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ARTICLES

The Influence of Musical Practice on Different Auditory Abilities

Influência da Prática Musical em Diferentes Habilidades Auditivas

La Influencia de la Práctica Musical en Diferentes Habilidades Auditivas

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Abstract

Introduction: Music offers psychological, cognitive, and social benefits, affecting the brain in distinct ways. The proper functioning of auditory skills is fundamental in the process of interpreting sound information. **Objective**: To compare the performance of adults in different auditory skills of Central Auditory Processing, according to the variable presence and absence of musical practice. **Method**: **Method:** The sample was composed by convenience of 48 normal-hearing adults, 21 males (43.75%) and 27 females (56.25%), with a mean age of 28.06 years. From the total number of subjects, 24 originated Group 1 (G1), that is, individuals with musical experience and practice, and 24 to Group 2 (G2), a group without any musical practice or experience. All subjects underwent a basic audiological evaluation and a full battery of CAP behavioral tests, which was composed of the Dichotic Sentence Identification Test (DSI), Masking Level Difference (MLD), Adapted Compressed Speech (FCA), Auditec's Pattern of Duration and Frequency Test (TPD and TPF), and Random Gap Detection Test (RGDT). **Results**: There was a statistically significant difference between the two groups, with G1 showing superior performance in all auditory skills. **Conclusion**: Adults with musical experience and practice showed normality in all evaluated auditory skills and statistically significant superior performance compared to their peers.

Keywords: Music; Adults: Auditory Perception; Neuronal Plasticity; Hearing Tests

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Resumo

Introdução: A música oferece benefícios psicológicos, cognitivos e sociais, afetando o cérebro de maneiras distintas. O bom funcionamento das habilidades auditivas é fundamental no processo de interpretação de informações sonoras. **Objetivo:** Comparar o desempenho de adultos em diferentes habilidades auditivas do Processamento Auditivo Central, segundo a variável presença e ausência da prática musical. **Método:** A amostra foi composta, por conveniência, por 48 adultos com limiares auditivos dentro dos padrões de normalidade, sendo 21 do sexo masculino (43,75%) e 27 do sexo feminino (56,25%), com média de idade de 28,06 anos. Do total, 24 deram origem ao Grupo 1 (G1), isto é, indivíduos com experiência e prática musical e, 24 ao Grupo 2 (G2), grupo sem qualquer prática ou experiência musical. Todos os participantes foram submetidos a uma avaliação audiológica básica e a uma bateria completa de testes comportamentais, a qual foi composta pelo Teste de Identificação de Sentenças Dicóticas(DSI), *Masking Level Difference*(MLD), Fala Comprimida Adaptado (FCA), Teste de Padrão de Duração e Frequência (TPD e TPF) da Auditec e Random Gap Detection Test (RGDT). **Resultados:** Houve diferença estatisticamente significativa entre os dois grupos, sendo que o G1 apresentou desempenho superior em todas as habilidades auditivas. **Conclusão:** Os adultos com experiência e prática musical apresentaram normalidade em todas as habilidades auditivas avaliadas e um desempenho superior estatisticamente significante quando comparado aos seus pares.

Palavras-chave: Música; Adultos; Percepção Auditiva; Plasticidade Neuronal; Testes Auditivos

Resumen

Introducción: La música ofrece beneficios psicológicos, cognitivos y sociales, afectando al cerebro de maneras distintas. El correcto funcionamiento de las habilidades auditivas es fundamental en el proceso de interpretación de la información sonora. **Objetivo**: Comparar el rendimiento de adultos en diferentes habilidades auditivas del Procesamiento Auditivo Central, según la variable presencia y ausencia de práctica musical. **Método**: La muestra estuvo compuesta por conveniencia por 48 adultos con umbrales auditivos dentro de los estándares de normalidad, siendo 21 del sexo masculino (43,75%) y 27 del sexo femenino(56,25%), con una edad promedio de 28,06 años. De la muestra total, 24 formaron el Grupo 1 (G1), es decir, individuos con experiencia y práctica musical, y 24 formaron el Grupo 2 (G2), grupo sin ninguna práctica o experiencia musical. Todos los sujetos fueron sometidos a una evaluación audiológica básica y a una batería completa de pruebas conductuales, que incluyó el Test de Identificación de Oraciones Dicóticas (DSI), Diferencia de Nivel de Enmascaramiento (MLD), Adaptación de Habla Comprimida (FCA), Test de Patrón de Duración y Frecuencia (TPD y TPF) de Auditec y Random Gap Detection Test (RGDT). **Resultados**: Hubo una diferencia estadísticamente significativa entre los dos grupos, siendo que G1 mostró un rendimiento superior en todas las habilidades auditivas. **Conclusión**: Los adultos con experiencia y práctica musical mostraron normalidad en todas las habilidades auditivas evaluadas y un rendimiento estadísticamente significativamente superior en comparación con sus pares.

Palabras clave: Música; Adultos; Percepción Auditiva; Plasticidad Neuronal; Pruebas Auditivas

Introduction

Music provides countless benefits to human beings, covering not only psychological aspects, but also cognitive and social aspects.[1] The understanding of music varies according to different brain states, activating specific regions of the brain and triggering corresponding physiological effects.[2]

Musicalization is important in improving brain functions, especially in cognitive aspects and Central Auditory Processing (CAP), impacting the quality of life and well-being of individuals.[3] Therefore, the benefits of such skills enable the individual to analyze and interpret the information captured peripherally, more efficiently, due to the stimulation of a set of specific auditory and cognitive skills, which are essential for understanding what is heard.[4] For this system of skills, both processing and cognition, to function properly, it is necessary that the auditory skills are functioning properly.[5]

In general, the development of auditory skills involves a complex system of neurons, which conducts acoustic information through electrical impulses to the primary auditory cortex, which has, as its main characteristic, the ability to discriminate sound in relation to its frequency, intensity and location. Furthermore, it also involves temporal aspects, such as temporal integration and discrimination, temporal ordering and temporal masking[6]. Studies report that musical experience can stimulate brain plasticity, through the reorganization of synaptic encounters between neurons and modifications in the brain circuit, making musicians perform better on auditory tasks than non-musicians.[7]

These findings are mainly justified due to changes that occur in regions of cortical functioning, for example, in Heschl's gyrus (auditory perception), secondary auditory cortex (temporal variations), corpus callosum (binaural integration) and temporal lobe (information processing and memory), which are activated, as these are areas of the brain involved in interpreting information.[8] It also stands out, areas linked to memory, such as the hippocampus, responsible for recognizing the familiarity of thematic and rhythmic elements. The areas of the cerebellum and the amygdala play a crucial role in giving emotional value to the sound experience. Furthermore, a nucleus of gray matter, the nucleus accumbens, is directly associated with feelings of pleasure and reward, which is important for processing musical information.[5]

Such musical experiences can provide a positive impact on the listening skills of the individuals who practice them. In view of this fact, a minimum battery of tests was used to evaluate different auditory abilities,[6] commonly used in speech therapy clinics, namely: binaural integration, binaural interaction, temporal resolution, temporal ordering and auditory closure.

Considering the above, the objective of this study was to compare the performance of adults in different CAP skills, according to the variable presence or absence of musical experience and practice.

Method

Retrospective, quantitative and cross-sectional study, approved by the Research Ethics Committee, under number 80732817.0.0000.5346.

The database was created from February to November 2017 by a research group from a public educational institution. All assessments were performed at the Audiology Outpatient Clinic of a University Hospital. Only individuals who agreed to voluntary participation and signed the Free and Informed Consent Form (FICF) were accepted, which contained information about the procedures carried out, risks, benefits and confidentiality of research data, following all ethical precepts, as per Resolution 466/12 of the Ministry of Health and 510/16 of the National Health Council.

Research criteria

For the study, individuals were selected with the following inclusion criteria: ages between 18 and 59 years, of both sexes, with hearing thresholds within normal limits in both ears (minimum response level up to 19 dBHL at conventionally evaluated frequencies - 250 to 8000Hz)[9], type A tympanometric curve and contralateral acoustic reflexes present at normal levels bilaterally[9], with Brazilian Portuguese being the mother language, right-handed manual preference, with and without musical practice and with at least eleven years of schooling.

Individuals with any evidence of neurological and/or psychiatric alterations that could impede the understanding of the tasks requested in the assessments, individuals with complaints of tinnitus, dizziness, exposure to high levels of sound pressure and individuals with a history of recurrent otitis and illicit drug users were excluded.

Thus, the sample consisted, for convenience, of 48 participants, 21 male (43.75%) and 27 female (56.25%), with an average age of 28.06 years. Of this total, 24 gave rise to Group 1 (G1), that is, individuals with musical experience and practice, and 24 to Group 2 (G2), a group without any musical practice and experience.

Previously, at the beginning of data collection, they answered questions regarding the time spent practicing music and the type of instrument played. As for the participants included in the group with musical experience and practice (G1), half were guitar class students (50%) and the other half were singers from a church choir (50%), both of whom performed musical practice on an amateur basis, weekly, with at least five years of musical experience.

Research strategy

Participants were seen at times previously scheduled with the responsible researchers and study collections were carried out in a single day, with the following procedures for sample composition:

- Audiological anamnesis: used with the aim of collecting information about previous illnesses, issues related to communication and family history of hearing diseases;
- Edinburgh Manual Dominance Test - reduced version: applied with the aim of obtaining information about manual preference in different daily situations;
- Visual Inspection of the External Acoustic Meatus: the Mikatos brand clinical otoscope was used to check the presence of any alterations that would prevent the procedures from being performed. In case of any alteration, individuals would be referred for medical management;
- Behavioral audiological assessment (research on tonal thresholds, speech audiometry - speech recognition threshold and percentage index of speech recognition and central auditory processing tests): Performed in a booth with acoustic treatment, with the procedures performed on an Interacoustics audiometer, model AD229, and using supra-aural headphones, model TDH 39;
- Acoustic Immittance Measurements: Were performed in the Interacoustics brand AT235 immittance meter, measuring the mobility of the tympanic-ossicular system and the contralateral stapedial acoustic reflexes, adopting values already proposed.

Behavioral assessment of central auditory processing skills:

The tests were applied randomly and selected with the aim of covering the minimum suggested battery, in accordance with the recommendations of the Brazilian Academy of Audiology[10], better described below:

- Standard Duration Test (SDT) - Auditec®[11]: used to evaluate the temporal ordering ability for duration. This has a list of 30 sequences of three pure 1000 Hz tones, which change according to duration, and can be long (500 ms) or short (250 ms). The interval between tones is maintained at 300 ms and the interval between stimuli is 6 s. It was applied binaurally, at a fixed intensity of 50 dB SL and the subject named, in order, the sequence heard. Results equal to or greater than 91.9% of correct answers were used as a standard of normality for the age group from 18 to 29 years old and from 30 to 58 years old, results equal to or greater than 89%.[12]
- Standard Frequency Test (SFT) - Auditec®[11]: applied to evaluate the temporal ordering ability for frequency. It is also composed of 30 sequences of pure tones, but they are modified by frequency, and can be low (880 Hz) or high (1430 Hz). The interval between tones is 150ms and the interval between stimuli is 7s. It was applied binaurally, at a fixed intensity of 50 dB SL and the participant named the sequence heard in an orderly manner, referring to “thick” for the low tones and “thin” for the high tones. As a standard of normality, percentages equal to or greater than 97.2% of correct answers were considered for the age group from 18 to 29 years old and from 30 to 58 years old, results equal to or greater than 96.6%.[12] For both tests that evaluate temporal ordering (SDT and SFT), the physiological mechanism evaluated is the discrimination of sounds in sequence.
- Random Gap Detection Test (RGDT) - Musiek[13]: applied to evaluate the auditory ability of temporal resolution. The physiological mechanism evaluated is the discrimination of inter-stimulus pauses. The test has intervals between tones that vary from zero to 40 ms in random order. The test was performed at 50 dB SL in the binaural condition and participants were instructed to respond verbally if they heard one or two tones.

The training and test ranges were used in order to verify the shortest interval in which the individual began to consistently identify two tones. The analysis was carried out using the average of the four test frequencies, with results equal to or less than 4.79 ms being considered normal for the age group from 18 to 29 years old and from 30 to 58 years old, results equal to or less than 5.58 ms. ms.[12]

- Adapted Compressed Speech Test (ACS) - Folgearini[14]: the Compressed Speech Test (CST),[15] conceived as the original test, was adapted for the ACS,[14] aiming to further improve its applicability. The ACS was used to evaluate the auditory closure ability and the physiological mechanism evaluated is the recognition of physically distorted sounds. It consists of a list of 25 words for each ear, with 60% compression. In this test, the words were presented in the monaural condition, with a fixed intensity of 40 dB SL, first in the right ear (RE) and then in the left ear (LE), and the individuals were instructed to repeat the words heard. The normality standard found for the age group from 18 to 29 years old was used, for the right ear 92.1% and the left ear 94% of correct answers. For the age group from 30 to 58 years, 88.9% of correct answers were considered normal in the right ear and 92.6% in the left ear.[12]
- Dichotic Sentence Identification Test (DSI) - Andrade[16]: used to evaluate the figure-background ability for verbal sounds and association of visual stimuli. The physiological mechanism evaluated is the discrimination of overlapping sounds in monotic and/or dichotic listening. It was applied at a fixed intensity of 50 dB SL. It started with training and then the binaural integration stage was performed, however, only the second was considered in the analysis of this study. In these two moments, two sentences were presented simultaneously, one in each ear, and the individual pointed out the sentences heard, on a card, which remained fixed in front of them. As a normality criterion, the values proposed by age group were followed: from 18 to 29 years: 96% correct in the RE and 94.3% in the LE; from 30 to 58 years old: 93.1% correct in the OD and 90% in the OE.[12]
- Masking Level Difference (MLD) - Auditec®: Used to evaluate the ability of selective attention and binaural interaction. The physiological mechanism evaluated is the identification of sounds in the presence of noise. The test is based on determining the hearing threshold using a 500 Hz pulsatile pure tone, in the presence of masking noise in two different conditions: noise and pure tone presented in phase to both ears; and pure tone presented in phase in both ears, with inverted phase noise in one ear. The same was carried out at 50 dB SL, in the binaural condition and participants were instructed to say "yes" when they heard the pure tone and "no" when they heard only the noise. The result was obtained by subtracting the threshold between the two conditions. The MLD was considered normal in the presence of threshold differences greater than or equal to 14 dB for the age group from 18 to 29 years old and 13.1dB for those aged between 30 and 58 years old, between the signal/noise conditions verified.[12]

Data analysis

To analyze the data, a description was first made, with mean, median, minimum, maximum, standard deviation, quartile 1 and quartile 3 values. Subsequently, the non-parametric test for comparison between variables, U-Mann-Whitney Test, was used. In all analyzes a significance level of 5% ($p \leq 0.05$) was considered.

Results

Comparison between groups with and without musical experience in the different auditory abilities of central auditory processing, showing statistically significant differences for all tests applied (Table 1).

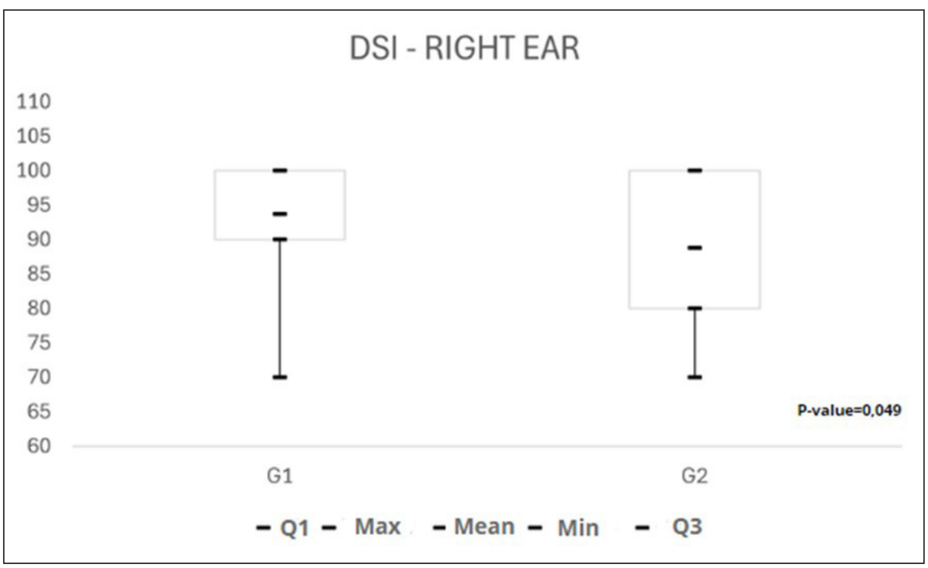
Table 1. Comparison between groups with and without musical experience in different central auditory processing auditory abilities.

	Grupo	N	Média	Mediana	Min	Max	Q1	Q3	DP	P-valor
DSI OD (%)	G1	24	93,75	90,00	70,00	100,00	90,00	100,00	7,11	0,049*
	G2	24	88,75	90,00	70,00	100,00	80,00	100,00	9,47	
DSI OE (%)	G1	24	94,17	100,00	70,00	100,00	90,00	100,00	9,29	0,040*
	G2	24	85,00	90,00	20,00	100,00	80,00	100,00	19,11	
MLD(dB)	G1	24	14,08	14,00	10,00	20,00	12,00	16,00	2,67	0,013*
	G2	24	11,50	12,00	4,00	18,00	8,00	14,00	3,74	
RGDT (ms)	G1	24	5,98	4,50	2,00	17,50	3,50	7,75	3,75	0,017*
	G2	24	8,63	5,88	2,00	40,00	4,25	10,00	7,88	
FCA OD (%)	G1	24	90,17	92,00	56,00	100,00	88,00	96,00	8,83	0,012*
	G2	24	85,33	86,00	64,00	96,00	80,00	92,00	8,14	
FCA OE (%)	G1	24	93,50	96,00	68,00	100,00	92,00	96,00	7,06	0,007*
	G2	24	88,33	92,00	64,00	100,00	86,00	94,00	8,74	
TPD (%)	G1	24	89,42	93,30	60,00	100,00	84,95	96,60	11,48	0,010*
	G2	24	82,88	88,30	23,30	100,00	74,95	94,95	18,06	
TPF (%)	G1	24	97,62	100,00	80,00	100,00	96,60	100,00	4,56	0,009*
	G2	24	89,70	94,95	53,30	100,00	83,30	100,00	13,77	

Caption: N=number of participants; Min=minimum; Max=maximum; Q1=quartile 1; G3=quartile 3; SD=standard deviation; RE=right ear; LE=left ear; ms=milliseconds; %=percent; *=statistical significance.

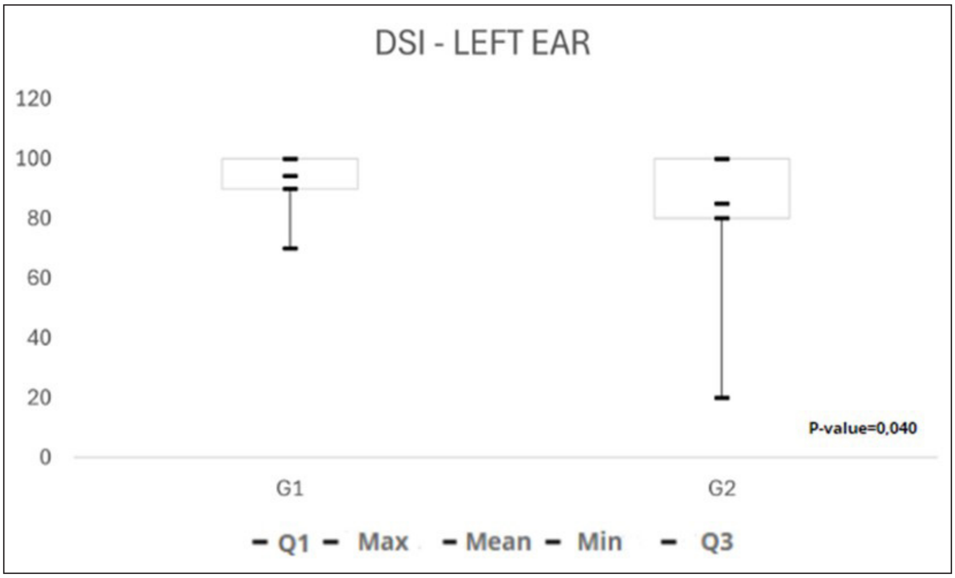
When comparing performance in the Dichotic Sequence Identification Test (DSI), by ear, in both groups, it is possible to observe superior performance in the group with musical experience and practice (G1), both in the right and left ears (Graphs 1 and 2).

Graph 1. Box-plot graphic representation of performance in both groups (G1 and G2) on the DSI in the right ear.



Caption: G1: group with musical experience; G2: group with no musical experience; Q1=quartile 1; G3=quartile 3; DSI= Dichotic Sentence Identification Test

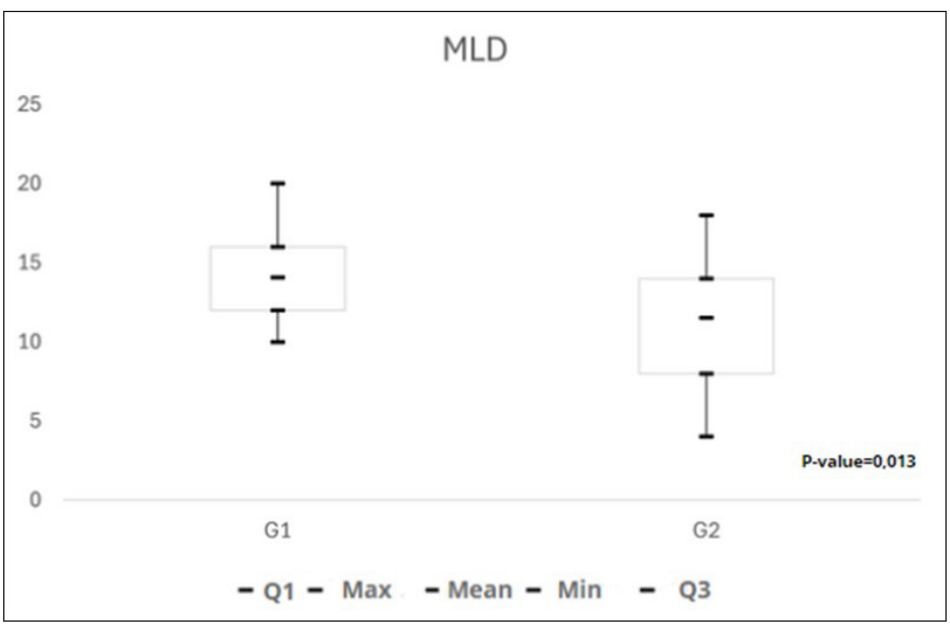
Graph 2. Box-plot graphic representation of performance in both groups (G1 and G2) on the DSI in the left ear.



Caption: G1: group with musical experience; G2: group with no musical experience; Q1=quartile 1; G3=quartile 3; DSI= Dichotic Sentence Identification Test.

In the means between the groups in the Masking Level Difference (MLD) test, it is evident that the measurement in dB (decibel) is higher in the group that has musical experience (Graph 3).

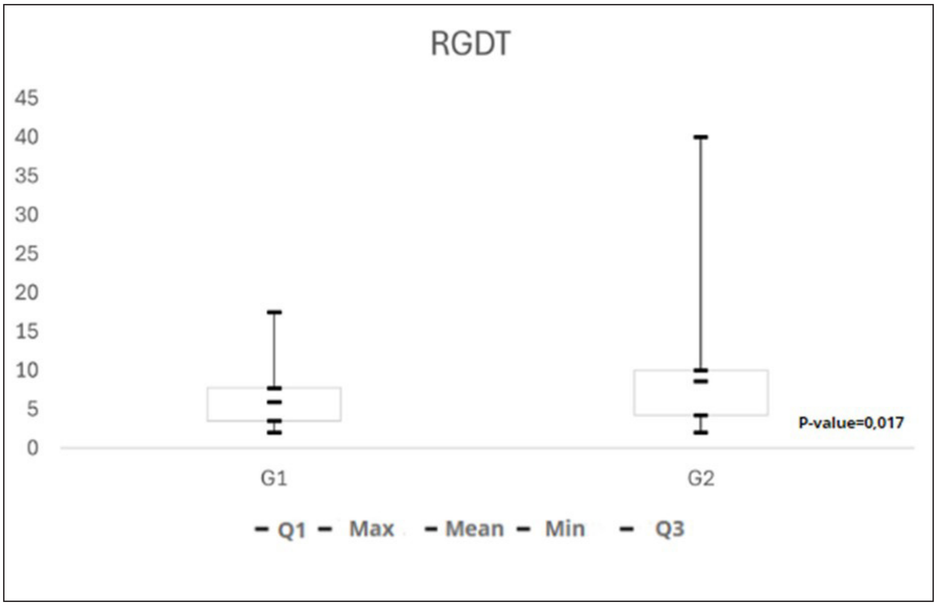
Graph 3. Box-plot graphic representation of performance in both groups (G1 and G2) in MLD



Caption: G1: group with musical experience; G2: group with no musical experience; Q1=quartile 1; G3=quartile 3; MLD= Masking Level Difference.

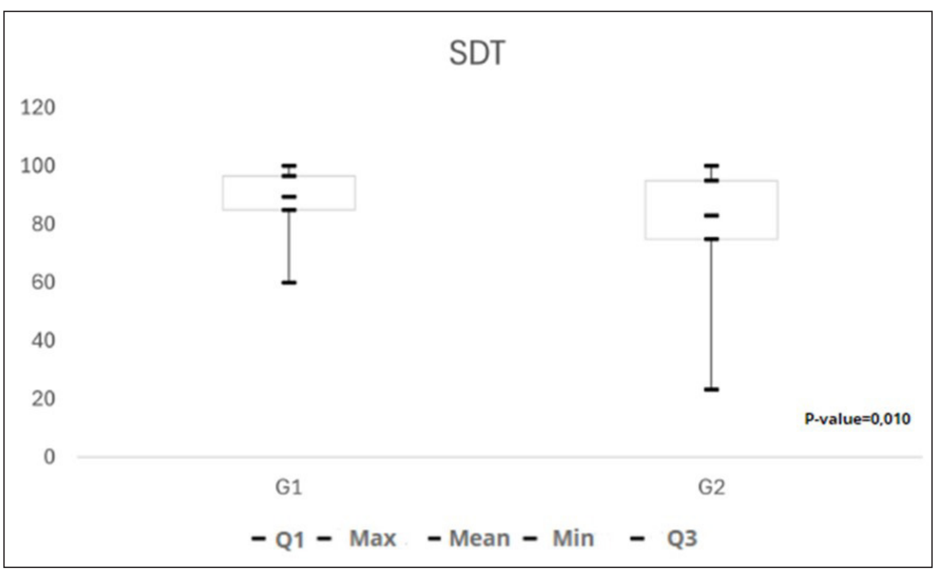
In relation to the RGDT, SDT and SFT tests to measure temporal abilities, respectively, of resolution and temporal ordering for duration and frequency, detection of smaller intervals and percentage of discrimination of sounds in longer sequences were evidenced for G1 (Graph 4, 5 and 6).

Graph 4. Box-plot graphic representation of performance in both groups (G1 and G2) in the RGDT..



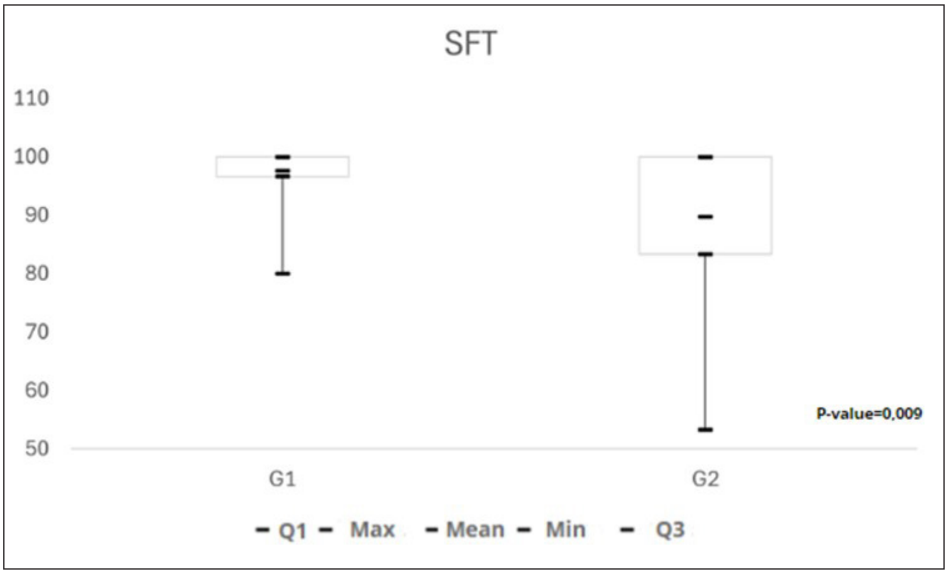
Caption: G1: group with musical experience; G2: group with no musical experience; Q1=quartile 1; G3=quartile 3; RGDT= Random Gap Detection Test.

Graph 5. Box-plot graphic representation of performance in both groups (G1 and G2) in SDT.



Caption: G1: group with musical experience; G2: group with no musical experience; Q1=quartile 1; G3=quartile 3; SDT= Standard Duration Test.

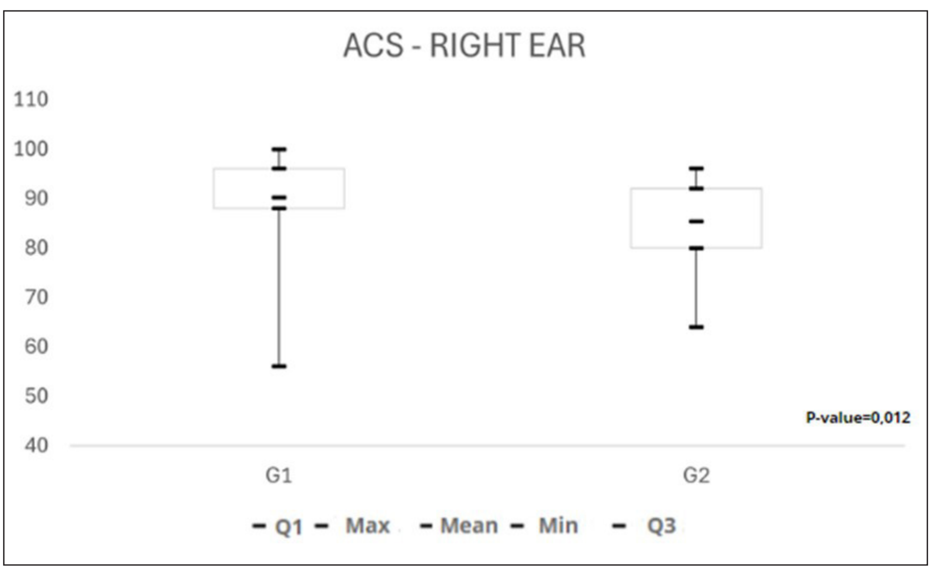
Graph 6. Box-plot graphic representation of performance in both groups (G1 and G2) in SFT.



Caption: G1: group with musical experience; G2: group with no musical experience; Q1=quartile 1; G3=quartile 3; SFT= Standard Frequency Test.

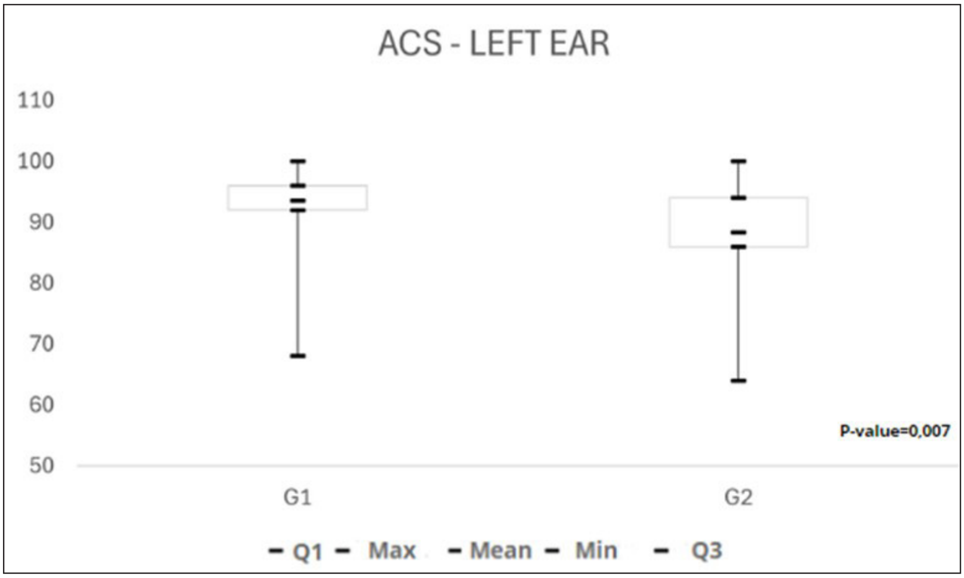
In the Adapted Compressed Speech Test (ACST), superior performance in response percentages was observed, both from the right and left ears (Graphs 7 and 8).

Graph 7. Box-plot graphic representation of performance in both groups (G1 and G2) in the ACS in the right ear.



Caption: G1: group with musical experience; G2: group with no musical experience; Q1=quartile 1; G3=quartile 3; ACS= Adapted Compressed Speech.

Graph 8. Box-plot graphic representation of performance in both groups (G1 and G2) in the ACS in the left ear.



Caption: G1: group with musical experience; G2: group with no musical experience; Q1=quartile 1; G3=quartile 3; ACS= Adapted Compressed Speech.

Discussion

The study provides important information about auditory abilities and their relationship with musical experience, through the application of a battery of hearing tests, suggested by regulatory bodies.[6,10]

Furthermore, when measuring it, it can be used as an important tool for the clinical management of individuals, due to the positive neuroplastic changes that occur at the level of the Central Auditory Nervous System with musical exposure.[17]

In Table 1, it is possible to observe the measurement of auditory interaction and binaural integration skills, temporal aspects (resolution and temporal ordering for frequency and duration) and auditory closure in the group exposed and not exposed to musical practice, of which were better performances were observed for G1. Such findings have already been found in specialized literature, with superior performance in auditory skills being observed, compared to individuals with no exposure and/or interest in musical practice.[18] In this sense, the results are justified, mainly, due to the characteristics of the musicians (playing the instrument and singing) and the neurophysiological changes that occur at the CANS level, of which the distinction between the musical notes when playing the instrument and the need to follow musical melodies with harmony and representing them through the voice are necessary and enable the improvement and/or development of various skills. Furthermore, the sensory coding of temporal information such as duration, interval and order of different stimulus patterns are clues that govern temporal processing, being important for the perception of music.[19]

In relation to the binaural integration ability, shown in graphs 1 and 2, per ear, better responses are evident for the study group, with a higher percentage of correct answers and less variability for individuals without musical exposure. Similar findings appear to be associated with variability in the exposure of enthusiastic musicians. Considering hemispheric dominance and stimulation, instrumental musicians tend to have right hemisphere dominance (non-verbal stimulus), while it can be assumed that vocalists have left hemisphere dominance, due to linguistic elements involved in singing. Thus, the findings are a result of global brain stimulation, since, during the act of active musical performance, it becomes necessary to develop melodic and harmonic auditory perception, through perceptual training of intervals, rhythm, between other acoustic parameters, corroborating the best findings for both the right and left ears.[20]

The ability of binaural interaction refers to the ability to identify sounds in the presence of noise, that is, to integrate the differences in time and intensity of acoustic information coming from both ears. In the study, musicians obtained better responses compared to their peers, due to musicians (instrumentalists and vocalists) having a significant advantage over non-musicians in binaural tasks, due to total brain activity.[21] Whole brain activity refines binaural processing due to interhemispheric interaction in the tasks performed and, thus, can provide benefits in spatial perception, height discrimination and intensity discrimination abilities.[20]

A recent study aimed to measure temporal aspects by comparing them to findings from musicians and non-musicians. For this, the RGDT, SDT and SFT tests were used and it was concluded that musical practice influences and improves temporal auditory skills, both resolution and ordering, regardless of the time of exposure to musical practice.[22] These findings were also observed in the present research, as significant differences were observed between the groups, with better scores for G1. Thus, musicality becomes codependent on basic auditory skills, such as the discrimination of frequencies, timbre, volume and duration of the tone, as well as higher order pattern recognition skills, such as subjective height perception, metric, rhythmic and melodic structures. Furthermore, playing a musical instrument requires extensive multisensory integration, such as planning finger movements and the simultaneous processing of sensorimotor and visual information.[23] In this way, the findings are justified, considering that for adequate performance, broad stimulation is necessary.

A survey carried out with musicians and non-musicians found superior results in the SFT and RGDT tests for the group of musicians. The groups were divided into: people who play instruments, people who sing, people who play instruments and sing simultaneously and people with no experience with musical practice. In SFT, it was possible to observe a better performance of the group of people who play and sing simultaneously. In the RGDT analysis, it was noted that groups of people who sing and the group of people who sing and play simultaneously have better temporal resolution abilities.[19] This can be explained by the stimulation of resolution and temporal ordering skills through music, which improves brain plasticity.[24,25]

Specialized literature[26] highlights the better perception of speech in noise in individuals with musical experience, a fact also observed in the test applied to measure the auditory ability of auditory closure[27]. These results coincide with the findings of the study by Bohn et al.[28], with better results from the group of amateur musicians, in the tests evaluated, when compared to the group of non-musicians. A current literature review by Braz et al.[29] found that individuals exposed to musical experiences can more easily discriminate spectrally complex acoustic signals, have better short-term cognitive processing and recognize speech in noise with less difficulty. Considering that cognitive training occurs inherent to musical training, exposure to music tends to improve the ability to ignore auditory distractors, since the sensory component of musical training can lead to a better ability to analyze the auditory scene, including the ability to separate signal from noise.[30] Furthermore, musicians tend to have an advantage in more difficult conditions, given that non-musicians perform well when the noise level is low (i.e., ceiling effect). In this sense, daily exposure to degraded signals, with different competitive stimuli (speech and tone), provides better findings in this ability.[31]

Therefore, the findings of this study demonstrate the benefits of musical experience on different auditory skills and how much it promotes neuroplasticity, as the more music is worked on, the more stimulated the brain will be. In general, musical training becomes an effective strategy for stimulating and improving auditory skills related to the abilities to recognize the presence or absence of sound, identify the place of origin of the sound, share attention between two stimuli, select a stimulus hearing in the presence of background noise, differentiate the variation in frequency, intensity and duration and perceive differences and similarities between verbal sounds.[32] Thus, by changing the neurobiological[23] functioning of the auditory pathway, at the level of global brain performance and thalamocortical auditory areas, its functional capacity will become better.[29]

Limitations of the study were considered to be the non-inclusion of scales and/or questionnaires, such as the Central Auditory Processing Skills Self-Perception Scale (CAPSSPS),[33] to measure the self-perception of CAP in adults. Furthermore, limitations in the study are highlighted regarding the differentiation of characteristics related to sound exposure, mainly, maximum limit of musical exposure and exact number of years of practice.

Conclusion

Adults with musical experience and practice showed normality in all auditory skills assessed and a superior performance in these when compared to the group without musical experience and practice.

It is also suggested that more studies be performed with the studied population and that neuropsychological tests be also included to measure cognitive abilities so that the only variable that differentiates the groups is musical exposure. Furthermore, a structured anamnesis to characterize the sample regarding musical practice seems to be important for future studies.

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