Original Article

Temporal Resolution Abilities in Musicians and No Musicians Violinists

Habilidades de Resolução Temporal em Músicos Violinistas e Não Músicos

Ricardo Alexandre Martinez Monteiro*, Franklin Martins Nascimento*, Carla Debus Soares**, Maria Inês Dornelles da Costa Ferreira.***

* Bachelor in Speech Therapy. Audiologist.
** Masters. Professor of Speech Methodist University Center - IPA (Porto Alegre), Department of Speech and Audiology, Mother of God Center (Porto Alegre).
*** PhD. Professor of Speech Methodist University Center - IPA (Porto Alegre) and the School Our Lady of Fatima (Caxias do Sul).

Institution: Methodist University - IPA.
Porto Alegre / RS - Brazil.
Mail Address: Maria Inês Dornelles da Costa Ferreira - Rua Luiz Afonso 158/702 Bairro Cidade Baixa - Porto Alegre / RS - Zip code: 90050-310 - Telephone: (+55 51) 9823-0198 - E-mail: costa.ferreira@terra.com.br
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SUMMARY

Introduction: The temporal resolution is the perception of a time interval in which the individual discriminates two sounds being a skill involved in music.

Objective: To identify the performance of temporal resolution in musicians and no musicians violinists and correlate it with the average of the thresholds of low frequencies and acute as well as the time of exposure to music daily.

Method: This study was characterized by be prospective and compared between two groups, one consisting of 20 violinists and other musicians for 20 semi no musicians matched for age and education were submitted to audiological evaluation and to the test Gaps In Noise (GIN) to evaluate the temporal resolution.

Results: The test performance of the GIN group of musicians was not significant in the control group is in the right ear (RE) or left (LE). The correlation between the average high frequencies for the LE with the GIN test was (p = 0.001) in the control group. The average frequencies for both ears in the group of musicians was statistically significant and the highest values for RE (p = 0.001).

Conclusion: There was no difference between the performance of the GIN test for both groups as well as the correlation between duration of daily exposure to music and GIN. The audiometric threshold of high frequencies seemed to be relevant for testing GIN.

Keywords: music, auditory threshold, auditory perception.

RESUMO

Introdução: A resolução temporal é a percepção de um intervalo de tempo em que o indivíduo discrimina dois sons sendo uma habilidade envolvida na música.

Objetivo: Identificar o desempenho da resolução temporal em músicos violinistas e não músicos e correlacioná-lo à média dos limiares das frequências graves e agudas, bem como, ao tempo de exposição diária à música.

Método: O presente estudo caracterizou-se por ser prospectivo e comparado entre dois grupos, sendo um composto por 20 músicos violinistas e outro por 20 não músicos semi pareados por idade e escolaridade que foram submetidos à avaliação audiológica e ao teste Gaps In Noise (GIN), para avaliar a resolução temporal.

Resultados: O desempenho do teste GIN do grupo de músicos não foi significativo em relação ao grupo controle seja na orelha direita (OD) ou na esquerda (OE). A correlação entre a média das frequências agudas para OE com o teste GIN foi (p=0,001) no grupo controle. A média das frequências graves para ambas as orelhas no grupo de músicos foi estatisticamente significativa sendo os maiores valores para OD (p=0,001).

Conclusão: Não houve diferença entre o desempenho do teste GIN para ambos os grupos assim como a correlação entre o tempo de exposição diária a música e o GIN. O limiar audiométrico das frequências agudas mostrou-se relevante na realização do teste GIN.

Palavras-chave: música, limiar auditivo, percepção auditiva.

INTRODUCTION

The intention in researching the auditory processing (central) (PA (C)), specifically the ability of temporal resolution occurred by observing the musicians and the ease with which they seem to perceive the sounds and turn them into melodies, sounds so much verbal and nonverbal. Thus, investigations were made highlighting the relationship between the PA (C) and music as well as the influence of some variables as time of exposure to music, cultural factors and family (1). PA (C) is defined by several authors as the perception of sound or modifications thereof within a limited period of time (2). It develops from childhood, and exposure to sound the first two years of life is extremely important for the maturation of the structures of central nervous system (3).

A study addresses the contribution that the PA (C) can provide to identify the aspects of auditory discrimination in schools (4). Thus, we highlight the importance of time factor for the discrimination of acoustic stimuli (5,6). PA (C) can be defined as the efficiency and effectiveness with which the central nervous system (CNS) utilizes auditory information. Involves, in addition to auditory discrimination, skills, location and lateralization of sound, recognition, temporal aspects, dichotic listening tests and with degraded acoustic signals (7). The auditory discrimination involves the perception of acoustic stimuli in very rapid succession requiring accuracy of information that are carried to the brain. Thus, it enables the decoding and understanding speech especially in unfavorable situations, as in the presence of background noise and speech competitive (4.8). For music, rhythm identification depends on the perception of time (9).

Thus, the processing time (PT) can be defined as the perception of sound or changing the same within a time domain. The same can be observed at many levels ~ the most basic (neural timing in the auditory nerve) to the more complex (cortical processing of binaural hearing and speech perception). This allows the human being, the perception of speech sounds and oral language comprehension (3, 10). The PT is divided into four subcomponents: temporal ordering, or sequencing, temporal resolution or discrimination or add ~ temporal integration and temporal masking. Currently, only the temporal resolution will be addressed in accordance with the purpose of this study (10).

Temporal resolution is defined as the perception of a short interval of time that each individual can discriminate between two auditory signals of about 2-3 ms. Thus, the threshold for temporal resolution is known as auditory acuity or temporal integration time limit (10). To accomplish this assessment, prepared the test Musiek (GIN), in which the individual must perceive intervals of 2ms to 20ms amid the white noise, (8, 11, 12, 13).

In contrast, studies of musicians suggest that musical training diary, used by professional musicians, can induce functional reorganization of the cerebral cortex. Therefore, the contact with the music before the age of seven could contribute to the development of PA (C), and more precisely the PT (14). The musicians surveyed had an increase in the left temporal plane identified by investigations of magneto encephalography. The authors concluded that musicians have better neural activation due to long-term musical training (15).

Other research points out that to be a better development in the planum temporale, the musical stimulus should begin before the age of nine being important for the PT. In the comparison of experienced musicians with no musicians, the first responded differently to musical stimuli compared with the brains of no musicians. This fact was also observed in musicians who started their musical activity early (14). However, other studies argue that musical ability is innate and that musical training is not responsible for the improvement in the PT. However, the authors confirmed the improvement of the PT in relation to individuals who were exposed to early music stimulus (16). Following the same theoretical assumption Another study shows that music has a positive influence on the development of the PT, because according to their study, subjects were exposed to musical training (singing) over four years compared to amateur musicians without professional guidance, performed better the ability of temporal resolution through the test Random Gap Detection Threshold (RGDT), (17). By performing a comparative study between young and through tests GIN RGDT, music therapy students stood out in relation to the speech therapy students in the two tests (12). Music is important in brain development and the sequential processing of sounds, rhythm and activity of the temporal gyros and the frontal lobe showing the existence of a relationship between musical rhythm, speech and expressive PT (18,19).

According to the above, the purpose of this study is to identify the performance of temporal violinists musicians and no musicians. Following these theoretical and from the research conducted it is hoped, through this work; identify best limits of temporal resolution in individuals musicians. It also aims at the correlation of this variable with mean thresholds of low frequencies and sharp, three-tone average and, with a time of daily exposure to music.

Method

The study was conducted in the audiology laboratory of the institution and was approved by the Research Ethics Committee, under protocol 123/2008. It is characterized by being a prospective, cross-sectional, individual, observational, prospective, and comparative.

After clarification aims of the research participants signed the Informed Consent (IC) and the responsible institution of which belonged to the group in the study signed the Deed of Knowledge Institutional (TCI). The criteria for including participants in the survey were all musicians violinists, who constituted the study group. For the control group participants were not included musicians paired with the study group according to age. The exclusion criteria were established to present those changes in auditory thresholds. Exclusion criteria for both groups stand out individuals who refused to participate in the survey, those who were representative of changes in tympanometry middle ear, as well as users of psychotropic medication or neurological. These criteria were obtained through a specific questionnaire for musicians and no musicians and measures of acoustic impedance. It is worth mentioning that the possible changes in pure tone audiometry shaped exclusion criterion for the group not to musicians and variable to be analyzed for the group of musicians.

The collection was made in the morning to ensure the hearing rest in the group of musicians. After fit on the criteria for inclusion all participants underwent inspection of the external auditory canal to check the conditions of the examinations thereafter. The acoustic immittance measures were performed with the equipment AT22t brand Interacoustics and consisted of tympanometry and acoustic reflexes. Pure tone audiometry was the second review conducted by the equipment AC30 and AC33 both brand Interacoustics. All equipment found to be calibrated on the date on which the assessments were performed.

The third test was used GIN accomplished by connecting the audiometer AC30 or AC33 CD player with the Philips brand model AX2420/78. The test consists in detecting intervals of silence amid the white noise with duration of 6 seconds. These intervals vary 0-3 whose duration varies from 2 to 20 ms, (13). First, participants held a full practice with the test after receiving instruction from the same responding by pear response audiometer. Following a list was applied to each ear to 40dBHL average of 500 Hz, 1000 Hz and 2000 Hz, obtained in pure tone audiometry. To describe the sample profile according to the variables under study were frequency tables of categorical variables, with the values of absolute frequency (n) and percentage (%), and descriptive statistics of continuous variables, with values of mean, standard deviation, minimum and maximum, and median.

To compare categorical variables between groups was used Fisher's exact test. To compare numerical variables between two groups we used the Mann-Whitney, and to compare numerical variables between three or more groups of test was used Kruskal Wallis due to the absence of normal distribution of variables. To compare numerical variables between OD and OS was used the Wilcoxon test for related samples, due to lack of normal distribution of variables. To examine the relationship between numerical variables we used the Spearman correlation coefficient, due to lack of normal distribution of variables. The level of significance for statistical tests was 5%, ie, $P < 0.05$.

Results

This study was based on a group of 20 violinists and other musicians, 20 no musicians semidetached participants by age and education which formed the control group, all male. In terms of age participated in the study 10 (50%) musicians under the age of 20 years, three (15%) aged between 20 and 29 years of age and seven (35%) aged less than 30 years. In the control group, nine (45%) participants were younger than 20 years, four (20%) aged between 20 and 29 years of age and seven (35%) aged less than 30 years.

Group of musicians, three (15%) had incomplete primary education, six (30%) had incomplete secondary school, seven (35%) teaching full, two (10%) higher education and two incomplete (10%) had a university degree. In the control group, in turn, five (25%) of the participants studied the elementary school, three (15%) had incomplete secondary school, seven (35%) completed high school, two (10%) higher education incomplete and three (15%) had a university degree.

Table 1 shows the comparative analysis of numerical variables between groups. It is worth mentioning that the performance of the group of musicians in the GIN test was not statistically significant in the control group. However, it can be seen higher incidence of change to the ability of temporal processing in the group of no musicians compared to the group of musicians. Following the analysis between the results of the GIN test, we compared the variables age and education level in each group, showing no statistically significant relationship. The correlation analysis results on the GIN test with the variables age, average of low frequencies, three-tone average and average high frequencies per ear were performed using the Spearman correlation test considering the groups separately.

Table 1. Comparative analysis of numerical variables between groups.

	No Musician						Musician						
	n	M.	S.D.	Min.	Med.	Max.	n	M.	S.D.	Min.	Med.	Max.	P Value
Age	20	24,65	12,01	9,00	23,00	48,00	20	24,60	12,10	10,00	22,50	48,00	0,978
Temp. Learn.	00	-	-	-	-	-	00	7,25	7,01	1,00	5,00	25,00	-
Expos. Music	00	-	-	-	-	-	00	27,25	11,06	10,00	27,50	45,00	-
GIN RE	20	6,00	2,13	3,00	5,00	10,0	20	5,50	2,84	2,00	5,00	15,00	0,333
GIN LE	20	5,95	2,28	2,00	6,0	10,0	20	4,90	1,62	2,00	5,00	10,00	0,156
Freq. Med. Rec. RE	20	10,45	8,20	-5,00	11,00	25,00	20	12,80	6,89	-2,00	12,50	23,00	0,299
Freq. Med. Trit. RE	20	7,05	7,58	-8,00	7,00	20,00	20	6,85	6,68	-2,00	6,00	27,00	0,775
Freq. Med. Acute. RE	20	9,25	7,40	-10,00	9,00	25,00	20	7,30	9,20	-8,00	6,00	35,00	0,117
Freq. Med. Rec. LE	20	9,25	7,11	-3,00	8,00	22,00	20	8,55	5,84	-2,00	8,50	20,00	0,775
Freq. Med. TritLE	20	5,90	5,44	-5,00	6,00	15,00	20	5,05	4,54	-2,00	5,00	12,00	0,686
Freq. Med. Acute. LE	20	8,50	7,29	-10,00	8,50	25,00	20	7,35	6,66	-2,00	8,00	27,00	0,430

Legend: learning time (Temp. Learn.) Exposure to music (Expos. Music); GAPS In Noise Test (GIN), Right Ear (RE) and Left Ear (LE) in musicians and no musicians violinists; the Media frequencies (Freq Med. Rec.) Average of high frequencies (Freq Med. Acute.) Average tritonal (Trit Med.) violinists in musicians and no musicians in the right ear (RE) and left ear (OE). Medium (M), Minimum (Min), Maximum (Max), Median (Med).

Figure 1 shows the test results obtained GIN in both ears when correlated to the variable average of high frequencies for LE in the control group, and the average correlation of high frequencies for LE with the performance of the GIN test for RE (r = 0.561 ~ p = 0.009) and medium to high frequencies with OE GIN test performance for the same ear (r = 0.521 ~ p = 0.001). These results indicate that the higher the average of the high frequencies of OE, the greater the gap detection threshold in the GIN test in the control group.

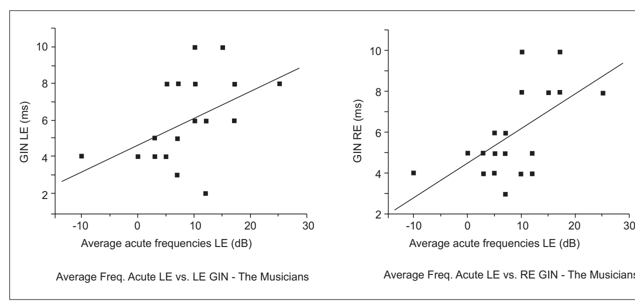

Figure 1. Correlation of the GIN test with the average frequencies in the control group of LE and RE. - RE: right ear, LE: left ear GIN: Gaps In Noise (noise in the interval).

There was also a significant correlation of time of daily exposure to music with the performance of the GIN test for LE, indicating that increased length of daily exposure to music is directly proportional to the *gap* detection threshold. This result can be seen in Figure 3. Finally, the comparative analysis between the OD and OS was performed in groups, being the only statistically significant difference from the average frequencies compared between the ears in the group of musicians and the OD values were higher (p <0.001) as shown in Figure 4. With this result it is clear that the group of musicians had audiometric thresholds at OD worse than in the contra lateral ear for the bass frequencies.

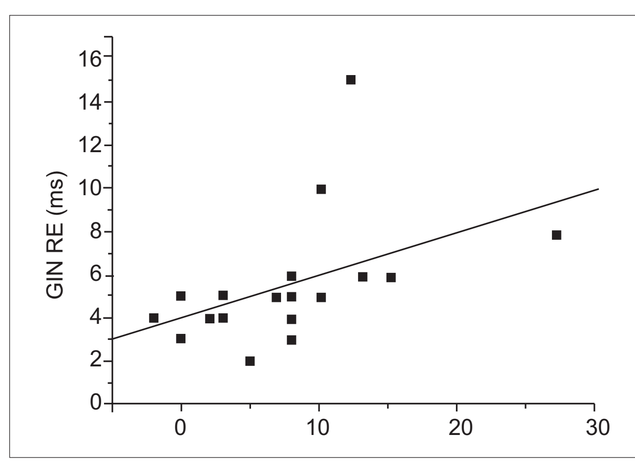

Figure 2. Correlation of the GIN test of RE with the average of high frequencies in the LE group of musicians. - RE: right ear LE: left ear GIN: Gaps In Noise (noise in the interval).

Discussion

A search for information about the correlation between music and temporal resolution comparing musicians and no musicians, has been a frequent factor in current research. In the GIN test, applied in both groups, there was no statistically significant relationship on the detection threshold interval of silence. During data collection

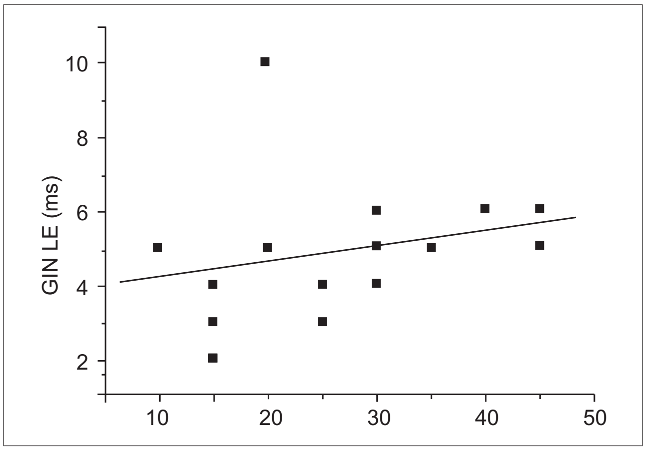

Figure 3. Correlation of the GIN test of LE with a time of daily exposure to music. LE: left ear GIN: Gaps In Noise (noise in the interval).

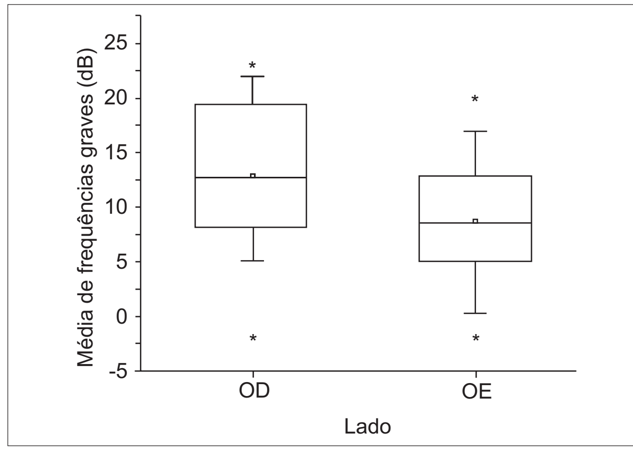

Figure 4. Comparative analysis of the average frequencies for right and left ears in the group of musicians. - RE: right ear: - LE: left ear.

it was observed that more experienced musicians were skilled in identifying the *gap* intervals. This fact combined with the result of this study allowed the coupling of the performance of temporal resolution ability of other factors such as age and time of musical initiation of daily exposure to music.

According to Table 1, the length of musical training ranged between one and 25 years with a mean of 7.25 years. As for age, was 10 years and maximum 48, average 24.6 years old. When considering the average age of participants and the average learning time, it is estimated that the average age of initiation of formal training of musicians was 17.4 years.

Considering the age of initiation Music is responsible for the development and maturation of the auditory areas related to music (14), a survey of neuroimaging studies identified a left hemispheric dominance in the performance skills of PT and concluded that the *pitch* and detection ranges time proved to be lower in subjects with left hemispheric lesion (19). Other studies have also considered the time of initiation and / or musical training as relevant to the performance and skills related to the perception of time (17, 20).

The population size and the possible existence of musicians with change in temporal resolution ability are also factors to be considered. In the group of musicians, the *gap* detection threshold for the maximum OD was 15 ms while the group of no musicians the same measure was 10 ms. The figure shows a correlation of the noise test with the average high frequencies for the group not to musicians, or raising the threshold for high frequencies is directly proportional to gap detection threshold. It is worth mentioning that the group had an average of 9.25 dB for high frequencies of the OD and 8.50 dB for the same frequency band of the LE, the latter being located in the default values of normality. Thus, we highlight the importance of thresholds of high frequencies in test performance GIN. This range of frequency waves has the shortest length whose cells responsible for identifying the time intervals must lie intact. The high frequencies are also more efficient for the detection of gap due to the use of broadband filters to the perception and found that the wider the band, the better the performance of temporal (2, 8). Thus, the elevation of audiometric thresholds of high frequencies may influence the test results GIN (2).

The results shown in Figure 2 show a statistically significant correlation of the GIN test of OD with the average of high frequencies in the OE group of musicians. This finding shows similar results between the group of musicians and no musicians in relation to the relevance of thresholds in the frequencies in test performance GIN (2), is in the ear ipsilateral to the contra lateral, but still cannot explain this relationship.

Figure 3 also shows a statistically significant relationship between duration of daily exposure to music and performance of the GIN test of OE, ie increasing the first variable is directly proportional to the increase of the second representing the worsening performance of temporal resolution. Thus, it is possible to argue that the time of daily exposure to music is not constituted as a facilitator of performance in temporal resolution, perhaps, due to late initiation Music (14).

Figure 4 showed the comparison of average frequencies between the ears in the group of musicians, pointing out that the thresholds of the OD of the group were worse when compared to the thresholds of the OE. The musicians surveyed, exposes the OD to other instruments, as well as other violins, a high sound pressure level that could justify increasing the threshold. A study has 30 musicians exposed to sound pressure levels exceeding 85 SPL and proven change in hearing thresholds in both ears (21). Moreover, a survey of workers exposed to occupational noise also identified worst thresholds in the RE for no apparent reason (22).

In a study involving musicians from the symphony orchestra of Minas Gerais was identified greater hearing loss in high frequencies in the left ear and not the average frequencies as the findings of this study (23). It is worth mentioning that the violin produces waves caused by the vibration of the strings in friction, which spread through his body by providing intensity near 80 SPL whose resonances results in directional spread to high frequencies, relating well with the result the present study (24).

Conclusion

The GIN test performance was not statistically significant compared to the control group. The threshold of high frequencies seemed to be relevant in determining the gap detection threshold for both groups. Besides, this time of daily exposure to music was not constituted as a facilitator of the performance of temporal resolution. Other studies with a larger population and with musicians whose musical initiation occurred earlier are necessary.

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