The Validation of a New Online Inventory for Assessing Spatial-Hearing Abilities

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Introduction

In this study we developed and validated the Inventory of Spatial Hearing Abilities (ISHA) with the following goals:

- Reduce response biases and improve response accuracy by including questions about behavior instead of only questions about perception.
- Facilitate recall of experiences with images
- Reduce the risk of response anchoring and carry-over effect by using verbal answers instead of numeric and avoiding consecutive questions that used the same answer alternatives (Krosnick et al., 1996; Hunter & Barge, 2012).

The design and analyses of the ISHA were conducted using the probabilistic (Bayesian) Item Response Theory (IRT).

To further validate the ISHA we compared the results with the Speech and Spatial Qualities questionnaire (SSQ) (Gatehouse and Noble, 2004)

Methods

Subjects

78 participants divided in 9 groups, including individuals with normal hearing, unilateral, asymmetric, or symmetric sensorineural hearing loss, hearing-aid wearers and non-wearers.

Experimental Design

- Various spatial-hearing abilities were assigned for each question of each questionnaire (Az-azimuth, D-distance, L/R- left-right discrimination, F/B-front-back discrimination, U/D-up-down discrimination, SSA-spatial selective attention)

Questionnaires

- ISHA – 27 questions on spatial-hearing abilities. Verbal answers and images.
  
Example:

- SSQ-S – 17 questions on spatial-hearing abilities. Used 0-10 rating scale. Previously validated questionnaire.
  
Example:

Data Analyses – (IRT) model

Participants completed online versions of the ISHA and the SSQ-S

Results

Sensitivity to effects of hearing loss and hearing aids

- Azimuth, Distance, and L/R, showed expected group differences when comparing most of the hearing impaired groups with the normal hearing group in both questionnaires.
- For two other abilities, F/B and SSA, significant differences between the normal hearing and various hearing impaired groups were observed with the ISHA, where none were found with the SSQ-S.

Figure 1. Mean spatial-hearing abilities, relative to the NH group, inferred using the SSQ-S and the ISHA for the different participant groups

Correlations between ISHA and SSQ-S

- Spatial-hearing abilities inferred using the two questionnaires were significantly correlated. As much as 66% of the inter-individual variance in ability inferred using one questionnaire could be accounted for by the ability inferred using the other.

Figure 2. Scatter plots (mean +/- SD) of individual inferred abilities for the ISHA versus the SSQ-S.

Results (cont.)

- The IRT framework allowed us to quantify the relative sensitivity and difficulty of each question. Questions with boxes above the dotted line on the top graph are more sensitive to spatial-hearing deficits (e.g. question 26) and questions with boxes below the dotted line on the bottom graph indicate increased difficulty (e.g. questions 4 and 11).

Figure 3. Posterior-distribution summaries for the relative sensitivity (!) and difficulty (") of each ISHA question measured using the IRT model. Dashed lines indicate the mean across all questions, which was set to 0 for the difficulty parameter, and to 1 for the discrimination parameter.

Conclusions

- The ISHA is a valid and useful tool that should be considered for use in research that investigates spatial hearing ability.
- IRT models provide a useful tool for the design and the evaluation, or validation, of questionnaires in hearing science and audiology.

References