of the decreases in power than the control group. These results suggest also deficits in attention and memory retrieval. It may be concluded that LD-NOS children showed physiological differences from normal children that may explain their cognitive deficiencies.

© 2012 Elsevier Inc. All rights reserved.

1. Introduction

Learning disabilities (LD) are one of the most frequent problems that afflict children in elementary school (DSM-IV). LDs are diagnosed when an individual's achievement on individually administered, standardized tests in reading, mathematics, or written expression is substantially below that expected for the individual's age, schooling, and level of intelligence. LD children are classified as “specific” (reading disorder, mathematics disorder, or disorder of written expression) or “learning disorder not otherwise specified,” which might include problems in all three areas

(DSM-IV). The children included in this study belonged to the latter group. Although LD children often have deficits in attention processes, the children in our study did not meet the criteria for Attention Deficit Disorder (ADD) and were not hyperactive.

Developmental dyslexia, which may be considered a specific learning disorder, has received considerable attention, and its functional deficits have been explored by neuropsychological, electrophysiological and neuroimaging procedures (Backes et al., 2002; Temple, 2011; Van der Mark et al., 2011). However, LD not otherwise specified (LD NOS) children have not received as much attention, although this type of LD is more common. The use of different labels to characterize specific subjects has complicated the comparison between studies (for a review, see Harmony, 2009); for example “poor readers” or less skilled readers have been defined as children who are reading between 1 and 2 years below their expected levels and have been differentiated from children with dyslexia or severe

* Corresponding author. Address: Departamento de Neurobiología Conductual y Cognitiva, Instituto de Neurobiología, Universidad Nacional Autónoma de México, Campus Juriquilla, Boulevard Juriquilla 3001, Querétaro 76230, Mexico. Fax: +52 442 238 1046.

E-mail address: thaliafh@yahoo.com.mx (T. Fernández).

reading impairments that tend to persist into adolescence and adulthood (Rayner & Pollatsek, 1989). At present, many authors use the classification listed in the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV, APA American Psychiatric Association, 1994). The DSM-IV facilitates comparisons from different reports, and for this reason, we have adopted this classification.

Electrophysiological studies of LD NOS children have shown that they frequently present more theta and less alpha power than what is normal for their age during relaxed rest. For this reason, the maturational delay hypothesis has been suggested as an explanation for their deficits (Chabot, di Michele, Prichep, & John, 2001; Fernández et al., 2002; Gasser, Rousson, & Schreiter-Gasser, 2003; Harmony et al., 1990; John et al., 1983). Using source analysis, Fernández et al. (2002) reported that LD children had more theta activity (3.5–7.02 Hz) in their frontal lobes and that control children had more alpha activity (9.75–12.87 Hz) in occipital areas. Because LD NOS children display these EEG characteristics, we wanted to determine if their EEG responses have different characteristics than the normal children.

Although the vast majority of authors emphasize the relevance of verbal deficits in LD, others have suggested that attention problems (Greenham, Stelmack, & Van Der Vlugt, 2003; Silva-Pereyra et al., 2010) and deficits in working and short-term memory may be involved (Silva-Pereyra et al., 2003; for a review see Harmony, 2009; Rayner & Pollatsek, 1989).

The functions of synchronous oscillations in language processing have been emphasized in recent years (Weiss & Mueller, 2003). There is growing evidence suggesting that synchronization changes in the oscillatory neuronal dynamics in the EEG or the MEG reflect the transient coupling and uncoupling of functional networks related to different aspects of language comprehension (Bastiaansen, Magyari, & Hagoort, 2010). However, these studies were performed in adult subjects and focused on lexical processing (Bastiaansen, Oostenveld, Jensen, & Hagoort, 2008; Bastiaansen, van der Linden, Ter Keurs, Dijkstra, & Hagoort, 2005; Khader & Rösler, 2004) and semantic (Hagoort, Hald, Bastiaansen, & Petersson, 2004; Hald, Bastiaansen, & Hagoort, 2006; Röhm, Klimesch, Haider, & Doppelmayr, 2001; Willems, Oostenveld, & Hagoort, 2008) or syntactic processes (Bastiaansen, Posthuma, Groot, & de Geus, 2002; Davidson & Indefrey, 2007) during sentence comprehension.

To our knowledge, EEG oscillations during cognitive tasks in LD children have not been reported. It is therefore of interest to know if their EEGs show normal responses to different events and, in particular, to language-related stimuli.

In the present paper, pairs of words that were semantically related or unrelated were presented to both LD NOS children and control children with good scholastic achievement. During this presentation, we recorded event-related EEG responses (EREEG). This task was selected because it requires several language processes and other associated processes, such as attention and working memory. This paradigm has been extensively studied using event-related potentials (Barber, Domínguez, & de Vega, 2002; Khateb, Pegna, Landis, Mouthon, & Annoni, 2010) and has been considered as a way to study semantic violations (Friederici, 2004; Kutas & Hillyard, 1980; Polich, 1985), and to detect these violations, children must comprehend the meaning of what they are reading.

In this study we propose that EEG oscillations may be different in LD NOS children versus normal control children in the presence of semantically related and unrelated pairs of words.

2. Methods

The Ethics Committee of the Instituto de Neurobiología of the Universidad Nacional Autónoma de México approved this study,

which also complied with the Ethical Principles for Medical Research Involving Human Subjects established by the Declaration of Helsinki. All of the children were volunteers, and informed consents from the parents were obtained for all study participants.

2.1. Procedure

Before the experiment, all of the children were evaluated using different procedures: a neurological and psychiatric evaluation conducted by an experienced neuropediatrician; the application of WISC-R; the variables of attention test (TOVA); Conner's questionnaires for parents and teachers; standardized tests in reading, mathematics, and written expression (Evaluación Neuropsicológica Infantil ENI Matute, Roselli, Ardila, & Ostrosky, 2007); and a clinical EEG.

2.2. Participants

Two different groups of children were studied: the LD NOS children and a control group of normal children with good academic achievement. Inclusion criteria for the control group included a normal neurological and psychiatric evaluation; a normal EEG; WISC-R values higher than 75; normal TOVA values; normal values in the Conner's questionnaire for parents and teachers; and normal values in the standardized tests for the evaluation of reading, mathematics and written expression.

The LD-NOS children were selected according to the following characteristics: no neurological or psychiatric disorders except for the presence of LD-NOS; IQ scores of at least 75; and scores for reading, mathematics and written expression below the 11th percentile. All children did not have severe sociocultural disadvantages.

A total of 16 control children (8 male) and 18 LD-NOS children (14 male) participated in the experiment. All children were right-handed.

Table 1 shows the age, gender and WISC-R values for each group. Comparisons of these values between the groups showed significant differences for verbal, performance and total IQ, with higher values in the control group than in the LD-NOS group. The most significant differences were in verbal IQ which was directly related to the learning deficits observed in this group, and because the mean values of the group were in the normal range, the results of the experiment were not considered to be biased by these differences.

2.3. Stimuli

The stimuli were presented in white over a black background on a PC monitor, and the subjects were seated 60 cm away from the stimuli. A Mind Tracer system (Neuronic, Inc.) synchronized with a Trackwalker data system (Neuronic, Inc.) presented the task. The stimuli were presented in 4 blocks of 30 pairs of words that lasted 4 min each, and the children rested after each block. There were a

Table 1
Characteristics of the groups.

Group	Age	WISC-R		
		Verbal	Performance	Total
<i>Control</i>				
Mean	9.42	108.73	107.13	108.93
s.d.	1.28	10.35	14.70	11.58
<i>LD-NOS</i>				
Mean	9.40	89.39	98.06	93.00
s.d.	1.07	17.79	17.46	17.68
t-Value	NS ^a	3.7144	NS ^a	2.9920
p		0.0008		0.0053

^a NS: no significant differences between groups.

Download English Version:

<https://daneshyari.com/en/article/924084>

Download Persian Version:

<https://daneshyari.com/article/924084>

[Daneshyari.com](https://daneshyari.com)