THE USE OF SOFTWARE ON AUDITORY TRAINING IN CHILDREN: THEORETICAL REVIEW

O uso de software no treinamento auditivo em crianças: revisão teórica

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ABSTRACT

The auditory processing disorder refers to the inability of the central auditory system to capture and interpret sound information from the external environment. To minimize or to remedy the effects of this disorder in daily life of the subjects is indicated therapy with auditory training. The aim of this study was to present a literature review on the use of software in the training of auditory skills in children. Have been take one search in databases: Scientific Eletronic Library Online (SCIELO)*, Sistema da Literatura Latino-Americana em Ciências da Saúde (LILACS),* National Library of Medicine (MEDLINE e PUBMED) and *Índice Bibliográfico Espanhol de Ciência da Saúde (IBECS)*. The research was carried out from 2008 to 2014, using the keywords: auditory perception; acoustic stimulation; Software; children. *Selection criteria:* Publication performed after 2008 and using computerized auditory training as a means of therapeutic intervention in children independent of the condition and/or disorder involved, in Portuguese or Spanish or English. According to research in the last six years, the use of software in the auditory training in children has been shown to be an effective tool. The articles analyzed demonstrate that the use of computer programs allows engagement and motivation, besides the rehabilitation of the auditory skills.

KEYWORDS: Auditory Perception; Acoustic Stimulation; Software; Child; Hearing

INTRODUCTION

Auditory training (AT) provides the acoustic stimulation of auditory skills through different approaches and also through the specific demand of each patient, in order to reorganize the auditory neural system and his connections with the other related sensory systems, enabling an improvement in lagged auditory skills[1].

There are two basic ways to accomplish the AT. The acoustically uncontrolled one (informal AT) carried out at home with the assistance of the family members or the school setting with support of the teachers, once the use of electronic devices and the acoustically controlled (formal AT), through electroacoustic equipment or computer programs[2] is not required. Despite not using these resources, the informal AT may also fulfill the stimulation of auditory skills, if well organized[3,4].

Another way to perform therapy is through the use of some software in computerized AT, which allows the control of stimuli and hierarchy activities[5]. AT by using specific software aims to meet different acoustic activities, to activate the auditory system and its connections with related systems, modifying old auditory behavior and forming new neural basis[6].

Each of these ways of therapeutic intervention has its unique advantages, including: formal AT has the opportunity to present the acoustic stimulus in a precise way mode[5,7]. On the other hand, computerized AT the greatest advantage is the standardization of training, as this kind of intervention allows different subjects perform the same activity. In addition, in this type of therapeutic intervention the subject must accomplish a sequence of tasks that

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respect a hierarchical order of complexity of the therapy program and all this in a ludic way[8,9].

Some authors[7,9-11] report that the use of computers in therapeutic environment provides the child contact with computerization, enabling access to multiple strategies that enhance global and auditory development. In order to obtain the successful treatment of the patient, it is important to encourage him, as well as highlighting his correct answers during therapy, thus characterizing them as motivational sections[11], as musical training and playing video games that allow a new learning of the subject[12]. The authors also [7,9-11] refer to the AT computer programs should stimulate the neural reward centers naturally and for that the professionals who develop this kind of intervention should consider some platforms that would make this possible.

Although there are few national publications relating AT with the use of software as a therapeutic intervention in the treatment of auditory processing disorders (APD) or aiming only at the auditory stimulation, this tool proves to be relevant and contemporary, deserving more emphasis on speech therapy.

Thus, the aim of this study was to present a review of literature on computerized auditory training as a means of therapeutic intervention in children, trying to identify which software were used, the attended population, the way it was used and the results of this kind of therapeutic intervention.

METHODS

It is a data collection study performed through bibliographic search in electronic databases, aiming at a theoretical review in the area of Audiology, on the theme of computerized auditory training.

For the search of papers in the literature, it was carried out some research in the following databases: Scientific Electronic Library Online (SciELO), *Sistema da Literatura Latino-Americana em Ciências da Saúde (LILACS),* National Library of Medicine (MEDLINE and PubMed), *Índice Bibliográfico Espanhol de Ciência da Saúde (IBECS)*, in October of this year. For the choice of the descriptors, we used the structured and trilingual vocabulary, descriptors in Health Sciences (DeCS), prepared by the *Biblioteca virtual em Saúde - Bireme.*

Table 1 presents the strategies which were used to perform a search in several searched databases. As well, another recovery method of bibliographic reference, by the search for items with “words” and not with descriptors.

Table 1 – Search strategies used to search in the databases

	Portuguese	English	Spanish
First strategy with descriptors (S1)	Percepção auditiva e estimulação acústica e software	Auditory perception and acoustic stimulation and software	Percepción auditiva y estimulación acústica y programas informáticos
Second strategy with descriptors (S2)	Estimulação acústica e transtornos da percepção auditiva	Acoustic stimulation and auditory perceptual disorders	Estimulación acústica y trastornos de la percepción auditiva
Third strategy with descriptors (S3)	Percepção auditiva e software	Auditory perception and software	Percepción auditiva y programas informáticos
First strategy with wors (S4)	Terapia, audição e *software*	Therapy, hearing and Software	Terapia, audición y *software*
Segund strategy with wors (S5)	Treinamento auditivo e reabilitação auditiva	Auditory training and auditory Rehabilitation	Entrenamiento auditivo y rehabilitación auditiva

First, the research was carried out considering the following inclusion criteria: current publication (subsequent to July/2009), written in Portuguese, English or Spanish, survey conducted in humans, children diagnosed with auditory processing, no other organic and/or emotional commitments besides presenting normal hearing. In the first search mode, we found 417 papers of which only one could be in this review paper. Due to this fact, the eligibility criteria have changed, like for instance, publication subsequent to 2008 and computerized auditory training as a means of therapeutic intervention in children, regardless of disease and/or disorder that was involved.

The selected papers were described concerning a chronological order of publication, trying to identify the software which was used, the attended population, the way such technological resource was used and the results obtained through this kind of therapeutic intervention.

The search for papers was carried out by only one evaluator that critically analyzed the results found in the databases. A first analysis was conducted based on the content of the title and of the summary. The relevant works were read in full, once they present the topic in question. Thus, it was considered appropriate for this narrative review a total of 25 papers, of which 13 were repeated in different databases. Thus, 12 papers were relevant (appropriate to the topic) to produce this study.

The bibliographic searches of the published papers were performed during the last six years with the use of the keywords and words as shown in Table 2.

Table 2 – Number of articles found in each database searched by descriptors

	SCIELO	LILACS	PUBMED	MEDLINE	IBECS	TOTAL
Articles found S1	01	02	142	38	none	183
Appropriate to the subject	none	01	none	none		01
Articles found S2	none	none	204	204	04	412
Appropriate to the subject			02	03	v	05
Articles found S3	07	03	583	74	none	667
Appropriate to the subject	01	02	02	01		06

Caption: SCIELO= Scientific Eletronic Library Online, LILACS= Sistema da Literatura Latino-Americana em Ciências da Saúde, MEDLINE e PUBMED= National Library of Medicine, IBECS= Índice Bibliográfico Espanhol de Ciência da Saúde

As a complementary form of research, a search using search strategy with words was performed, and the following results were found (Table 3).

After the selection of the 12 abstracts, it was conducted the analysis of the complete texts. Then, it was considered in this research: aims, samples, instruments to assess hearing, found results and the method of measurement. Tables 4 to 5 systematize the papers and the data used for this study in both research strategies.

Table 3 – Number of articles found in each database searched by words related to the subject

	SCIELO	LILACS	PUBMED	MEDLINE	IBECS	TOTAL
Articles found S4	none	04	447	138	none	589
Appropriate to the subject		none	02	01		03
Articles found S5	03	none	1008	none	none	1011
Appropriate to the subject	02		08			10

Caption: SCIELO= Scientific Eletronic Library Online, LILACS= Sistema da Literatura Latino-Americana em Ciências da Saúde, MEDLINE e PUBMED= National Library of Medicine, IBECS= Índice Bibliográfico Espanhol de Ciência da Saúde

Table 4 – Studies that performed computerized auditory training, in children, considering the findings with descriptors such as search strategy

Author	Year	Method for CAT	Sample	Software
Martins, Pinheiro and Blasi[10]	2008	Patients were submitted to eight CAT sessions.	Two children of nine years (a boy and a girl) with APD	*Pedro na casa mal-assombrada*®
Germano and Capellini[19]	2008	Subjects underwent 13 CAT sessions, lasting 45 minutes twice a week.	20 students (aged eight to twelve years). Divided into two groups: Ten subjects with developmental dyslexia and ten good readers. Both groups were divided into two subgroups: those who made the 13 sessions of the software and those who did not.	*Play on - Jeu d´entraînement à la lecture*
Russo *et al.*[26]	2010	Five to ten sessions with different lengths according to the individual need of the patient.	11 children: six boys (mean age of nine years) with pervasive developmental disorder and autism spectrum who did not undergo the AT; five of them (mean age of nine years and four months) passed by the AT.	Fast ForWord
Murphy and Schochat[21]	2011	The subjects performed the CAT at home using his personal computer. CAT should be performed five times per week with length of 20 minutes per day for a period of two months. The subjects should refer to the researchers, by e-mail, his performance in the work.	58 children between seven and 14 years, divided into two studies: 1) 40 children with dyslexia: 12 performed AT in the study group, and 28 without AT - control group; 2) group compared with 18 dyslexic children who performed AT in three different moments, two months earlier, at the start of therapy and after completion.	Software Auditory Temporal Processing (ATP)
Cameron and Dillon[16]	2011	The software was installed on the personal computer of the child to perform CAT at home, however, before the beginning of AT, parents and children had the opportunity to use the software in a clinical setting. CAT was performed five times per week for 15 to 20 minutes a day, which should be made in two sets, until they are 120 games. The TAC lasted about three months. Parents held weekly control of the evolution of the child using the table in Excel.	Nine children aged between six and 11 years , being six boys and three girls.	LiSN &Learn auditory training software
Silva *et al*[9]	2012	Subjects underwent CAT twice a week for 30 minutes per session.	17 children with hearing impairment, ten users of IC and seven users of AASI	*Software* for Hearing Disorders Rehabilitation (SARDA)
Krishnamurti *et al.*[27]	2013	Patients underwent eight weeks of CAT, lasting 50 minutes, five days a week.	Two children with APD from the Speech and Hearing Clinic of Auburn University at Montgomery (AUM)	Fast ForWord

Caption: DPA: Disorder Auditory Processing; CAT: Computerized Auditory Training; AP: Auditory Processing; BAEP: Brainstem Auditory Evoked Potential; ISAD: Individual Sound Amplification Device; CI: Cochlear Implant; Lins-S: Listening in spatialized Noise - Sentences Test; CNS: central nervous system; IC: Informed Consent; CONFIAS: Phonological Awareness - Sequential Assessment Instrument.

Table 5 – Studies that performed computerized auditory training in children, considering words as search strategy

Author	Year	Method	Sample	*Software*
Balen, Massignani and Schillo[14]	2008	CAT held 80 minutes per day for five days a week for up to eight weeks of training.	Three children (aged from nine to 14 years) diagnosed with APD	Fast ForWord
Given *et al*.[15]	2008	CAT for 12 weeks in five different groups: 1. two phases of rapid intervention with ForWord (FFW, experimental group); 2. Intervention Stages SuccessMaker (SM, active control group); 3. FFW followed by SM; 4. SM followed by FFW; 5. No intervention beyond the classroom in regular class (development control group). CAT was held five days a week for 88 minutes a day for two class periods of 47 minutes.	65 children randomly divided into five groups	Fast ForWord
Rochette and Bigand[18]	2009	CAT held with one session a week for 20 weeks, lasting 30 minutes each.	Four children with profound hearing loss and two with severe hearing loss (mean age of nine), five of them exposed to a second language, however, poor.	Sounds in hand
Pinheiro and Capellini[20]	2010	CAT was performed two times per week, total of 18 sessions of 50 minutes.	40 students (eight to 14 years): 10 with learning disabilities who underwent CAT; 10 with learning disabilities without CAT; 10 without learning difficulties who underwent CAT and; 10 students without learning disabilities and without CAT.	Audio Training Software®
Heim *et al.*[28]	2013	CAT was performed five days in the week, for an average of 32 days with length of 100 minutes each session.	21 children (six to nine years) diagnosed with language disorder that underwent CAT - study group. And the control group with 12 children with typical language development.	Fast ForWord

Caption: CAT: Computerized Auditory Training; APD: Auditory Processing Disorder; CG: Control group; SG: Study Group; IC: Informed Consent; CONFIAS: Phonological Awareness - Sequential Assessment Instrument; CELF-4: Clinical Evaluation of Language Fundamentals - Fourth Edition; WRMT-R: Woodcock Reading Mastery Tests - Revised; WASI: Wechsler Abbreviated Scale of Intelligence.

LITERATURE REVIEW

The analyzed papers showed similarity in relation to their aims, methods and findings. In general, they analyzed the effectiveness of this form of intervention by different software as: *Pedro na Casa Mal Assombrada®,* Fast ForWord®, *Auxiliar na Reabilitação de Distúrbios Auditivos (SARDA)*, Audio Training Software®, Software Auditory Temporal Processing (ATP), Sounds in hand, LiSN & Learn auditory training software, *Play on - Jeu d´entraînement à la lecture.*

AT as a therapeutic intervention is a means to minimize the complaints reported by the patients allowing improvement in hearing, in relation to the auditory processing (AP)[13]. All studies found in this review showed that there were differences related to alterations in hearing, after hearing training with the use of software as a therapeutic strategy, consequently, considered an effective and efficient method for auditory rehabilitation. The most used software in the searches found in this review was the Fast ForWord Language®, 41.7% (n = 5). Such software stimulates the auditory skills through seven tasks that include frequency standard activities involving phonemes, words and, last of all, sentences. It also enables the daily record of performance achieved by the patient, being used to monitor the developments during the auditory training period[14]. The subjects achieve gains related to oral language and reading during the intervention[15].

The authors[10] realized that the use of computer games in the auditory training of children with APD through the use of software, enable the development of auditory skills and building new learning possibilities, changing old behaviors and treating

possible hearing difficulties. The subjects of that research were able, gradually, to assimilate the information stored in memory, as well as developed auditory attention. Corroborating the findings of other researchers[16] who observed improvement related to attention, memory, as well as the reports of children in the self-assessment questionnaire associated to listening skills. The questionnaires are important because they show the perception of the subject himself in terms of limitations and the limitations of his family members or teachers, with hearing improvement after CAT[17].

APD may be associated with reading and writing disorders, and it was important to study the effectiveness of CAT in this audience. In a study of three subjects with alteration of the most predominant AP types: auditory-linguistic association, decoding and auditory-linguistic association and auditory integration and or prosody, respectively. The authors showed that CAT has been effective once the first two subjects reached normality and the third, even with progress during activities, remained difficult in evidenced auditory integration in AP behavioral assessment pre and post CAT[14].

The efficiency of using a computer program in the (re)habilitation of hearing impaired child, user of hearing aids or cochlear implants, was shown in a research[9], with an improvement in speech perception in quiet and in noise. The researchers verified that these children needed more time to do the activities, especially those ones which involved non-verbal and verbal sounds directly related to sustained attention[18]. In relation to the software, the authors refer to the need of the internet with fast and stable speed as a negative aspect, which is not always possible in care centers. They also emphasize that "the use of software should be an aid in speech therapy and not a substitute, as the guidance and assistance from the audiologist during the application of SARDA was essential" (p.40). Two children with severe hearing loss and four with profound hearing loss showed to have presented benefits with the auditory stimulation, which was observed through a better discrimination of sounds of speech[18].

The use of software is also used as interventional tool in other disorders, not the ones related to alterations in hearing skills like the APD. A study carried out in children with dyslexia, which aimed to verify the effectiveness of CAT in this population, showed an improvement in reading and writing activities, in phonological awareness and also in auditory processing. The subjects had such positive results because the used software allows easy handling and the information is presented clearly, allowing the subject with difficulty in perceiving auditory information might have concomitant visual aid. It was also observed that this intervention provided longer time of attention at the activities by the students[19]. Subsequently, the effects of CAT in students with learning disabilities were researched, verifying that such audience presents delayed development of auditory skills, which prevents the correct assimilation of received auditory information[20]. However, with therapeutic intervention, the development of skills to the level of auditory attention, perception of speech sounds, word recognition and listening comprehension were verified.

AT in children with dyslexia was studied again in 2011, corroborating the previous favorable results. It enables significant improvements in phonological awareness skills (syllable and phoneme), reading texts and non-verbal listening skills. This study suggests that there is a connection between verbal and non-verbal skills[21].

In the studies found, the researchers used an electrophysiological[22-25] or behavioral[22,24] evaluation of AP as a biomarker of therapeutic evolution, aiming to measure the effectiveness of this type of therapeutic intervention, corroborating other research. Researchers[26] studied the effects of CAT in five children diagnosed with autism spectrum, concluding that the use of software generates alterations in cortical responses, which are observed by means of brainstem auditory evoked potential assessments with speech stimuli and long-latency auditory evoked potential. This study showed that the software as intervention allows the benefits seen in objective and biological changes. This finding was also found in two other studies in 2013: the first showed that the brain capacity in modifying itself through the stimulation could be seen in the evaluation of brainstem auditory evoked potential with speech stimuli, carried out pre and post CAT in two children diagnosed with APD, being this evaluation sensitive to changes by auditory stimulation[27]; and another noted that the neuronal plasticity involves getting response with increased range while the oscillation of the activity related to temporal organization remains atypical[28].

CONCLUSION

From this review it was noticed that the choice of software as a strategy in the AT is not commonly used in children. With this study it was possible to visualize a current panorama, which is still limited, by linking research with computer training for stimulation of auditory skills, which have incidence of alteration in the population of school age.

The new research with case studies may also assist in the dissemination and understanding of the

benefits and effectiveness of AT in the population with therapy indication with sound stimulation. In addition, greater recognition of these therapeutic approaches extends the option and possibility of therapeutic success for professionals who work with rehabilitation or stimulation of children with the presence of risk factors for communication alterations, linguistic or auditory. It is emphasized the importance of using such contemporary means, attractive and motivating the therapeutic approach, especially considering children.

RESUMO

O distúrbio do processamento auditivo refere-se incapacidade do sistema auditivo central em captar e interpretar as informações sonoras oriundas do ambiente externo. Para minimizar ou sanar os efeitos deste distúrbio no cotidiano dos sujeitos, é indicado terapia com treinamento auditivo. O objetivo deste estudo foi apresentar uma revisão de literatura sobre o uso de *software* no treinamento de habilidades auditivas em crianças. Como estratégia de pesquisa realizou-se busca em bases de dados: *Scientific Eletronic Library Online (SCIELO), S*istema da Literatura Latino-Americana em Ciências da Saúde (LILACS)*, National Library of Medicine (MEDLINE e PUBMED)* e Índice Bibliográfico Espanhol de Ciência da Saúde (IBECS) considerando estudos publicados em 2008 a 2014, utilizando as palavras-chave: percepção auditiva; estimulação acústica; software; crianças. Para inclusão, os artigos deveriam possuir publicação posterior a 2008 e treinamento auditivo computadorizado como forma de intervenção terapêutica em crianças, independente da patologia e/ou distúrbio envolvida**,** idioma em inglês português ou espanhol. Nos estudos realizados nos últimos seis anos, o uso de *software* no treinamento auditivo em crianças tem se mostrado uma ferramenta eficaz. Os artigos analisados mostraram que o uso de programas computadorizado permite engajamento e motivação, além da reabilitação das habilidades auditivas alteradas.

DESCRITORES: Percepção Auditiva; Estimulação Acústica; Software; Criança; Audição

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