Audiology - Communication Research
ISSN: 2317-6431
Academia Brasileira de Audiologia

Original Article

https://doi.org/10.1590/2317-6431-2017-1935

Audiology Communication Research
ISSN 2317-6431

Translation and cross-cultural adaptation of a listening in noise auditory training software to brazilian portuguese

Tradução e adaptação de um *software* de treinamento da escuta no ruído para o português brasileiro

Karenina Santos Calarga[1], Caroline Rocha-Muniz[1], Benoît Jutras[2], Eliane Schochat[1]

ABSTRACT

Purpose: To translate and to adapt the software "LEB", verify its effectiveness and playability in a group of students without hearing and / or learning complaints. **Methods:** (I) Effectiveness was investigated by analyzing the performance of two paired groups before and after training in the compressed speech test. The trained group (TG), composed by 22 students aged 9 to 10 years old, received training with the software and the control group (CG), composed by 20 students of the same age, did not receive any type of stimulation; (II) after the training, the subjects of the TG responded to a qualitative evaluation about the software. **Results:** The commands were understood and executed easily and effectively. The questionnaire revealed that LEB was well accepted and stimulating, providing new learning. The GT presented significant evolutions in comparison to the control group. **Conclusions:** The success in the software's translation, adaptation and gameplay process is evidenced by the observed changes in the auditory closure ability, suggesting its effectiveness for training speech perception in the noise.

Keywords: Hearing; Auditory perceptual disorders; Rehabilitation; Software; Acoustic stimulation; Child

RESUMO

Objetivo: Traduzir e adaptar o *software Logiciel d'Écoute dans le Bruit* - LEB, verificar sua efetividade e jogabilidade em um grupo de escolares sem queixas auditivas e/ou de aprendizagem. **Métodos:** A efetividade foi investigada por meio da análise do desempenho de dois grupos pareados, antes e depois do treinamento, no teste de fala comprimida. O grupo treinado (GT), constituído por 22 escolares, entre 9 a 10 anos de idade, recebeu treinamento com o *software* e o grupo controle (GC), composto por 20 escolares da mesma faixa etária, não recebeu nenhum tipo de estimulação. Após o treinamento, os sujeitos do GT responderam a uma avaliação qualitativa sobre o *software*. **Resultados:** Os comandos foram compreendidos e executados com facilidade e eficácia. O questionário revelou que o LEB foi bem aceito e estimulante, proporcionando novos aprendizados. O GT apresentou evoluções significativas, em comparação ao GC. **Conclusão:** O êxito na tradução, adaptação e jogabilidade do *software* fica evidenciado pelas mudanças observadas na habilidade de fechamento auditivo, sugerindo sua efetividade para treinamento da percepção da fala no ruído.

Palavras-chave: Audição; Transtornos da percepção auditiva; Reabilitação; *Software*; Estimulação auditiva; Criança

Study carried out at Departamento de Fisioterapia, Fonoaudiologia e Terapia Ocupacional, Faculdade de Medicina, Universidade de São Paulo – USP – São Paulo (SP), Brasil.
[1]Departamento de Fisioterapia, Fonoaudiologia e Terapia Ocupacional, Faculdade de Medicina, Universidade de São Paulo – USP – São Paulo (SP), Brasil.
[2]École d'orthophonie et d'audiologie, Faculté de Médecine, Université de Montréal – UdeM – Montréal (QC), Canada.
Conflict of interests: No.
Authors' contribution: KSC participated in the research design, writing of the manuscript, data collection, analysis and interpretation; CRM in the statistical analysis, analysis and interpretation of data, critical review of the manuscript; BJ in the research design, financing; ES in the research conception and design, analysis and interpretation of data, funding, critical review of the manuscript regarding the important intellectual content, and approval of the final version for publication.
Funding: FAPESP (Process 2013/04094-0), LACREG and *Pró-Reitoria de Pesquisa* – USP.
Corresponding author: Karenina Santos Calarga. E-mail: karenina.calarga@usp.br
Received: October 11, 2017; **Accepted**: August 28, 2018

INTRODUCTION

In our daily lives, speech perception often occurs in challenging environments (with multiple speakers or competitive noises, for example). Under these conditions, the message tends to be degraded and / or corrupted. Since recognition depends on the integration of temporal and spectral traits, any decrease in the redundancy of acoustic cues can lead to a decrease in speech perception[1], even to individuals who do not present alterations in central auditory processing[2].

This ability to recognize the whole (words or phrases), when parts are omitted or deteriorated, is called auditory closure[3]. The auditory closure ability uses acoustic (bottom-up processing) and semantic information (top-down processing) of the degraded message and crosses it with information already existing in the lexicon in order to deduce the completeness of information[4-7].

Children often show lower performance compared to adults with normal auditory acuity in tasks of speech recognition in the noise, which suggests that they may find it more difficult to understand speech in noisy environments[8]. This can be explained by neural, cognitive and linguistic immaturity of children, which does not provide full use of the sensory information received[3,8].

This immaturity could justify the low performance of children in a set of communication situations in the presence of noise, especially in classroom, where they can manifest these deficits in different ways, such as, for example, difficulty in maintaining attentive, difficulty understanding words and instructions, particularly when they are long or complex, frequently requesting to repeat information. Possibly at the end of the day, these students are more tired than other students due to the effort required to maintain auditory attention[3,9].

Auditory training (AT) is a procedure that seeks to develop or rehabilitate altered auditory abilities[10]. Such rehabilitation process is based on the principles of neural plasticity, in which the practice of a skill or frequent exposure to a stimulus can trigger changes in neural activity[11].

The development of auditory training software enables treatments to be more intense and less stressful, since access to computers allows patients to perform daily training in an interactive, playful and personalized way. In addition, the records made by the software make it possible to monitor the frequency of use, the general evolution, the points of difficulty and the training stage[12,13].

The literature has pointed out some reasons for the translation / adaptation of instruments in other languages such as the fact that adaptation is a faster and less costly process than the production of a new instrument in a new language and also the fact that an adapted instrument is more reliable than a newly developed one due to previous successful experiences[14,15].

Although there are several auditory training software available in the Brazilian market, there are few reports in national literature on the use of specific software for the training of speech perception in the noise with schoolchildren with no auditory processing complaints. In addition, most are focused on the exclusive training of auditory skills, without stimulating cognitive aspects such as memory and attention.

In recent years, a growing number of studies have shown that more positive results are obtained when using the auditory-cognitive approach, which include cognitive processes that support speech perception, allowing a better structuring of the auditory information received[16-18].

Canadian Logiciel d'Écoute dans le Bruit - LEB software can be considered auditory-cognitive training software, because in addition to improving the sensorial perception of the auditory signal, also stimulates cognitive and linguistic abilities, such as memory, attention, phonological awareness, lexical access, listening comprehension and interpretation.

Thus, for training benefits to be applied in day-to-day communication, an integrated auditory-cognitive approach should be performed, since training would improve the cognitive processes already applied to the use, that is, integrated with speech perception, rather than isolated sensory stimulation, which tends to be less beneficial because tasks are not equivalent to the objective.

Based on the above, the aim of this study was to translate, transculturally adapt and validate for Brazilian Portuguese The Canadian *Logiciel d'Écoute dans le Bruit – LEB* auditory training software, which aims to improve the speech perception in the noise through auditory-cognitive approach and evaluate its effectiveness and playability through a pilot study in a group of schoolchildren with no hearing and / or learning complaints.

METHODS

The present study was approved by the Ethics Research Committee of the University of São Paulo under protocol No. 329/14. Parents of students who accepted to participate in the pilot study signed the Informed Consent Form (TCLE) and the children signed the Consent Form.

To facilitate understanding, the methodology will be presented in three parts: (A) Software presentation; (B) Translation and Adaptation Process and (C) Pilot Study.

A - Software presentation

The Canadian *Logiciel d'Écoute dans le Bruit – LEB* software is designed to improve the understanding of speech in noisy environments through tasks in which verbal stimuli (words, phrases or small texts) are presented simultaneously to a background noise (cafeteria noise), which varies according to the participant's performance.

The playful context of the software is the adventures of two children (Fred and Miyuki) and a dog (Decibel), who go through 13 phases (themes) with different semantic fields. Each theme is composed of 19 activities, which are divided into five categories:

(1) Discrimination of words and not isolated words, which may be phonetically distinct or very similar: the child listens to two words and has to identify whether they are the same or different;

(2) Identification of words and not words in phrasal context: in this set of activities, the child listens to a sentence and then must identify, among three written representations, which one is correct;

(3) Identification of words and not isolated words: the child listens to a word or not a word and then must identify, among three graphic or written representations, which one is correct;

(4) Understanding of orders and phrases: the child must identify and understand the components of phrases listened to in order to fulfill the tasks proposed. At this stage, there is greater demand for other skills, such as figure-visual background and auditory phonological memory;

(5) Understanding short texts: in this set of activities, the child must understand, interpret and infer information about the texts being listened to.

Each of the 19 activities has a different purpose and proposes five to ten tasks, that is, the child listens to a word or phrase and has to follow the instructions given in order to be able to correctly respond to what has been proposed. This process is repeated five to ten times in each activity.

To succeed and move on to the next stage, the child must hit a number equal to or greater than 70% of the tasks proposed in an activity. All tasks of the first theme are performed with neutral signal / noise ratio (S / N = 0). If the goal of 70% of correct responses in activity X is reached, in the next theme (theme 2, for example), activity X is performed with a greater degree of difficulty, with reduction in the signal / noise ratio by 2 dB. If the child continues to achieve more than 70% of tasks of this activity, in the next theme (item 3), the S / N ratio will be decreased again by 2 dB. This process continues, successively at each theme until minimum S / N ratio stabilization at -10dB.

If the child hits between 30% and 70% of the tasks of some activity, he / she will have to redo it with the same S / N ratio. If the child hits less than 30% of the tasks, he / she will have to redo it with S / N ratio 2 dB more in relation to the previous value in order to reduce the degree of difficulty. If, even then, the goal of 70% of hits is not reached, this activity will be re-presented with signalized responses, providing listening with visual feedback. This process continues, successively at each theme until maximum S / N ratio stabilization at -10dB.

B - Translation and adaptation process

Stage 1. Translation and adaptation

The process of cultural translation and adaptation involved three stages[1]: cultural translation and adaptation[2]; back translation and[3] scientific and linguistic review. The stimuli (words, phrases, texts) were translated from Canadian French (fr-CAN) into Brazilian Portuguese (pt-BR) by a Brazilian speech therapist with knowledge on auditory training and French language. Then, back translation and linguistic review were performed by a Brazilian speech therapist, fluent in French, living in Montreal (Canada). Finally, the project manager, a speech therapist (with broad experience in auditory training and French language knowledge), reviewed the adequacy of the stimuli translated to stimulate auditory processing and verified the linguistic equivalence made in the translation.

Stage 2. Software recording, mixing, and programming

The stimuli were recorded by two natural speakers from São Paulo (SP), one male and one female, in an acoustically isolated room using the Matrox Vetura Capture software on an Apple Mac Mini Serveur computer, Mipro ACT-5T microphones and a Soundcraft EPM6 sound mixing console. The background noise used was a cafeteria-type noise, recorded in an environment with conversations and laughter, by means of a microtrack-T microphone.

The mixing process followed parameters adopted in the original version of the software to guarantee standardization of the sound intensity. With the use of an artificial ear (model AEC100 0656) and a sonometer (model 824A), both of Larson-Davis brand, it was checked that all stimuli should be calibrated at an average RMS (Root Mean Square) value of -22.2 dB in the Soundforge 9.0 software, so that sound output would allow good auditory acuity and be comfortable, without causing hearing damage[19]. It should be mentioned that the final sound output intensity was adjusted in the computer by participants themselves, respecting their auditory comfort thresholds.

The Brazilian version of LEB software adopted the same interface as the Canadian version, which was developed with Visual Studio 2005 software, using the UML (Unified Modeling Language) methodology, VB.NET language. The stimuli were entered into a database in the Microsoft Access 2007.

C - Pilot study

Casuistry

A total of 42 students aged 9-10 years participated in this study, all of them 4th grade students of two classes of a public elementary school located in the city of São Paulo.

The present research adopted the following criteria:

- Inclusion criteria: to be approved in the hearing screening, to attend the 4th grade of elementary school, to be in the age group of 9-10 years, not to present reading and writing complaints.
- Exclusion criteria: presence of syndromes, psychiatric or neurological disorders, school and / or hearing complaints.

Data were obtained through anamnesis answered by parents and reports of teachers.

Subjects were divided into two groups:

- TG: composed of 22 4th grade students (11 girls and 11 boys), who performed auditory training with the Brazilian version of the Listening in the Noise Program (PER).
- CG: composed of 20 4th grade students (10 girls and 10 boys), who received no training or any type of auditory stimulation.

The choice of a class to receive training was random. It is worth mentioning that, after the period of research conduction, training was offered to CG subjects who expressed interest.

Material and procedures

The subjects of both groups underwent assessments before and after the training period at the school environment during regular class hours. The following procedures were performed:

1. All subjects underwent hearing screening with the Interacoustics PA5 pediatric audiometer. Children who responded to 20 dBNA stimuli at frequencies of 500, 1000, 2000 and 4000 Hz participated in the study.
2. The time-compressed speech test[20] was used to evaluate the auditory closure ability, in which 50 dissyllable words with 70% compression were monoaurally presented in both ears, and the left ear (LE) was the first to be evaluated. Children were instructed to listen carefully and repeat the words they heard.
3. Subjects in the TG received auditory training with PER software during computer classes, twice a week, with Phillips SHP2000 earphones coupled to computers. Each session lasted 45 minutes. The examiner provided only support in case of doubt and recorded all observations. Training was finalized when the child completed all themes. In total, children performed the proposed auditory training over a period of seven to nine weeks (or 14 to 18 sessions, according to performance). During this time, CG subjects received no auditory stimulation as part of this study.
4. All subjects were reevaluated with the compressed speech test - dissyllables - 70% compression[20], after the proposed auditory training period, maintaining the same methodology applied in the initial evaluation.
5. Subjects in the TG answered a qualitative evaluation questionnaire about the experience of playing the PER software.
6. Analyses were performed in the SPSS 20 software. In order to compare the means of tests in both groups and periods, the multivariate analysis of variance (MANOVA) technique with repeated measures (Dancey and Reidy, 2013) and significance level of 5% were applied (p-value ≤0.05).

RESULTS

Translation and adaptation of the software

The Brazilian version of the software was called the Listening in the Noise Program (PER). The adaptation process did not prioritize the literal translation of stimuli, but rather the maintenance of semantic aspects and linguistic similarities between word pairs. For example, the pair of *orteil-oreille* stimuli (literally translated: toe-ear) has been translated as "pelvis-skin", maintaining the semantic field "human body" and phonological similarity of structures. This process also valued cultural adaptation, in which elements of the Canadian culture were replaced by elements of the Brazilian culture. For example, a section with the description of érable (typical Canadian tree) is adapted for the description of a coconut tree.

Stimuli recording, mixing and programming

At the end of each stage of this process, stimuli were individually checked. After programming, the software was tested by specialists in auditory training to verify the presence of possible errors or failures and to certify that the material was able to provide the stimulation of speech understanding in the noise. The final version of the software is the result of this study. The results are presented by data obtained with the pilot study and with the evaluation of participants.

Pilot study

With regard to sex, there was an intragroup symmetrical distribution. According to the Chi-square test, no statistically significant difference was found among percentages, both for the control group $\chi2(1) = 0.18$, $p = 0.67$, and for the trained group $\chi2(1) = 0, 04$, $p = 0.84$.

In relation to age, similar distribution was observed between groups. According to ANOVA, no statistically significant differences were found between mean ages [$F (1.20) = 1.78$, $p = 0.19$].

In order to verify if the initial results of the compressed speech test differed from the final results, multivariate analysis of variance (MANOVA) was performed, which showed that there was no statistically significant difference between groups for the initial evaluation [$F(14,29) = 12$, $p = 0.38$, partial $\eta2 = 0.35$, Wilks $\lambda = 0.65$]. Therefore, it is possible to affirm that the groups presented similar performances for variables applied at the time of the initial evaluation.

Table 1 characterizes the performances of both groups in pre-training and post-training periods in the compressed speech test and investigates whether groups presented similar performance evolution patterns through MANOVA.

Data are illustrated in Figure 1, in which the error bar indicates the confidence interval (95%).

From this result, it is possible to state that the variable "compressed speech in LE" (p = 0.03 *), highlighted in Table 1, presented a statistically significant difference in the comparison between TG and CG, suggesting that the groups showed different development patterns.

Perceptions of participants

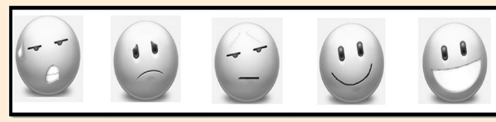
In order to obtain devolutive from TG subjects on the software, regarding the aspects regarding preferences, gameplay, difficulties and gains provided by the game, a qualitative questionnaire was applied, whose questions and results are shown in Chart 1.

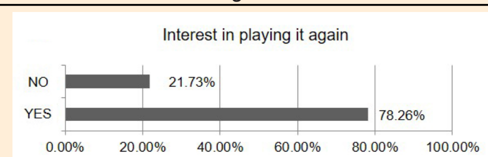
Table 1. Mean values and standard deviation for the performance of both groups in pre-training and post-training auditory assessments

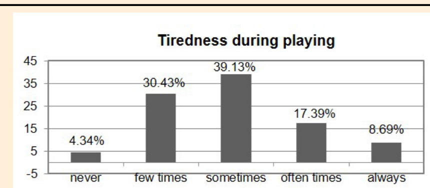
		TG				CG						
		Pre		Post		Pre		Post				
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	F	p-value	partial η^2
Compressed Speech	**RE**	52.00	8.37	63.91	8.20	49.85	9.95	58.60	9.50	1.87	0.18	0.05
	LE	46.27	11.15	61.91	10.91	47.90	9.37	57.50	7.25	4.85	0.03*	0.11

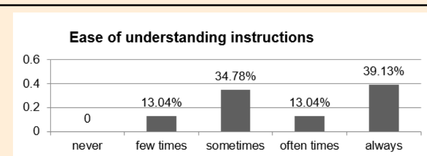
Subtitle: TG = Trained Group; CG = Control group; SD = Standard Deviation; RE = Right Ear; LE = Left Ear. *statistically significant

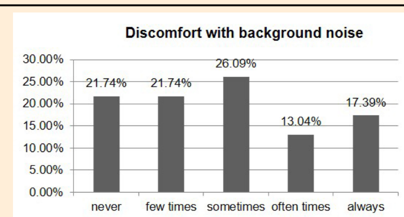
Chart 1. Questions and answers from the qualitative evaluation questionnaire of the Listening in the Noise Program

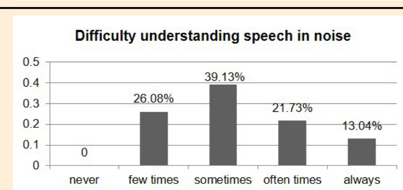
<table>
<tr><th></th><th>Questions</th><th>Results</th></tr>
<tr><td>1</td><td>What grade do you give to the game, according to these emoticons? (Scale 1-5)</td><td>


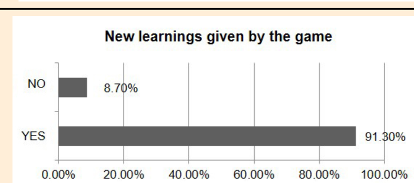
Mean grade: 4.30</td></tr>
<tr><td>2</td><td>If you had the option, would you like to play this game more often?</td><td>


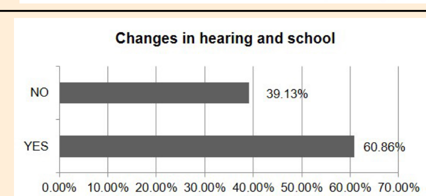
</td></tr>
<tr><td>3</td><td>Did you feel tired while playing this game?</td><td>


</td></tr>
<tr><td>4</td><td>Did you understand the instructions with ease?</td><td>


</td></tr>
<tr><td>5</td><td>Did the background noise bother or irritate you?</td><td>


</td></tr>
<tr><td>6</td><td>Did you have trouble understanding the characters' speech in the noise?</td><td>


</td></tr>
<tr><td>7</td><td>Did you learn something new with this game?</td><td>


</td></tr>
<tr><td>8</td><td>Você percebeu alguma mudança na sua audição/ou na escola depois de ter jogado esse jogo?</td><td>


</td></tr>
</table>

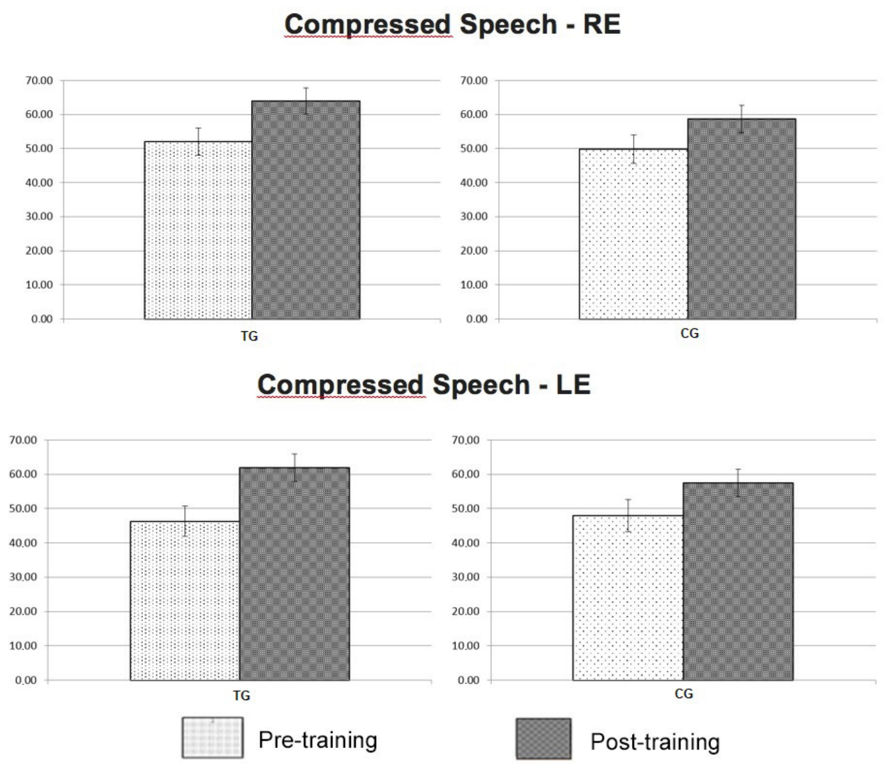


Figure 1. Mean scores and confidence interval (95%) between pre- and post-training periods for auditory closure ability (compressed speech test)
Subtitle: TG = Trained Group; CG = Control group; SD = Standard Deviation; RE = Right Ear; LE = Left Ear

DISCUSSION

Stimuli translation, adaptation, recording, mixing and programming

The translation and adaptation process counted on scientific reviews - in order to verify the content adequacy for auditory and linguistic stimulation to guarantee the adequacy of idiomatic equivalences - of professionals with experience in auditory training and knowledge of both languages.

In many activities, it was possible to perform the direct translation, but in others, it was necessary to substitute words that were more appropriate to Portuguese (pt-BR). For that, previous criteria were chosen for the choice of substitute words, with similar syllabic (extension) or phonetic structure (initial sound similar to the original stimulus). It is important to emphasize that the adaptation of the stimuli was performed according to the linguistic aspects of the Portuguese language. The cross-cultural adaptation was accomplished with substitutions of terms, figures, syllables and words to guarantee the semantic and cultural equivalences of the original software.

Regarding evaluation instruments (such as questionnaires or tests), literature[15,21] recommends a careful translation and adaptation process in order to avoid unexpected meanings that could interfere with normative data. However, although rigorous follow-up of a translation and cultural adaptation methodology is fundamental for diagnostic tests and questionnaires[21], it is not necessary for clinical practice tools without normative samples, such as PER, which only provides records of correctness and errors, with the exclusive purpose of monitoring the therapeutic evolution.

As it is an auditory training, the adaptation process is focused on clarity in the provision of task instructions and evidence-based confirmation of its therapeutic effectiveness. Thus, the method adopted for translation becomes less important than the demonstration of clinical applicability and its possible effects on a significant number of subjects.

It should be noted that, although there were no quantitative results on the process of stimuli recording, mixing and programming, this stage was not less important. The researchers involved praised the quality of materials, which were carefully created and verified.

Pilot study

Subjects were homogeneously distributed according to sex and age, guaranteeing equivalence between groups. The age range of 9-10 years was adopted because students were expected to be properly literate, a fundamental criterion to enable reading and solving of tasks proposed in the software, as they have achieved auditory neural maturation, allowing the evaluation of the auditory closure ability.

The choice of children who participated in the study was a way to guarantee the exclusion of possible clinical sample biases when a future study is conducted with target populations, such as students with alterations in auditory processing already diagnosed and / or with learning disorders, who should obtain the best benefits from PER.

It is noteworthy that all children were submitted to the same evaluation procedures. Regarding the screening process, it was not possible to perform the complete audiological evaluation (acoustic immitance and audiometry), due to study limitations the regarding the time and infrastructure available for data collection.

Although training for CG subjects was offered after the experimental period, there was no manifestation of interest by parents.

Regarding the training duration, it is worth mentioning that, because it is a validation study of the PER software as a stimulation tool, one of the objectives was precisely to find out how long children without hearing and school complaints would take to complete their tasks. It was observed that the children took from seven to nine weeks (with two sessions per week) to play all phases of the game, totaling from 14 to 18 training sessions. Therefore, when analyzing the results, it was possible to conclude that the training period was able to provide changes in the parameters used to measure the results presented by the software.

All PER tasks had the presence of cafeteria-type noise in order to continuously exercise the auditory closure ability. Therefore, the evaluation of this ability is fundamental to detect possible changes coming from the proposed auditory training.

As the use of more than one test to evaluate the same auditory ability would only increase the collection time (which is not desirable) and would not bring more pertinent data, we opted for the use of the compressed speech test, which, in addition to counting with low redundancy stimuli[20], presents greater sensitivity than the others used to evaluate the same ability, such as filtered speech and speech in the noise tests.

Compressed speech tests are often used in studies on auditory training[22-24]. Although the test developed by Rabelo and Schochat[20] does not present standardization validated for Brazilian children, in the present study, its use was only to measure the effectiveness of auditory training with PER, comparing the results found in pre-training and post-training assessments. The range with 70% compression for disyllables was chosen because it presents higher level of difficulty and, therefore, greater sensitivity to the effects of training with PER.

As previously explained, the compressed speech test applied in the present study does not have a registered normality pattern for children. However, considering that a previous study performed with adults found average of 68.8% of correct answers in the same test, it is estimated that children achieve maximum performance lower than that achieved by adults, since they are not yet prepared to fully process degraded sensory information due to their neural, cognitive and linguistic immaturity[20].

Statistical analysis performed using MANOVA showed that there was a statistically significant difference only in the left ear of TG ($F = 4.85$, p-value = 0.03 and partial n2 = 0.11), that is, auditory training with PER led to the development of the auditory closure ability. These findings confirm the results of several studies[14,24-26], in which auditory training provided improvements in auditory abilities, evidencing the effectiveness of PER.

As for the fact that there was no statistically significant evolution for the RE, there are two hypotheses: ceiling effect and learning effect of the task. The values found for this ear in the post-training period (63.91% of correct answers), were already close to the maximum percentage of correct answers that children in this age group could reach. Therefore, there would be less space to observe significant changes.

Regarding the hypothesis of the learning effect of the task, it is emphasized that the first ear to be evaluated was the left ear. The literature[5,27] has reported that better performances in the second ear tested usually occur because, as the listener had his fist ear already submitted to the test, the auditory system becomes accustomed to that situation and can count on more acoustic cues. Another factor that contributed to the learning effect was that the compressed speech test used in this study had the same list of words in both ears. This hypothesis would be confirmed by the study of Wilson et al.[28], which demonstrated that improvements in speech reception thresholds were associated with learning to take the test - not with the learning of its words and phrases.

The results highlighted that one of the differentials of PER is the focus on speech perception in noise, while working other cognitive (attention and memory) and linguistic abilities, providing the associated stimulation of top-down and bottom-up aspects, which affirmation is evidenced in the study of Brasil[29].

Perceptions of participants

The qualitative analysis obtained through the questionnaire responses (Table 1) showed that PER was well accepted among children, since it obtained good mean score in Question 1 - 4.3 points, with 5.0 being the maximum score - and 78.26% of participants reported that they would like to play it more often (Question 2). This is possibly due to the friendly, interactive and motivating interface of the game. While reporting that the proposed activities were sometimes tiring (Question 3), most children reported having understood the software instructions in most situations (Question 4). These data proved to be important, confirming that PER presents clear and accessible language for children. At the same time, however, attention was drawn to tiredness, probably caused by the high degree of requirement of activities, which may guide studies on new duration times for auditory training sessions.

All children reported that in at least one moment, noise interfered with speech comprehension (Question 5). However, noise did not always cause them discomfort (Question 6), so that several levels of complaints were recorded, suggesting that discomfort is associated with the individual susceptibilities of each subject.

Another interesting aspect is that, practically all participants reported having acquired new skills with PER (Question 7) and many affirmed to have obtained lexical knowledge (with the presentation of new words) and encyclopedic knowledge (mode of functioning of objects, new information), suggesting that, in addition to a therapeutic instrument, PER also aggregates contents in the educational and cultural spheres. In addition to these learnings, most children (60.86%) reported having noticed changes in their own auditory behavior and school performance after training (Question 8).

Post-training devolutives did not point out the need for new modifications in instructions or stimuli, defining this PER version as the final for clinical intervention processes. Thus, the qualitative analysis of the pilot study agrees with data obtained in the formal evaluation, confirming the adequacy of PER for the auditory stimulation of the study population.

CONCLUSION

The success in the translation, adaptation and validation of the Listening in the Noise Program (PER) is evidenced by changes in the auditory closure ability of the trained group, suggesting its effectiveness in the training of speech perception in the noise. In addition, as far as playability is concerned, participants reported high satisfaction with the software, recognizing it as stimulating and motivating.

REFERÊNCIAS

1. Ziegler JC, Pech-Georgel C, George F, Lorenzi C. Speech-perception-in-noise deficits in dyslexia. Dev Sci. 2009;12(5):732-45. http://dx.doi.org/10.1111/j.1467-7687.2009.00817.x. PMid:19702766.
2. Fallon M, Trehub SE, Schneider BA. Children's perception of speech in multitalker babble. J Acoust Soc Am. 2000;108(6):3023-9. http://dx.doi.org/10.1121/1.1323233. PMid:11144594.
3. Jerger J, Musiek F. Report of the consensus conference on the diagnosis of auditory processing disorders in school-aged children. J Am Acad Audiol. 2000;11(9):467-74. PMid:11057730.
4. Keith RW. Central auditory and language disorders in children. San Diego: College-Hill. 1982; Audiological and auditory language tests of central auditory function; p. 61-76.
5. Schochat E. Percepção de fala: presbiacusia e perda auditiva induzida pelo ruído [tese]. São Paulo: Universidade de São Paulo - Faculdade de Filosofia, Letras, Ciências Humanas; 1994.
6. Tremblay K, Kraus N, McGee T, Ponton C, Otis B. Central auditory plasticity: changes in the N1-P2 complex after speech-sound training. Ear Hear. 2001;22(2):79-90. http://dx.doi.org/10.1097/00003446-200104000-00001. PMid:11324846.
7. Russo FA, Pichora-Fuller MK. Tune in or tune out: age-related differences in listening to speech in music. Ear Hear. 2008;29(5):746-60. http://dx.doi.org/10.1097/AUD.0b013e31817bdd1f. PMid:18596643.
8. Eisenberg LS, Shannon RV, Martinez AS, Wygonski J, Boothroyd A. Speech recognition with reduced spectral cues as a function of age. J Acoust Soc Am. 2000;107(5 Pt 1):2704-10. http://dx.doi.org/10.1121/1.428656. PMid:10830392.
9. Keith RW. Clinical issues in central auditory processing disorders. Lang Speech Hear Serv Sch. 1999;30(4):339-44. http://dx.doi.org/10.1044/0161-1461.3004.339. PMid:27764342.
10. Musiek FE, Schochat E. Auditory training and central auditory processing disorders. Semin Hear. 1998;19(04):357-66. http://dx.doi.org/10.1055/s-0028-1082983.
11. Musiek FE, Shinn J, Hare C. Plasticity, auditory training and auditory processing disorders. Semin Hear. 2002;23(4):263-76. http://dx.doi.org/10.1055/s-2002-35862.
12. Thibodeau LM. Computer-based auditory training (CBAT) for (Central) Auditory Processing Disorders. In: Chermak GD, Musiek FE. Handbook of central auditory processing disorders. San Diego: Plural Publishing; 2007. p. 167-206 (Volume II: Comprehensive Intervention).
13. Balen AS, Silva LTN. Programas computadorizados no treinamento auditivo. In: Boéchat EM, Menezes PL, Couto CM, Frizzo ACF, Scharlach RC, Anastasio ART. Tratado de audiologia. Rio de Janeiro: Guanabara Koogan; 2015. p. 523-31.
14. Murphy CFB, Schochat E. Effect of nonlinguistic auditory training on phonological and reading skills. Folia Phoniatr Logop. 2011;63(3):147-53. http://dx.doi.org/10.1159/000316327. PMid:20938195.
15. Hambleton RK, Patsula L. Increasing the validity of adapted tests: myths to be avoided and guidelines for improving test adaptation practices. Journal of Applied Testing Technology. 1999;1:1-12.
16. Anderson S, White-Schwoch T, Choi HJ, Kraus N. Training changes processing of speech cues in older adults with hearing loss. Front Syst Neurosci. 2013;7:97. http://dx.doi.org/10.3389/fnsys.2013.00097. PMid:24348347.
17. Anderson S, White-Schwoch T, Parbery-Clark A, Kraus N. Reversal of age-related neural timing delays with training. Proc Natl Acad Sci USA. 2013;110(11):4357-62. http://dx.doi.org/10.1073/pnas.1213555110. PMid:23401541.
18. Smith GE, Housen P, Yaffe K, Ruff R, Kennison RF, Mahncke HW, Zelinski EM. A cognitive training program based on principles of brain plasticity: results from the Improvement in Memory with Plasticity-based Adaptive Cognitive Training (IMPACT) study. J Am Geriatr Soc. 2009;57(4):594-603. http://dx.doi.org/10.1111/j.1532-5415.2008.02167.x. PMid:19220558.
19. Berglund B, Lindvall T, Schwela DH, editors. Guidelines for community noise. Geneva: World Health Organization; 1999.
20. Rabelo CM, Schochat E. Time-compressed speech test in brazilian portuguese. Clinics. 2007;62(3):261-72. http://dx.doi.org/10.1590/S1807-59322007000300010. PMid:17589666.
21. Beaton DE, Bombardier C, Guillemin F, Ferraz MB. Guidelines for the process of cross-cultural adaptation of self-report measures. Spine. 2000;25(24):3186-91. http://dx.doi.org/10.1097/00007632-200012150-00014. PMid:11124735.
22. Banai K, Lavner Y. Perceptual learning of time-compressed speech: more than rapid adaptation. PLoS One. 2012;7(10):e47099. http://dx.doi.org/10.1371/journal.pone.0047099. PMid:23056592.
23. Murphy CFB, Moore DR, Schochat E. Generalization of auditory sensory and cognitive learning in typically developing children. PLoS One. 2015;10(8):e0135422. http://dx.doi.org/10.1371/journal.pone.0135422. PMid:26267275.
24. Karawani H, Bitan T, Attias J, Banai K. Auditory perceptual learning in adults with and without age-related hearing loss. Front Psychol. 2016;6:2066. http://dx.doi.org/10.3389/fpsyg.2015.02066. PMid:26869944.
25. Tallal P, Miller SL, Bedi G, Byma G, Wang X, Nagarajan SS, Schreiner C, Jenkins WM, Merzenich MM. Language comprehension in language-learning impaired children improved with acoustically modified speech. Science. 1996;271(5245):81-4. http://dx.doi.org/10.1126/science.271.5245.81. PMid:8539604.
26. Merzenich MM, Jenkins WM, Johnston P, Schreiner C, Miller SL, Tallal P. Temporal processing deficits of language-learning impaired children ameliorated by training. Science. 1996;271(5245):77-81. http://dx.doi.org/10.1126/science.271.5245.77. PMid:8539603.
27. Pereira LD, Gentile C, Osterne FJV, Borges ACLC, Fukuda, Y. Considerações preliminares no estudo do teste de fala com ruído em indivíduos normais. Acta AWHO. 1992;11(3):119-22.
28. Wilson RH, Bell TS, Koslowski JA. Learning effects associated with repeated word-recognition measures using sentence material. J Rehabil Res Dev. 2003;40(4):329-36. http://dx.doi.org/10.1682/JRRD.2003.07.0329. PMid:15074444.
29. Brasil PD. Eficácia do treinamento auditivo utilizando o software Programa de Escuta no Ruído (PER) em escolares com transtorno do processamento auditivo e baixo desempenho escolar [tese]. São Paulo: Universidade de São Paulo – Faculdade de Medicina da Universidade de São Paulo; 2017. http://dx.doi.org/10.11606/D.5.2017.tde-29112017-081635.