Treinamento auditivo em escolares com distúrbio de aprendizagem***

Auditory training in students with learning disabilities

Fábio Henrique Pinheiro*
Simone Aparecida Capellini**

*Fonoaudiólogo. Mestre em Educação pela Faculdade de Filosofia e Ciências da Universidade Estadual Paulista (FFC - Unesp) - Marília - SP.
Endereço para correspondência: R. José Bonifácio, 269 - Marília - SP - CEP 17509-004 (fabiohenriquepinheiro@yahoo.com.br)

**Fonoaudióloga. Doutora em Ciências Médicas pela Faculdade de Ciências Médicas da Universidade Estadual de Campinas - SP. Docente do Departamento de Fonoaudiologia e do Programa de Pós-Graduação em Educação da FFC - Unesp - Marília - SP.

***Trabalho Realizado no Centro de Estudos da Educação e Saúde - FFC - Unesp - Marília - SP. Apoio do Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq).

Artigo Original de Pesquisa

Artigo Submetido a Avaliação por Pares

Conflito de Interesse: não

Recebido em 13.02.2009.
Revisado em 25.08.2009; 03.12.2009; 19.01.2010.
Aceito para Publicação em 01.02.2010.

Abstract
Background: auditory training program in students with learning disabilities. Aim: to verify the efficacy of an auditory training program in students with learning disabilities; to compare the results of students with and without learning disabilities, who were and were not submitted to the auditory training program, in pre and post-testing. Method: participants were 40 students who were divided according to the following: GI, subdivided in: GIe (10 students with learning disabilities who were submitted to the program), GIc (10 students with learning difficulties who were not submitted to auditory training) and GII, subdivided in: GIIe (10 students without learning difficulties submitted to the auditory training program) and GIIc (10 students without learning difficulties who were not submitted to auditory training). The auditory training program Audio Training® was used. Results: the results indicate that GI presented a lower performance when compared to GII in activities related to auditory skills and phonological awareness. When comparing the pre and post-testing results, GIe and GIIe presented better performances in activities involving auditory skills and phonological awareness after the auditory training program. Conclusion: the performance of the students with learning disabilities in auditory and phonological tasks is lower when compared to the students without learning disabilities. The use of the auditory training program was effective and allowed students to develop these skills.
Key Words: Learning Disabilities; Intervention; Learning.

Resumo
Tema: programa de treinamento auditivo em escolares com distúrbio de aprendizagem. Objetivos: verificar a eficácia de um programa de treinamento auditivo em escolares com distúrbio de aprendizagem e comparar os achados dos procedimentos de avaliação utilizados nas pré e pós-testagem em escolares com distúrbio de aprendizagem e sem dificuldades de aprendizagem, submetidos e não submetidos ao programa de treinamento auditivo. Método: participaram deste estudo 40 escolares, sendo que esses foram divididos em: GI, subdividido em: GIe (10 escolares com distúrbio de aprendizagem submetidos ao programa de treinamento auditivo), GIc (10 escolares com distúrbio de aprendizagem não submetidos ao programa de treinamento auditivo) e GII, subdividido em: GIIe (10 escolares sem dificuldades de aprendizagem submetidos ao programa de treinamento auditivo) e GIIc (10 escolares sem dificuldades de aprendizagem não submetidos ao programa de treinamento auditivo). Foi realizado o programa de Treinamento Auditivo Audio Training®. Resultados: os resultados mostraram que o GI apresentou desempenho inferior ao de GII em atividades relacionadas com as habilidades auditivas e de consciência fonológica. O GIe e o GIIe apresentaram melhor desempenho em habilidades auditivas e de consciência fonológica depois da aplicação do programa de treinamento auditivo, quando comparados os achados de pré e pós-testagem. Conclusão: o desempenho de escolares com distúrbio de aprendizagem nas tarefas auditivas e fonológicas apresenta-se inferior no que concerne ao de escolares sem distúrbio de aprendizagem. A utilização do programa de treinamento auditivo mostrou-se eficaz e possibilitou aos escolares o desenvolvimento dessas habilidades.
Palavras-Chave: Transtorno de Aprendizagem; Aprendizagem; Intervenção.

Referenciar este material como:
Pinheiro FH, Capellini SA. Auditory training in students with learning disabilities (original title: Treinamento auditivo em escolares com distúrbio de aprendizagem). Pró-Fono Revista de Atualização Científica. 2010 jan-mar;22(1):49-54.

Introduction

Aiming at minimizing altered auditory skills found in individuals with learning disabilities, a procedure which has been recurrently proposed by a number of authors 1-4 is the auditory training.

Students with learning disability diagnosis present altered characteristics in skills such as word identification or decoding, reading comprehension, calculus, mathematical reasoning, spelling and written expression, and may also have problems in academic areas which involve, in a wider way, oral expression and comprehension. The way individuals with learning disability process and acquire information is different from the typical functioning expected for a child or adult5-6.

Therefore, the association between school difficulties and disorders in the development of auditory skills has become the focus of works conducted with auditory processing7-8 and, more recently, some studies have focused on the work with auditory training programs1-4,9-10. These studies have indicated the efficacy of such programs; however, there are few researches which focus on national literature, mainly when referring to learning disabilities.

Based on what was exposed above, this study aimed at verifying the efficacy of an auditory training program in students with learning disabilities and comparing the findings of the procedures used in pre and post-testing in students with learning disabilities and without learning difficulties, submitted and not submitted to the auditory training program.

Method

This study was approved by the Committee of Ethics in Research of the Faculty of Philosophy and Sciences of the Universidade Estadual Paulista (CEP - FFC - Unesp) under the protocol number 2595/2007.

The participants of the study were 40 students aged between 8 and 14 years old, from both genders, attending from 2nd to 4th grade of municipal schools in Marília - SP. These students were divided into two groups: Group I (GI) comprised 20 students with interdisciplinary diagnosis of learning disability, from both genders, who were subdivided into Group Ie (GIe) - 10 students with interdisciplinary diagnosis of learning disabilities who were submitted to the auditory program; and Group Ic (GIc) - 10 students with interdisciplinary diagnosis of learning disabilities who were not submitted to the auditory training program.

The diagnosis of learning disability was made by an interdisciplinary team of the Center of Studies in Education and Health (CSEH - Unesp) from Marília and the Ambulatory of Child Neurology - Learning Disorders of the Medical School (FM - Unesp) from Botucatu, including speech pathology, neurological and neuropsychological evaluations. The students were characterized with learning disability when, during the evaluations, presented results which were lower to the expected to their age and school level in relation to reception and emission of speech, reading, writing, mathematical calculus and phonological working memory.

Group II (GII) consisted of 20 students without difficulties, from both genders, paired according to gender and school level to GI and subdivided into: Group IIe (GIIe), comprising 10 students without learning difficulties submitted to the auditory training program; Group IIc (GIIc), comprising 10 students without learning difficulties who were not submitted to the auditory training program.

The control group was formed by students without learning difficulties, who were indicated by the teachers from 2nd to 4th grades based on satisfactory performance in exams in two consecutive semesters. Furthermore, these students did not present a history of auditory, cognitive, motor or visual deficiency in the school records.

The data collection with the students was made at the Cees - Unesp, after the signing of the Term of Free and Informed Consent by parents or caretakers of the students.

Before the beginning of the study, the students from GI and GII were submitted to a basic audiological exam: pure-tone audiometry, logoaudiometry and acoustic immittance measures, with results within normal standards.

The procedure used for the evaluation during pre and post-testing was the evaluation of auditory processing, composed of verbal dichotic tests, being used the dichotic test of digits and alternate disyllables11 and the test of phonological awareness - sequential evaluation instrument (Confias)12, with the duration of four 50-minute sessions, being two sessions for pre-testing and two for post-testing.

Groups GIe and GIIe were submitted to the auditory training by the use of the Audio Training Software®13, in a therapy room equipped with a computer and headphones for the collection and reception of acoustic stimulus in all activities. This program was used once it widely comprises auditory

skills which may be assailed in the presence of auditory processing disorders and also assist auditory perception of the grapheme-phoneme correspondence, an important prerequisite for the teaching of the alphabetical writing system of the Portuguese language14.

The activities of the program were done individually in 18 sessions of 50 minutes each. The frequency of the students submitted to the training program was twice a week. The sequence of activities for the auditory training was the same to all the students, as described below:

. identification of the duration pattern of sounds: the student was instructed to indicate by speech the category of the sound; and this indication occurred with the presentation of the sound in a monaural form (right ear followed by left ear) and afterwards in a binaural form. This form of exposition was used in all trained abilities;

. identification of the frequency pattern of sounds: the student was exposed by a headphone to 20 frequencies (10 low tones and 10 high tones) with the discrimination of sound frequencies between 880 Hz e 1122Hz. The student was supposed to answer by naming the stimuli (thin-thick)

. evocation of non-verbal sounds in sequence (memory for non-verbal sounds): 20 pairs of two, three and four non-verbal sound stimuli were presented to the students. Concomitantly to the presentation of the sound there was an image presentation, which the student should sequence by indicating pictures that corresponded to the sound sequence he/she heard.

. discrimination and evocation of verbal sounds: a list of words picturing phonemes worked according to the order of development of speech and language was used. After the presentation of the words, the student was supposed to differentiate them by indicating if they were the same or different, referring to the words he/she heard afterwards.

. auditory attention: sequences of numbers and months of the year were presented to the students with the insertion of cuts, that is, the stimulus was sequentially presented but with omitted parts which had been previously selected. The students were supposed to indicate the moments of cut and evocate the numbers and months which had been suppressed. A text was also used, to which the student was supposed to pay attention in order to answer comprehension questions related to its content subsequently.

The results were statistically analyzed by the program SPSS (Statistical Package for Social Sciences), version 13.0. The Mann-Whitney Test and the Wilcoxon signed-rank test were also used. A level of significance of 5% (0,050) was adopted for the application of the statistical tests (*).

Results

The results revealed improvement in the performance of the students who were submitted to the training program when compared (GIe e GIIe) in pre and post-testing situation, and in the comparison with their respective control groups (GIc e GIIc) in the dichotic digits test and alternated disyllables, as may be observed in Table 1.

In Table 2, the results show statistically significant difference of GIe in relation to GIc in the subtests of rhyme production and syllable transposition, revealing a superior performance of GIe. When the total scores of the subtests were analyzed, it was verified that the groups GIe and GIIe presented averages of performance which were superior in relation to GIc and GIIc after the application of the auditory training program.

As for the time average in the execution of the tasks, it was verified that GII presented inferior time average in relation to GI, what ratifies the better performance of GII in the tests.

Regarding the performance in the phonemic subtests of the test of phonological awareness - sequential evaluation instrument (Confias), a statistically significant difference was verified in the results of GIe in relation to GIc in the subtests of phonemic synthesis, phonemic transposition and total score in the subtests of phonemic skills.

When comparing the performances of groups GIIe and GIIc, a statistically significant difference was verified in the subtests of identification of final phoneme, phonemic segmentation and phonemic transposition, suggesting better performance of GIIe. The total score in the subtest of phonemic skills presented by GIIe and GIe after the auditory training revealed statistically significant difference in post-testing, indicating better performance of the groups submitted to the auditory training.

In relation to the time average for the execution of the tasks, it was verified that group GII performed the activities in a time average inferior to GI, ratifying, thus, the better performance of GII in the tests, as may be observed in Table 3.

TABLE 1. Intragroup comparison of the students from GIe, GIc, GIIe and GIIc in the Dichotic Digit Test and SSW with the Mann-Whitney Test.

Variable	Group pairs							
	GIE x GIC		GIIE x GIIC		GIE X GIIE		GIC x GIIC	
	DD	SSW	DD	SSW	DD	SSW	DD	SSW
RE_PRE	0,734	0,427	0,606	0,770	0,001*	0,001*	0,001*	0,001*
RE_POST	0,001*	0,001*	0,032*	0,018*	0,001*	0,001*	0,001*	0,001*
LE_PRE	0,448	0,363	0,395	0,376	0,003*	0,036*	0,001*	0,001*
LE_POST	0,002*	0,004*	0,398	0,004*	0,003*	0,001*	0,001*	0,001*
CLPRE	0,999	0,999	0,001*	0,999	0,001*	0,001*	0,001*	0,001*
CLPOST	0,029*	0,002*	0,004*	0,999	0,001*	0,030*	0,001*	0,001*

Caption: DD = dichotic digit, SSW = alternate disyllables. CL=Classification

TABLE 2. Distribution of the averages, standard deviations and significance (p) of the performance in pre and post-testing of the groups GIe, GIc, GIIe and GIIc in the syllabic subtests of the CONFIAS.

Skill		Groups	Average	Standard deviation	Value of p
syllabic skills	syllabic synthesis	GIe	4,00	0,00	0,317
		GIc	3,80	0,63	
		GIIe	4,00	0,00	> 0,999
		GIIc	4,00	0,00	
	syllabic segmentation	GIe	4,00	0,00	0,317
		GIc	3,70	0,95	
		GIIe	4,00	0,00	> 0,999
		GIIc	4,00	0,00	
	initial syllable identification	GIe	3,70	0,48	0,259
		GIc	3,20	1,03	
		GIIe	4,00	0,00	0,147
		GIIc	3,70	0,67	
	rhyme identification	GIe	3,10	0,88	0,745
		GIc	2,90	1,20	
		GIIe	4,00	0,00	0,068
		GIIc	3,60	0,70	
	production of word with offered syllable	GIe	3,70	0,95	0,358
		GIc	3,50	0,85	
		GIIe	4,00	0,00	> 0,999
		GIIc	4,00	0,00	
	identification of medial syllable	GIe	2,30	0,95	0,164
		GIc	1,60	1,17	
		GIIe	3,60	0,52	0,131
		GIIc	3,90	0,32	
	rhyme production	GIe	2,30	0,48	0,002*
		GIc	0,70	1,06	
		GIIe	3,90	1,60	0,212
		GIIc	3,00	1,05	
	syllable exclusion	GIe	4,70	2,06	0,485
		GIc	4,10	2,38	
		GIIe	7,00	1,25	0,129
		GIIc	6,10	1,60	
	syllable transposition	GIe	2,60	1,17	0,040*
		GIc	1,30	1,25	
		GIIe	3,70	0,48	> 0,999
		GIIc	3,70	0,48	
	total score of syllabic level	GIe	30,10	5,13	0,087
		GIc	24,60	8,28	
		GIIe	38,20	1,40	0,370
		GIIc	37,00	2,54	
	time	GIe	24,60	4,25	0,519
		GIc	26,60	7,18	
		GIIe	15,00	2,00	0,122
		GIIc	17,50	4,99	

TABLE 3. Distribution of the averages, standard deviation and significance (p) of the performance in pre and post-testing of the groups GIe, GIc, GIIe and GIIc in the phonemic subtests of the CONFIAS.

Skill		Groups	Average	Standard deviation	Value of p
phonemic skills	production of word with given sound	GIe	3,30	0,82	0,336
		GIc	2,70	1,34	
		GIIe	4,00	0,00	> 0,999
		GIIc	4,00	0,00	
	identification of initial phoneme	GIe	3,00	0,94	0,158
		GIc	2,30	1,16	
		GIIe	4,00	0,00	0,146
		GIIc	3,80	0,42	
	identification of final phoneme	GIe	2,30	0,48	0,064
		GIc	1,70	0,82	
		GIIe	3,40	0,52	0,039*
		GIIc	2,70	0,82	
	phoneme exclusion	GIe	2,90	1,60	0,067
		GIc	1,60	1,51	
		GIIe	5,00	0,94	> 0,999
		GIIc	5,00	0,82	
	phonemic synthesis	GIe	2,10	0,57	0,012*
		GIc	1,20	0,79	
		GIIe	2,70	0,48	0,067
		GIIc	2,20	0,63	
	phonemic segmentation	GIe	0,00	0,00	> 0,999
		GIc	0,00	0,00	
		GIIe	1,70	0,95	0,036*
		GIIc	0,80	0,79	
	phonemic transposition	GIe	1,00	0,82	0,002*
		GIc	0,00	0,00	
		GIIe	1,20	1,03	0,002*
		GIIc	0,00	0,00	
	total score of phoneme level	GIe	16,20	5,33	0,004*
		GIc	9,40	3,86	
		GIIe	22,00	2,49	0,004*
		GIIc	18,80	1,62	

Discussion

The findings of this study revealed that the students with diagnosis of learning disability presented a delay in the development of auditory skills, what may hinder the appropriate processing of information and, in consequence, affect normal development of language and writing, once for the student to learn properly at school, he must present a satisfactory development of his auditory skills13,15.

According to international literature5-4,16, the average performance in auditory processing tests of students with learning disabilities is inferior to the one of normal students. This fact may be verified in the findings of this study when the performance of the groups with and without learning disabilities was compared, showing a prevalence of superior performance of the students without difficulties.

The analysis of the auditory test results of the students from the group diagnosed with learning disability suggests inefficacy in the integration of auditory information, made evident in the performances of these groups in the Dichotic Digits and Alternate Disyllables Tests. However, in the post-testing, the averages of performance in the auditory processing tests of the students with learning disabilities improved in relation to the pre-testing.

A number of studies1-4,9 have brought similar data about the efficacy of the use of auditory training programs and its effects on the tests of auditory processing evaluation, corroborating the findings of this study.

Some students with reading problems presented smaller memory extension for the material presented in audio form and tend to have an inferior performance in tasks which require phonological awareness17. The students who present difficulties in processing speech sound stimuli might encounter obstacles in the segmentation and manipulation of the

phonological structure of language and will, consequently, be subjected to presenting difficulties in reading and writing18-19. This may be verified in the results obtained by the use of the CONFIAS.

The performance of the students in the phonological awareness tasks showed that the performances of the students from all groups were superior in the syllabic tasks in what concerns the phonemic tasks, what is in accordance to the findings in the literature12,20.

When the average of the total of the performances in the syllabic subtests was compared, it was verified that the experimental groups presented superior performances in relation to their respective control groups, indicating improvement in the average of performance for the groups submitted to the auditory training program, and the same was found in the performances of phonemic skills.

These results suggest a more appropriate performance of these students in relation to the levels of auditory attention, perception of speech sounds, word recognition and auditory comprehension.

Conclusion

The findings of this study allow to conclude that: the students with learning disabilities and without difficulties submitted to the auditory training program presented improvement in their performances in post-testing in comparison to the students who were not submitted to program from both groups, revealing, thus, the efficacy of the auditory training program with the software used; the students with learning disabilities presented inferior performance when compared to the students without learning difficulties in tests of phonological awareness and auditory processing.

References

1. Hayes EA, Warrier CM, Nicol TG, Zecker SG, Kraus N. Neural plasticity following auditory training in children with learning problems. Clin Neurophs. 2003; (114): 673-48.

2. Moore DR, Amitay S. Auditory training: rules and applications. Seminar in Hearing. 2007; (28) 2: 99-109.

3. Zalcman TE. & Schochat E. A eficácia do treinamento auditivo formal em indivíduos com transtorno de processamento auditivo, Revista da Sociedade Brasileira de Fonoaudiologia. 2007; 12 (4): 310-14.

4. Moore DR, Ferguson MA, Halliday LF, Rilley A. Frequency discrimination in children: Perception, learning and attention. Hearing Research. 2008; (238): 147-54.

5. Silver CH, Ruff RM, Iveson GL, Barth JT, Broshek, DK, Bush SS, Koffer SP, Reynolds, CR. Learning disabilities: The need for neuropsycological evaluation. Archives of Clinical Neuropsychology. 2008; (23): 217-19.

6. Wu TK, Huang SC, Meng YR.. Evaluation of ANN and SVM classifiers as predictors to the diagnosis of studentes with learning disabilities. Expert Systems with Appplications. 2008; (34): 846-56.

7. Ramos CS, Pereira LD. Processamento auditivo e audiometria de altas freqüências em escolares de São Paulo. Pró-Fono Revista de Atualização Científica. 2005 maio-ago; 17 (2): 153-64.

8. Sauer L, Pereira LD, Ciasca SM, Pestun M, Guerreiro MM. Processamento auditivo e SPECT e crianças com dislexia. Arquivos de. Neuropsiquatria. 2006; 64 (1):108-111.

9. Agnew JA, Dorn C, Eden GF. Effect of intensive training on auditory processing and reading skills. Brain Lang. 2004; (88): 21-25.

10. Berlau KM, Weinberger NM. Learning strategy determines auditory cortical plasticity. Neurobiology of learning and memory. 2008; (89): 153-166.

11. Pereira LD, Schochat E. Processamento Auditivo Central: manual de avaliação. São Paulo: Lovise, 1997.

12. Moojen S, Lamprecht R, Santos RM, Freitas GM, Brodacz R, Siqueira M, et al. Consciência fonológica: Instrumento de avaliação seqüencial. São Paulo: Casa do Psicólogo, 2003.

13. Nunes C, Frota S. Audio Training: fundamentação teórica e prática. São Paulo: AM3 Artes, 2006

14. Capellini SA. Distúrbios de aprendizagem versus dislexia. In: Ferreira LP, Befi-Lopes D, Limongi S, organizadores. Tratado de fonoaudiologia. São Paulo: Ed. Roca; 2004. p. 862-76.

15. Santos MFC, Pereira LD. Escuta com dígitos. In: Pereira LD, Schochat E. Processamento auditivo central: manual de avaliação. São Paulo: Ed. Lovise; 1997. p.147-50.

16. Dawes P, Bishop DVM, Sirimanna T, Bamiou DE. Profile and aetiology of children diagnosed with auditiry processing disorder (APD). Int J Pediatr Otorhinolaryngol. 2008; (72): 483-489.

17. Nunes MVRS. A aprendizagem de leitura e o "loop" fonológico. RFML, série III. 2001; 6 (1): 21-28.

18. Cherry R, Rubinstein A. Comparing Monotic and Diotic Selective Auditory Attention Abilities in Children. Lang. Speeech and Hear. Serv. Sch. 2006; (37): 137-42.

19. Idiazábal-Aletxa MA, Saperas-Rodrígues, M. Procesamiento auditivo em el trastorno específico del lenguaje. Revista de Neurología. 2008; 46 (supl.1): 91-5.

20. Tirapegui CJC, Fajardo LRC, Ortiz ZDB. Conciencia fonológica y lengua en niños con trastorno específico del lenguaje expressivo. Rev. Cefac. 2005 out-dez; 7(4): 419-25.