Aud Vestib Res (2020);29(3):147-155.

RESEARCH ARTICLE

The speech, spatial, and qualities of hearing scale for children-validity of children's responses to a Persian translation

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Received: 17 Jan 2020, Revised: 28 Jan 2020, Accepted: 13 Apr 2020, Published: 15 Jul 2020

Abstract

Background and Aim: Spatial hearing plays an important role in listening in complex hearing situations, including contributing to localization, lateralization, spatial release from masking, distance estimation from a sound source, and perceiving a signal in noise. Questionnaires are useful tools for assessing spatial processing disorder in adults. Given the high prevalence of this disorder in children and that the extent of children's ability in completing questionnaires is not clear, this study aimed to evaluate the response validity of children to the Persian translation of the child version of the Speech, Spatial and Quality of Hearing Scale (PSSQ-Ch).

Methods: The child version of the SSQ was translated into Persian and cross-culturally adapted. The final version was administered to 150 children (6 to 12 years of age) with normal hearing. The children's response validity was evaluated qualitatively and the percentage of valid responses calculated for each of 7 age groups.

Results: Across the three sections, the percentage of valid responses for children under age 10 was minimum 44.4% and maximum 83.3%, and the mode was around 60%. There was no child in the under-10 age group who answered all questions validly. The response validity of children aged 10 or more was higher with a minimum of 93.3%, a maximum of 100% and mode of 100%.

Conclusion: Children ≥ 10 years can reliably respond to the PSSQ-Ch. The response validity of children below 10 years is low; therefore, this questionnaire cannot be used as a self-assessment questionnaire in children below age 10.

Keywords: Spatial hearing; children; validation; self-assessment questionnaire; speech understanding questionnaire; spatial hearing and hearing quality

Citation: Dowlatabadi S, Adel Ghahraman M, Farahani S, Galvin K, Jalaie S. The speech, spatial, and qualities of hearing scale for children-validity of children's responses to a Persian translation. Aud Vestib Res. 2020;29(3):147-55.

Introduction

Spatial hearing means using spatial cues to detect and consider sound sources, and also to perceive the target signal, especially speech, in the presence of background noise [1,2]. In other words, spatial hearing is the ability to use both ears simultaneously to identify the direction of sound

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sources and to ignore sounds coming from other directions [1]. Spatial hearing is the result of binaural processing and plays an important role in the individual's hearing performance, especially in complex hearing environments, and in tasks involving localization, lateralization, spatial release from masking, estimation of distance from the sound source, and signal detection in background noise [3].

Spatial processing disorder (SPD) is a special kind of central auditory processing disorder (CAPD). The main manifestation of SPD is inability to use binaural cues in order to achieve spatial release from masking. Difficulty understanding speech in background noise is the most functional complication in patients with SPD. This problem is not necessarily related to hearing loss and may even occur in children or adults with normal hearing [2,4,5]. Compared to other normal peers, children with SPD usually need significantly higher levels of signal-to-noise ratio (SNR) in order to achieve the same speech reception thresholds (SRTs) [5,6]. The prevalence of CAPD is reported to be 2−5% [4,7], however, the proportion of individuals with SPD in the general population is not exactly known. In a study by Australian Hearing, 19% of children with listening difficulty were diagnosed as having SPD according to the Listening in Spatialized Noise-Sentences (LiSN-S) test [4].

There are various tests and questionnaires available to diagnose and examine SPD. The questionnaires estimate the extent of problems arising from SPD from the perspective of the individual [8]. Currently, the only questionnaire available for spatial hearing evaluation in children is the child version of the Speech, Spatial, and Qualities of Hearing Scale (SSQ). The original version of this questionnaire was designed for adults and was written in English to assess the hearing ability and listening experience in complex everyday situations, which require the use of spatial hearing [9]. Studies using the SSQ indicate the sensitivity of this questionnaire in performance differentiation between different groups, including normal and hearing-impaired individuals, and even between the users of hearing aids and cochlear implants, as well as between individuals with symmetrical and asymmetrical hearing losses [10]. The child version of this questionnaire, the SSQ-Ch, is an adaptation of the adult version by Galvin and Noble. This version, like the original, has three sections of Speech, Spatial, and Qualities of Hearing [11].

Given the high prevalence of SPD in children, and also the shortage of suitable questionnaires for this age group in Persian, it was necessary to cross-culturally adapt and translate this questionnaire for Persian-speaking children. On the other hand, it should be noted that completion of the questionnaire by children is challenging and the ability of children to respond to self-administered questionnaires seems to be different from that of adults. Therefore, it is necessary to confirm the validity of the answers provided by children before determining the validity and reliability that are calculated using the target group score in response to the questionnaire. Therefore, the purpose of this study was to evaluate children's response validity to this questionnaire in different age groups from 6 to 12 years.

Methods

The questionnaire was translated and cross-culturally adapted in six stages according to the first step of International Society for Quality of Life Assessment (IQOLA) project [12]. Having obtained the permission from the author of the questionnaire, English-to-Persian translation of the questionnaire was completed by two non-audiologist experienced translators. An initial version of the common translation was prepared. twelve audiologists, linguists, researchers, and teachers of child literacy were asked to rate the quality of the translation, and cultural and age adaptation of each question on a 100-point scale and write their suggestions and comments, if necessary. The experts confirmed that all items were age appropriate. On the basis of the experts' opinions, some listening situations in the questionnaire were revised to be more culturally appropriate. For example, in the spatial section, "barking of dog" was replaced with "car beep" in question 5 and replaced with "car alarm" in question 13. The average score of the experts to all items in the revised version was 100. The face

validity of the questionnaire was confirmed by 12 experts, 5 parents and 5 teachers of the target group, and 8 children. The final child version of the Persian SSQ (PSSQ-Ch) was translated into English by two other translators and was approved by the original author of the English version of SSQ-Ch. The study was approved by the Ethics Committee of Tehran University of Medical Sciences Code No. IR.TUMS.FNM.REC.1398.004.

One hundred and eighty three male and female students in the age range of 6 to 12 years were considered for the primary study; One hundred and fifty children (57 girls) were eligible for inclusion in this descriptive study according to the criteria of normal hearing thresholds in both ears based on pure tone audiometry (250−8000 Hz), tympanogram type An, monolingual and native Persian speaker, no spatial hearing processing disorder based on the Persian Spatialized Word in Noise test [13], and good or very good results in Literature, Mathematics and Sciences courses. There were 28 first graders, 18 second graders, 18 third graders, 30 fourth graders, 24 fifth graders, and 32 sixth graders. In the pure tone test, all children had normal hearing thresholds (less than 15 dB HL) at octave frequencies of 250 to 8000 Hz. The children were assumed to have no auditory processing disorder based on their educational achievements and other inclusion criteria. The mean score obtained on the Persian Spatialized Word in Noise test by the children in this study was 93.78 (SD = 5.46 and median = 94.60) with minimum 11.82 percent and maximum 100.

Children were asked to complete the Persian version of the questionnaire in a self-assessment manner. To complete the questionnaire, the children were grouped together in a classroom or conference room or school prayer room. To ensure that the children had a clear understanding of the situations in each question, the questions were read to the children and each situation in the questions was elaborated for them. However, the "self-assessment" approach used here did not follow the instructions provided with the original SSQ-Ch. The instructions that come with the SSQ suggests that the child must complete the SSQ under the close supervision of the clinician. The questionnaire had three sections of A) Speech, B) Spatial, and C) Qualities of Hearing. Section A contains 10 questions about speech perception in different noise conditions, in groups, in reverberant environments, and in competing and dynamic speech listening settings. Section B has 13 questions based on the perception of the direction, distance, and movement of sound sources. Section C has 10 questions evaluating Other Qualities of Hearing such as the recognition and segregation of sounds, ease of listening, identifiability of sounds, and naturalness/clarity.

Each question has two types of response options: a numerical rating response (on a 0−10 scoring ruler) or a categorical response (choosing from the three categories of "would not hear it", "do not know", "not applicable") if the listening performance could not be rated. Child response validity meant consistency of his or her answers in the qualitative and quantitative parts of each question. Invalid responses, for instance, included those in which 1) the child provided an answer to both parts of the question; i.e. the child chose one of the options of "Would not hear it", "Do not know" or "Not applicable" in the categorical response, but gave a numerical rating response on the scoring ruler for their performance; or 2) the child chose two of the three categorical responses; or 3) the child gave two numerical rating responses on the scoring ruler. The invalid response shows that the child did not understand the question correctly and failed to provide a valid answer to that question.

The response validity in each of the age groups is been expressed in terms of the percentage of occurrence of valid responses.

Results

Common errors of children in completing the questionnaire were in the form of answering both parts of the question, providing two numbers on the ruler or choosing two categories. 53.57% of 6 and 7-year old children, 72.22% of 8-year old children and 66.66% of 9-year old children answered to both parts of the question, and 17.85% of 6 and 7-year old children, 5.5% of

Table 1. Percentage of children in each age group providing a valid response to each question in the speech perception section of the Persian speech, spatial, and qualities of hearing scale

Question	Age group and size sample						
	6yr n = 11	7yr n = 17	8yr n = 18	9yr n = 18	10yr n = 30	11yr n = 24	12yr n = 32
1	63.6	64.7	61.6	50	96.7	95.8	100
2	72.7	58.8	55.6	77.8	93.3	95.8	100
3	63.6	58.8	44.4	66.7	96.7	100	100
4	81.8	58.8	50	83.3	100	100	100
5	72.7	88.2	50	83.3	100	95.8	100
6	72.7	58.8	50	77.8	100	100	100
7	63.6	82.4	50	66.7	96.7	95.8	100
8	72.7	70.6	55.6	83.3	100	95.8	100
9	63.6	58.8	61.1	72.2	100	95.8	100
10	63.6	52.9	44.4	66.7	100	95.8	100

8-year old children and 22.22% of 9-year old children provide two numbers on the ruler and only 5.5% of 8-year old children had chosen two categories.

The percentage of valid responses provided by the children in each age group for each question of the sections of Speech, Spatial, and Qualities of Hearing questions are presented in Tables 1 to 3 respectively.

The percentage of children who gave a valid response to individual questions in the Speech section was 100% for 12-year old children, at least 95.8% for 11-year old children, and at least 93.3% for 10-year old children. For children younger than 10 years, the percentage of children who gave a valid response to individual questions ranged from 44.4% to 83.3% across age groups. The lowest percentage of valid responses was for questions 1, 3 and 10 (1. You are talking with your Mum or Dad and there is a TV on in the same room. Without turning the TV down, can you understand what your Mum or Dad is saying to you? 3. You are in a group of about five people, sitting round a table. It is a quiet place. You can see everyone else in the group. Can you understand what the group is talking about? And 10. Is it easy for you to talk on the telephone with a friend or your Mum or Dad?). 8-year old children gave the lowest percentage of valid responses for 9 out of 10 questions (Table 1).

The percentage of children who gave a valid response to the individual questions in the Spatial section was at least 93.3% for 10-year old children, at least 87.5% for 11-year old children, and 100% for 12-year old children. For children younger than 10 years of age, the percentage of children who gave a valid response to individual questions, ranged from 41.2% to 81.8%. The lowest percentage of valid responses was for questions 3, 7, and 9 (3. You are sitting between two friends. One of them starts to talk. Can you tell right away if it is the friend on the left or on the right who is talking, without having to look? 7. You can hear a bus or truck. Can you tell whether it is coming towards you or moving away just from the sound? And 9. You can hear

Table 2. Percentage of children in each age group providing a valid response to each question in the spatial hearing section of the Persian speech, spatial, and qualities of hearing scale

Question	Age group and sample size						
	6yr n = 11	7yr n = 17	8yr n = 18	9yr n = 18	10yr n = 30	11yr n = 24	12yr n = 32
1	72.7	58.8	61.1	77.8	96.7	100	100
2	72.7	64.7	72.2	66.7	96.7	100	100
3	54.5	41.2	50	72.2	96.7	100	100
4	81.8	47.1	61.1	66.7	93.3	100	100
5	72.7	52.9	55.6	55.6	93.3	100	100
6	63.6	70.6	55.6	61.1	96.7	91.7	100
7	63.6	52.9	50	61.1	96.7	100	100
8	63.6	64.7	44.4	66.7	93.3	95.8	100
9	63.6	52.9	55.6	61.1	100	100	100
10	81.8	76.5	44.4	66.7	100	95.8	100
11	81.8	70.6	50	66.7	96.7	100	100
12	72.7	70.6	61.1	61.1	100	100	100
13	72.7	58.5	44.4	72.2	100	87.5	100

a bus or truck. Just from the sound, can you tell which direction it is moving (for example, from your left to your right, or from your right to your left)?). For this section, 8-year old children had the lowest percentage of valid answers.

The percentage of children who gave a valid response to individual questions in the Qualities of Hearing section was at least 93.3% of 10-year old children, at least 95.8% of 11-year old children, and 93.8% of 12-year old children. Considering results across sections, the percentage of valid responses for the Qualities of Hearing section across all age groups was generally higher than the percentage for the other two sections. For children younger than 10 years of age, the percentage of children who gave a valid response to individual questions ranged from 44.4 to 100% and the lowest percentage of valid responses was for questions 2, 3, and 4 (2. Think about when you can hear two noises at once, for example, water running into the bath and a radio playing, OR a truck driving past and the sound of knocking at the door. Do you hear these as two separate sounds? 3. Do you know which person in your family is talking just by the sound of their voice, even if you can't see them? 4. You can hear a song you know being played. Is it easy for you to tell what song it is just by listening?). 8-year old children also had the lowest percentage of valid responses in this section.

Overall, there was no child under 10 years of age who provided a valid answer to all questions. In the age group of 10 years and over, more than 90 percent of children's responses to individual questions were valid (with the exception of question 13 in the Spatial section, for which only 87.5% of 11-year old children provided a valid response).

Table 3. Percentage of children in each age group providing a valid response to each question in the other qualities of hearing section of the Persian speech, spatial, and qualities of hearing scale

Question	Age group and sample size						
	6yr n = 11	7yr n = 17	8yr n = 18	9yr n = 18	10yr n = 30	11yr n = 24	12yr n = 32
1	81.8	82.4	61.6	72.8	96.7	100	100
2	72.7	58.8	55.6	66.7	100	100	100
3	72.7	58.8	50	72.2	100	100	100
4	63.6	52.9	44.4	72.2	100	95.8	100
5	72.7	76.5	55.6	72.2	100	100	100
6	81.8	64.7	61.1	72.2	93.3	100	93.8
7	72.7	64.7	72.2	100	93.3	100	100
8	72.7	70.6	55.6	77.8	96.7	100	100
9	72.7	52.9	77.8	94.4	96.7	100	100
10	81.8	64.7	72.2	72.2	96.7	100	100

Discussion

The findings of our study revealed that children over the age of 10 years can provide valid answers to PSSQ-Ch questions in a self-assessment manner. The widest range of valid responses across individual questions in children under 10 years of age was 44.4%−94.4% for the Qualities of Hearing section, followed by 44.4%−83.3%, for the Speech section, and 44.4%−81.8% for the Spatial section. In the age group of 10 years and over, the range of valid responses across individual questions was 93.3%−100% for the Speech section, 87.5%−100% for the Spatial section, and 93.3%−100% for the Qualities of Hearing section.

Various studies have shown that several factors are involved in determining whether any measurement instrument is age-appropriate for the population being evaluated. Some of these factors are: the complexity of the response format, the number of factors to be measured, and the respondent community. For example, in the Anderson et al. [14,15] study, the minimum age for using the Children's Home Inventory for Listening Difficulties (CHILD; 15 questions for children and 15 questions for family members to answer) was reported as 7 to 8 years, whereas when the family members are the respondents, the minimum age of use is reduced to 3 years. In the other part of CHILD questionnaire, the parents judge their child's dynamic communication listening behaviors in situations with different distances and in background noises with 15 items by using an eight-point scale. This questionnaire is appropriate for use with 3−12 years of age children. Kessler et al. [16] reported a minimum age of 8 years for the Hearing Performance Inventory for Children.

For each of the PSSQ-Ch sections, 8-year old children provided the highest percentage of invalid answers. Primary schools in Iran consists of six grades with 1st–3rd grades in First primary school and 4th–6th grades in Second primary school. According to teachers and school principals, children of the final grades in the First (8-year old children) and the Second (11 and 12-

year old children) primary schools are commonly more active and less focused compared to other children. As language skills and abilities of the children of Second primary school are much developed than in children of First primary school, they usually had no problem in understanding the questions and answering the questionnaire. For children of First primary school, in addition to the lower level of language skills, less attention and naughtiness likely contributed to the higher percentage of invalid responses.

PSSQ-Ch administration in Persian-speaking primary school children showed that children over the age of 10 years provided valid answers in all three sections. The highest percentage of valid responses in all age groups occurred for the section of Qualities of Hearing and the lowest percentage of valid responses occurred for the section of Spatial.

For the English version of the SSQ-Ch, it is recommended that the scale can be administered to children with a language age of 11 years or older; this highlights the importance of cognitive and linguistic abilities in children because some children with hearing impairment might be older in terms of chronological age, but have a below average language age so they may not understand the questions [8]. Thus, the results obtained in this study are in line with the opinion of the original author of the questionnaire. There is not much information on child SSQ results in other languages.

These results are also consistent with the results of a Demeester et al. [17] on normal adults. In their study, items that require greater cognitive abilities, such as rapid selective attention, and items that relate to dynamic aspects of auditory processing, such as estimation of distance and perceiving movement of the sound sources have the lowest scores. In contrast, items that require less attention capacity and relate to static aspects of directional hearing have higher scores. Similar results have been also reported by Banh et al. In their study the SSQ was administered to 48 younger (mean age = 19 yr; SD = 1.0) and 48 older (mean age = 70 yr, SD = 4.1) adults with normal audiometric thresholds up to 4 kHz. The younger group have had higher SSQ scores than the older group. Not far from mind that, items that require higher levels of cognitive and/or suprathreshold auditory processing abilities are reported to be particularly challenging by older adults even if their audiometric thresholds are relatively normal; however, none of the participants in their study, could get the maximum score in complex listening situations that require dividing attention, speech understanding in presence of background noise, estimation of the distance and elevation of a sound source, and separating speech from noise and inhibition of their interference [18]. Agus et al. also has reported that, items of SSQ that assess competing speech situation (e.g. listening in multi-talker situations or to two simultaneous targets) had lower scores than other simpler items [19].

It seems that it is not easy for children under 10 to imagine the hearing situations described in these questions and the children are not able to complete the questionnaire on their own. In this study, to complete the questionnaire, the children were grouped together in a classroom or conference room or school prayer room. Having had the questions read aloud, and having had the situation in each question explained, students were asked to complete the questionnaire. Despite the detailed explanation that this questionnaire was by no means a test and each individual's answers were completely personal and unique, each student's responses were strongly influenced by the responses of the other students because students who were next to each other had the same responses.

Given the distribution of invalid responses across all age groups under 10, it seems that, despite the assessment of the content and face validity of the questionnaire by audiologists, linguists, researchers and writers in the area of child's literature, due to insufficient encouragement for children to read books or materials other than their lessons, and elementary students' inability to "read fluently" according to their teacher, it seems likely that sometimes the question was not read correctly by the child. This would lead to invalid answers to the question. According to a study by the International Center for Time Studies, conducted in nine countries around the world,

most of the time devoted to studying between forty-four minutes a day is in Finland [20]. This statistics in Iran is about 14 minutes [21]. According to the Statistical Center of Iran, per capita reading for non-textbooks in students over 15 years, is 18 minutes and eight seconds (https://www.amar.org.ir/Portals/0/amarmozuii/infographics/SARANEH96.pdf). Also according to the National Library and Archives of I.R. Iran, the per capita reading of books in Iran is 12−15 minutes per day in 2018 (https://fbarnamerizi.farhang.gov.ir/ershad_content/media/image/2019/08/788556_orig.pdf).

Completing the questionnaire was time consuming and tedious, and this may have led to low levels of cooperation for some children, such that they did not make an effort to provide valid answers. In addition, the qualitative and quantitative parts of the question sometimes confused the child, thereby leading to invalid responses. Therefore, it is suggested that, in preparing the new version of the questionnaire, the qualitative part should be designed so that the child is more easily able to see when he/she should answer the quantitative part. For example, separate questions could be asked (e.g. this situation occur in your life? Yes/no. Can you hear the sound in this situation? Yes/no), and then provide the rating with the "do not know" option included with the rating scale.

Considering that the questionnaire was lengthy, time-consuming, and tedious for children to complete, it is necessary to design and administer a standardized screening version for children. However, given the vast amount of information that needs to be gathered from children's hearing abilities this tool cannot be used as a clinical diagnostic tool and is merely used to refer children for more accurate diagnostic tests. Moreover, if it is necessary to assess the problems of this age group through a self-assessment questionnaire, it can be suggested that, in designing this kind of questionnaire, videogame or imaging techniques can also be used which are interesting and entertaining for children. However, in general, it seems better that to assess the problems of children under 10 years old from the perspective of parents and teachers.

Conclusion

The finding of this study showed that children over the age of 10 years can provide valid responses to the PSSQ-Ch when administered in a self-assessment format. The PSSQ-Ch cannot be used as a self-assessment method for children under 10 years as the proportion of valid responses to individual questions is low (45 to 80%).

Acknowledgments

This study is extracted from the MSc. thesis of S. Dowlatabadi that submitted to Tehran University of Medical Sciences.

Conflict of interest

The authors declared no conflicts of interest.

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