Adaptation of the Speech, Spatial and Qualities of Hearing Scale for use with
children, parents, and teachers

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Abstract

Subjective assessment of hearing ability in everyday life complements more objective forms of evaluation. A broad evaluation of the additional benefit provided to children by a second bilateral cochlear implant required such an assessment. As no paediatric tool provided detailed evaluation of performance in the areas of daily listening in which benefit was likely to be demonstrated, an adult questionnaire was adapted. Items of the Speech, Spatial and Qualities of Hearing Scale (SSQ) focused mainly, although not exclusively, on hearing functions requiring the binaural system (Gatehouse & Noble, 2004; Noble & Gatehouse, 2004). The adapted child, parent and teacher versions of the SSQ retained the structure of rating listening performance in everyday scenarios across the domains of speech perception, spatial hearing, and other qualities of hearing. Modifications were minimised, although deletion of some items and wording changes were required, and some subdomains could not be included. Observation periods were introduced so that parents and teachers observe performance prior to providing ratings. The suggested minimum age is 11 years for the child version and 5 years for the parent and teacher versions. Instructions indicate interview-style administration in which interpretation of the described listening scenarios can be clarified and use of the ruler-style response format demonstrated. Researchers applying the SSQ for Parents have reported higher performance ratings for bilateral over unilateral cochlear implants, particularly in the spatial hearing domain. Further research should provide evidence for the target age range, compare child and parent responses, and evaluate modifications for use with younger children.

Background

Subjective assessment of hearing ability in everyday life is a useful complement to more objective forms of evaluation. An appropriately designed questionnaire inquires about realistic situations that may be almost impossible to reproduce in the laboratory. Such information gives insight into how limitations on access to auditory information and/or particular deficits in auditory skills are experienced as disabilities by an individual in their daily activities. When interventions such as hearing aid fitting or training are provided there is the opportunity to measure if changes in access or skill level are experienced as benefits by the individual in everyday life. Previous authors have emphasised the value of collecting

information via questionnaires (Cox, 2003; Weinstein, 1997) and discussed their specific application with children (Arlinger, 2001; Bagatto et al., 2011; Stelmachowicz, 1999).

The Speech, Spatial and Qualities of Hearing Scale (SSQ; Gatehouse & Noble, 2004; Noble & Gatehouse, 2004) was originally developed in adult clinical samples and has become recognized as a broad-ranging measure of auditory abilities (cf. Singh & Pichora-Fuller, 2010). The prompt to adapt the SSQ for use with the paediatric population was a research project initiated in 2003 to evaluate the benefits of sequential bilateral implants in children aged 5 to 10 years¹. There was very limited information in the literature at that time as to the additional benefits which may be available to children through the use of bilateral implants. It was therefore considered essential that a broad assessment protocol be implemented with this relatively novel group of recipients so that evidence-based selection criteria and guidelines for pre-operative and post-operative counselling could be developed. A “broad” assessment protocol would need to include a tool for collecting subjective reports of performance in everyday life for the reasons outlined in the previous paragraph, and also because such data are invaluable for informing pre-operative counselling and post-operative management. In 2003, numerous paediatric self-report tools existed which were well-suited for other purposes (see reviews by Ching et al., 2007 and Bagatto et al., 2011), however, there was no paediatric tool which provided a detailed assessment of the areas of daily listening performance which were likely to benefit from the provision of a second cochlear implant. A review of the intent and proposed uses of the adult SSQ, as described below, indicated that an adaptation of that questionnaire for use with the paediatric population would be most suited to the purpose.

The SSQ was designed to evaluate the effects of a deficit in hearing in real-world listening environments. Such environments are often challenging, with sound sources potentially occurring in multiple directions and overlapping with one another. They are also dynamic in nature, with sound sources moving around and often changing rapidly. Effective functioning in such environments requires that the listener is able to identify and focus on the sound or sounds of interest, switching attention between them as required. At the same time, the acoustic environment must be constantly monitored for the occurrence of new sounds to which the listener may need to attend. When a new sound occurs, the listener must locate its source, assess its importance, and, if required, switch attention to it. Gatehouse and Noble

¹ Research participants were recruited from children attending The University of Melbourne/Eye and Ear Hospital Cochlear Implant Clinic. Prior to this research project the Clinic had only offered bilateral implants to adults. Bilateral implantation is now a clinical treatment option and there is no age range restriction.

(2004) noted that performance of these tasks draws heavily on binaural hearing, and that the items selected for inclusion in the SSQ focused mainly, although not exclusively, on hearing functions for which the binaural system was essential.

Evidence that items of the SSQ did indeed tap into dynamic binaural hearing functions was provided by an analysis of results from respondents with inter-aural asymmetry (Noble & Gatehouse, 2004), with unilateral versus bilateral hearing aid fitting (Noble & Gatehouse, 2006), and unilateral versus bilateral cochlear implantation (Noble et al., 2008; 2009). The significance of dynamic binaural hearing was shown in a report that involved a novel test of binaural masking level difference (Gatehouse & Akeroyd, 2006). In contrast to traditional tests of this function, using acoustically stationary signal and masking sounds, a masker was constructed whose phase relations varied rapidly and systematically over time. It was found that performance on this test correlated with dynamic speech listening items on the SSQ, whereas there was no correlation between such items and performance on a traditional masking level difference test. Ratings obtained with the SSQ have been used to compare outcomes for different groups or treatments, including patients with profound unilateral hearing loss following acoustic neuroma surgery versus those with normal hearing (Douglas et al., 2007), pre-operative versus post-operative cochlear implant recipients with single-sided profound hearing impairment and intractable tinnitus (Vermeire et al., 2009), users of a bone-anchored hearing aid with single-sided versus bilateral hearing loss (van Wieringen et al., 2011), and linked versus unlinked processing in bilateral hearing aid fittings (Smith et al., 2008).

Adaptation of the original adult SSQ

Structure of the original SSQ

The adult SSQ assesses ability across three general domains:

- *Section A: Speech* – speech perception in different noise conditions, in groups, in reverberant environments, in competing and dynamic speech listening settings.
- *Section B: Spatial Hearing* – the perception of the direction, distance, and movement of sound sources.
- *Section C: Other Qualities of Hearing* – the recognition and segregation of sounds, ease of listening, identifiability of sounds and naturalness/clarity.

In all sections, most items begin with a description of a specific listening scenario. The respondent is then asked to use a 10-point scale, presented as a ruler, to rate their performance or experience in the scenario described. A sample item and the 10-point response scale are presented in Figure 1.

You are talking with your child person. There is a continuous background noise, such as a fan or running water. Can your child follow what you say?

(i)

Would not hear it

Do not know

Not applicable

Figure 1: Sample item from the speech section of the SSQ for Parents and the 10-point response scale.

Adaptation for the paediatric population

In adapting the original SSQ for the paediatric population the aim was to produce one version for children, one for parents, and one for teachers, making as few modifications to the intent of the items and the structure of the scale as possible. The basic structure of the SSQ, in terms of the three general domains covered and in terms of the format of the items and the response scale, remained the same in the paediatric versions.

Modifications made to the original SSQ

Adapting the SSQ for the paediatric population involved removal of listening scenarios that are not applicable to children (e.g., being the driver of a car), and modifying other scenarios to better reflect a child's lifestyle (e.g., changing the setting of items about conversations in a restaurant). The alternative of "Do not know" was also included as a response option in each item for the circumstance in which the respondent felt unable to provide a rating. Further changes specific to the SSQ for Children were simplifying the wording of some items, and

removing items that were likely to be difficult for those with significant hearing loss from early childhood (e.g., items regarding the “naturalness” of sounds). Of the 49 items comprising the standard version of the SSQ (5.6, available at <http://www.ihr.mrc.ac.uk/products/display/ssq>), 33 remained in the SSQ for Children.

Further changes specific to the SSQ for Parents and the SSQ for Teachers were the modification of the wording of all items, the deletion of some items, and the inclusion of observation periods, as described below. The wording of all items was modified because the respondent was rating the listening performance of the child rather than providing a self-rating. Items which were very difficult to answer on behalf of another (e.g., the item which asked if the listener missed the start of a new speaker in a group conversation) were deleted. Additional items were deleted from the SSQ for Teachers because they related to scenarios not relevant to the school setting: telephone use and identifying speaker location within the home. Of the 49 items comprising the standard version of the SSQ, 23 remained in the SSQ for Parents, and 21 remained in the SSQ for Teachers. Observation periods were included to maximise the accuracy and reliability of the performance ratings. In these periods, the parent or teacher observes the child in the types of listening scenarios for which they will subsequently provide a rating. A further change specific to the SSQ for Parents only was the inclusion of additional parts to each item which addressed the frequency and importance of each type of listening scenario. The parent was asked to indicate how often each type of listening scenario occurred for the child and how important they considered it to be for the child either to have or to develop the requisite listening skills. Gathering this additional information allows consideration of whether an intervention has resulted in improvement in performance in the types of listening scenarios which are experienced frequently by the child, and/or which the parent considers to be important.

As noted previously, Gatehouse and Akeroyd (2006) formulated a set of 10 subscales for the adult SSQ. Gatehouse and Akeroyd classified 44 of the items into these subscales, with between 2 and 9 items in each subscale (refer to Table 1). The percentage of items retained in each subscale when the adult version was adapted to produce the paediatric versions is presented in Table 1. In the SSQ for Children, at least 50% of the items were retained from the adult version for nearly all subscales, indicating that the majority of areas covered by the original SSQ were also covered by the SSQ for Children. The exceptions were “Multiple speech stream processing and switching”, for which only one out of three items was retained, and “Sound quality and naturalness”, for which no items were retained due to the likely

Table 1: Subscales formulated for the original SSQ (Gatehouse & Akeroyd, 2006), the number of items included in each subscale from the original SSQ, and the percentage of these items retained in the SSQ for Children, the SSQ for Parents, and the SSQ for Teachers.

Subscale	No. of items from original SSQ	% of items retained from original SSQ		
		SSQ for Children	SSQ for Parents	SSQ for Teachers
Speech in quiet	2	100	100	100
Speech in noise	4	100	100	100
Listening effort	3	100	100	100
Localization	6	83	83	67
Identification of sound & objects	5	80	60	60
Segregation of sounds	3	67	67	67
Speech in speech contexts	4	50	50	50
Distance and movement	9	78	11	11
Multiple speech stream processing & switching	3	33	0	0
Sound quality & naturalness	5	0	0	0

difficulty for children with early onset hearing loss in rating if sounds were “natural”. In the SSQ for Parents and the SSQ for Teachers, at least 50% of the items were retained from the original SSQ for most subscales, again indicating that the majority of areas covered by the adult version were also covered in these versions. The exceptions were “Multiple speech stream processing and switching” and “Sound quality and naturalness”, as well as “Distance and movement”. These are areas in which it would be difficult to assess the performance of a third person.

Determining the appropriate age range for administration

There are a number of factors which are important in determining the appropriate age range for a tool designed to subjectively measure children’s listening performance; these include the respondent, the number and type of scenarios in which performance is being measured, and the complexity of the response format. With regard to child respondents, a review of assessment procedures for paediatric hearing aid fitting outcomes indicated that children can provide useful information from between 8 and 10 years of age (Arlinger, 2001). For example, the recommended minimum age of administration is 7 to 8 years for the Children’s Home Inventory for Listening Difficulties (Anderson & Smaldino, <<http://successforkidswithhearingloss.com>>) and 8 years for the Hearing Performance Inventory for Children (Kessler et al., 1990). For a tool which contains more specific items and/or a more complex response format, an older age range has been recommended. The APHAP (Auditory Profile of Hearing Aid Performance; Cox et al., 1995) was modified for use with children and trialled with a group aged 10 to 16 year old (Kopun et al., 1998). The difficulty experienced by some participants led the authors to conclude that it was unlikely to be suitable for children under 10 years. Regarding the SSQ for Children, the first author’s research team has not administered the scale to any children with hearing loss younger than 11 years, and considers that the reliability of the self-ratings may be reduced for younger children. The team’s experience has indicated that adolescents over the age of 14 years are capable of understanding the items and rating their own performance. Adolescents between the ages of 11 and 14 years are less consistent in their ability to complete the scale due to individual variation in cognitive and language abilities. As noted by Anderson and Smaldino (<<http://successforkidswithhearingloss.com>>), it is always necessary to consider the age, maturity and comprehension of the individual child. Given the length, specificity of the items, and complexity of the response format, this minimum age of 11 years for the SSQ for

Children is consistent with the literature discussed above. Nevertheless, further work is required to provide evidence-based recommendations for the minimum target age, which may prove to be lower than 11 years.

When a parent or other adult is the respondent, subjective measures of performance via a questionnaire can be obtained on behalf of significantly younger children. Although self-ratings are not being requested, other difficulties come into play when rating the abilities of younger children. They are more likely to have inconsistent listening and other behaviours so that it is more difficult to provide a reliable rating of performance. Additionally, it can be difficult to separate language limitations from hearing limitations when rating performance on more complex speech perception tasks. Not surprisingly, therefore, questionnaires administered to the parents of very young children assess relatively broad listening behaviours, and include fewer items and a more limited number of response options than do questionnaires for older children. Examples include the Parent Evaluation of Aural/Oral Performance of Children (PEACH), which has been applied with children as young as 4 months (Ching et al., 2007), and the Infant/Toddler – Meaningful Auditory Integration Scale (IT-MAIS; McConkey Robbins et al., 2004).

For longer and more detailed scales, use with the parents of school-age children has been recommended. Examples include the Auditory Behaviour in Everyday Life Scale (ABEL; Purdy et al., 2002), the Children's Home Inventory for Listening Difficulties (CHILD; Anderson & Smaldino, 1999), the Hearing Performance Inventory for Children (HPIC; Kessler et al., 1990), and Meaningful Auditory Integration Scale (MAIS; Robbins et al., 1991). For the first two questionnaires, the recommended minimum age includes pre-school children aged from 3 years (for the CHILD) or 4 years (for the ABEL). Compared with the SSQ for Parents and the SSQ for Teachers, most of the listening behaviours evaluated in the ABEL are relatively simple, as is the response format; the respondent is only required to select one of seven options to indicate the frequency with which the specified behaviour occurs. The items contained in the CHILD are more similar to the specific style of item in the SSQ, and there is actually some overlap in item content. The CHILD does, however, include fewer items, and has a response format which respondents are likely to find easier to use than that of the SSQ. Published studies using the CHILD include only parents of children aged from 5 years (Condie et al., 2002) so that there is no information in the literature regarding its administration with the parents of children aged 3 or 4 years. The first author's research team has not applied the SSQ for Parents or the SSQ for Teachers with parents or

teachers of children younger than 5 years of age. Given the complexity of the items and of the response format of the SSQ, this suggested age limit of 5 years is reasonably consistent with the age recommendations in the literature for other parent questionnaires evaluating children's listening performance. Again, further work is needed to provide evidence-based recommendations for the target age range.

Administering the pediatric SSQ

Observation periods in the SSQ for Parents and the SSQ for Teachers

When administering the SSQ for Parents or the SSQ for Teachers, an observation period is included prior to the administration of each section. At the start of each observation period, a list of the relevant listening scenarios is provided to guide the parent or teacher in their observation of the child. In the first author's experience, one week is a reasonable observation period for each section of the SSQ. The interview to collect the ratings for that section of the SSQ is then conducted and the observation period for the next section begins. Completion of the three observation periods and the three sections of the SSQ would therefore require a minimum of three weeks and four points of contact with the parent or teacher. This does limit the applicability of the parent and teacher versions for clinical purposes, however the importance of the observation periods has been repeatedly emphasised via parental feedback. Many parents have indicated that they had not previously considered their children's listening performance in some of the listening scenarios included in the SSQ for Parents, particularly some of those in the spatial hearing section and the other qualities of hearing section. As such, they would be unlikely to provide an accurate rating without the observation periods. Very limited experience has been gained with administering the SSQ for Teachers, so the importance of the observation periods for this group has not been established; it can be reasonably assumed, however, that teachers are also likely to have not considered children's listening performance in some of the scenarios included in the scale. It is vital that parents and teachers do not provide training to the child during the observation period. Explaining the purpose of administering the SSQ and how the data will be used will help to emphasise why training must not be provided.

When instructing the parent or teacher on the conduct of the observation period, the administrator should:

- Clarify that the purpose of the observation period is to:

- Provide the opportunity to observe the child's listening performance in the scenarios described in the scale.
- Note the frequency of occurrence of these types of listening scenarios (for the parent version).
- Emphasise that training or help to improve performance must not be provided.
- Specify the length of the observation period.
- Provide the relevant list of listening scenarios and review each listening scenario to ensure correct interpretation, noting the following:
 - Unless explicitly stated otherwise, the speech perception items refer to face-to-face communication at 1 metre distance at normal conversational levels (around 65dBA).
 - In the SSQ for Parents, the item regarding the frequency of occurrence relates to the type of scenario described, not just to the exact scenario.

Format of administration

The paediatric versions of the SSQ should be administered interview-style rather than self-completion. Gatehouse and Noble (2004) recommended a face-to-face interview for the adult version, and this is also far preferable for the SSQ for Children. Given the requirement for multiple points of contact, it is only realistic to expect that the SSQ for Parents and the SSQ for Teachers will be administered in a telephone interview. An interview provides the opportunity to ensure each item is correctly interpreted, and allows for the collection of any additional information. The respondent should view the written items and the response ruler during the interview. Either the respondent or administrator may record the responses.

Instructing the respondent

The sample item provided in the scale should be used to demonstrate how to answer the items. The following points should be emphasised at this time (and repeated if required when later obtaining the ratings):

- A mark can be made anywhere on the ruler to indicate the rating out of 10 representing typical performance in the scenario described; responses are not restricted to whole numbers.
- If no rating can be provided, the respondent must select one of the alternative response, i.e.:

- “Would not hear it” if the target voice or sound would not be detected in the scenario described.
- “Do not know” if the respondent is unable to provide an accurate rating.
- “Not applicable” if the scenario is not experienced by the child.

Obtaining the ratings

For each item, the administrator should ensure that the respondent has correctly interpreted the description of the listening scenario. Respondents should be encouraged to provide a rating of typical performance without restrictions, if this can be done accurately. Additional information relevant to the response should be noted.

Data collected previously with the paediatric versions of the SSQ

There is a limited amount of published data using the SSQ for Parents or the SSQ for Children. All studies involved a within- or between-subjects comparison of performance with one versus two cochlear implants. Initial data has been reported from the administration of the SSQ for Parents pre-operatively and post-operatively to parents of young adults and children over five years of age who received sequential bilateral implants (Galvin et al., 2007a; Galvin et al., 2007b). The most consistent and largest increases in pre- to post-operative ratings for individuals were shown on the spatial section of the SSQ and on the items relating to understanding conversation in groups without visual cues; improvements in other areas were also shown by some individuals. Longer-term data is currently being collected and the SSQ for Children is being administered to older participants when cognitive and language abilities are suitable. The SSQ for Parents has been applied in three other published studies (Beijen et al., 2007; Lovett et al., 2010; Sparreboom et al., online 2012)². Between-groups comparisons indicated significantly higher ratings for the bilateral group on the spatial section in all three studies, and on the speech section in one study (Lovett et al., 2010). A within-subject comparison indicated a significant increase in pre-operative to 24-months post-operative ratings for all three sections (Sparreboom et al., online 2012). Interestingly, the youngest children in these studies were just 2.5 years (Beijen et al., 2007), 2.4 years (Sparreboom et al., online 2012), and 18 months (Lovett et al., 2010). In the former two studies, sufficient demographic detail was provided to indicate that around half of the

² Beijen et al. (2007) and Sparreboom et al. (2012) used the parent version of the paediatric SSQ as translated into Dutch by the Division of Experimental Otorhinolaryngology at Katholieke Universiteit Leuven, Belgium. Other groups have produced Norwegian, Danish, Korean, and Spanish translations.

participants were younger than 5 years of age, at least at the initial administration of the SSQ. The administration of the SSQ for Parents in these three studies has provided important information regarding the functional benefit of a second cochlear implant for children of a range of ages, including those less than 5 years. Nevertheless, additional research is still needed to clarify the limitations of evaluating the performance of young children using such a complex questionnaire. For example, the group evaluated by Lovett et al. (2010) had the highest mean age and included older participants (up to 16 years), and it was the only group for which a bilateral benefit was shown on the speech section. The likelihood of detecting a bilateral benefit for the speech section may have been reduced in the other studies due to the increased difficulty of accurately rating the performance of younger children in areas such as “following a group conversation”. Furthermore, for within-subject comparisons, the inclusion of younger children increases the chance that the measurement of an intervention effect over time is confounded by developmental change; although this problem is not unique to the paediatric versions of the SSQ.

Future research

In order to explore the application of both the SSQ for Children and the SSQ for Parents with a wider age range, the first author’s research team has initiated a study involving children with normal hearing. This study will also provide comparative information on how parents and children perceive the performance of children with normal hearing in the listening scenarios in the paediatric versions of the SSQ. Optimally this work will be extended to include administration of the SSQ for Teachers, as very little experience has been gained with this scale so far. Potential directions for future research include trialling the changes suggested by clinicians who have administered the SSQ for Children and the SSQ for Parents. These suggestions include using pictures to accompany or replace the text of the items, reducing the number of response options, and/or replacing the ruler with descriptive terms. These changes, if implemented, are likely to increase the suitability of the paediatric versions for younger children.

The paediatric versions of the SSQ can be obtained by emailing the first author.

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