Case report

https://doi.org/10.1590/2317-6431-2021-2517

Audiology Communication Research
ISSN 2317-6431

Cognitive and acoustically uncontrolled auditory training for elderly: a case study

Treinamento cognitivo e auditivo acusticamente não controlado para população idosa: um estudo de caso

Hélinton Goulart Moreira[1], *Ana Laura Motta Brasil*[1], *Vitor Cantele Malavolta*[2], *Mirtes Brückmann*[3], *Michele Vargas Garcia*[3]

ABSTRACT

The objective of the work was create an auditory and cognitive training protocol for the elderly and to analyze its effectiveness. This study was carried out in three stages: (1) Selection of materials, composed of existing materials and others made by the authors, (2) Analysis of expert judges, for consensus regarding the assessed skills and type of training, and (3) Application of the protocol in a clinical case, with a battery of tests for pre-and post-intervention, composed of cognitive and auditory assessment (behavioral and electrophysiological). It was possible to structure the protocol according to the suggestions of the expert judges, which generated a new proposal for auditory and cognitive training with 39 tasks arranged in six sessions. With the application of the protocol in the clinical case, it was possible to observe positive changes in both trained aspects. The new therapeutic proposal has been completed and applied. The clinical case has shown improvement after the intervention, and the effectiveness was verified through behavioral tests of central auditory processing, cognitive screening, and long-latent auditory evoked potential.

Keywords: Elderly; Rehabilitation; Cognition; Speech perception; Neuronal plasticity

RESUMO

O objetivo do trabalho foi criar um protocolo de treinamento auditivo e cognitivo para idosos e analisar a sua eficácia. O estudo foi realizado em três etapas: (1) seleção de materiais, compreendendo materiais existentes e outros confeccionados pelos autores; (2) análise de juízes especialistas, para consenso quanto às habilidades avaliadas e tipo de treinamento; (3) aplicação do protocolo em um caso clínico, com realização de uma bateria de testes para avaliação pré e pós-intervenção, consistindo em avaliação cognitiva e auditiva (comportamental e eletrofisiológica). Foi possível a estruturação do protocolo de acordo com as sugestões das juízas especialistas, o que gerou uma nova proposta de treinamento auditivo e cognitivo com 39 tarefas, dispostas em seis sessões. Com a aplicação do protocolo no caso clínico, observaram-se modificações positivas nos dois aspectos treinados. A nova proposta terapêutica foi concluída e aplicada. O sujeito do caso clínico obteve melhoras pós-intervenção e a eficácia foi verificada por meio dos testes comportamentais de processamento auditivo central, de rastreio cognitivo e do potencial evocado auditivo de longa latência.

Palavras-chave: Idosos; Reabilitação; Cognição; Percepção de fala; Plasticidade neuronal

Study carried out at Curso de Fonoaudiologia – Departamento de Fonoaudiologia, Universidade Federal de Santa Maria – UFSM – Santa Maria (RS), Brasil.
[1]Curso de Fonoaudiologia da Universidade Federal de Santa Maria - UFSM - Santa Maria (RS), Brasil.
[2]Programa de Pós-graduação (Mestrado) em Distúrbios da Comunicação Humana do Departamento de Fonoaudiologia, Universidade Federal de Santa Maria – UFSM – Santa Maria (RS), Brasil.
[3]Departamento de Fonoaudiologia da Universidade Federal de Santa Maria – UFSM – Santa Maria (RS), Brasil.
Conflict of interests: No.
Authors' contribution: HGM participated in the general review, manuscript writing and literature update; ALMB participated in the data collection and writing of the manuscript, which was the theme of her course completion work; VCM contributed to the writing of the manuscript and analysis of the results; MB contributed to the writing and co-supervision of the manuscript; MVG participated in the orientation and correction of the manuscript.
Corresponding author: Hélinton Goulart Moreira. E-mail: helintongoulart@hotmail.com
Received: May 07, 2021; Accepted: September 02, 2021

INTRODUCTION

Complaints by the elderly about communication difficulties in acoustically unfavorable environments are frequent and this problem has implications in their lives, especially in speech understanding. Such difficulties may result from hearing loss or deficit in the central auditory nervous system (CANS), related to advancing age, causing difficulties in central auditory processing (CAP) skills, that is, central auditory processing disorder (CAPD)[1]. In cases of CAPD, intervention through programs based on auditory training and improvement of the acoustic signal is necessary. In addition, the use of language, cognitive and metacognitive strategies are important, as they will promote plasticity and cortical reorganization in these individuals[2].

Currently, there are many auditory training programs. Some work with different listening skills, while others focus on a particular form of training, with specific stimuli. Furthermore, there are different methods of auditory stimulation: formal and informal. In the formal method, currently called acoustically controlled, electroacoustic equipment, booths and/or computer programs are used. In the informal method, nowadays called acoustically uncontrolled, training is carried out without the use of sophisticated equipment and without acoustic control, that is, the activities are carried out in the therapeutic setting itself[3].

Many auditory training programs were developed considering age groups (children, adults and elderly) or hearing characteristics of users (normal hearing or with hearing loss), as in a study in which the authors proposed an informal auditory training program, including techniques for deaf patients, in addition to those applied to subjects with CAPD. At the time, the authors also suggested guidelines for improving the acoustic environment and communication strategies[3]. However, in the elderly population, besides the hearing issues, the need to stimulate cognition is evident, as there is a relationship between sensory aging and cognitive decline and, therefore, one influences the other and, consequently, causes damages in communication, speech recognition in noise and quality of life of the elderly[4].

Given the above, the hypothesis of this study is that a training that includes auditory and cognitive skills, with six sessions, which is a smaller number than what has already been shown in the literature[3], can also demonstrate positive results, generating benefits in performance, with greater adherence to treatment and, mainly, in the communication of daily life. Thus, this study is justified by the scarcity of protocols that address auditory and cognitive skills and, considering the clinical applicability, the restriction of the number of sessions granted by health plans and by the hearing health programs of the Unified Health System (UHS) should be considered. Thus, the aim of this study was to create an auditory and cognitive training protocol for the elderly with six sessions and analyze its effectiveness.

CLINICAL CASE PRESENTATION

This is a case study, carried out in a speech therapy clinic-school, approved by the Ethics Committee for Research with Human Beings at the Federal University of Santa Maria – CEP-UFSM, under protocol number 3326307. The elderly woman who agreed to participate in the research previously read and signed the Informed Consent Form.

The study was conducted in three stages: (1) selection of materials; (2) analysis by expert judges; (3) application of the protocol in a clinical case.

Stage 1: Selection of materials

The intervention proposal was based on existing materials, that is, the tests to assess the CAP were used within the therapeutic proposal, being: Sentence Identification Test with Pictures[5], Synthetic Sentence Identification[6], Duration Pattern Test[7], Frequency Pattern Test[7], Gaps-in-Noise[8] and Compressed Speech Test[6]. In addition to these, letters from the collection "Memory Exercises – 50 Letters to Train the Mind"[9] and the eArena® software[10] were used as a therapeutic resource. It is noteworthy that, for training criteria (learning), the research subject was submitted to an initial model and, in case of difficulties, corrections were made, with the objective that the proposal was understood, that is, that there were no errors due to lack of understanding of the requested task.

Other materials based on activities that are normally conducted in a therapeutic setting were also developed by the authors and will be detailed later. Seeking treatment in a shorter period of time (six sessions), the authors recommended intervention in some auditory and cognitive skills such as: attention, memory, figure-background for verbal sounds, temporal ordering and resolution, auditory closure, executive functions and motor praxis, so that they could be performed in a therapeutic setting, using a computer and a speaker. Next, items 1 to 8 describe the tests selected to compose the intervention proposal, being used as instruments for training (intervention carried out in an open field, with speakers connected to the computer). The details of each session are shown in Chart 1. Item 9 specifies the materials and strategies created by the authors.

1. Sentence Identification Test with Pictures (SIT-P)[5]: compact disc that features seven tracks containing ten sentences, a competitive story and a card with ten pictures to be pointed out, corresponding to the actions of the sentences;
2. Synthetic Sentence Identification (SSI)[6]: the test offers as auditory stimulus linguistic material with ten synthetic sentences, presented simultaneously to the competitive linguistic message, in the form of a story, and a card containing the sentences to be pointed out;
3. Duration Pattern Test (DPT)[7]: the stimuli consist of long (2000 ms) and short (500 ms) musical tones (flute), applied in ten sequences of three stimuli and ten sequences of four stimuli, with a fixed frequency of 440 Hz and an interstimulus interval of six milliseconds;
4. Frequency Pattern Test (FPT)[7]: it has flute musical tones with a frequency of 440 Hz for bass sound and 493 Hz for treble sound, with a fixed duration. It can be presented in ten sequences of three stimuli and ten sequences of four stimuli;
5. Gaps-in-Noise(GIN)[8]: silence intervals of different durations (2, 3, 4, 5, 6, 8, 10, 12, 15, 20 milliseconds), distributed in white noise presentations. In each list, there are six silence intervals for each duration time, totaling 60 stimuli;

Chart 1. Task schedule and expert judges' agreement on the skills assessed in each therapeutic task

Material and task instruction	Skills stimulated	Material and task intruction	Skills stimulated
Beginning of the first session	Attention	**21. Four cards that are part of the Memory Exercises collection – 50 Mind Train Cards:** *"Observe the pictures for 30 seconds. Turn the card over and draw the pictures without looking."*	Attention
			Memory
1. Image sheet (SIT-P): "*Tell what actions are taking place in each picture. What is each person doing?*"			Constructive praxis
2. SIT-P Audio: *"Listen to a story and phrases about these actions from the previous task at the same time. Pay attention to the sentences and point them out on the card, ignoring the story."*	Auditory Skills (figure-background for verbal sounds and selective attention)	**22. Ten melodies of songs known by the elderly population:** *"Listen to some melodies and, from the melody, identify the song."*	Attention
			Memory
3. SIT-P Audio: *"Change the focus, pay attention to the story and forget about the sentences, then tell excerpts or words that you remember from the story."*	Auditory Skills (figure-background for verbal sounds and selective attention)	**23. Home made auditory memory game:** *"Each box has a material inside that produces certain sounds; find similar ones."*	Auditory Skill (auditory discrimination for non-verbal sounds)
	Memory		Attention
			Memory
4. SIT-P printed history: *"Read the story and tell what you understood after reading it." (Read aloud)*	Attention	**Beginning of the fourth session**	Language
		24. Card with the SSI phrases: *"Read the following sentences aloud." (show the card)*	
5. Images of cats that have difference (in the length of the tails - short and long): *"Here are two pictures of cats, what's the difference between them?"*	Attention	**25. Card with the SSI phrases:** *"Answer the requested questions. Each question is related to one word of the sentences read in the previous task. Remember that answers must be short."*	Memory
6. DPT audio (3 sounds): *"Listen to three sounds, some are short and some are long like cats' tails. After hearing the three sounds, you should name them as short and long and then use three pictures of the cats and place them in the same order as the sound heard. E.g.: short-short-long".*	Auditory Skill (temporal ordering for duration)	**26. SSI Audio:** *"Listen to the phrases and the story simultaneously and point out the phrases heard on the card."*	Auditory Skills (figure-background for verbal sounds and selective attention)
	Attention		
7. *eArena*® *Software*. DAY 2 – STRATEGY 2: *"Listen to a sequence of two sounds and say which was the long tone (the 1st or the 2nd)."*	Auditory Skill (temporal ordering for duration)	**27. SSI Audio:** *"Listen to the phrases and the story again, reversing your attention from the previous task. Focus your attention on the story and then tell or recall excerpts."*	Auditory Skills (figure-background for verbal sounds and selective attention)
	Attention		Attention
			Memory
			Speech processing
8. *eArena*® Software. DAY 3 – STRATEGY 6 (connect noise simultaneously): *"Listen to sequences of numbers with two digits and noise together. Pay attention to the numbers and then point to the number heard on the computer screen."*	Auditory Skills (selective attention)	**28. Printed SSI History:** *"Read aloud the story of the previous assignment and state what you understood."*	Attention
9. *eArena*® *Software*. DAY 3 – STRATEGY 7 (connect noise simultaneously): *"Listen to two-syllable words and noise together. Pay attention to the words and then point to the word heard on the computer screen."*	Auditory Skills (selective attention)	**29. Images of trees that have difference (on the trunk - thick and thin):** *"Here are two figures of trees; What's the difference between them?"*	Attention
		If necessary, use facilitation: and in width?	

Caption: SIT-P = Sentence Identification Test with Pictures; SSI = Synthetic Sentence Identification; DPT = Duration Pattern Test; FPT = Frequency Pattern Test; GIN = gaps-in-noise

Chart 1. Continued...

Material and task instruction	Skills stimulated	Material and task intruction	Skills stimulated
Beginning of the second session	Attention	**30. FPT Audio (three sounds):** *"Hear three sounds; some are thick, others thin, like tree trunks. After hearing the three sounds, you should name them thick and thin. And then, use three figures from the trees and place them in the same order as the sound heard. E.g.: thin-thin-thick."*	Auditory Skill (temporal ordering for frequency)
10. Lyrics of a actual song printed. Suggestion: O Sol, Vitor Kley *"The following are the lyrics to a song; I ask you to read it aloud."*			
11. Reprinted lyrics of the song lyrics with competitive noise: *"Read the same letter out loud, but with noise simultaneously."*	Attention	**31. Four cards that are part of the Memory Exercises collection – 50 Cards to Train the Mind:** *"See some cards, memorize them for 30 seconds and then recall them without the visual clue."*	Attention Memory
12. Isolated words taken from music, associated with motor activity: *"Every time you hear the word "sol", clap your hands, the word "quem", clap your feet, and the word "tranquilo", clap your hand on the table. Those words were in the song, but for now I'm just going to pronounce them in isolation while you do the task.*	Attention Executive Functions Motor praxis	**Beginning of the fifth session** **32. Audio of two songs unknown by the elderly population, played simultaneously and the lyrics of one of them:** *"Listen to two songs simultaneously, pay attention to only one, which you have the lyrics in your hands and you must sing."*	Auditory Skills (figure-background for verbal sounds) Attention
13. Music O Sol, Vitor Kley, performing the actions trained in the previous task: *"Perform the trained actions, but with the music playing, that is, when you hear the words in the music, you must perform the actions."*	Attention Executive Functions	**33. Audio and lyrics of the song that was not the focus of the previous task, with random words throughout the text:** *"Change the focus, the music that was in the way before, becomes the one that should keep the attention, since the lyrics of this song are altered and will have absurd words that are not part of it, which should identify and highlight."*	Attention
14. Four cards that are part of the Memory Exercises collection – 50 Cards to Train the Mind: *"See some cards, memorize them for 30 seconds and then remember them without the visual clue."*	Attention Memory	**34. *eArena*©*Software*. DAY 19 – STRATEGY 10:** *"See (12 hole cards. Point to a card and you will hear a sound sample. Now point a second card. If the sounds presented are the same, the images of the cards will reveal themselves. Find all pairs. Attention: sometimes the sounds differ only in intensity, frequency or duration."*	Auditory Skill (hearing discrimination) Memory
15. *eArena*® *Software*. DAY 3 – STRATEGY 9: *"Listen to a sequence of three everyday sounds. Then point the three sounds on the computer screen, following the order."*	Auditory Skill (auditory discrimination for non-verbal sounds)	**35. *eArena*® *Software*. DAY 19 – STRATEGY 5:** *"Listen to a sequence of everyday sounds. Then point the sounds on the computer screen, following the order."*	Auditory Skills (auditory discrimination and auditory ordering) Attention Memory
16. *eArena*® *Software*. DAY 4 – STRATEGY 4: *"View multiple images on your computer screen. Afterwards, you will see a sequence of three images highlighted with an orange frame; point out on the computer screen which images were highlighted in the order of presentation."*	Attention Memory	**36. Compressed Speech Test - monosyllables (right ear list) with competitive noise:** *"Listen to the compressed words, recognize them and repeat."*	Auditory Skill (hearing closure)

Caption: SIT-P = Sentence Identification Test with Pictures; SSI = Synthetic Sentence Identification; DPT = Duration Pattern Test; FPT = Frequency Pattern Test; GIN = gaps-in-noise

Chart 1. Continued...

Material and task instruction	Skills stimulated	Material and task intruction	Skills stimulated
Beginning of the third session	Attention	**Beginning of the sixth session**	Auditory Skill (temporal resolution)
17. *eArena*® *Software*. DAY 2 – STRATEGY 7: *"View multiple images on your computer screen. Afterwards, you will see a sequence of three images highlighted with an orange frame; point out on the computer screen which images were highlighted in the order of presentation."*	Memory	**37. GIN Tracks 1, 2, 3 and 4:** *"Listen to a sizzle and in that sizzle there will be some intervals of silence; you will have to identify and respond each time you perceive silence. They may have one, two, three or no breaks."*	Attention
18. *eArena*® *Software*. DAY 2 – STRATEGY 8: *"Look at 12 images and their respective names. You will then have 30 seconds to make as many associations between words and pictures as possible."*	Memory Attention	**38. DPT Audio (four sounds):** *"Listen to four sounds, some are short and some are long. After hearing the four sounds, you should name them as short and long. E.g.: short-short-long-short."*	Auditory Skill (temporal ordering for duration)
19. *eArena*® *Software*. DAY 2 – STRATEGY 9: *"See 12 closed cards. Point to a card and you will hear a sound sample. Afterwards, point a second card. If the sounds presented are the same, the images of the cards will reveal themselves. Find all pairs. Attention: sometimes the sounds differ only in intensity, frequency or duration."*	Attention	**39. FPT Audio (four sounds):** *"Listen to four sounds, some are thick and some are fine. After hearing the four sounds, you should name them as thick and thin. E.g.: thin-thin-thick-thin"*	Auditory Skill (temporal ordering for frequency)
20. Presentation of 15 slides with words describing colors, highlighted in a different color and with a different color background: *"Here are some images with words describing colors, highlighted in a different color and with a different color background. Afterwards, I will ask for the color according to the location requested. For example: What color is the word?*	Executive Functions		

Caption: SIT-P = Sentence Identification Test with Pictures; SSI = Synthetic Sentence Identification; DPT = Duration Pattern Test; FPT = Frequency Pattern Test; GIN = gaps-in-noise

6. Compressed Speech Test (CST)[6]: presentation of verbal stimuli; In this study, only monosyllable words that suffered a 60% compression were used, that is, they were accelerated through the electromechanical time process;
7. "Memory Exercises – 50 Letters to Train the Mind"[9]: collection with memory exercises, produced by Editora Matrix. From these cards, some specific for the tasks were selected (letters with geometric figures, cards with figures of kitchen utensils, cards with figures of random objects, letters describing names). Four images were placed on a table and shown to the patient for a specified time (30 seconds); then, the patient was asked to perform a specific action (Chart 1);
8. eArena® software[10]: program recorded on CD, with 20 sessions and exercises that train auditory and non-auditory skills. It was originally developed by Chalupper in 2008, in Germany, by the company Siemens. In 2011, it was translated into Brazilian Portuguese, with the objective of being a new proposal for auditory and cognitive training, aimed at elderly patients using individual hearing aids (IHA). From the eArena®, specific exercises were extracted from the software calendar (day 2 - strategy 2, 7, 8 and 9; day 3 - strategy 6, 7 and 9; day 4 - strategy 4; day 19 - strategy 5 and 10), in order to represent a therapeutic alternative in this proposal, believing that all these strategies are suitable for the population of this study. The instructions and skills trained in each strategy are shown in Chart 1;
9. Materials and strategies built by the researchers: the strategies used materials that are easy to prepare, such as songs. In this case, it is suggested songs that the elderly population has little knowledge, avoiding immediate recognition. Another material created was a slideshow with words describing colors, highlighted in a different color and with a background of another color,

based on an auditory training activity on the website "Afinando o Cérebro". In addition, a memory game of sounds was made, in a simple way, in which pairs of accessible materials were selected (rubber, styrofoam, coins, stones, grains) placed in acrylic boxes, so that the correct pair with the sounds alike. Finally, as described in the literature[11] on the use of visual aids during the performance of DPT and FPT, the authors created cards of cats with short and long tails to differentiate sounds with such characteristics. Also, cards with images of trees with thick and thin trunks, to be used as support for the FPT, in order to help organize the sequence. This material was planned and conceived for this intervention protocol for the elderly, and has not previously been applied to other populations (Figure 1).

Stage 2: Analysis by expert judges

Seeking to meet the psychometric criteria in the development of materials, that is, in order to validate the new training proposal, five expert judges were invited via e-mail (three from the Language area and two from Audiology). After acceptance, the material was sent by email in an editable document, in which 39 items (activities) were presented, with options of stimulated skills, namely: attention, memory, figure-background for verbal sound, selective attention, language, temporal ordering for duration and frequency, executive functions, motor praxis and temporal resolution. Skills were marked according to the experts' understanding and, if they did not agree with the suggestions, they could describe new skill options.

The construction of this protocol was, therefore, based on the authors' proposal, who agreed with the expert evaluators, considering the skills stimulated in the task, according to the consensus of 100% of the expert judges.

Stage 3: Application of the protocol in a clinical case

After the expert judges returned, a case study was conducted to verify the applicability and understanding of the proposed activities. An elderly woman with low education was chosen to precisely verify the possibility of applying strategies involving reading. Thus, a 61-year-old right-handed elderly woman, with five years of schooling, without middle ear alterations and with hearing thresholds within normal limits, in both ears (25 dBHL) participated in this stage[12]. She presented as complaints difficulty in speech understanding in acoustically unfavorable environments and memory.

First, the elderly woman was submitted to a screened for cognitive aspects, using the Montreal Cognitive Assessment (MoCA) test, version 8.1[13], behavioral assessment of central auditory processing skills through the Random Gap Detection Test (RGDT)[6], Dichotic Digit Test in the binaural integration stage (DDT) and Speech-in-Noise Test (SNT)[6]. The CAP tests were performed using a two-channel audiometer, brand Interacoustics, model Ad229e and earphones type TDH-39P,

Figure 1. Sound memory game made by the authors, cats with short and long tails (duration discrimination) and trees with thick and thin trunks (frequency discrimination)

brand Telephonics. A temporal ordering test was not performed, even knowing its importance, due to the number of procedures performed in a single day. The electrophysiological evaluation was also performed, through the Long Latency Auditory Evoked Potentials (LLAEP) (P1, N1, P2, N2, P300). To elicit the potential, the SmartEp model equipment, from the Intelligent Hearing Systems® (IHS) brand, was used. The reference electrodes were placed on the right and left mastoids, the ground electrode placed on the forehead in Fpz and the active electrode in Cz, keeping the impedance less than or equal to 3 KOhms. The auditory stimuli were transmitted via insert headphones in a binaural mode, at an intensity of 60 dBnHL. A total of 300 verbal sound stimuli were presented, composed of the syllable /ba/ (frequent stimulus) - appeared 80% of the time - and the syllable /di/ (rare stimulus) - appeared 20% of the time (about 60 stimuli). Stimulus presentation speed was one stimulus per second, with 1-25 HZ bandpass filter and 520 ms recording window. The elderly woman was instructed to pay attention only to the rare stimulus, mentally count and respond at the end of the test.

As for the intervention, the six sessions lasted approximately 50 minutes, once a week.

All assessment procedures (MoCA, DDT, SNT and LLAEP) were performed before and after three months of therapeutic intervention. The study was blinded to assessment, intervention and reassessment. Therefore, each of the steps was performed by different researchers. The instructions for each task, the composition of the tasks in each session and the skills stimulated according to the expert judges' analysis are presented in Chart 1.

Besides to informing, in the 39 items mentioned above, which skills they believed were being stimulated, the expert judges were asked about the type of training. They should inform whether they considered auditory, cognitive or other training (checking the desired option and adding some text, if deemed necessary) and suggesting an appropriate name to be considered for this type, according to the proposed activities. In this question, there was a divergence between acoustically uncontrolled auditory training and acoustically uncontrolled cognitive and auditory training, with the second being the most voted (experts 1 and 3).

During the intervention in the pilot study, the need for adjustments regarding the songs selected for the tasks was verified, as it was identified that old songs could cause immediate recognition, which was not the objective of the task. Thus, they were replaced by more actual songs, which, in this protocol, are included as a suggestion.

The pictures proposed for use in the intervention protocol proved to be adequate for the tasks, that is, they were easily understood. On the reassessment date, the elderly woman reported having noticed improvements in her daily life routine, such as in speech comprehension in the presence of competitive noise and aspects of memory and attention. No self-assessment questionnaire was applied, which is a limiting factor in this research.

The results of MoCA, CAP behavioral tests and pre and post-intervention electrophysiological tests were analyzed intra-subject, pre and post-training, thus being a subject-related approach. The analysis was qualitative, considering for the behavioral tests the performance (scores) and for the electrophysiological one, the latency and amplitude before and after the intervention. Thus, according to the behavioral tests of the CAP, there was a decrease in the RGDT time (105 ms to 90 ms), an increase in correct answers in the DDT of the left ear (92.5% to 97.5%), in the percentages of SNT correctness for the right ear (73% to 76%) and for the left ear (88% to 92%) and, mainly, the elicitation and normalization of the P300 in latency and amplitude, which, in the pre-intervention moment, were absent. These results indicate improvements in auditory skills of temporal resolution, binaural integration and auditory closure, as well as benefits in auditory information processing and cognitive skills. Chart 2 presents the results of the MoCA,

Chart 2. Results pre and post therapeutic intervention of the evaluated clinical case

Evaluation	Pre intervention	Post Intervention
MoCA	15 points	20 points
RGDT	105 ms	90 ms
DDT- RE	65%	65%
DDT- LE	92.5%	97.5%
SNT- RE	72%	76%
SNT- LE	88%	92%
P1RE	49.00 ms	49.00 ms
P1 LE	51.00 ms	51.00 ms
N1RE	109.00 ms	103.00 ms
N1 LE	113.00 ms	109.00 ms
P2 RE	209.00 ms	213.00 ms
P2 LE	212.00 ms	210.00 ms
N2 RE	Absent	Absent
N2 LE	Absent	Absent
P300-RE (latency)	Absent	345.00 ms
P300-LE (latency)	Absent	347.00 ms
P300-RE (amplitude)	Absent	4.21 µV
P300-LE (amplitude)	Absent	3.81 µV

Caption: MoCA = Montreal Cognitive Assessment; DDT = Dichotic Digits Test; SNT = Speech in Noise Test; P1, N1, P2, N2, P300 = components of long latency auditory evoked potentials; RE = right ear; LE = left ear; % = percentual; ms = milliseconds; µV = microvolt

the CAP behavioral tests and the pre and post-intervention electrophysiological tests.

DISCUSSION

A proposal for auditory stimulation is able to promote the neuronal reorganization of the auditory system and the connections with other sensory systems related to it, generating improvement in abilities that were altered[3]. This study intended to meet the demands of the elderly with greater precision, thus seeking, through a case study, to verify a proposal for auditory and cognitive intervention, with one session less than what has already been shown in the literature[14] (Chart 1).

Like other existing training protocols, this one used CAP tests as intervention strategies and brought, as an innovation, the inclusion of cognitive aspects, that is, a acoustically uncontrolled auditory-cognitive training. Also, as an innovation, it brought other materials produced and others that already existed (Chart 1). All therapeutic strategies and organization of materials were designed so that they could be attractive to the elderly. The benefits of the proposal in the case presented were evident in the results after reassessment (Chart 2). The inclusion of cognitive aspects agrees with a recent study, which referred to the importance of this aspect in the ability to recognize speech in noise in the elderly[4]. Still, in relation to the skills selected for this protocol, according to the suggestions of the expert judges, it should be noted that although the skills (Chart 1) have obtained 100% agreement between them, it is understood that, in many cognitive tasks, they may exist, in addition to attention, other skills involved, such as memory. A study carried out in 2015 showed satisfactory results from a purely auditory training program[11]. The inclusion of cognitive aspects in this proposal only adds to the possibility of therapeutic success[4].

A systematic review and meta-analysis aimed to verify in the literature the effectiveness of auditory or cognitive training to improve cognitive function in elderly people with hearing loss and concluded that auditory training, by itself, makes the subject obtain significant improvements in cognition, and, therefore, combined training (auditory-cognitive), in addition to bringing benefits in altered auditory skills, becomes more effective to improve cognitive function[14]. Given this and the results obtained in the new proposal for auditory-cognitive training exposed here, the agreement with the findings of this recent review is highlighted.

A recent study showed the importance of cognitive stimulation in the prerogative of minimizing sensory and cognitive changes resulting from aging. In addition, working on cognitive functions represents a benefit for the elderly, in particular to increase self-esteem, reduce psychological illnesses and dependence on basic and instrumental activities of daily life. The authors also used MoCA for cognitive screening[15]. In the case studied in the present research, even though the MoCA score has remained altered, the value reached was closer to normal than the pre-stimulation/training value (Chart 2). Normalizing a cognitive screening test is not the only marker that demonstrates that an intervention has succeeded. Improved outcomes already prove plasticity in the central nervous system and intervention effects.

When applying the protocol in the selected clinical case and comparing pre- and post-intervention evaluations, changes were observed in all evaluated parameters. Monitoring the intervention with CAP, MoCA and LLAEP tests favor the visualization of benefits in the central nervous system (Chart 2).

The P300 was absent and became present after the intervention, with latency and amplitude within the normal range, bilaterally (Chart 2). The P300 is the component that best reflects mental functions, being highly influenced by cognitive abilities, including attention and discrimination. Thus, the neural plasticity at the cortical level and the cognitive benefit presented by the elderly woman after the intervention is evident, with emphasis on the potential amplitude. The P300 assesses the neuronal response with contributions from areas that participate in cognitive performance, but such performance does not depend only on these areas. Therefore, it is likely that, in order to obtain a performance within the normal range for the elderly, cognitive and auditory stimulation will need more time. However, with six sessions it was possible to promote benefits to the elderly.

A study observed improvements in the P300 amplitude after the application of computerized auditory-cognitive training in the elderly, but not in latency and justifies the occurrence because the attention process is improved with the auditory-cognitive training, favoring the appearance of waves[16]. Given this and the normalization of the examination in latency and amplitude, it is clear, in the present study, that in addition to cognitive changes, the acoustically uncontrolled auditory-cognitive training caused changes in neural plasticity, increasing the processing speed at a central level.

It was not found in the literature a proposal for a mixed intervention, including auditory and cognitive aspects, therefore, we believe in the potential of this protocol, even though it is presented in a case study. The heterogeneity of the elderly in relation to peripheral hearing acuity and education, for example, makes it difficult to carry out a survey with a sample group. The results of the case study presented demonstrate that such proposal can be adequately applied in the speech therapy clinic with the elderly population (Chart 2). Having fewer sessions than the literature[14] points out and bringing cognition to hearing are strengths of the research presented. To better understand the effectiveness of this proposal, sample groups (different peripheral acuities and education) are essential, as well as a control group, in addition to the use of self-assessment questionnaires to observe the benefits perceived by the subjects of auditory/cognitive training. This possibility is believed and there is this future perspective.

FINAL COMMENTS

The new therapeutic proposal was completed and applied. The subject of the clinical case presented improved after the intervention and the effectiveness was verified through behavioral tests of central auditory processing, cognitive tracking and long latency auditory evoked potential.

REFERENCES

1. Roberts RA, Lister JJ. Effects of age and hearing loss on gap detection and the precedence effect. J Speech Lang Hear Res. 2004 Out;47(5):965-78. http://dx.doi.org/10.1044/1092-4388(2004/071). PMid:15603455.
2. CISG: The Canadian Interorganizational Steering Group for Speech-Language Pathology and Audiology. Clinical practice: auditory

processing disorder in children and adults: assessment & intervention [Internet]. 2019 [citado em 2020 Jun 22]. Disponível em: http://cshbc.ca/wp-content/uploads/2019/02/CSHBC-ACPG-01-Auditory-Processing-Disorders-in-Children-Adults-EN.pdf

3. Samelli AG, Mecca FFDN. Treinamento auditivo para transtorno do processamento auditivo: uma proposta de intervenção terapêutica. Revista CEFAC. 2010;12(2):235-41. http://dx.doi.org/10.1590/S1516-18462010005000006.

4. Mukari SZMS, Yusof Y, Ishak WS, Maamor N, Chellapan K, Dzulkifli MA. Relative contributions of auditory and cognitive functions on speech recognition in quiet and in noise among older adults. Braz J Otorhinolaryngol. 2020. 86(2):149-56. http://dx.doi.org/10.1016/j.bjorl.2018.10.010.

5. Vellozo FF, Dellaméa APL, Garcia MV. Design of a sentence identification test with pictures (TIS-F) based on the pediatric speech intelligibility test. Rev CEFAC. 2017 Dez;19(6):773-81. http://dx.doi.org/10.1590/1982-021620171965517.

6. Pereira LD, Schochat E. Testes auditivos comportamentais para avaliação do processamento auditivo central. São Paulo: Ed. Pró Fono; 2011. 82 p.

7. Lizzaro T. Processos temporais auditivos em músicos de Petrópolis [monografia]. São Paulo: Universidade Federal de São Paulo; 1999.

8. Musiek FE, Shin JB, Jirsa R, Bamiou D, Baran J, Zaida E. GIN (Gaps-In-Noise) test performance in subjects with confirmed central auditory nervous system involvement. Ear Hear. 2006 Jun;27(3):228. PMid:16377996.

9. Nascimento R, Lopes P, Lopes R. Exercícios de memória: 50 cartas para treinar a mente. Matrix, 2018. 50p.

10. Machado L A. Desenvolvimento de um manual instrutivo de uso do treinamento auditivo computadorizado eArena [tese]. São Paulo: Faculdade de Ciências Médicas da Santa Casa de São Paulo; 2015.

11. Stroiek S, Quevedo LS, Kieling CH, Battezini ACL. Treinamento auditivo nas alterações do processamento auditivo: estudo de caso. Rev CEFAC. 2015 Mar-Abr;17(2):604-14. http://dx.doi.org/10.1590/1982-021620157914.

12. OMS: Organização Mundial de Saúde [Internet]. Prevention of blindness and deafness. 2014 [citado em 2020 Jun 22]. Disponível em: http://www.who.int/pbd/deafness/hearing_impairment_grades/en.

13. Sarmento AL. Apresentação e aplicabilidade da versão brasileira do MoCA para rastreio de Comprometimento Cognitivo leve [tese]. São Paulo: Universidade Federal de São Paulo – Escola Paulista de Medicina; 2009.

14. Lawrence BJ, Jayakody DMP, Henshaw H, Ferguson MA, Eikelboom RH, Loftus AM, et al. Auditory and cognitive training for cognition in adults with hearing loss: a systematic review and meta-analysis. Trends Hear. 2018 Jan-Dez;22:1-20. http://dx.doi.org/10.1177/2331216518792096. PMid:30092719.

15. Duran-Badillo T, Salazar-González BC, Cruz-Quevedo JE, Sánchez-Alejo EJ, Gutierrez-Sanchez G, Hernández-Cortés PL. Sensory and cognitive functions, gait ability and functionality of older adults. Rev Latino-Am Enfermagem. 2020;28:e3282. http://dx.doi.org/10.1590/1518-8345.3499.3282. PMid:32491121.

16. O'Brien JL, Lister JJ, Fausto BA, Clifton GK, Edwards JD. Cognitive training enhances auditory attention efficiency in older adults. Front Aging Neurosci. 2017;9:322. http://dx.doi.org/10.3389/fnagi.2017.00322.