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Validity and reliability of the Persian version of spatial hearing questionnaire

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Abstract

Background: Our hearing ability in space is critical for hearing speech in noisy environment and localization. The Spatial Hearing Questionnaire (SHQ) has been devised to focus only on spatial haring tasks (e.g., lateralization, distance detection and binaural detection). The aim of the present study was to determine the reliability and validity of the Persian translation of the SHQ (Spatial Hearing Questionnaire).

Methods: Translation and back-translation, reliability, content and construct validity were investigated. Eighty patients with sensory neural hearing loss (SNHL) (52.50% female and 47.5 % male) with the mean±SD age of 49.02±13.60 years completed SHQ, and they were categorized into mild, moderate, moderate to severe and severe groups based on their hearing threshold. Inclusion criteria in this study were the MMSE questionnaire score of higher than 21, good general health, no history of psychiatric disorders, dizziness or vertigo, dementia or alcohol abuse.

Results: The reliability was assessed by Cronbach's alpha and found to be 0.99. Item-total correlation was between r= 0.84 and 0.92. There was a significant difference between the mean score of P-SHQ in the four groups. Based on the factor analysis, two factors were extracted from the questions in P-SHQ: sound localization; and music and speech understanding in noise and quiet. These factors could explain 82.1% and 9.3% of the total variance, respectively.

Conclusion: The present study proved the reliability and validity of the Persian version of SHQ (P-SHQ). This provides a suitable tool for spatial hearing assessment in clinical/research environments.

Keywords: Spatial Hearing, Questionnaire, Validity, Reliability, Persian Language.

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Introduction

Spatial processing includes our ability to focus on sounds coming from one direction and suppressing sounds coming from other directions (1,2). The sound detection and identification are facilitated by spatial processing (3). Binaural hearing make spatial hearing possible (4,5) and is based on ITD (interaural time differences) and ILD (interaural level differences) (6-8). Disorders of spatial hearing include a reduced ability to attend to the signal in the presence of background sounds (9,10). Cameron et al. (2008) noted that spatial hearing disorder causes a decrease in speech perception in noise, in both normal hearing and hearing impaired children (11,12). Some might consider this a special type of central auditory processing disorder (CAPD) (12).

Spatial processing problems can be

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caused by peripheral hearing loss, central hearing loss and cognitive problems (10, 13). The ITD and ILD cues should be conducted correctly by the peripheral auditory system and then interpreted accurately in the central auditory nervous system (14). Therefore, any disruption in the peripheral or central auditory system can lead to spatial processing disorder (10, 15). Additionally, disruption in working memory, attention, speed of information processing and language skills affects the ability of spatial processing (13, 16).

Previous studies have shown that people with spatial processing disorder have difficulties in localization, speech understanding in noise and estimating distance (11, 15, 17-19). Due to the lack of standard protocols, evaluation of impairment, disability and handicap severity of spatial hearing is a complex task. One way to assess the severity of spatial processing disorder is using the questionnaire of Speech, Spatial and Qualities of Hearing Scale (SSQ) (20) and the Spatial Hearing Questionnaire (SHQ) (21), in which the patient is asked to find functions that are affected by the disorder.

In 1995 Gatehouse et al. provided a 38-item questionnaire for assessing disability and handicap associated with the binaural hearing and localization disorders. The questionnaire developers concluded that localization ability is closely related to the capability of hearing speech. The SSQ(Speech, Spatial, and Qualities of Hearing) was developed in 2004 (20). It contains 49 questions and three subscales and measures the correlation between disability and handicap in different hearing environments. The subscales are: 1) The hearing speech which involves the comparisons of the target speaker and participants in the conversation; 2) Directional or spatial hearing and estimation of distance; 3) Other aspects such as sound resolution, understanding, clarity and other listening conditions (20). Based on an interest in binaural hearing in cochlear implant and hearing aid users, another spatial hearing questionnaire (SHQ) was also designed in the late 1990s. The two groups stated independently that there is a need to develop a questionnaire focusing on spatial hearing. The SHQ is comprised of 24 questions and eight different characteristics: Male voices; female voices; children's voices; music; source localization; understanding speech in quiet; understanding speech in noise with target and noise sources from the front; understanding speech in noise with spatially separate target and noise sources (21).

These initial studies showed that the SHQ is valid and reliable and has good construct validity and high internal consistency. It also has a good relation with other psychometric hearing tests (21). The SHQ has been standardized in Dutch(22).

As spatial hearing questionnaires are important tools for assessing the effects of spatial hearing disorder on the patient's function in everyday life and there is not any valid and reliable spatial hearing questionnaire in Persian, developing the Persian version of SHQ is of prime importance.

The International Quality of Life Assessment (IQOLA), approved by WHO, provides some guidance for translating questionnaires into other languages and adapting them into other cultures (23). This questionnaire was translated according to the IQOLA approach. The Persian version of the SHQ questionnaire can be applied by different experts such as audiologists, otolaryngologists, psychiatrists and psychologists. The aim of this study was to translate and validate the Persian version of the SHQ questionnaire.

Methods

Translation and Adaptation

The questionnaire was translated according to the WHO approach (24). Two professional English translators, whose native language was Persian, translated the SHQ questions into Persian. Then, the text was reviewed by three audiologists. In the next step, the questionnaire was back translated into English by two bilingual translators whose native language was English. Back translations were sent to some of the authors of SHQ, Tyler & Perreau. They compared the original SHQ with back translation and recommended some minor changes. The recommended modifications were applied accordingly. For the pre-test, the initial version of the questionnaire was tested on 20 Persians with hearing loss, and some changes were applied based on their responses, and a preliminary version was developed.

Patients

Eighty SNHL participants (52.50% female and 47.5 % male) with an age range of 19 to 73 years and the mean±SD age of 49.02±13.60 years who referred to an educational hospital in Ahwaz were included in the study. Forty two females aged 19 to 69, and 38 males aged 22 to 73 years were tested. The original and similar studies were considered to estimate the sample size. Sample selection was done non-randomly based on the available population. The participants filled in a questionnaire voluntarily and with consent. Patients were divided into four subgroups of mild (26-40dBHL), moderate (41-55dBHL), moderate-to-severe (56-70dBHL) and severe (71-90dBHL) sensory neural hearing loss. There were 20 participants with SNHL in each sub-group.

All the participants were Persian native speakers with at least high school education. Before completing the P-SHQ, participants were invited to complete the MMSE (Mini Mental State Examination) questionnaire. Only those with the MMSE score of higher than 21 participated in this study. Also, participants' basic information such as age, sex and medical history were recorded. Inclusion criteria in this study were good general health, no history of psychiatric disorders, dizziness or vertigo, dementia, or alcohol abuse and good cognitive performance. All participants had used hearing aids for the last three years, but had not received any other aural rehabilitation. They were asked to complete the questionnaire based on life experience without hearing aids. The score of each question in SHQ was from 0 (the situation would be very difficult for the listener) to 100 (the situation would be very easy for the listener)). The researcher ensured that none of the questions were unanswered. Two males and one female were excluded because they did not complete the questionnaires. The average time needed to fill the questionnaire was 15 minutes. This study was approved by the Ethics Committee. All participants signed a written consent before participating in the study.

Statistical Analysis

Kolmogorow-Smirnov test was used to assess the normality assumption for the data. Descriptive statistical analysis was performed to measure the total score of the patients. Internal consistency was calculated by Cronbach's alpha. Cronbach's alpha greater than 0.7 was considered acceptable (25,26). Content validity was assessed by 10 professional audiologists (27). Construct validity was determined by factor analysis. In order to determine the efficiency of factor analysis, the Kaiser-Meyer- Olkin was calculated. As The Kaiser-Meyer- Olkin was greater than 0.50, the sample size was appropriate for using factor analysis. Also, construct validity was assessed by comparing the mean scores of the SHQ among the subgroups. Data analysis was performed using SPSS16 and significance level was considered 0.05.

Results

According to Kolmogorov-Smirnov test, the mean of score was normally distributed in the four groups (p=0.200). The mean±SD for the total score of the SHQ was 50.2±24.33 in males, and it was 53.2±20.31in females. An independent-samples t-test was conducted to compare the mean scores of the SHQ between males and females .There was not a significant difference in the mean scores of males and females (p= 0.552). Also, Pearson correlation coefficient was computed to assess the relationship between the ages and mean

Table 1. Item-total Correlation for Each Item on (P-SHQ)

Item	Item-Total Correlation	Item	Item-Total Correlation
1	.914	13	.915
2	.888	14	.913
3	.894	15	.902
4	.927	16	.925
5	.877	17	.924
6	.889	18	.917
7	.868	19	.919
8	.848	20	.881
9	.911	21	.873
10	.893	22	.913
11	.881	23	.911
12	.854	24	.902

score of the SHQ. No correlation was found between the two variables (= -0.343, n= 80, p= 0. 2).

Reliability

Internal consistency was evaluated by coefficient Cronbach's Alpha, which was 0.99. The item-total correlation was obtained between 0.84 and 0.92 (Table 1). This value of internal consistency and item-total correlation indicate a high reliability.

Factor Analysis

Factor analysis can be used for grouping different questions which might address similar features. In this study before performing factor analysis, the Kaiser-Meyer-Olkin and Bartlett's tests were calculated. The Kaiser-Meyer- Olkin indicates the proportion of variance in the variables that might be caused by underlying factors. A ratio close to 1 indicates that factor analysis can be an appropriate test, and a ratio close to 0 indicates that another form of analysis should be performed (28). In this study Kaiser-Meyer- Olkin value was obtained to be 0.92, indicating that Kaiser-Meyer- Olkin test is appropriate.

Bartlett's test can show the strength of the relation among the variables. Bartlett's test results showed that the factors made of variables were valid (X2 = 4.72, $p<0.05$). Therefore, based on Kaiser-Meyer- Olkin and Bartlett's test, correlation matrix can be explained in the sample group.

Another analysis is communality value that show how much of the variance in the total scores has been accounted by each item. In this study, the communality of each item ranged from 0.84 to 0.96.

There were two factors with eigenvalues greater than 1. Thus, the two factors extracted from the variables could explain 82.1% and 9.3% of the total variance, respectively.

By analyzing the factor structure of the P-SHQ, we found that 12 items loaded on Factor 1, and 12 items on Factor 2. The items in the first factor included Items 13–24 and were related to the sound localization subscale, and the items in Factor 2 included Items 1–12 and were related to music and speech understanding in noise and quiet.

Table 2 demonstrates the eigenvalue, percent of variance and cumulative percent of variance for these two factors. Cronbach's Alpha was 0.99 for Factor 1, and 0.99 for Factor 2.

Rotation of the component matrix for the two factors makes the interpretation of the analysis easier. Rotated component matrix for the two factors is demonstrated in Table 3.

Content validity

Content validity was determined based on the Content Validity Index (CVI). For this

Table 2. Eigenvalue, Percentage of Variance and the Cumulative Percentage of the Variance for the two factors

Factor	Eigenvalue	% of Variance	Cumulative % of Variance
1	19.724	82.182	82.182
2	2.247	9.363	91.545

Table 3. The Rotated Component Matrix for the Two Factors. Questions are categorized according to the factors (in bold) and are shown numerically by item number (n= 80).

Item	Factor	
	1	2
1	.493	.817
2	.463	.814
3	.475	.809
4	.521	.806
5	.374	.894
6	.393	.891
7	.362	.894
8	.369	.862
9	.439	.872
10	.427	.860
11	.408	.865
12	.420	.816
13	.871	.422
14	.893	.397
15	.896	.379
16	.870	.437
17	.885	.419
18	.898	.398
19	.900	.397
20	.846	.404
21	.815	.426
22	.810	.484
23	.800	.491
24	.810	.469

purpose, questions were evaluated by 10 Persian native audiologists. They rated whether the questions could assess the question construct by a 3-point scale. The content validity ratio (CVR) was computed with scores ranging from 0 (no agreement) to 2 (perfect agreement)(29) . Content validity ratio (CVR) was obtained more than 92% for all the questions. CVI was calculated by determining the mean CVR for all of the remaining items (30). In this study, CVI was obtained to be 96%. Therefore, all questions had high content validity.

Construct Validity

The mean and standard deviation of P-SHQ in mild (73.48) 8.77, moderate 66.87(9.05), moderate to severe 45.37(6.33) and severe 20.77 (9.83) hearing loss were obtained. The construct validity was assessed by comparing the mean scores of SHQ in the four groups. One-way ANOVA was used to display SHQ scores differences among the four groups. SHQ means scores differed significantly across the four groups ($F(3, 76)= 153.74$, $p<0.001$). SHQ scores decreased with the increase of hearing loss; the maximum mean scores were obtained in mild hearing loss and minimum mean scores were obtained in severe hearing loss. Tukey post-hoc comparisons of the four groups indicated that SHQ mean scores for severe hearing loss (M= 20.7, SD= 9.83) and moderate to severe hearing loss (M= 4.37, SD= 6.33) were statistically lower than the mild hearing loss (M= 73.5, SD= 8.77)). However, the SHQ mean scores in moderate hearing loss (M= 66.9, SD= 9.05) did not significantly differ from the mild hearing loss group (Table 4).

Discussion

In the recent years, specialists realized the importance of the assessment and monitoring of the rehabilitation of hearing disorder. Spatial hearing disorder does not consist of one single domain. This disorder can affect several aspects of patients' life including: localization, understanding speech in noise and distance estimating.

The aim of this study was to develop the

Table 4. Tukey Post-Hoc Comparisons of SHQ Score in the Four Groups

Groups		Mean Difference	Std. Error	p
Mild	Moderate	6.614	2.719	.080
	Moderate to severe	28.112*	2.719	<0.001
	Severe	52.772*	2.719	<0.001
Moderate	Mild	-6.614	2.719	<0.001
	Moderate to severe	21.497*	2.719	<0.001
	Severe	46.158*	2.719	<0.001
Moderate to severe	Mild	-28.112*	2.719	<0.001
	Moderate	-21.497*	2.719	<0.001
	Severe	24.660*	2.719	<0.001
Severe	Mild	-52.772*	2.719	<0.001
	Moderate	-46.158*	2.719	<0.001
	Moderate to severe	-24.660*	2.719	<0.001

Persian version of the SHQ and compare it with findings from the original English and Dutch version. Dutch versions have already been developed (22), and versions in other languages are currently under development.

As compared to other similar questionnaire such as SSQ that consist of general hearing ability questions, the SHQ specifically emphasizes spatial hearing. In addition, this questionnaire evaluated male, children and female voices. Therefore, it can assess subjective hearing ability in different frequency ranges.

The mean difference of P-SHQ score between the females and males was not statistically significant. In a study conducted by Tyler et al., there were no differences between males and females (21). Therefore, it seems that gender cannot affect the P-SHQ score.

The participants aged 73-19 years. To evaluate the effect of age on the mean scores of the P-SHQ, we computed Pearson correlation coefficient. There was no correlation between the age and mean score of the P-SHQ. This finding was in agreement with the original study of Tyler et al. (21).Therefore, it can be stated that spatial hearing ability was not affected by age.

With respect to internal consistency, the present study showed a high internal consistency for the P-SHQ. The item-total correlation values were 0.84 to 0.92. Therefore, each of the 24 questions was strongly correlated with the total score of Spatial Hearing Questionnaire, and none of the items were removed. These values are close to the original (0.41 to 0.88). The Cronbach's α in the Persian version was 0.99, which is in good agreement with the original study (0.98) and the Dutch (0.98)version(21, 22). These findings recommend that the P-SHQ is a reliable tool to evaluate spatial hearing ability.

In this study, the P-SHQ mean scores were obtained to be 73.48, 66.87, 45.37, and 20.71 in mild, moderate, moderate to severe and severe hearing loss, respectively. All mean scores were lower than the average scores (87%) of the normal hearing participants based on the findings of the perreau et al. study (31). Therefore, P-SHQ is sensitive to differentiate spatial hearing ability in normal and different degrees of hearing loss. Also, the P-SHQ score decreased with increasing hearing loss, showing that spatial hearing ability is influenced by degree of hearing loss.

The Persian version revealed two factors. Factor1 related to localization (item 13-24) and Factor 2 referred to speech and music perception in quiet and noise (item 1-12). Factor analysis in the original article by Tyler et al. showed 3 factors for 24 items: Factor 1(item 13-24) related to sound localization; factor 2 (item 4-12) referred to speech understanding in noise and music listening in quiet; and Factor 3 (item 1-3) accounted for speech perception in quiet. Potvin et al. obtained 4 factors in the Dutch version of the SHQ. Factor 1through 4 consist of speech understanding in noise, sound localization of voice and music source, spatial hearing of other sound sources and speech understanding in quiet, respectively.

Although the SHQ consists of eight subscales for binaural hearing, the data from listeners with SNHL represented two different factors that can explain their responses. It seems that the SHQ subscales overlap partly on these factors. Further work with more population should be conducted to document which factors are related to spatial hearing.

In the present study, the communality value was 0.84 to 0.96. In the Dutch version, the communality value ranged from 0.78 to 0.96(22) . The original study by Tyler et al. showed this value to be between 0.55 and 0.91(21). High values communality indicates that questions fit well with the factors of spatial hearing and should be remained in the analysis.

The mean score of P-SHQ revealed a significant difference between all groups distinguished by the severity of the hearing threshold loss except between mild and moderate hearing loss. It seems that some of the subscales in spatial hearing did not differ in mild and moderate hearing loss.

Higher scores on P-SHQ were obtained in mild hearing loss, and lower scores were seen in severe hearing loss. Thus, the greater hearing threshold loss, the more difficulties people experience in spatial hearing. The results here showed that the SHQ is an appropriate instrument to detect function difference attributed to the degree of hearing loss. These findings provide further evidence of SHQ validity. Tyler et al. reported that the SHQ is a sensitive test to distinguish spatial hearing ability between unilateral and bilateral cochlear implant patients. Potvin et al. found a significant difference between asymmetric and symmetric hearing loss for the total score of SHQ. Also, the Dutch version of the SHQ revealed a low correlation between the symmetric and asymmetric hearing loss group.

In this study, we found that the Persian version of the SHQ is administered easily and quickly. Further, we found that P-SHQ can be used to explore spatial hearing in less than 15 minutes and easier than behavioral methods.

Due to the lack of access to tools for evaluating spatial hearing ability in clinics, it is necessary to use subjective outcome measures. The P-SHQ is useful for determining the degree of disability due to localization and spatial hearing disorders.

Limitations

This study was limited to the evaluation of P-SHQ in different degrees of SNHL and cannot be generalized to other hearing disorders. The sample size was small and therefore the finding should be interpreted with caution. Also, sample homogeneity may be another limitation. Despite these limitations, the results of the present study could help audiologists to have a valid and reliable spatial hearing evaluation. To reach stronger conclusions about the potential clinical benefits of P-SHQ, we recommend further research, particularly in different types of hearing disorder.

Cconclusion

In conclusion, the P-SHQ is a valid and reliable instrument for spatial hearing assessment. P-SHQ can be used for both clinical and research purposes and distinguish between different degrees of hearing loss problems and therefore is useful for monitoring hearing rehabilitations effects.

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