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Original articles

Difficulties of normally-hearing adults in daily listening situations

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ABSTRACT

Purpose: to verify hearing difficulties related to everyday listening situations self-reported by normally-hearing adults.

Methods: a cross-sectional observational study in which adult individuals with clinically normal hearing, verified through audiometry and tympanometry, were included. The participants answered the Brazilian Portuguese version of the Speech, Spatial and Qualities of Hearing Scale (SSQ) questionnaire. Statistical analysis comprised descriptive and Spearman's correlation test with a significance level of 5%.

Results: the sample consisted of 28 participants, aged between 20 and 44 years. The median SSQ score was 8.75, in the Hearing to Speech domain, 8.11, in the Spatial Hearing domain, and 8.91, in the Quality-of-Hearing domain. There was an association between the participant's age and the score on five questions, demonstrating less self-reported difficulty as age increased.

Conclusion: difficulties in everyday listening situations, self-reported by normally-hearing adults, participating in this study, were more related to situations with competitive noise and listening effort.

Keywords: Hearing; Auditory Perception; Spatial Processing; Adult; Surveys and Questionnaires

A study conducted at the Centro Universitário Planalto do Distrito Federal - UNIPLAN, Brasília, Federal District, Brazil.

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INTRODUCTION

Hearing is commonly measured by means of the pure-tone audiometry (PTA), a reference testing, which enables the classification of the existence, type and degree of the hearing loss[1] through audiometric thresholds. However, PTA is held in an ideal listening environment; thus, it may not be a good predictive measurement of the hearing ability in a real listening environment, which may entail a variety of characteristics, demanding the individuals' identification, location and attention of sound stimuli, in an alternate way, in order for them to keep their communicative competence[2].

The recognition of words in a situation of competitive noise is significantly reduced to the extent that the mean of the thresholds in the PTA increases, even if they are still within normal ranges[3]. Moreover, unfavorable situations related to signal/noise (S/N) directly interfere with speech intelligibility, even among listening individuals[4].

Individuals with the same audiometric configuration may feature completely differing daily communicative needs[1]. In this sense, hearing questionnaires are a complement required for adults' screening regarding their experiences in actual listening situations[5].

The *Speech, Spatial and Qualities of Hearing Scale Questionnaire* (SSQ) was elaborated to assess the abilities and experiences involving hearing in complex daily listening situations[2], translated and adapted to Brazilian Portuguese in 2015[6].

The SSQ comprises 49 questions that assess three domains: (1) Hearing to Speech (14 items), including a series of conversational contexts, such as the situation of competitive noise, reverberation and different sound sources; (2) Spatial Hearing (17 items), entailing listening contexts in relation to direction, distance and movement; and (3) Qualities of Hearing (18 items), comprising items related to sound segregation, recognition and listening effort[2].

Information on the scores obtained in the SSQ by listening individuals may enable professionals to evaluate, in a more attentive way, results of hearing-impaired individuals, setting more real intervention goals, contributing for researchers to understand the influence of non-auditory factors on the hearing ability[7]. Additionally, it can be a referral for groups of normally-hearing individuals, who report some hearing complaints, but, currently, do not feature any hearing impairment; thus, they are not referred to Otorhinolaryngology or Speech-Language Pathology Clinics.

Therefore, this study aims to verify hearing difficulties related to everyday listening situations, self-reported by normally-hearing adults.

METHODS

Ethical issues

This study began after its approval by the Ethics Research Board of the Federal District University Center, Brazil, Certificate for Ethical Presentation (CAAE, in Portuguese) 26509619.1.0000.5650, and register number 3.757.898. The study had observational and cross-sectional design. All participants signed the Free-Informed Consent Form, attesting their participation in the study

Inclusion and Exclusion Criteria

The inclusion criteria adopted were as follows: ages between 18 and 45 years, airway hearing thresholds at frequencies from 250 Hz to 8000 Hz between 0 and 25 dB hearing level, both ears[8], type A tympanogram (static compliance from 0.30 ml to 1.65 ml, and middle ear pressure from -100 to +100 daPa)[9], both ears, and signing of the Free Informed Consent Form.

As exclusion criteria, the presence of self-report and/or diagnosis of neurological disorders or self-report and/or diagnosis of central auditory processing disorder, verified during the interview, were adopted.

Procedures

Data collection was held at the Speech-Language Pathology Teaching Clinic of the Centro Universitário Planalto do Distrito Federal (UNIPLAN), in the city of Brasília, Federal District, Brazil.

All participants underwent screening of the outer ear acoustic meatus (MD otoscope, Mark II 2.5), tympanometry (Acoustic Orlandi AO 400D impedance meter), and search for auditory thresholds at frequencies from 250 Hz to 8000 Hz (GN Otometrics Midimate 622 audiometer).

The participants answered the Brazilian Portuguese version of the SSQ questionnaire[6] ignoring the screening result and guided by the research team. The questionnaire was self-administered by the participants, and a member of the research team was available to clear the participants' doubts on the questions and/or the way to complete it.

For each one of the 49 items comprising the questionnaire, the participant should select, from 0 to 10, his/her observed degree of difficulty in a certain

listening situation. The higher the score, the lower the self-reported difficulty[2,6].

Data analysis

The results were descriptively and statistically analyzed in relation to age and tritonal mean. Due to the abnormal distribution of data, the analysis was conducted by means of median, percentiles and non-parametric tests. Regarding the correlations between the SSQ questionnaire scores and the age and tritonal mean variables, the analyses were conducted by means of the Spearman's correlation test, significance level of 5% ($p<0.05$).

RESULTS

Thirty-one adults agreed to participate in the assessment. From those, three of them were not included in the study for presenting worse thresholds than 25 dB hearing level at frequencies between 4000 Hz and 6000 Hz. Thus, the sample comprised 28 participants (16 females and 12 males), ages between 20 and 44 years (24±5.09).

In the tympanometry, all participants featured Type A tympanograms bilaterally. In the PTA, all participants featured tritonal means (500, 100 and 2000 Hz) between 0 and 11.66 dB hearing level in both ears, median of 5.0 dB hearing level (Q1= 2.91 dB hearing level and Q3= 6.66 dB hearing level) in the right ear, and 5.0 dB hearing level in the left ear (Q1= 1.66 dB hearing level and Q3= 6.66 dB hearing level).

The score analysis was described according to each one of the three domains assessed by the questionnaire.

The score median in the Hearing to Speech domain (part 1) was 8.75 points (Q1=7.31 and Q3=9.25). Questions with the greatest difficulties, that is, with the lowest score medians were Q6, Q10 and Q14, all of them with median of 7.0. Regarding the Spatial Hearing domain (part 2), the score median was 8.11 (Q1=7.80 and Q3=9.56), and Q16 was rated the highest level of difficulty, with median of 7.0. Finally, in the Quality of Hearing domain (part 3), the score median was 8.91 (Q1=7.49 and Q3=9.62), and the worst scores were verified in the medians of Q7, Q14 and Q18, rated 8.0 (Tables 1 and 2).

Table 1. Median scores and percentiles (Q1 and Q3) of each answered questionnaire item

Question	Median part 1 (Q1; Q3)	Median part 2 (Q1; Q3)	Median part 3 (Q1; Q3)
1	9.0 (Q1= 7.75; Q3= 10.0)	9.0 (Q1= 8.0; Q3= 10.0)	9.0 (Q1= 8.0; Q3= 10.0)
2	10.0 (Q1= 10.0; Q3= 10.0)	9.0 (Q1= 7.0; Q3= 10.0)	9.0 (Q1= 5.75; Q3= 10.0)
3	10.0 (Q1= 8.0; Q3= 10.0)	10.0 (Q1= 9.75; Q3= 10.0)	10.0 (Q1= 9.0; Q3= 10.0)
4	8.5 (Q1= 7.0; Q3= 10.0)	9.5 (Q1= 7.75; Q3= 10.0)	10.0 (Q1= 9.0; Q3= 10.0)
5	10.0 (Q1= 8.0; Q3= 10.0)	8.0 (Q1= 7.0; Q3= 10.0)	10.0 (Q1= 9.0; Q3= 10.0)
6	7.0 (Q1= 4.75; Q3= 9.0)*	9.5 (Q1= 8.0; Q3= 10.0)	10.0 (Q1= 10.0; Q3= 10.0)
7	10.0 (Q1= 8.75; Q3= 10.0)	9.0 (Q1= 8.0; Q3= 10.0)	8.0 (Q1= 5.0; Q3= 10.0)*
8	9.0 (Q1= 6.0; Q3= 10.0)	8.0 (Q1= 6.0; Q3= 9.5)	10.0 (Q1= 9.0; Q3= 10.0)
9	9.0 (Q1= 8.0; Q3= 10.0)	8.0 (Q1= 6.5; Q3= 10.0)	10.0 (Q1= 9.0; Q3= 10.0)
10	7.0 (Q1= 5.0; Q3= 9.0)*	8.5 (Q1= 6.88; Q3= 10.0)	10.0 (Q1= 9.0; Q3= 10.0)
11	9.0 (Q1= 7.75; Q3= 10.0)	9.0 (Q1= 7.75; Q3= 10.0)	10.0 (Q1= 8.75; Q3= 10.0)
12	9.0 (Q1= 5.75; Q3= 10.0)	9.0 (Q1= 8.0; Q3= 10.0)	10.0 (Q1= 9.0; Q3= 10.0)
13	10.0 (Q1= 8.75; Q3= 10.0)	9.0 (Q1= 8.75; Q3= 10.0)	9.0 (Q1= 8.0; Q3= 10.0)
14	7.0 (Q1= 5.0; Q3= 8.0)*	9.0 (Q1= 8.0; Q3= 10.0)	8.0 (Q1= 5.0; Q3= 10.0)*
15	-	8.0 (Q1= 5.0; Q3= 10.0)	9.0 (Q1= 5.0; Q3= 10.0)
16	-	7.0 (Q1= 4.0; Q3= 9.0)*	9.0 (Q1= 6.5; Q3= 10.0)
17	-	8.0 (Q1= 5.0; Q3= 10.0)	10.0 (Q1= 8.0; Q3= 10.0)
18	-	-	8.0 (Q1= 5.75; Q3= 10.0)*
Total	8.75 (Q1= 7.31; Q3= 9.25)	8.11 (Q1= 7.80; Q3= 9.56)	8.91 (Q1= 7.49; Q3= 9.62)

*Questions with the lowest scores in each scale; Q1=1st Quartile; Q3=3rd Quartilel

Table 2. Questions with the highest difficulty (the lowest scoring)

Part 1: Hearing to Speech	Part 2: Spatial hearing	Part 3: Qualities of hearing
Q6: "'You're in a group, about 5 people, in a crowded restaurant. You CAN'T see everyone in the group. 'Can you follow the conversation?"	**Q16:** "Sounds from people or things that you can hear but you can't see end up being farther that expected when you see them?"	**Q7:** "When you listen to music, can you tell what instruments are being played?"
Q10: "You're listening to someone talking to you and, at the same time, you try to follow the news on TV. Can you follow what both are saying?"		**Q14:** "Does it take you a lot of focus when you're listening to something or someone?"
Q14: "You're on the phone and someone near you starts talking. Can you follow what is being said by both speakers?"		**Q18:** "Can you easily ignore other noises when you're trying to listen to something?"

Caption: Q=Question

In the analysis to verify the correlation between age and the score obtained in each question of the SSQ questionnaire, five items had positive correlation and statistically significant difference ($p<0.05$), showing less self-reported difficulty as age increased (Table 3).

Table 3. Questions with statistically significant correlation ($p<0.05$) between age and the questionnaire scoring

Domain	Question	Enunciation	P	R
Part 2	Q3	You're sitting between two people. One of them starts talking. Can you immediately tell, without looking, whether it's the person on your right or on your left who is talking?	p=0.004	0.524
	Q6	You're outdoors. A dog barks loudly. Can you immediately tell, without looking, where it is?	p=0.008	0.493
	Q8	On the street, can you tell how far someone is by the sound of his/her voice or the sound of his/her steps?	p=0.040	0.397
	Q12	Can you tell by one's voice or one's steps whether one is coming towards you or walking away?	p=0.026	0.420
Part 3	Q13	Can you easily judge one's mood by the sound of his/her voice?	p=0.029	0.413

Caption: Q=Question
Inferential analysis by means of the Spearman's correlation test, statistical difference for $p<0.05$(*).

No statistically significant difference ($p<0.05$) was observed for the analyzed correlation between the tritonal mean of auditory thresholds by airway in the right or left ears and the score for each question and each domain in the SSQ.

DISCUSSION

The early detection of hearing impairment is fundamental in order to prevent communicative and psychosocial damages, which affect the quality of life. That scenario justifies hearing screening in adults and, in that sense, self-reported questionnaires can be used, as they do not require acoustically controlled environment or specialized equipment and professionals[10].

There is no specific scoring for the SSQ to be used as a parameter for decision making. Therefore, further studies may contribute to establish scores for the questionnaire version in the Portuguese language according to different age groups[11]. In the analysis, it may be useful to assess the score disparities between the different domains of the SSQ in order to evaluate specific aspects in hearing impairment[12].

The current study assessed how adults with normal tonal hearing thresholds perceive everyday communicative situations. The defined age group was delimited so that the aging process could not influence the responses, considering that age increase may be proportional to the increase in the hearing thresholds,

and as hearing thresholds increase, there is greater difficulty in hearing performance[13].

Score average between the assessed domains ranged between 8.1 and 8.9, which corroborated the result of other studies, showing that adults with auditory thresholds within normal ranges do not always obtain the maximum scoring in the SSQ[13-15]. In this study, the lowest score was observed in the Spatial Hearing domain, which was also verified in other studies that assessed adults with normal hearing between 18 and 27 years of age[13,15]. In addition, the domain with the highest score was the Quality of Hearing, with median of 8.91. Likewise, other studies also pointed to better scores in that domain among that population, rating above 8.0[16] and 9.0[13].

The fact that adults with clinically normal hearing rated scores below 10 in the different domains of the SSQ must be taken into consideration in order to assess the scores of hearing-impaired subjects in the questionnaire[15]. In the current study as well as in other studies[15,17,18], the lowest score by individuals with normal hearing was in the Spatial Hearing domain from the SSQ. Studies evidenced that hearing-impaired adults also featured the lowest scores in the Hearing-to-Speech domain of the SSQ, which is the domain with the greatest score discrepancy when compared with groups of normally-hearing adults[5,12,15,17].

The questions where the lowest scores occurred in the current study are also among the lowest scores in a study conducted with hearing-impaired Brazilians[17]. Regarding the Hearing-to-Speech domain specifically, the questions with the lowest scores in the current study were questions 6, 10 and 14. Question 14 also had the lowest rate in a study[19] held with adults between 18 and 25 years old. In another study[5], the authors assessed two groups of adults with normal hearing. One group comprised adults without any disorders in their central auditory processing, and another group with disorders in their central auditory processing (those who featured at least two tests of altered central auditory processing). Questions 6, 10 and 14 are also among the lowest scored ones.

The central auditory processing is responsible for the analysis and auditory perception carried out in the central auditory nervous system and, among its functions, are the sound location and auditory discrimination, in addition to the listening functions during situations with competitive acoustic signals or with attenuation of the acoustic signal[20]. Study conducted in 2020 assessed the abilities of the central auditory processing among 94 adults with normal hearing, average age of 28 years, and pointed that some essential abilities to maintain the quality of a conversational situation were altered, such as the selective attention, auditory pattern timely ordering and auditory closure[21]. Thus, the absence of altered auditory tonal thresholds does not necessarily imply good listening quality in real situations. That is, it is possible that the self-reported difficulties evidenced by the SSQ in individuals with normal hearing, in the current study, are related to the abilities of the central auditory processing, which were not assessed.

In addition to hearing loss, other variables may interfere in the SSQ scores, such as gender, schooling[15] and age[16]. Hearing quality during the activities of daily living depends on inner and outer elements to the individuals[2].

Studies evidenced that as age increases, auditory performance is reduced, even in the absence of hearing loss[13,22]. However, the results in the current study pointed to a positive correlation between age increase and higher scoring (lower self-reported difficulty) in five questions from the SSQ. That correlation between age and SSQ results was not found in another study, which assessed adults with normal hearing[22].

From the five questions that showed correlation to the age, none of them are related to the speech perception in situations of competitive noise. From those, four are related to the abilities of sound location and one of them is related to the auditory discrimination (to identify one's mood by the voice). With the aging process, adults may feature compensations in their auditory speech perception[23,24]. Moreover, it is important to point out that speech perception depends on the sensory, central interaction, and on cognitive factors. In addition, life experiences may favor abilities of memory and auditory attention, determining the listening quality in real situations[24,25]. Therefore, that interaction of factors may have enabled higher scores in those questions by the adult participants in this study, justifying fewer complaints as age increases. In that sense, it is important for researchers to understand that the auditory speech perception goes beyond listening in situations of competitive noise. Moreover, age increase may favor some auditory abilities related to greater cognitive background, which in turn, are favored by listening experiences along one's life.

As formerly mentioned, currently, there is not a definition for the expected scoring of individuals with normal hearing in the SSQ questionnaire. Therefore, the

current study is believed to contribute to such analyses. In addition, it is fundamental to know the scores of that population in the SSQ in order to understand what can be expected from the scores of individuals with hearing loss in the same questionnaire.

One of the study limitations is the fact that no assessment of the central auditory processing was conducted in the participants, despite they did not report any specific complaints in that sense. Therefore, further studies are suggested using the application of the SSQ in normally-hearing subjects, with larger samples, the assessment of the central auditory processing in different age groups in order to verify the influence of age, life experience and cognitive perceptions on the self-reported difficulties in real listening situations.

CONCLUSION

Difficulties in self-reported daily situations by normally-hearing adults, participants in this study, were more related to situations with competitive noise and listening effort. Older adults with normal hearing may feature less self-reported difficulty in certain real listening situations, which raises the hypothesis that other non-auditory resources may influence auditory perception.

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VLDF, MRJ: conception and design of the study, analysis and interpretation of data, preparation of the article, critical review for relevant intellectual content and final approval of the version to be presented for publication;

ABH, DMC: analysis and interpretation of data, preparation of the article;

RML, AMS, VGS: acquisition of data and preparation of the article;

DL: critical review for relevant intellectual content and final approval of the version to be presented for publication.