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Development of the Device-Oriented Subjective Outcome (DOSO) Scale

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Abstract

Background—The empirical basis for this work is derived from previous research completed in our laboratory and published in 2005 and 2007. The previous work suggested that self-report hearing aid outcomes can be viewed as device-oriented or wearer-oriented. Further, compared to wearer-oriented outcomes, device-oriented outcomes were more independent of personality variables.

Purpose—To develop a device-oriented questionnaire to measure self-report hearing aid outcomes.

Research Design—A descriptive study in which 140 potential questionnaire items were evaluated and a questionnaire was devised.

Study Sample—A total of 306 adult hearing aid wearers participated. One hundred and eighty-nine were clinical patients and 117 were subjects in hearing aid field trials.

Data Collection and Analysis—Some items and some subjects were removed due to insufficient responses. The final data set included 295 subjects and 66 items. Response data were subjected to exploratory principal component analysis with orthogonal rotation. Six components, explaining 64% of the variance, were retained. Item statistics were examined.

Results—Six subscales were identified. Long and short forms of the questionnaire were developed. There are two equivalent versions of the short form.

Conclusions—The DOSO questionnaire is suitable for quantifying subjective hearing aid outcomes in both research and clinical settings. The DOSO is especially suited for comparing outcomes with different hearing aids. Future research is needed to cross-validate the results, determine retest consistency, and to explore the extent to which data from the DOSO is independent of personality.

Keywords

Outcome measure; Hearing aids; Self-report; Adults; Questionnaire design

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Introduction

It is widely agreed that the most ecologically valid method of quantifying real-world outcomes of a hearing aid fitting is to ask for the opinions of the hearing aid wearer. Although there have been many investigations of questionnaire methods for measuring real-world outcomes, (e.g., Humes, 2004), there is no consensus about the best approach. This is not surprising for several reasons.

First, stakeholders have different priorities. For example, manufacturers need to measure the merit of emerging hearing aid technologies, whereas practitioners need to measure the extent to which individual patients' problems have been mitigated in daily life. Also, researchers must emphasize data reliability, whereas practitioners must pay close attention to requirements for administration time. These diverse priorities plausibly could result in different stakeholders preferring different questionnaires.

Second, research in subjective hearing aid outcomes has highlighted some subtle differences among them, and has shown that subjective hearing aid outcomes are not one-dimensional (e.g., Cox et al, 2000; Humes, 2003). In fact, there are at least five different outcome dimensions/domains in which a hearing-impaired listener can testify to the value of his/her hearing aids: benefit (improvement), satisfaction, amount of use, remaining problems, and quality of life changes. Among the existing questionnaires, different ones assess different outcome domains and use differently worded items. When questionnaire responses have been compared, some intriguing aspects have come to light. It has been demonstrated that the apparent outcome of hearing aid fittings can vary with the domain(s) and specific questionnaire(s) that are used for the assessment (e.g., Gatehouse, 1994; Humes et al, 2001; Cox et al, 2007). When these differences occur, it is not always obvious which outcome more accurately portrays the “real” merit of the fitting.

Third, it has been shown that at least some outcome questionnaires produce data that are significantly associated with the patient's personality (e.g., Gatehouse, 1994; Cox et al, 1999). Links with personality can be a desirable feature in some circumstances, such as determining whether a patient feels that problems have been addressed. However, they are problematic in other circumstances, such as assessing the merit of a technological feature in hearing aids. When personality comes into play, the questionnaire data cannot be viewed as measuring the technological merit of the hearing aid itself, separate from the patient wearing it.

These considerations illustrate that subjective hearing aid outcomes are complex and multidimensional. Our understanding of them is still emerging. Nevertheless, patient opinions about treatment success appropriately occupy a central position in determining the effectiveness of individual hearing aid fittings as well as technological improvements in hearing aid design. Thus, research that deepens insights into the most valid means of measuring outcomes continues to be an important priority. Published research from our laboratory attempted to tackle this matter by determining the underlying structure of self-reported hearing aid outcomes (Cox et al, 2005a; Cox et al, 2005b, Cox et al., 2007). We studied a large group of older hearing aid wearers by means of ten widely-used

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questionnaires that measured outcomes in different ways. We observed that, regardless of the a priori measurement domains, the outcomes fell into two broad categories. Based on their item content, these categories were labeled device-oriented and wearer-oriented. Examination of item content suggested that the precise wording of the items was a variable that discriminated between the two types of outcomes. Items that clearly directed attention outward towards the amplification device produced device-oriented data. In contrast, items that promoted introspection about everyday problems produced wearer-oriented data. A typical device-oriented item would be “how well does the hearing aid separate speech from noise?” A typical item that elicits wearer-oriented responses addresses the listener directly, asking for example: “how well do you understand speech in a noisy place”? In the past, these two items would have been thought of as very similar. These studies from our laboratory indicated that they tend to produce responses that fall into different categories.

Another focus of this earlier work was the assessment of relationships between personality traits and self-report measures of hearing ability and hearing aid outcomes. In this work, personality was quantified using the NEO Five Factor Inventory (Costa and McCrae, 1992). It was determined that three aspects of personality (Neuroticism, Extraversion, and Agreeableness) explained a substantial proportion of the variance in several, but not all, of the self-report measures. This is illustrated in Figure 1 which shows the percent of variance accounted for by personality for a selection of self-report questionnaires used as hearing aid outcome measures. Notice that handicap measured using the HHIE total score (Ventry and Weinstein, 1982), disability measured using the APHAB Global subscale score (Cox and Alexander, 1995), and satisfaction measured using the SADL PI (Personal Image) subscale score (Cox and Alexander, 1999) were all quite strongly associated with personality, whereas other outcome measures were minimally or less associated with personality. Also note that differential effects of personality can be seen between overall scores of questionnaires (HHIE compared to SHAPIE), and also within the subscale scores of a given questionnaire (APHAB global versus AV; SADL PI versus the three other SADL subscales). These kinds of associations between self-reports and personality also have been observed in other hearing research (e.g., Cox et al, 1999, Gatehouse, 1994, Saunders and Cienkowski, 1996).

The work by Cox et al. (2007) produced a further insight when it was noted that wearer-oriented outcome data was associated with the personality of the hearing aid users but device-oriented outcome data was not associated (or much less associated) with user personality. In addition, each category (device-oriented and wearer-oriented) encompassed items within several nominal outcome domains, including residual problems, benefit, satisfaction, and use. These results suggested a new paradigm for self-report outcomes. In this new paradigm, items are fashioned to point towards the wearer or towards the hearing aid: the specific outcome domain, while remaining important, might be less fundamental than previously thought. This way of thinking about hearing aid fitting outcomes might help to explain the apparent contradictions sometimes seen in outcomes research, as described above, and reveals that viewing outcomes data as simply depicting different outcome domains (such as benefit or satisfaction) can be an oversimplification.

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An obvious application of these findings would be to develop self-report outcome questionnaires to separately assess device-oriented and wearer-oriented outcomes. Applications for these questionnaires are not difficult to envision. For example: (1) Manufacturers who wish to evaluate hearing aid technology in daily life would profit from using a device-oriented questionnaire in which effects of wearer personality issues will be reduced or eliminated. This would promote more valid and replicable results. (2) Because third-party payers are mostly concerned with management of daily life problems, they would be best served by a wearer-oriented questionnaire so that daily life problems could be directly assessed. After all, a hearing aid with advanced technology is not valuable if the wearer does not perceive that his/her problems have been mitigated by its use. (3) If researchers wish to conduct a randomized controlled trial to assess whether a new rehabilitative approach is superior to a standard approach in resolving hearing problems, they should use a wearer-oriented questionnaire but also should ensure that the groups are matched on personality variables[1]. (4) Practitioners could use a device-oriented questionnaire to compare two different hearing aids for a given patient in real life. However, they should use a wearer-oriented questionnaire to assess the extent to which the chosen hearing aid has helped to resolve the patient's hearing problems.

No questionnaires currently exist that have been developed according to these principles. This article describes the development of a questionnaire that is intended to be device-oriented and relatively independent of personality[2]. The goal was to produce a longer version with psychometric properties suitable for research purposes and a shorter version to be employed when resources do not allow use of the longer version. We anticipate that the questionnaire will appeal to industry and to academic researchers for the study of emerging hearing aid technologies. A secondary application will be in clinical practice, to document the results of hearing aid provision for an individual, or to compare two ways of programming hearing aids (e.g., with and without frequency lowering). The questionnaire is called the Device-Oriented Subjective Outcome (DOSO) Scale.

Methods

Participants

The participants comprised 306 hearing aid wearers. Ninety-seven percent of them were experienced hearing aid users (defined as use for three months or more). The remaining 3% were relatively new to amplification, having worn their hearing aids for less than 3 months.

These individuals were drawn from the University of Memphis clinic and laboratory (73), audiology private practices located in Canada, Texas, and Louisiana (116), and research subjects participating in field trials of hearing aids (117). Each subject used a five-category scale to rate his/her degree of hearing difficulty when listening unaided. Figure 2 summarizes these data and reveals that 75% of the participants rated their degree of unaided hearing difficulty as moderate or moderately-severe.

[1]See (Cox, 2006)
[2]The association between questionnaire responses and personality was not tested in this developmental study.

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Ages ranged from 21 to 94 with a mean of 72 years (SD=10.7). Sixty percent of the individuals in the group were men. Seventy-one percent of subjects wore two hearing aids and 27% preferred to wear one device (even if they had two). Two percent wore either one or two hearing aids depending on the situation.

Questionnaire Development

The DOSO was developed according to the principles of classical test theory (e.g., Nunnally and Bernstein, 1994). The process involved: (1) development of initial item pool, (2) administration of items to hearing aid wearers, (3) data review and removal of unsuitable items, (4) analysis of remaining items, and (5) selection of final items for the questionnaire.

Development of Initial Items

The goals were to develop items that would “point to” the hearing aid, and to minimize wording that might promote introspection. Thus, items were written to be compatible with the stem “How good are the hearing aids at….” The word “you” was avoided as much as possible. Specific content of the items was based on our experience developing other questionnaires (e.g., Cox and Alexander, 1995; Cox and Alexander, 1999) as well as consideration of real world listening challenges that might be addressed by technological improvements in hearing aids. Twenty-six potential item topics (e.g., soft sound audibility, telephone/TV, localization) were developed, and specific items were composed to explore each topic. Efforts were made to generate items that were colloquial, avoided jargon, and provided enough variety to keep the reader engaged. A list of 140 items was created. Several clinical audiologists independently reviewed the list and scored each item on a scale of 1-3 to reflect their judgment of its merit. Based on these ratings, 63 items were eliminated, leaving 77. Next, seven non-audiologist hearing aid wearers were asked to review and comment on these 77 items. Based on their feedback, 5 more items were eliminated, leaving 72.

The response scale for these 72 items comprised seven categories and was identical to the one used in the SADL questionnaire (Cox and Alexander, 1999). The words used to describe each category were: not at all, a little, somewhat, medium, considerably, greatly, and tremendously. These words were selected from a list reported by Levine (1981) which provided an empirical determination of the value assigned to each word on a scale from 1 to 7. The set of seven response categories was chosen to cover the response range of 1 to 7 and to fulfill the following criteria: approximately equal intervals apart; substantial consistency in interpretation (small standard deviation); and clear semantic distinctions (minimal overlap). In addition, Levine determined that the chosen descriptors were equally applicable to low and high educational groups and his subjects included a substantial proportion of low-income, older individuals as well as those of higher incomes. For the 72 items scored on a 1-7 scale, a higher score was indicative of a better outcome.

In addition to the 72 items, three additional items were composed to explore hearing aid use. There are at least three approaches to assessing use of hearing aids: hours per day, days per week, and use when needed. All three are arguably valid. Questionnaires that encompass the domain of hearing aid use typically include only one of these approaches. It has not been

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obvious if the three types of items provide equivalent information. To provide a more comprehensive assessment of use, an item was developed using each type of approach. These three items were scored on a 1-5 scale with a higher number corresponding to greater use. The total number of initial items was thus 75. These 75 items were administered by mail to the 306 participants described above.

Results

Descriptive analyses of the data resulted in elimination of some items and some subjects, as follows:

- For five items, the response was omitted by more than 10% of the 306 subjects. It was assumed that these items were unsuitable for some reason and they were deleted from further consideration, leaving 70 items.
- Eleven subjects failed to respond to 10 or more of the remaining 70 items, so these subjects were eliminated, leaving 295 subjects.
- Missing Value Analysis (MVA, SPSS version 16) was run to explore the patterns in the few remaining missing data points with 70 items and 295 subjects. Separate variance t- tests were used to identify items whose pattern of missing values appeared to be not random ($p < .05$). Four items were identified by this procedure and these also were deleted, leaving 66 items.
- The MVA procedure with an expectation-maximization algorithm was used with the 66 items and 295 subjects to replace the remaining missing data points by data imputation. Missing data were imputed for 1.4% of the data points.

This provided a complete dataset for 66 items with 295 subjects.

Principal Components Analysis (PCA) with orthogonal (Varimax) rotation was conducted on the dataset of 66 items and 295 subjects. In preliminary analyses, sampling adequacy was found to be excellent (Kaiser-Meyer-Olsen measure = .97). In addition, Bartlett's test of sphericity indicated that inter-item correlations were adequate to support principal component analysis (χ^2 (2145) = 18541, $p<.001$). The PCA analysis identified eight components with eigenvalues >1.0 and these explained 70% of the variance in the data. The decision about which of the eight components to retain for the questionnaire was based partly on a consideration of the results of a parallel analysis (Horn, 1965) and partly on the interpretability of each component judged by the content of items it encompassed. The first 6 components (capturing 64% of the outcome variance) were retained. Items were selected from each component to comprise six subscales. Items with loadings less than .45 were not considered for inclusion in any subscale.

Selection of Items and Subscales

Subscale 1: Speech Cues—The first principal component (PC1) explained 30.3% of the variance in the data after rotation. Thirty-two items loaded most heavily on PC1 and twenty-one of these had factor loadings >.70. The items most strongly associated with PC1 concerned ability to detect and understand speech in specific situations (e.g., speech across a

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large room, whispered speech, names when introduced). It was decided to select from the items with factor loading >.70 to compose two equivalent short forms (a and b) of a Speech Cues subscale. Seven item pairs were selected based on consideration of mean scores, score variances, item-total correlations, distribution of item responses, and item content. Then, one of each pair was assigned to each form. Two short forms of seven items were generated. Item statistics are summarized in Table 1.

Subscale 2: Listening Effort—The second principal component (PC2) explained 13.7% of the variance in the data after rotation. Twelve items loaded most heavily on PC2 with factor loadings from .48 to .71. The items most strongly associated with PC2 concerned ease of listening (e.g., making conversation easy and clear, increasing enjoyment of activities). It was decided to select from these items to compose two equivalent short forms of a Listening Effort subscale. The same method was used as with the Speech Cues subscale described above. Five item pairs were selected based on consideration of mean scores, score variances, item-total correlations, distribution of item responses, and item content. Then, one of each pair was assigned to each form. Two short forms of five items each were generated. Item statistics are summarized in Table 2.

It was noted that the items from the first two subscales appear superficially similar and it seemed curious that they fell into different components. Close consideration of item wording revealed that the items in the Speech Cues subscale almost all describe a specific situation whereas the items in the Listening Effort subscale are more global in scope.

Subscale 3: Pleasantness—The third principal component (PC3) explained 5.9% of the variance in the data after rotation. Six items loaded most heavily on PC3. Two were eliminated due to low factor loadings. The remaining four had factor loadings from .54 to .79. The items most associated with PC3 concerned pleasantness of sounds produced by the hearing aid (e.g., own voice natural, pleasant quality). It was decided to use the four items to compose a Pleasantness subscale. Item statistics are summarized in Table 3.

Subscale 4: Quietness—The fourth principal component (PC4) explained 5.5% of the variance in the data after rotation. Five items loaded most heavily on PC4 with factor loadings from .55 to .73. The items associated with PC4 concerned ability of the hearing aid to keep environmental sounds from being too loud. It was decided to use all five items to compose a Quietness subscale. Item statistics are summarized in Table 3.

Subscale 5: Convenience—The fifth principal component (PC5) explained 4.6% of the variance in the data after rotation. Four items loaded most heavily on PC5 with factor loadings from .46 to .73. The items associated with PC5 concerned user-friendliness. Although the four items have lower inter-correlations that those in the other subscales, each item addresses an issue that is widely reported to be an important aspect of a hearing aid's merit. It was decided to use all four items to compose a Convenience subscale. Item statistics are summarized in Table 4.

Subscale 6: Use—The sixth principal component (PC6) explained 4.2% of the variance in the data after rotation. The three items that address hearing aid use from different

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perspectives comprised this component. Factor loadings were .75 to .85. It was decided to compose a Use subscale that included all three items. Item statistics are summarized in Table 4.

Final Questionnaire Formats

The process of item selection described above allowed us to achieve the goal of designing both long and short forms of the questionnaire. There is one long form, DOSO, and there are two equivalent short forms: DOSOs(a) and DOSOs(b). Files in standard layout for each questionnaire form are provided as Figure 1S, Figure 2S, and Figure 3S, supplemental to the online version of this article. The same files also may be downloaded from the Hearing Aid Research Laboratory website (www.HARLmemphis.org)

The short forms DOSOs(a) and DOSOs(b) are equivalent forms of 28 items each. The 12 items in the Speech Cues and Listening Effort subscales differ across these two forms, but the 16 items in the four other subscales are identical. These forms are appropriate for use by practitioners or in research where administration time is a decisive factor. They each yield a summary of hearing aid fitting outcomes in about 5 minutes.

The long form, DOSO, includes all the items in the two short forms of the Speech Cues subscale and all the items in the two short forms of the Listening Effort subscale, as well as all the items in the Pleasantness, Quietness, Convenience, and Use subscales. Because it comprises 40 items, this form probably is most appropriate for use in research applications. It provides the advantages of greater precision in assessing scores for Speech Cues and Listening Effort. However, administration time is almost 50% longer than for the short forms.

Interim Norms for the DOSO Subscales

Scoring for the DOSO questionnaire is as follows. For items with the 7-point response scale, numbers from 1 to 7 are assigned to the responses (not at all =1; a little =2; somewhat =3; medium = 4; considerably = 5; greatly = 6; and tremendously = 7). For the three items in the Use subscale, numbers from 1 to 5 are assigned to the 5 alternatives, with higher numbers representing more reported use. For all items, a higher number is associated with a better outcome. A score is computed for each subscale by averaging the scores for the items within that subscale.

Norms for the DOSO subscales should be obtained in future research using different subjects. In the meantime, it is important for individuals who use the questionnaire to have some indication of expected performance. In the interest of providing temporary guidelines, interim norms were computed using the 179 clinic patients whose data were used in the development of the questionnaire. Table 5 gives interim norm values for each subscale. These interim norms were computed using data from the 40-item DOSO questionnaire. They also are very similar to norms computed for each short questionnaire form. A norms template for recording and interpreting individual data is provided as Figure 4S, supplemental to the online version of this article, or it may be downloaded at www.HARLmemphis.org. Instructions for manual scoring and software for automated scoring also are available at www.HARLmemphis.org.

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Discussion

In this research, we developed a new questionnaire for quantifying subjective outcomes of hearing aid fitting. The rationale for composing the questionnaire items was derived from the results of previous work which indicated that some subjective hearing aid outcome measures are strongly influenced by the personality of the listener whereas others are not influenced, or less influenced. Based on results reported by Cox et al. (2007), the goal was to develop a questionnaire that directed attention away from the listener and towards the hearing aid. One hundred and forty items were created at the outset. After a multi-layered elimination process, 40 items remain in the final product. The 40 items are allocated into three questionnaire forms ranging in length from 28 to 40 items. The questionnaire forms encompass six subscales and, in the short format, these range from 3 to 7 items in length. Despite the relative brevity of the subscales, all except two have excellent internal consistency, quantified in Cronbach's coefficient alpha of .86 or higher. This high value of alpha indicates that the items in these subscales are closely related and the group of items represents a common underlying trait or domain. The lower values of coefficient alpha in the Convenience and Use subscales are the result of the combined effects of relatively few items and lower item inter-correlations. Nevertheless, the alpha levels for these short subscales (.67 and .71, respectively) are well within the range commonly observed in behavioral research (Peterson, 1994) and there are convincing reasons (presented earlier) for retaining both subscales.

When we composed the original items for the questionnaire, they were targeted to encompass 26 predefined topics that were each postulated to be important to device excellence. Responses revealed that, for the most part, these topics were not seen by listeners as distinct. Almost half of the items were most strongly associated with the first principal component which comprised an ability of the hearing aid to supply an audible speech signal under a variety of specific listening conditions (Speech Cues). The less prominent but still important features of hearing aids that emerged from the data included making sounds clear and enjoyable (Listening Effort), pleasant in quality (Pleasantness), not too loud (Quietness); and being user-friendly (Convenience). These kinds of considerations have been seen in other hearing aid outcomes research and are well-known to practitioners who deal with hearing aid fittings. Even though our approach is novel in pointing attention at the hearing aid instead of the listener, this new questionnaire converged on familiar content themes, which lends overall construct validity to the undertaking. In addition, the Use subscale emerged as a separate and coherent entity with the three items showing substantial overlap. Compared to the typical single item measure, a three-item Use subscale will provide a more comprehensive assessment of the patient's point of view regarding his/her reliance on using amplification in daily life.

The goal of producing both short and long versions of the questionnaire was realized. The 28-item forms DOSOs(a) and DOSOs(b) are typically completed in about 5 minutes. As noted above, these forms have 16 identical items and 12 equivalent items. It is not certain that there is a need for equivalent forms of the questionnaire. However, the use of differing forms can help alleviate any patient boredom or carelessness that can result from repetition of the same set of items over numerous conditions.

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Hearing aid outcome questionnaires previously developed in this laboratory and elsewhere have tended to focus on specific outcome domains, such as benefit, satisfaction, etc. However, as mentioned earlier, items from several different nominal outcome domains were seen to contribute to device-oriented outcomes by Cox et al. (2007). In constructing the DOSO items, no particular attention was paid to outcome domains. Nonetheless, it is of interest to consider which domains are represented in the final questionnaire. There is room for debate about this. However, it seems reasonable to propose that the Speech Cues and Listening effort subscales quantify benefit, the Pleasantness and Quietness subscales provide performance data, and the Convenience subscale is related to satisfaction. The Use subscale encompasses a separate domain that is familiar from many previous studies.

Although the DOSO questionnaire was developed to be independent of personality variables quantified using the five-factor model (Costa and McCrae, 1992), it remains to be seen whether this goal was achieved. Future research will address this issue. To maximize external validity, it would be desirable to compare DOSO scores and personality profiles for a clinical population rather than for seasoned research participants. As mentioned above, it also is important for future research to establish norms for the DOSO subscales to validate or refine those presented in Table 5.

Conclusion

The DOSO questionnaire has been developed in long and short forms comprising 40 and 28 items, respectively. Depending on the form used, the questionnaire will typically take 5 to 8 minutes to complete. The items of the DOSO were worded to point towards the hearing aid rather than towards the wearer with the intention of minimizing the involvement of personality in item responses. If this goal has been successfully achieved, it is anticipated that this will result in more valid and robust self-reports concerning the merits of hearing aids and in comparing hearing aids with each other. Additional research is needed to validate the questionnaire structure, to generate normative data, and to explore the association between questionnaire responses and personality attributes.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Abbreviations and Acronyms

HHIE	Hearing Handicap Inventory for the Elderly
APHAB	Abbreviated Profile of Hearing Aid Benefit

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SADL	Satisfaction with Amplification in Daily Life
DOSO	Device-Oriented Subjective Outcome
SHAPIE	Shortened Hearing aid Performance Inventory for the Elderly
MVA	missing values analysis
SPSS	Statistical Package for the Social Sciences
PCA	principal components analysis

Appendix: Items of DOSO

How good are the hearing aids at…..?

1. Not whistling during use?
2. Providing a pleasing sound quality?
3. Making loud speech clear?
4. Making music pleasant?
5. Eliminating the need to have someone else explain what was said?
6. Making other people's voices sound clear in a moving car?
7. Making children's voices understandable?
8. Making your voice sound natural to you?
9. Catching the beginning of sentences?
10. Picking up overhead announcements in stores?
11. Catching your name being called in a waiting room?
12. Making the batteries easy to change?
13. Picking up speech when the talker's lips are not visible?
14. Keeping background noise to a minimum?
15. Catching what waiters say in a busy restaurant?
16. Catching what someone says on the first try?
17. Cutting out background noise in a restaurant?
18. Picking up soft sounds that follow loud ones?
19. Making speech clear in a face-to-face conversation?
20. Not using up batteries too fast?
21. Picking up what strangers say the first time?
22. Keeping the sound of your voice comfortable to you?

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23. Improving enjoyment of everyday activities?
24. Catching the words when someone speaks from another room?
25. Picking up what someone says across a large room?
26. Being easy to put in and take out of your ears?
27. Picking up sounds that are missed without them?
28. Making loud music tolerable?
29. Catching a person's name when they are introduced?
30. Recognizing different voices?
31. Reducing misunderstandings during conversations?
32. Making the television sound clear?
33. Making conversation easier?
34. Keeping wind noise from being annoying?
35. Keeping the volume at a pleasing level?
36. Distinguishing between male and female voices?
37. Keeping loud sounds from being uncomfortable?
38. How many days a week do you usually wear hearing aids?
39. On the days you use hearing aids, how many hours do you usually wear them?
40. In situations where you need to improve your hearing, how often do you wear hearing aids?

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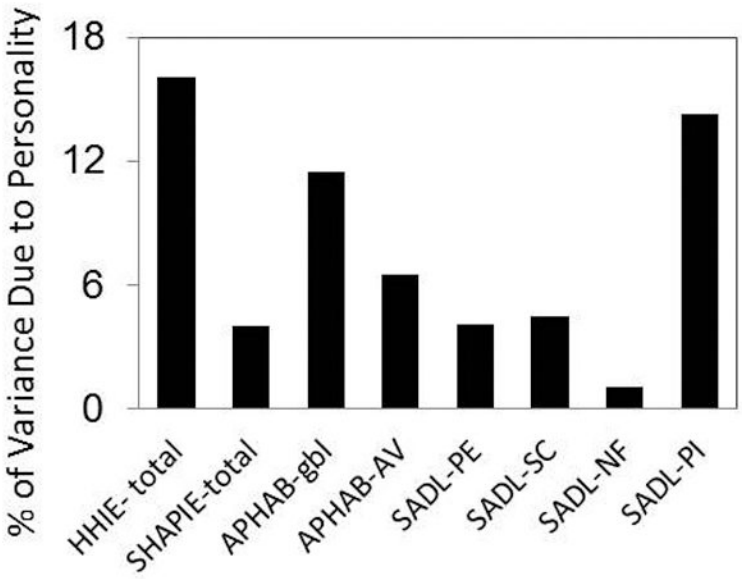

Figure 1.

Percent of variance accounted for by personality in selected self-report questionnaires used as hearing aid outcome measures. HHIE= Hearing Handicap Inventory for the Elderly (Ventry & Weinstein, 1982), SHAPIE= Shortened Hearing Performance Inventory of the Elderly (Dillon, 1994), APHAB= Abbreviated Profile of Hearing Aid Benefit (Cox & Alexander, 1995), SADL= Satisfaction with Amplification in Daily Life (Cox & Alexander, 1999).

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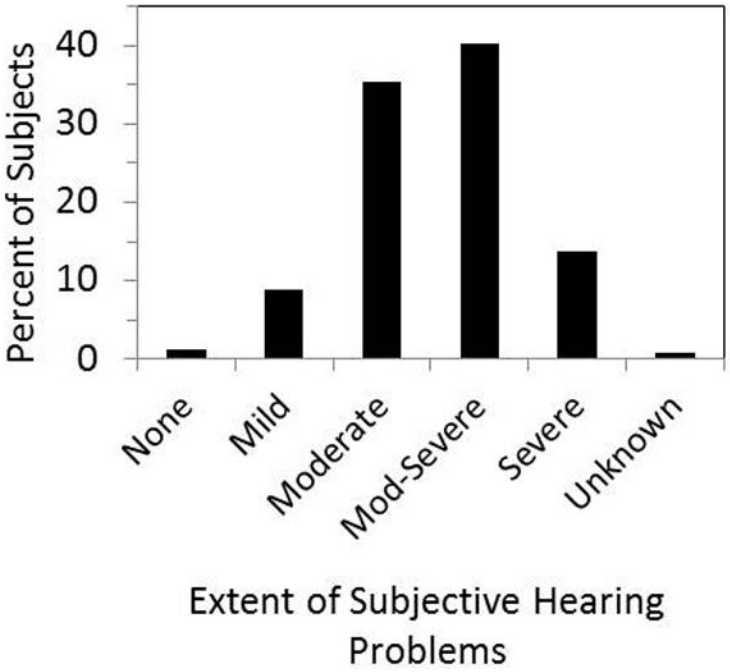

Figure 2.

Distribution of participants' self-rated subjective hearing difficulty when listening without a hearing aid (N=306).

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Table 1

Item statistics (N=295) for two short forms of the Speech Cues subscale. The Table includes a few words from the item, the item mean score and standard deviation (SD), the rotated factor loading, and the corrected item-total correlation ($Corr_{i-t}$). Cronbach's Alpha for each short form is given in the last column. Each item is numbered according to its placement in the long form of the questionnaire, given in the appendix

Item No.	Words from item	Mean	SD	Factor Loading	$Corr_{i-t}$	α
	Short form a:					.94
24	Words from other room	3.77	1.7	.83	.82	
21	Strangers, 1st time	4.38	1.4	.77	.83	
09	Beginning of sentences	4.36	1.4	.79	.81	
07	Understand children	4.12	1.5	.82	.82	
06	Voices clear in car	4.28	1.4	.75	.80	
11	Name in waiting room	4.64	1.5	.75	.82	
10	Overhead announcement	4.04	1.6	.77	.81	
	Short form b:					.94
15	Waiter in busy restaurant	3.91	1.6	.77	.83	
16	Catch on 1st try	4.34	1.5	.78	.84	
29	Catch name introduced	4.40	1.5	.71	.83	
25	Speech across large room	3.99	1.7	.81	.81	
13	When can't see lips	4.34	1.5	.76	.80	
05	Don't need other to help	4.55	1.7	.74	.77	
18	Soft sounds after loud	3.87	1.6	.76	.78	

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Table 2

Item statistics (N=295) for two short forms of the Listening Effort subscale. The Table includes a few words from the item, the item mean score and standard deviation (SD), the rotated factor loading, and the corrected item-total correlation ($Corr_{i-t}$). Cronbach's Alpha for each short form is given in the last column. Each item is numbered according to its placement in the long form of the questionnaire, given in the appendix

Item No.	Words from item	Mean	SD	Factor Loading	$Corr_{i-t}$	α
	Short form a:					.89
33	Conversation easier	5.25	1.4	.71	.84	
31	Reduce misunderstandings	4.94	1.5	.54	.75	
23	Improve enjoyment	5.18	1.4	.63	.74	
30	Recognize voices	4.98	1.4	.50	.72	
03	Loud speech clear	4.84	1.4	.48	.63	
	Short form b:					.86
19	Clear face-to-face	5.39	1.3	.64	.74	
35	Volume level pleasing	4.76	1.4	.57	.70	
27	Pick up missed sounds	5.27	1.5	.60	.66	
32	Television sound clear	5.02	1.5	.58	.66	
36	Know male or female	5.15	1.3	.60	.67	

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Table 3

Item statistics (N=295) for the Pleasantness and Quietness subscales. The Table includes a few words from the item, the item mean score and standard deviation (SD), the rotated factor loading, and the corrected item-total correlation ($Corr_{i-t}$). Cronbach's Alpha for each form is given in the last column. Each item is numbered according to its placement in the long form of the questionnaire, given in the appendix

Item No.	Words from item	Mean	SD	Factor Loading	$Corr_{i-t}$	α
	Pleasantness:					.86
08	Own voice natural	4.27	1.6	.79	.72	
22	Own voice comfortable	4.64	1.4	.63	.72	
02	Pleasing sound quality	4.82	1.4	.55	.74	
04	Music pleasant	4.87	1.4	.55	.66	
	Quietness:					.87
28	Loud music tolerable	3.43	1.7	.73	.66	
37	Loud sounds not uncomfortable	4.09	1.7	.71	.69	
14	Keep down background noise	3.58	1.6	.66	.76	
17	Background noise in restaurant	3.23	1.7	.66	.73	
34	Wind noise not annoying	3.48	1.7	.55	.60	

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Table 4

Item statistics (N=295) for the Convenience and Use subscales. The Table includes a few words from the item, the item mean score and standard deviation (SD), the rotated factor loading, and the corrected item-total correlation ($Corr_{i-t}$). Cronbach's Alpha for each form is given in the last column. Each item is numbered according to its placement in the long form of the questionnaire, given in the appendix

Item No.	Words from item	Mean	SD	Factor Loading	$Corr_{i-t}$	α
	Convenience:					.67
20	Not using batteries too fast	4.65	1.6	.73	.46	
12	Batteries easy to change	5.49	1.4	.56	.53	
26	Easy to insert/remove	5.28	1.6	.51	.46	
01	Not whistling during use	4.53	2.0	.46	.39	
	Use:					.71
38	Number days/week	3.57	0.8	.85	.63	
39	Number hours/day	3.72	1.4	.83	.61	
40	Used when needed	4.68	0.6	.75	.64	

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Table 5

Interim norms for the six DOSO subscales. These were obtained from 179 clinic and private practice patients who participated in the development of the questionnaire. All subscales except Use were scored on a 1-7 scale. Use was scored on a 1-5 scale. These interim norms were obtained using the DOSO (long form) questionnaire, but they are also applicable to the DOSOs(a) and DOSOs(b) short forms

Subscale	Percentile Score 5	10	25	50	75	90	95
Speech Cues	1.9	2.1	2.7	3.6	4.7	5.4	5.8
Listening Effort	2.7	3.2	4.1	4.8	5.5	6.3	6.5
Pleasantness	2.5	3.0	3.8	4.5	5.3	6.0	6.4
Quietness	1.4	1.6	2.4	3.2	4.0	5.0	5.8
Convenience	3.3	3.5	4.0	4.8	5.8	6.3	6.5
Use	2.3	2.7	3.7	4.3	4.7	4.7	4.7