ORIGINAL ARTICLE

Verbal auditory processing in boys with specific reading disability

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Abstract

The present study focused on lateral asymmetry in auditory perception in boys with specific reading disability. Two verbal dichotic listening tasks (nonsense consonant-vowel syllables and monosyllabic consonant-vowel-consonant nouns) were administered to groups of 25 boys with reading disability and 25 control right-handed boys, aged 10-15 years. For nonsense syllables a right ear advantage was found in both groups. For monosyllabic nouns, no ear advantage was found in either group, but the total accuracy of recall was lower in the group with reading disability. There was a strong positive relationship between lateralization for syllables and words in the control group. No such relationship was found in the group with reading disability. The results suggest a specific effect of developmental dyslexia on lateralization of phonemic and semantic auditory processing.

Introduction

Specific reading disability (or developmental dyslexia) is characterized by failure or difficulty in reading acquisition in spite of normal intelligence and conventional instruction. There is converging evidence that specific reading disability is a verbal deficit. The central problem appears to be a deficit in phonological processing, in ability to manipulate the sound structure of words (Vellutino et al 2004). Several studies have also pointed to impaired auditory processing (Heiervang et al 2002), especially in processing rapidly presented acoustic information, such as the brief formant transisions within stop-consonant/vowel syllables (Tallal et al 2002) in children with reading disability.

Dichotic listening, that is the simultaneous presentation of two different stimuli, one in each ear, is a noninvasive technique for the study of brain-behaviour relationships and functional hemispheric asymmetry. This technique has been widely used in studies of auditory processing and functional asymmetry in children with reading disability employing spoken digits, words or consonant-vowel syllable pairs as stimuli (Bryden 1988). Only a few studies used different verbal dichotic stimuli in the same subjects with reading disability (Moncrieff & Black 2008; Thomson 1976; Watson & Engle 1982).

In the present study we focused on lateral asymmetry in processing of dichotically presented verbal stimuli in boys with reading disability using both nonsense as well as meaningful verbal material as stimuli.

Method

Participants

Twenty-five boys with specific reading disability and 25 control right-handed boys, aged 10-15 years participated in the study (mean age= 12.8 years, SD=1.5, age range 10 – 15 years). Handedness was assessed through the Hand Preference Questionnaire (Bryden 1982). Normal hearing for pure tones at 250 Hz, 500 Hz, 1000 Hz, and 2000 Hz was controlled by a Home Audiometer software (version 1.7).

Dichotic listening

Each subject was presented with two verbal dichotic listening tasks (Jariabková 1987). Six stop-consonant-vowel (CV) syllables ‚ba', ‚da', ‚ga', ‚ka', ‚pa', and ‚ta', pronounced by a female speaker were used as stimuli. The dichotic task consisted of four trials with a single pair of syllables, four trials with two pairs of syllables, and four trials with three pairs of syllables. In the second task, monosyllabic Slovak consonant-vowel-consonant nouns were used as stimuli, pronounced by the same speaker as in the CV syllables task. The task consisted of three trials with a single pair of words, three trials with two pairs of words, and three trials with three pairs of words. In both tasks the stimuli were paired randomly, with the restriction of ensuring the occurrence of the same stimulus in only one channel within a trial. The stimuli of both tasks were remastered, recorded on a CD and adapted so that they are repeated with the channels reversed (Špajdel 2009). Both tasks were played from a CD player via supraaural headphones and were presented to participants in a random order. A free recall dichotic listening paradigm was employed without time limit for the answer.

Monoaural identification of stimuli

The same CV syllables and monosyllabic Slovak CVC words as in the dichotic condition were used. Stimuli were presented monoaurally in a random order once to the left and once to the right ear.

Results

In monoaural identification of stimuli, there were no significant differences in right ear and left ear performance between the group with reading disability and control subjects. The dichotic listening results revealed a higher total accuracy of recall [t(48)= 3,36; p=0,02] for the CVC words in the control group. For the CV syllables, no difference between the groups in the total accuracy was found [t(48)= -0,79; p=0,49].

A mixed-design analysis of variance (ANOVA) for each task (CV syllables, CVC words) was calculated with a within-subject factor "ear" (correct responses from the left ear, correct responses from the right ear) and between-subject factor "group" (group with reading disability, control group).

For the CV syllables a right ear advantage was found in both groups [F(1;48)=12,70; p=0,01], but there was neither the difference between the groups [F(1;48)=0,63; p=0,429], nor the interaction of factors „ear" and "group" [F(1;48)=1,20; p=0,260] (***Fig. 1***).

For monosyllabic CVC words, no ear advantage was found in either group [F(1;48)=1,33; p=0,254], but the overall accuracy of recall was lower in group with reading disability [F(1;48)=12,77; p=0,001]. The interaction of factors "ear" and "group" was not significant [F(1;48)=1,23; p=0,254] (***Fig.1***).

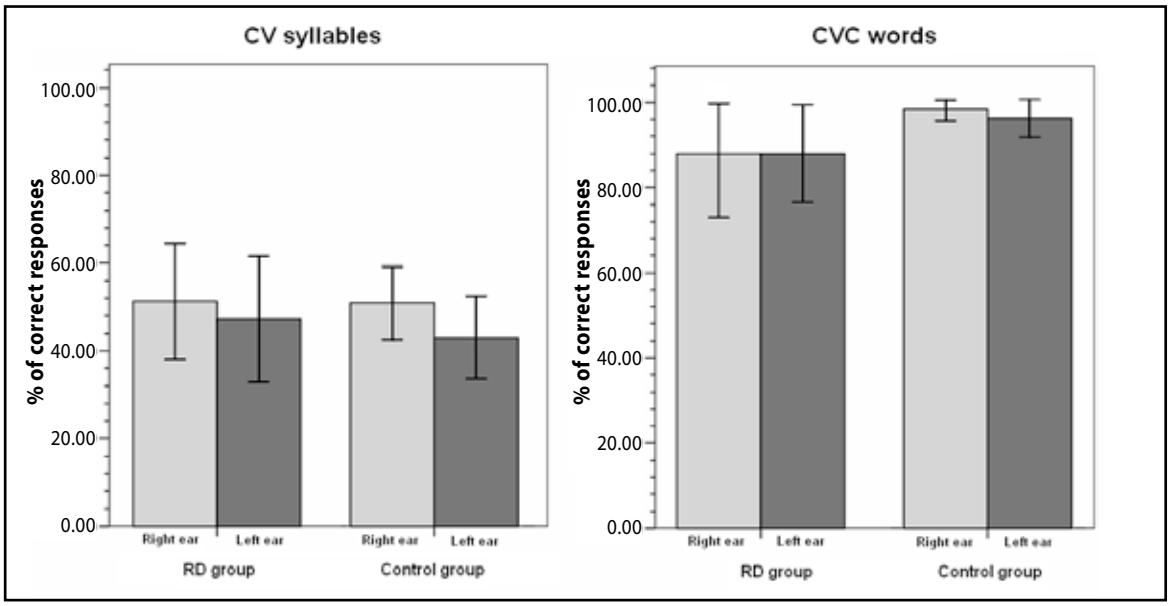

Fig. 1. The mean performance of group with reading disability (n=25) and control group (n=25) in the dichotic listening to CV syllables and CVC words

Table 1. Distribution of the ear preference for CV syllables and CVC words in the group with reading disability and control group

	RD group		Control group	
	n	%	n	%
CV syllables				
Right ear advantage	15	60	17	68
Left ear advantage	7	28	7	28
No ear advantage	3	12	1	4
CVC words				
Right ear advantage	8	32	12	48
Left ear advantage	2	8	8	32
No ear advantage	15	60	5	20

Morover, there was a difference between the groups in the distribution of right ear advantage, left ear advantage and no ear advantage for the CVC words [chi(2)=9,40; p=0,009]. No difference between the groups in the distribution of right, left or no ear advantage for CV syllables was found (***Table 1***).

In addition, a relationship between the lateralization for CV syllables and CVC words in both groups was explored. As a measure of lateralization a laterality index (LI) was used. LI was calculated for each task and subject according to the formula: LI = (R-L)/(R+L), where ‚R' and ‚L' are numbers of correct responses delivered from the right and left ear respectively. There was a strong positive relationship between the lateralization for syllables and words in the control group (r= 0,696; p<0,001). No such relationship was found in the group with reading disability (r= 0,168; p=0,423).

Discussion

Monoaural presentation did not show any differences between the groups, whereas dichotic listening revealed some significant differences.

In the dichotic listening condition, the overall performance and the ear asymmetry depended on stimulus type. For CV syllables, the right ear advantage was found in both groups. Moreover, no differences in overall performance between the groups were found. For CVC words, no ear advantage was found in either group. However, the total accuracy of CVC words recall was lower in the group with reading disability. Moreover, most boys with reading disability did not produce ear advantage in the dichotic task with CVC words. It may be possible that children with reading disability are processing dichotically presented meaningful verbal material in a different way than children with normal reading ability. Significant correlation between the laterality indices for CV syllables and CVC words in the control group points to a consistency in auditory processing of nonsense and meaningful material in children with normal reading ability. On the other hand, the absence of this significant association in the group with reading disability might suggest a different functional organization of the auditory processing of verbal stimuli according to meaningfulness of verbal material. Similarly, in the study by Watson and Engle (1982), using CV syllables and words as stimuli, children with reading disability showed a more complex pattern of results than children with normal reading ability.

Generally, the results showed differences in verbal dichotic listening performance between the group with reading disability and the control group. The results might indicate a specific effect of developmental dyslexia on the lateralization of phonemic and semantic auditory processing.

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