Auditory disabilities, individual fitting targets, and the compensation power of hearing aids

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There is lack of a systematic approach how to select an adequate hearing aid and how to evaluate its efficacy towards the personal needs of rehabilitation. The goal of this study was to examine the applicability and added value of two widely used self-reporting questionnaires (COSI and AVAB) in relation to the evaluation of hearing aid fitting. We analysed responses from 740 subjects who filled in the questionnaires pre and post hearing aid fitting. Results show a moderate to strong correspondence between COSI scores for overall degree of change and final ability. Most COSI responses are at or near the maximum possible score and show slight differences in overall scores considering the effect of hearing aid experience or hearing loss. AVAB results reveal a more refined evaluation of the hearing aid fitting. Combining the advantages of both methods results in a profound evaluation of hearing aid rehabilitation. Our results suggest that both methods should be used complementary, rather than separately.

INTRODUCTION

A patient's personal experience and judgement are known to be essential factors in the rehabilitation with hearing aids. Self-reporting questionnaires are by design very suitable methods to collect and assess such information. The Amsterdam Inventory for Auditory Disability and Handicap (AIADH), developed by Kramer *et al.* (1995) is an example of a questionnaire to assess hearing disabilities in daily life with a high reliability and validity (Meijer *et al.*, 2003). In this study we used a slightly adapted version of the AIADH, called AVAB (in Dutch: Amsterdam Questionnaire for Auditory Disabilities), resulting into a six dimensional profile: detection of sounds, speech in quiet, speech in noise, auditory localization, sound discrimination, and noise tolerance (Dreschler and de Ronde-Brons, 2016). Not only could the characteristics of the AVAB be advantageous in selecting and fitting a hearing aid according to the specific needs of a patient, it might also be an adequate tool for evaluating the benefit of a hearing aid with respect to different aspects of auditory functioning (see also Fuente *et al.*, 2012).

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AVAB is a questionnaire limited to a fixed list of general listening conditions, which are not necessarily applicable for each patient. This could be considered an important drawback. Alternatively, Dillon *et al*. (1997) introduced the Client Oriented Scale of Improvement (COSI) for the evaluation of hearing aids, which makes use of personally defined targets for rehabilitation. This makes COSI very useful for individual patients, but complicates the comparison of needs or benefits for groups of patients. To overcome the problem of low comparability between individual targets, Dillon *et al*. (1997) proposed to categorize each target into a total of sixteen pre-designated categories. Zelski (2000) showed a high level of inter-observer agreement in assigning COSI targets to those categories, but concluded that the amount of categories could be reduced. It has been shown by Dreschler and de Ronde-Brons (2016) that individual COSI targets can be categorized to match the same six dimensions as the AVAB auditory disability profile. This opens the possibility to compare individual hearing disabilities (AVAB) and individual compensation targets (COSI) along the same dimensions and to combine AVAB and COSI results for each individual.

The goal of this study was to examine the applicability and added value of the combined use of AVAB and COSI in relation to the evaluation of a hearing aid fitting. The analyses primarily address the correspondence between the AVAB and COSI results, and the effects of hearing loss and level of experience on these results.

METHODS

Over a period of 10 months data were collected from various hearing aid dispensers that took part in a study which explored the advantages of self-report questionnaires in the hearing aid rehabilitation process. Auditory disability, before and after the hearing aid fitting, was assessed by the AVAB method. In addition, the COSI method was implemented to define individual targets and to measure the degree of change due to the hearing aid fit and the final ability afterwards with respect to the individual targets.

Prior to the hearing aid selection and fitting process, pre-AVAB questionnaires were administered to the subjects, followed by a question to describe a maximum of 5 situations in which they experience hearing difficulties. These situations formed the basis for formulating the COSI in dialogue with the hearing aid dispenser. The dispenser assigned matching AVAB dimensions to each COSI target (multiple dimensions per target were possible). Additionally, pure tone audiometry and speech audiometry were deemed mandatory aspects for the selection of a new hearing aid. Once fitted and after a trial period COSI targets were evaluated resulting in scores for degree of change and final ability for each individual target, again in dialogue with the hearing-aid dispenser. Furthermore a post-AVAB questionnaire was administered. Speech intelligibility in quiet, with and without the fitted hearing aid, was assessed as part of the final assessment of the benefit of the fitting. The fitting, trial and evaluation process were similar for first time users and experienced users.

Subjects

A representative sample of both new hearing aid users and experienced hearing aid users who needed replacement of their hearing aid were included from 64 hearing aid dispensers in the Netherlands. Subjects participated voluntarily and were included when agreeing upon usage of their data as they fully completed the hearing aid fitting process including the purchase of the hearing aid. Subjects with a CROS or biCROS-fitting were excluded.

RESULTS

Data from 1223 subjects were collected, but data from 483 subjects were incomplete. A number of 740 subjects fulfilled the criteria of inclusion and their data were used for further analysis. The median of the trial period after the hearing aid fitting was 47 days. Of the total group 58% was male and 42% female and about half (54%) of them were first time hearing aid users. The median age of the total group was 72 years. Pure tone threshold averages for 0.5, 1, 2 and 4 kHz were calculated for the better ear (PTAB) of all subjects, which showed a median hearing loss of 44 dB HL. Pure tone frequencies that exceeded the maximum output of the audiometer were denoted 125 dB HL. The median difference between PTAB and the pure tone average at the other ear was 5 dB HL, indicating that by far most of the subjects had a symmetrical hearing loss. As a consequence, 90% of the fittings were bilateral. COSI responses showed that on average 3.8 fitting targets were formulated per individual. These fitting targets were attributed to AVAB dimensions by the hearing aid dispenser, who indicated on average 1.6 matching dimensions per fitting target.

The overall scores for AVAB and COSI

Overall AVAB and COSI scores (i.e., the mean of the scores per dimension for each subject, not the mean of all individual items) were analysed by examining the cumulative distributions of the reported scores. These cumulative plots show the percentage of subjects whose COSI or AVAB score had a value less than or equal to the score indicated on the x-axis. Figure 1a shows that both methods reveal large benefits of hearing aid fitting. In the COSI results there is a strong visual correspondence between the distribution of COSI scores for overall degree of change and final ability. These results are in line with the findings previously described by Dillon *et al.* (1999), which have also been plotted in Fig. 1a. The extent of similarity in our data is emphasized by a moderate to strong correlation (Spearman's rho = 0.69), confirming the close relation between the two reported scores, not only on a group level but also on an individual basis.

Further analyses reveal ceiling effects, most pronounced in the COSI scores (see Fig. 1b). In fact, over 87% of all subjects reported mean scores equal or greater than 4, and 32% even reported the maximum score on all given targets.

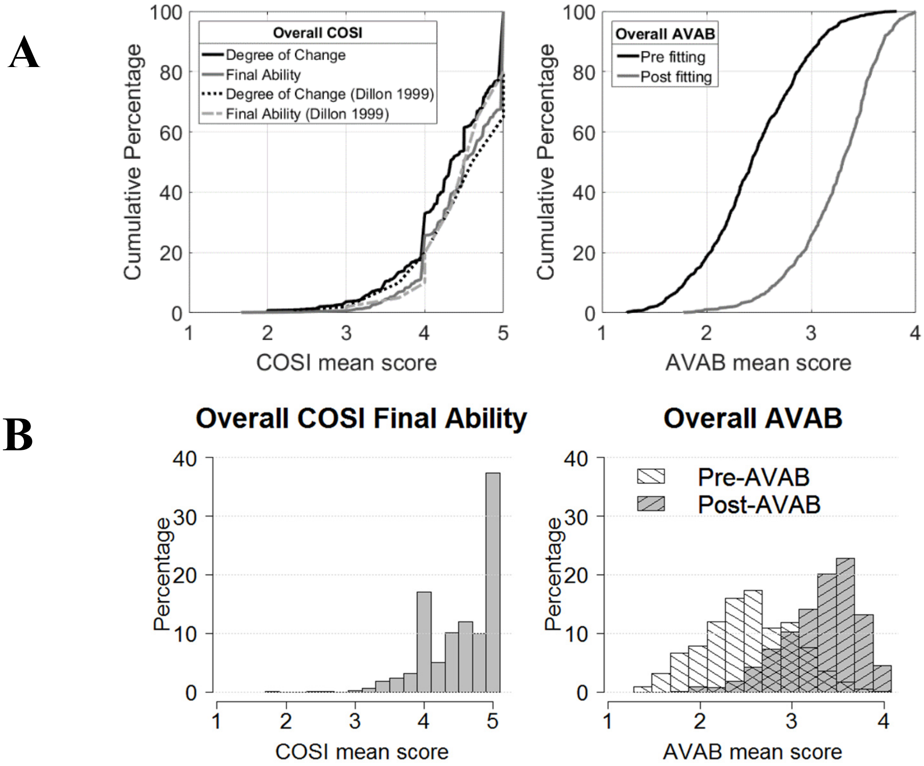

Fig. 1: (A) Cumulative distributions of overall mean COSI results (left), degree of change (black) and final ability (grey), dotted and striped lines show results found by Dillon *et al.* (1999). AVAB results (right) show overall mean pre-fitting results (black) and post-fitting results (grey). (B) Histogram of overall COSI Final Ability scores (left), and pre- and post- AVAB scores (right).

Effects of hearing aid experience

Effects of hearing aid experience of overall COSI final ability and overall pre- and post-fitting AVAB results are shown in Fig. 2. The responses of both COSI and AVAB were divided between first time users (54%) and experienced users (46%). COSI shows a slight difference between first time users and experienced users, while both pre- and post-fitting AVAB results show apparent differences.

Effects of degree of hearing loss

To analyse the effects of hearing loss on overall COSI and AVAB results, subgroups were composed based on pure tone average of the better ear (PTAB): ≤ 35 dB HL, 36-45 dB HL, 46-55 dB HL, and > 55 dB HL. The cumulative distributions (Fig. 3) of the COSI results show a strong visual correspondence between subgroups, except for the group comprised of the largest hearing losses. In contrast, overall AVAB results pre- and post-fitting are well distinguishable and show higher average scores for subjects with less severe hearing losses at the better ear.

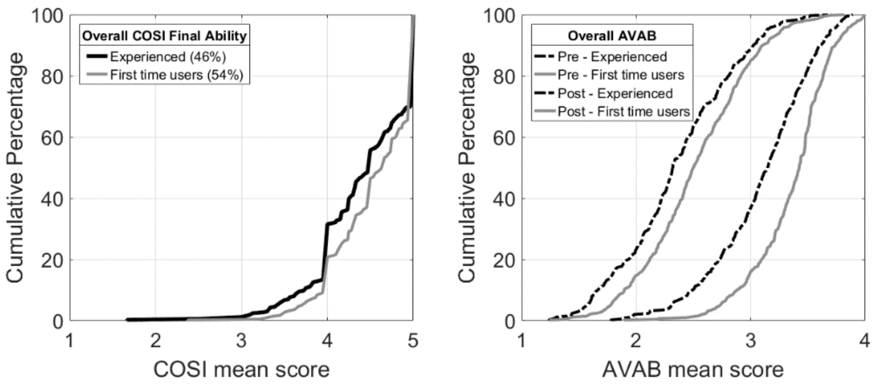

Fig. 2: overall COSI final ability (left) and pre/post-AVAB (right) cumulative distributions for first time users and experienced users.

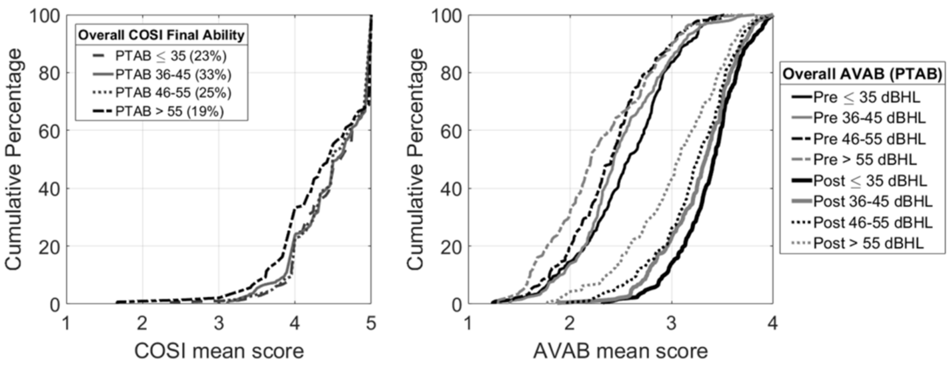

Fig. 3: Overall COSI final ability (left) and pre/post-AVAB (right) cumulative distributions for different groups of PTAB.

Effects for different dimensions of auditory functioning

Individual COSI targets can be summarized and categorized according to the six auditory disability dimensions resulting from the AVAB questionnaire. This results in specific distributions among the six dimensions. The largest contribution of matched COSI targets was to the dimension *speech in noise* (98% of the subjects had at least one target for this dimension), followed by *speech in quiet* (75%), *discrimination* (41%), *detection* (37%), *localization* (37%), and lastly *noise tolerance* (23%). A total of 2844 COSI fitting targets was formulated.

Figure 4 shows boxplots for pre- and post-fitting AVAB scores and COSI final ability scores in all six dimensions. It should be noted that these results comprise different numbers of responses between COSI and AVAB per dimension, which prevent a direct comparison. The median post-fitting AVAB scores were found to be higher relative to pre-fitting AVAB scores in all six dimensions. More specifically, pre- and post-fitting AVAB scores shows clear differences in the degree of benefit among each of the six dimensions. The *speech in noise* dimension showed the largest difference between pre- and post-fitting AVAB score, the smallest effect is denoted by the *tolerance* dimension. Differences between dimensions were less pronounced in the average COSI final ability results.

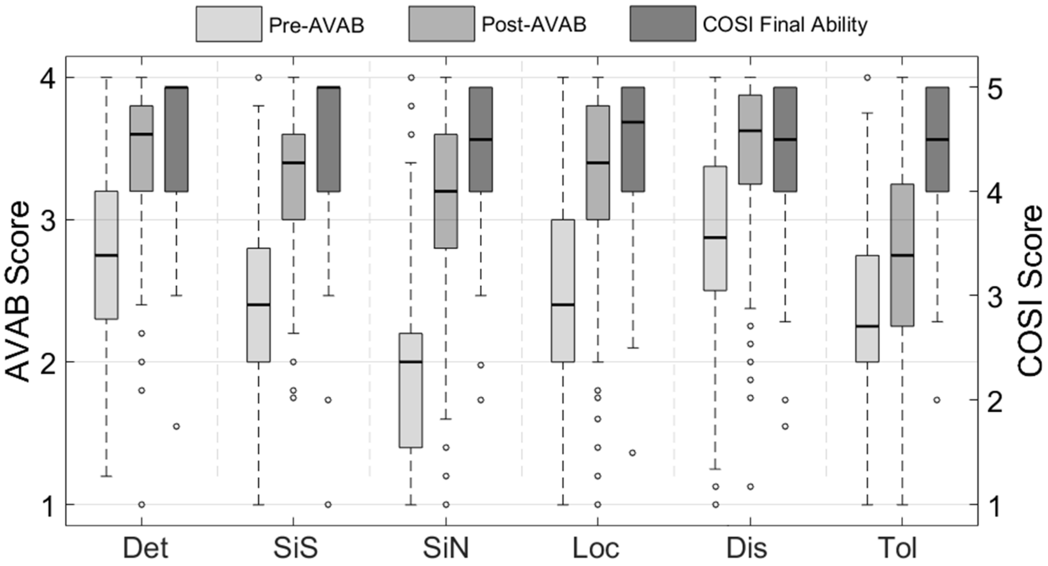

Fig. 4: Boxplots of COSI and pre/post AVAB scores per auditory disability dimension: Det=Detection; SiS=Speech in silence; SiN=Speech in noise; Loc=Localization; Dis=Discrimination; Tol=Noise tolerance.

DISCUSSION

Our study focused on the combination of two self-report questionnaires (AVAB and COSI) for the selection and evaluation of hearing aids. In a representative population of hearing aid users, both AVAB and COSI show a beneficial effect of fitting new hearing aids for six dimensions of auditory functioning. AVAB scores show more differentiation than COSI scores between user types (first time user or experienced user), degrees of hearing loss, and between the six dimensions.

The current study indicates that the two outcome measures resulting from COSI (degree of change and final ability scores) are closely related. Both measures show similar overall cumulative distributions, as well as a moderate to strong correlation between individual scores. These results match those found by Dillon *et al.* (1999) and suggest that there is no apparent distinction between the two measures. Therefore, it could be argued that merely evaluating final ability could be sufficient to assess individual COSI targets. COSI scores had a skewed distribution, with a tendency towards maximum scores. A possible explanation for the ceiling effect in the COSI scores might be a biased judgement by the audiologist/dispenser. On the other hand, Dillon *et al.* (1999) reported very similar results concerning the observed ceiling on the COSI results and argue that there may be a tendency for individuals to exaggerate their level of satisfaction. COSI targets are central to the rehabilitation process and efforts will be made to achieve maximum results on each of these targets, which implies considerable attention from the dispenser for the subject's COSI targets. This is not necessarily the case for conventional questionnaires such as AVAB of which not all items are equally relevant or even applicable to the subjects rehabilitation needs. In other words, greater attention to the COSI targets might contribute to the ceiling effect in final ability scores.

Although AVAB post scores also show a skewed distribution (Fig. 1), AVAB scores vary more between subjects than COSI scores. As a result, AVAB scores show differences between groups of user types (first time or experienced users) and degrees of hearing loss, which were not matched by COSI scores (Figs. 2 and 3). Furthermore, AVAB scores differ more between the six dimensions than COSI scores (Fig. 4). One reason for this might be that within the AVAB questionnaire all subjects had answered questions about all six dimensions, whereas COSI included only a limited range of situations. Assignment of these situations to the six dimensions is subjective and might differ between dispensers, although previous results show high inter-observer agreement. Also, multiple dimensions could be assigned to one target, resulting in the same score for different dimensions for one COSI target. This reduces the ability to discriminate between dimensions in final COSI scores.

Due to the low variability in scores, COSI in its current form appears to have limited value for evaluating effects of hearing aid fitting between different groups of users. AVAB, on the other hand, seems to be a useful outcome measure for such analyses. However, for counseling purposes COSI forms a useful addition to the AVAB questionnaire in that it provides concrete targets for an individual hearing aid fitting. Assigning the COSI targets to the six AVAB dimensions, supports the interpretation and weighting of the AVAB results for an individual, and the translation into important hearing aid functions and settings. On the other hand, the AVAB has added value in combination with the COSI in that it always provides results for all six defined dimensions of auditory functioning and therefore provides a broader overview of the fitting results. In addition, by first completing the AVAB questionnaire pre fitting, subjects are encouraged to think about their hearing ability in a broad range of situations before they define their individual need for rehabilitation.

In conclusion, both COSI and AVAB are very suitable in the evaluation of hearing aid rehabilitation, each method having specific strengths and weaknesses. AVAB contributes to the formulation of individual needs of rehabilitation used by COSI and provides detailed information on pre- and post-fitting evaluation. COSI is a very strong tool for the assessment of individual rehabilitation needs but is less sensitive for comparison between groups due to responses at or near the top of the response scale. AVAB on the other hand seems to be a useful tool for such comparisons and provides a broader insight in the auditory functioning of individuals. These differences between COSI and AVAB point to the fact that both methods should be used complementary, rather than separately.

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