

Evaluation of the Hearing Aid Rehabilitation Questionnaire in Dutch: examination of its psychometric properties and potential use as a screening instrument

Micheline N. Chenault,^{1,2,3} Lucien J.C. Anteunis,^{1,3} Martijn P.F. Berger²

¹Department of Otorhinolaryngology and Head and Neck Surgery, Maastricht University Medical Centre; ²Department of Methodology Statistics, Faculty of Health, Medicine and Life Sciences, Maastricht University; ³School of Mental Health and Neuroscience, Faculty of Health, Medicine and Life Sciences, Maastricht University, Maastricht, The Netherlands

Abstract

Items pertaining to hearing and hearing aids from the Hearing Aid Rehabilitation Questionnaire were applied to a heterogeneous sample of Dutch patients aged 55 years and more to evaluate their potential use in hearing screening. Subjects aged 55+ were recruited from a large general practitioners practice to participate. Three groups were formed: a group of 63 persons with a hearing aid, a group of 64 without a hearing aid but with sufficient hearing impairment to qualify for hearing aid reimbursement, and a group of 85 non-hearing impaired persons. Factor and reliability analyses revealed a structure with two scales regarding hearing, namely functionality and social hearing and three scales pertaining to hearing aids, namely hearing aid stigma, pressure to be assessed and not wanting a hearing aid. Scale validity was assessed with pure tone averages over the frequencies 1, 2 and 4 kHz and with a visual analogue scale for subjective hearing. The derived scales can be applied reliably in audiological assessment in an adult hearing screen setting to detect experienced hearing problems as well as attitudes related to hearing and hearing aids.

Correspondence: Micheline N. Chenault, Methodology & Statistics, Maastricht University, P.O. Box 616, 6200 MD Maastricht, The Netherlands. Tel. +31.433884294 - Fax: +31.433618388. E-mail: m.chenault@mumc.nl

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Introduction

It has been shown that hearing impairment has a profound effect upon an individual's quality of life.¹ Even though hearing aid use improves quality of life² and hearing aid fitting is a cost effective health intervention,³ there is a great disparity between those who might benefit and those who actually pursue hearing rehabilitation. This disparity has been attributed to a number of factors which are either related to behavioral strategies and/or the presence of stigma's and attitudes towards hearing impairment and hearing aids.^{4,5} Moreover it has been shown that cognitive ability is related to successful hearing aid use.⁶

Loss of hearing ability, specifically presbycusis, is an accompaniment of the aging process and thus is usually gradual whereby the individual goes through stages in which limitations in hearing are experienced and responded to with various behaviors including coping, avoidance, denial, and help-seeking. Various studies have attempted to describe the process from the onset of hearing impairment to either successful or unsuccessful hearing rehabilitation. Manchaiah *et al.*⁷ performed a qualitative study to map the patient journey from the onset of hearing impairment to successful hearing rehabilitation and identified seven stages: i) pre-awareness, ii) awareness, iii) movement, iv) diagnostics, v) rehabilitation, vi) self-evaluation and vii) resolution, whereby the first two stages are the most relevant for hearing screening. The pre-awareness stage is characterized by the individual not recognizing his/her hearing limitations while others do recognize it. The individual may experience frustration and exhibit avoidance behavior. In the awareness stage the person has recognized some hearing limitations and attempts to identify situations in which problems are most prominent. The stages thereafter pertain to help-seeking behavior, clinical assessment and initiation of rehabilitation.

Hearing screening facilitates the help-seeking behavior as it confronts the individual with the facts of his/her hearing impairment.⁸ Stephens and Kramer⁹ pointed out that audiological assessment in screening should be based on the person's experienced difficulties in hearing rather than on audiometric outcomes. Based on an extensive literature study, including a number of studies reporting the necessity of enhancing audiological assessment with patient reporting, Knudsen *et al.*¹⁰ concluded that self-reported auditory difficulty is possibly more important than clinical audiometric measurements for hearing assessment. Other studies have investigated an approach towards screening which combines audiometric testing and patient reporting. Yueh *et al.*¹¹ conducted a scientific review of screening methods for adult hear-

ing loss and concluded that using a tone-emitting otoscope conjointly with the Hearing Handicap Inventory for the Elderly-Screening Version (HHIE-S)¹² was the best strategy. They pointed out that audiometry assesses physiological hearing loss while the HHIE-S addresses social and emotional handicap.

Pronk *et al.*¹³ conducted an extensive and comprehensive literature study on hearing screening. In particular they discussed interventions, which follow failing the hearing screen, which usually is limited to referral for hearing aid fitting. However there are studies, which have implemented interventions including education and training regarding hearing impairment and how to cope with it. Hickson *et al.*¹⁴ found that communication programs should be integrated in audiological rehabilitation and supplement traditional interventions such as hearing aid fitting.

Health screening programs are meant to filter out those individuals who would benefit from intervention. Without screening, hearing rehabilitation depends solely on help-seeking behavior with the hearing impaired person having already transgressed into the movement stage. Assessment of experienced limitations and difficulties should therefore accompany audiometric testing in hearing screening. Patient-answered questionnaire items facilitate the quantification of limitations experienced as a result of hearing impairment and thus the burden experienced. Methodology regarding the application of questionnaire items for assessing health outcomes has been developing at a fast pace with increasing emphasis being placed on health functional aspects rather than clinical measurement.

The validity and reliability of a questionnaire designed to measure health outcomes must be examined like any other measurement tool. Cronbach and Meehl¹⁵ were pioneers in the development of classical test theory regarding the reliability and validity of tests and questionnaires. Since then, others such as Terwee *et al.*¹⁶ have suggested additional criteria to be met for questionnaires targeting health status. Hyde¹⁷ specifically investigated standards for subjective rating scales used in audiological rehabilitation and made suggestions regarding various aspects of validity and reliability. In particular, he emphasized the necessity of examining existing measures with regard to i) purpose: whether the objective is assessment of hearing ability or ability to successfully undergo rehabilitation, ii) context: whether the items are appropriately formulated for the population of interest and for the hearing-related trait(s) being measured and iii) responsiveness: whether the items are formulated to minimize unusable responses such as *non-applicable* while obtaining responses which truly reflect the traits being measured.

Screening will filter out persons already recognizing their disability but also those who are in the pre-awareness stage. Screening should be supplemented with questionnaire items which quantify experienced burden. In this way not only those recognizing their disability but also those who may be beginning to experience limitations can be discerned. Screening should also assess attitudes, which potentially thwart help-seeking behavior. Items are then needed which are directed towards measuring how the individual views others with hearing disability and/or hearing aids. Screening items addressing such topics may also serve as an intervention mediating, that is confronting the individual with heretofore unacknowledged hearing difficulties, or moderating how the individual views his/her own hearing impairment. Such items are included in the Hearing Aid Rehabilitation Questionnaire (HARQ).¹⁸

The HARQ was developed and validated in the UK to assess attitudes to serve as a tool in the rehabilitation process of middle-aged to elderly persons, aged 60 years or more. It is not clear how widespread the HARQ has been applied in hearing rehabilitation, although studies can be mentioned which used parts of the HARQ to measure initial attitudes before hearing intervention. Hickson *et al.*¹⁴ used the 20 hearing

impairment items as one scale to measure the impact of initial attitudes in the Active Communication Education program for elderly persons, while Jerram and Purdy¹⁹ used the hearing aid stigma scale consisting of 9 items to assess pre-fitting attitudes. Furthermore, the domains determined by the HARQ have been adopted in the development of other questionnaires such as the questionnaire developed by Meister *et al.*²⁰ addressing pre-fitting expectations. The HARQ addresses a wider range of topics than the HHIE-S, including attitudes, perceived benefit, experienced social limitations and social pressure. The HHIE-S consists of 10 questions addressing the emotional and social impact of hearing difficulty. The 40-item HARQ addresses not only these aspects but also coping and whether the individual has been pressured to be assessed, and issues related to hearing aids such as stigma and whether hearing aids are considered useful and desirable. Two other questionnaires which have been developed by Cox and Alexander^{21,22} for use in hearing rehabilitation deserve mention. The Satisfaction with Amplification with Daily Life (SADL)²¹ measures hearing aid satisfaction while its sister questionnaire Expected Consequences to Hearing Aid Ownership (ECHO)²² has the same items as the SADL but the wording is in the future tense. Although these instruments are more comprehensive in how they measure (expected) satisfaction the authors found the items in the HARQ addressing hearing aid expectation appropriate for the present study.

In the present paper the results of the administration of a translated version of the HARQ in a Dutch sample will be investigated to determine whether it (or parts of it) can be applied in adult hearing screening to detect experienced hearing problems and assess attitudes related to hearing and hearing aids. In contrast to these earlier studies, which used the HARQ for persons at the start of the rehabilitation process, our focus is on screening and therefore calls for a more heterogeneous sample. Hearing aid users have also been included to form a base for comparison for the non-hearing aid users. This latter group is composed of persons with varying degrees of hearing impairment, *e.g.* persons who would and would not qualify for hearing aid reimbursement according to their level of hearing impairment and thus resembling a screening population. The validation is therefore twofold with attention for both the translation and its application in a screening setting. Since the HARQ was originally designed to assess persons at the beginning of the rehabilitation process not only different response patterns are expected but also missing values due to lack of suitability for some in the target audience. Furthermore, the HARQ will be examined relative to the patient journey towards hearing rehabilitation. Although hearing aid users would not typically be screened for hearing, they are being included in this study for comparison purposes as these persons are at the end of the patient journey towards hearing rehabilitation.

Materials and Methods

Original development of the Hearing Aid Rehabilitation Questionnaire

The HARQ items are on a three-point response scale: *true*; *partly true* and *not true* with *non-applicable* or *don't know* as additional response categories. Factor analysis was originally performed by Hallam and Brooks¹⁷ separately for the hearing impairment items and the hearing aid items although these items are presented in mixed form in one questionnaire. They derived three scales addressing hearing loss: i) personal distress/inadequacy, ii) hearing loss stigma and iii) minimization of hearing impairment and four scales addressing hearing aids: i) hearing aid stigma, ii) aid not wanted, iii) pressure to be assessed and iv) positive expectation of aid. The items were summed

so that the higher the sub-scale score, the more manifest the dimension, with four items recoded, which had reversed. The Manual of the HARQ was revised in 2008 and is available on request from the author R. Hallam (polpresa@gmail.com).

For the present study, the original HARQ was translated into Dutch by a Dutch native speaker and then independently back translated into English by an English native speaker to verify retention of the original meaning. The original and the back-translated English versions were then checked by both translators, first independently and then together, leading to minor changes in formulations before it was found suitable for use in this study.

Study group

Our heterogeneous sample consisted of persons recruited from the patient population of the Health Centre Neerbeek, a large general practitioner (GP) group practice in the province of Limburg in the Netherlands with 1302 registered patients aged 55 and more. This group was stratified by age to obtain random samples of relatively equal size for three age categories: 55-64, 65-74 and 75+ years, so that the sample would include individuals who are either employed, are retired but relatively active and those who are clearly elderly, since this might influence how important hearing is in their daily life. A letter was sent by their GP to a random sample of 557 patients requesting them to participate in a hearing study, followed by telephone contact two weeks later resulting in 271 participants who were scheduled for an audiogram, from which participants were included in one of three study groups. The aim was to obtain three approximately equal study groups: individuals with moderate hearing impairment and using a hearing aid: the aided group, individuals with a moderate hearing impairment not owning a hearing aid: the unaided group, and individuals without hearing impairment and without a hearing aid: the normal hearing group. Prior to 2013 Dutch health insurance granted (partial) reimbursement for hearing aids at a best ear pure tone average (BEPTA) of ≥ 35 dB. Therefore this criterion was applied to define our groups in the recruitment stage. This cutoff point of 35 dB over the frequencies 1, 2 and 4 kHz does not coincide with hearing impairment classifications adhered to by the European Commission (EC) and the World Health Commission (WHO). The EC (1996) and the WHO (2001) classify hearing impairment according to average thresholds for the frequencies 0.5, 1, 2 and 4 kHz in the better. The EC classification is no impairment for less than 20 dB, mild for 21-39, and moderate for 40-69, while according to the WHO classification: 25 dB or less is considered no impairment, 26-40 dB as slight, 41-60 dB as moderate and more than 60 dB as severe. Persons with mild to moderate hearing loss were therefore considered the target hearing impaired participants for the present study. As only 14 moderately hearing-impaired hearing aid users could be recruited from the GP clinic, this group was supplemented with 46 hearing aid users from the records of the Audiological Department of the Maastricht University Hospital. These 46 hearing aid users were recruited in the same way via an invitation letter from their own GP followed up by a phone call. The sample resulting consisted of 212 persons, 106 males and 106 females with three study groups: the *normal* group ($n=85$) with hearing impairment less than 35 dB in the better ear for the frequencies 1, 2, 4 kHz, the *unaided* group ($n=64$) with hearing important of 35 dB or more in the better ear without a hearing aid and the *aided* group ($n=63$) with a hearing aid. The distribution according to the WHO hearing impairment classification within these groups is presented in Figure 1.

Questionnaire administration

The Dutch HARQ was administered by one of two research assistants in a personal interview setting where the participant completed the questionnaire in written form and the research assistant was present to clarify any questions the participant may have. A visual analogue

scale (VAS) was used to register the participant's subjective hearing (dis)ability, without a hearing aid for the hearing aid users, a score of 0 being the worse and 100 being the best possible hearing ability. This scale was presented as a horizontal ruler of 10 cm with 10 marks from 0 to 100 and the participant was asked to provide a mark to indicate his/her subjective hearing. Audiometric measurement was scheduled prior to the interview. The present study was approved by the University Hospital Medical Ethics Committee and informed consent was obtained from the participants.

Statistical methodology

The 21 HARQ hearing impairment and 20 HARQ hearing aid items were analyzed separately just as in the original study.¹⁸ As the items are on a 3-point ordinal scale, polychoric correlation matrices were obtained separately for the hearing and hearing aid items, on the basis of which factor analysis was performed. The calculation of polychoric correlations is a technique for estimating the correlation between two theorized normally distributed continuous latent variables, from two observed ordinal variables.²³

Statistics were obtained to determine whether the assumptions regarding sampling adequacy were met. Values for Kaiser-Meyer Olkin Measure of Sampling Adequacy (KMO) < 0.5 are unacceptable while values above 0.7 are preferable. Bartlett's Test of Sphericity tests the null hypothesis that there are no correlations between the items so that a highly significant result indicates that there are correlations between items. Scree plots and parallel analysis were applied to determine the number of factors. The *Scree test*²⁴ is a graph of the eigenvalues plotted against the factors. The number of factors is indicated by the point above the elbow: the cut-off point between major and trivial factors. Parallel analysis²⁵ is based on comparing eigenvalues obtained from the data and those obtained from generating random values. Thus a comparison is made between what is observed and what would be expected if there were no factor structure present. As the obtained scales were expected to correlate, oblique (oblimin) rotations were performed to identify factor structures and these were substantiated with orthogonal rotation (varimax). A loading of 0.4 or more was considered as a significant contribution of the item to the factor.²⁶ The identified factor structures were compared to those found by Hallam and Brooks.¹⁸ Cronbach's α of each scale was calculated. Items were discarded if they compromised the reliability coefficient.

Criterion or concurrent validity of hearing scales were investigated by comparing scale outcome values with BEPTA 1, 2, 4 kHz and the VAS assessing subjective rating of hearing ability, for the hearing aid group this was answered without a hearing aid. Criterion group validity was assessed by comparing scale scores of the three hearing groups and according to the WHO hearing impairment classification.

Since the items are on an ordinal scale the software program PRELIS was used to obtain polychoric correlation matrices to be used in the factor analysis. Data analysis was conducted with SPSS 18.

Results

Sample characteristics

Age and gender characteristics of the whole sample and separately for the three groups are presented in Table 1 along with pure tone averages (PTA), asymmetry, and the original HARQ scale scores. Mean age did not differ significantly between the groups, however there were relatively more males in the aided group (Chi-square=8.63, 2 df, $P=0.013$). One way ANOVA confirmed that PTA's differed significantly between the three groups, all three pair-wise comparisons being statistically significant ($P<0.0005$) after Bonferroni adjustment, with as

expected the aided group having the greatest mean hearing impairment and the normal hearing group the lowest. There were relatively more persons with asymmetry exceeding 10 dB for the frequencies 0.5, 1, 2, 4 kHz in the hearing aid group (chi-square=8.30, 2 df, $P=0.016$). Likewise, the VAS hearing score was highest for the normal hearing group and lowest for the aided group, all three pair-wise comparisons being statistically significant ($P<0.0005$) after Bonferroni adjustment. Sub-scale scores obtained for the original HARQ scale conformed to ranges given by Hallam and Brooks.¹⁷ Moreover, the scale scores obtained per hearing (aid) group were plausible with the aided group having the highest mean values for the scales personal distress and pressure to be assessed and the lowest mean values for the other four scales. In contrast the scale scores for hearing aid stigma and positive expectation of aid were highest for the impaired but unaided group.

Polychoric correlations

In the calculation of the polychoric correlation coefficients of the 21 hearing items, PRELIS gave a warning regarding the accuracy of the estimated correlation coefficients for an item from the original minimization of hearing impairment scale: *hearing is not a serious problem for me*. This item was therefore discarded leaving 20 hearing items for the factor analysis. In calculating the polychoric correlations of the hearing aid items, PRELIS gave a warning regarding the accuracy of coefficient esti-

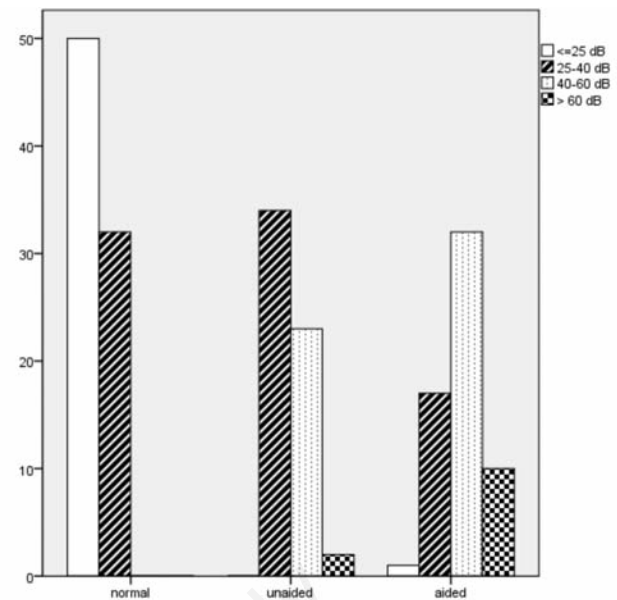


Figure 1. World Health Organization hearing impairment classification per hearing group in counts.

Table 1. Percentage of males and asymmetry >10 dB, mean (SD), median (range) of age, pure tone averages, visual analogue scale-hearing, original Hearing Aid Rehabilitation Questionnaire scale scores for hearing groups: i) normal: non-hearing impaired; ii) unaided: hearing impaired without hearing aid (best ear pure tone average 1, 2, 4 kHz >35 dB); iii) aided: hearing aid.

	Total sample (n=212) Mean (SD) Median (min, max)	Normal (n=85) Mean (SD) Median (min, max)	Unaided (n=64) Mean (SD) Median (min, max)	Aided (n=63) Mean (SD) Median (min, max)
% Males	50.0	41.2	46.9	65.1
Age (years)	71.1 (8.6) 71 (59, 96)	69.1 (8.8) 68 (56, 96)	74.8 (7.4) 76 (58, 92)	70.0 (8.8) 69 (56, 92)
BEPTA 1, 2, 4 kHz	38.3 (15.9) 37 (7, 88)	23.5 (6.6) 25 (7, 33)	44.7 (8.8) 43 (35, 68)	52.3 (13.3) 51 (25, 88)
BEPTA 0.5, 1, 2, 4 kHz	36.3 (14.1) 35 (11, 78)	23.6 (6.0) 24 (11, 39)	41.7 (8.2) 40 (29, 61)	48.3 (12.6) 49 (24, 78)
WEPTA 0.5, 1, 2, 4 kHz	43.7 (17.0) 41 (13, 94)	29.8 (10.6) 28 (13, 68)	47.9 (12.0) 44 (31, 83)	58.4 (13.5) 60 (35, 94)
Asymmetry dB (0.5, 1, 2, 4 kHz)	7.4 (8.5) 5 (0, 41)	6.2 (7.9) 4 (0, 41)	6.3 (7.4) 4 (0, 35)	10.1 (9.8) 6 (0, 39)
% Asymmetry >10 dB	19.4	13.4	15.3	31.7
VAS hearing score	65.7 (20.5) 70 (5, 100)	79.4 (14.5) 80 (45, 100)	61.8 (17.3) 60 (15, 100)	51.8 (19.3) 50 (5, 90)
Personal distress	16.3 (5.5) 14 (11, 33)	13.8 (3.5) 13 (11, 28)	16.4 (5.7) 14 (11, 33)	19.9 (5.6) 19 (11, 33)
Hearing loss stigma	6.0 (1.7) 5 (5, 15)	6.2 (1.6) 5 (5, 10)	5.7 (1.2) 5 (5, 10)	6.1 (2.1) 5 (5, 15)
Minimization of hearing loss	12.4 (2.5) 12 (6, 18)	13.0 (1.9) 12 (9, 18)	12.8 (2.8) 13 (6, 18)	11.0 (2.5) 11 (6, 16)
Hearing aid stigma	12.6 (3.0) 12.0 (9, 25)	12.8 (2.7) 12 (9, 20)	12.7 (2.8) 12 (9, 21)	12.2 (3.4) 11 (9, 25)
Aid not wanted	8.5 (2.5) 9 (5, 15)	9.4 (1.8) 9 (5, 15)	9.3 (2.4) 9 (5, 15)	6.2 (1.7) 5 (5, 11)
Pressure to be assessed	3.6 (1.2) 3 (3, 9)	3.2 (0.7) 3 (3, 7)	3.5 (1.1) 3 (3, 7)	4.3 (1.6) 4 (3, 9)
Positive expectation aid	7.0 (1.8) 7 (3, 9)	7.0 (1.8) 7 (3, 9)	7.2 (1.6) 7 (4, 9)	6.8 (2.1) 7 (3, 9)

BEPTA, best ear pure tone average; WEPTA, worse ear pure tone average; VAS, visual analogue scale. Asymmetry: absolute difference PTA 0.5, 1, 2, 4 kHz left/right ears.

mations of two of the three items from the original positive expectation scale. These two items pertained to the time that would be required to adjust to using a hearing aid. The third item from this scale, which addressed expected benefit, had a high percentage of missing values. It was therefore decided to exclude these three items. Estimation of correlations with the seventh item of the hearing aid stigma scale: *Many people don't know how to react to you when you have a hearing aid* also presented problems and therefore this item was discarded as well leaving a total of 16 hearing aid items for factor analysis.

Reliability analysis of the Hearing Aid Rehabilitation Questionnaire hearing items

Assumptions required for factor analysis were met regarding sampling adequacy ($KMO=0.8$) and Bartlett's test of sphericity was highly significant ($P<0.0005$). The scree plot suggested a two-factor solution with the elbow more clearly between the second and third eigenvalues and this was supported by parallel analysis. The item: *I've come to regard whatever hearing difficulties I may have as a problem not worth bothering about* had a low loading on both factors. Of the remaining 19 items there were 11 items with loadings >0.4 on the first factor and 10 on the second factor, thus with 2 items loading on both. After examination of the contents of the two factors it was decided that the 11-item-factor could be labeled *functionality* while the 10 item-factor could be labeled *social hearing*. The *functionality* pertains to experienced difficulties in functioning while *social hearing* pertains to difficulties experienced in a social context. Factor loadings of the items of the derived hearing scales are presented in Table 2 (for each item the loading obtained by Hallam and Brooks is presented in parentheses). Scale sum scores were obtained by adding the response values of 1, 2, and 3 for disagree, partly agree and agree whereby the items with negative loadings were recoded (1=3, 2=2 and 3=1). A Cronbach's α of 0.85 was obtained for the 11 item *functionality* scale and 0.84 for the *social hearing* scale.

Reliability analysis of Hearing Aid Rehabilitation Questionnaire hearing aid items

The assumptions required for factor analysis were met: $KMO=0.60$ and Bartlett's test of sphericity was highly significant ($P<0.0005$). The scree plot and parallel analysis supported a three-factor solution for the hearing aid items. There were two items, which loaded on two factors and one, which loaded on all three. The obtained factor structures for the hearing aid items could be labeled *aid stigma*, *social pressure*, and *aid unwanted* (Table 3).

Cronbach's α 's of 0.62, 0.61, and 0.49 were obtained respectively for the 6 item *aid stigma*, the 7 item *social pressure* and the 5 item *aid unwanted* scales.

Validity analysis

For each of the scales a higher scale score indicates a greater problem. Inspection of the mean values of the five derived scales (Table 4) shows that the *functionality*, *social hearing* and the *social pressure* scales were lowest for the normal hearing group and highest for the aided group, while the *aid stigma* scale was lowest for the aided group and highest for the normal hearing group. All pair-wise comparisons for the *functionality* scale relative to either the hearing group or the WHO classification were statistically significant even after Bonferroni correction ($P<0.0005$). For the *social hearing* scale the greatest difference was observed between the normal and aided group ($P=0.031$ but after Bonferroni correction this was 0.092). The *social hearing* scale means differed significantly for all pair-wise comparisons of the WHO classifications with the exception of the no impairment and slight categories. The scale *aid stigma* was highest for the normal group and lowest for the aided group but these differences were small while no trend could

be observed relative to the WHO classification. The *social pressure* scale scores were lowest for the normal and highest for the aided group and this trend was also observed for the WHO classification. All pair-wise comparisons were statistically significant with only the difference between the normal and aided group not being highly significant (0.092) after Bonferroni correction. The scale *aid unwanted* was highest for the unaided and lowest for the aided group. Pair-wise comparisons showed statistically significant differences between the normal hearing and unaided group ($P=0.05$) and between the normal hearing and aided groups ($P<0.0005$), however after Bonferroni correction the difference between the normal and unaided groups was no longer significant. The *aid unwanted* scores decreased relative to the level of impairment as defined by the WHO classification but these differences were not statistically significant.

The correlation coefficients between the five derived scales and objective and subjective hearing impairment are presented in Table 5. The *functionality* scale correlated positively with all the pure tone averages and negatively with the VAS hearing scale for the entire sample. These relations were also present within the unaided and aided groups but only held for the VAS scale in the normal hearing group. The *social hearing* scale was positively correlated with the pure tone averages for the whole sample and within the aided group. The *social hearing* scale correlated negatively with the VAS-hearing scale for the whole sample and within the aided and unaided groups. The *aid stigma* scale was only negatively correlated with pure tone averages within the normal group. Further investigation revealed that within the unaided group this relation was observed only for those persons in the WHO classification of no impairment. Examination of the unaided group relative to the WHO classification revealed that within the WHO defined mildly impaired range the correlations were stronger being 0.498 with BEPTA 1, 2, 4 kHz. *Social pressure* was positively correlated with pure tone averages and negatively correlated with the VAS scale for the entire sample, and only correlated negative with the VAS scale within the unaided group. *Aid unwanted* did not appear to be related to either pure tone averages or the VAS hearing scale.

Discussion

The purpose of this study was to validate the HARQ for use in a more heterogeneous group than for which it was originally designed and to investigate its usefulness to assess hearing dimensions in a potential screening population. Factors have been discerned which address issues prominent in the patient journey towards hearing rehabilitation.

Specifically scales were derived which relate to how the individual experiences his own hearing ability. Laplante-Levesque *et al.*²⁷ ascertained in their qualitative study that it is experienced difficulties in hearing which influence help seeking rather than clinical services, and persons who are aware of the gradual process of becoming hearing impaired feel that clinicians failed to recognize this process. In a study of 63 hearing impaired persons conducted at a geriatric outpatient clinic, Wu *et al.*²⁸ found that willingness to use a hearing aid was related to hearing functionality but not to audiometric outcomes. The awareness stage described by Manchaiah⁷ is marked by experienced functional and social limitations. The transition from awareness to movement will be moderated by attitudes towards hearing aids and mediated by pressure experienced to be assessed. The scales developed here could help mark the position on the *patient journey* with as destination successful hearing rehabilitation and resolution.

Clearly, each scale evaluates an aspect of hearing or factors related to the passage of the hearing impaired person from the (pre)-awareness to the movement stage. The *functionality* and *social hearing* scales could be applied to assess experienced hearing difficulties as

part of a screen for referral for rehabilitation. In this context it might be important to realize that hearing aid fitting does not necessarily have to be the first step in the rehabilitation process keeping in mind the implementation of the Active Communication Education program by Hickson *et al.*¹⁴ whereby individuals could discover the possibility of improving communication through hearing strategies.

The *functionality* items are clearly an indication of disability as these items address the limitations experienced in functional hearing. This is indicated by the fact that the mean scores obtained were lowest for the normal and highest for the aided group and further varied relative to the severity of the WHO classification. The same trend was observed for the *social hearing* scale relative to our hearing groups. However the increase in mean scores did not correspond uniformly to the severity of the WHO classification with the range for 20-40 dB having the lowest values. Perhaps the relation is compromised by Dutch policy providing hearing aid reimbursement for hearing impairment for 35 dB or more in the best ear. Nevertheless the scale appears to measure experienced social limitations and how the person feels his/her hearing limitation is perceived by others. Therefore the *functionality* and *social hearing* scales represent positions in the pre-awareness and awareness stage.

In the Active Communication Education program,¹⁴ the greatest improvement was found among participants with higher pre-test scores for the HARQ hearing items, further supporting the notion that these HARQ items help to define the patient's location in these first stages on the journey towards rehabilitation. It is thus the experienced hearing,

which is at the core of awareness of potential transition to the movement stage.

The hearing aid scale *social pressure* reflects whether the individual has experienced others noticing his/her hearing problems. Even though it is composed of hearing aid items it is about hearing functionality as viewed by others. This scale may help identify persons in the pre-awareness stage where others notice the hearing limitations of the hearing impaired individual while the hearing-impaired individual does not. The other two hearing aid scales, *Aid Stigma* and *Aid Unwanted*, quantify barriers to reaching the movement stage.

The factor structure obtained for the hearing aid items is markedly different from those obtained in the original HARQ study. The only clear similarity lies in that six of their hearing aid stigma items comprise our *aid stigma* scale. One item *many people don't know how to treat you when you have a hearing aid* gave problems in the calculation of the polychoric matrix. This may be attributable to the fact that our sample consists of persons with and without the experience of wearing a hearing aid. Two other original HARQ Hearing Aid Stigma items had low loadings on our *aid stigma* scale. *I think the behind-the-ear aids are really quite small and inconspicuous* and *From what I know, hearing aids don't help a great deal*. These items also had relatively the lowest loadings in the original study.¹⁸ All three items from the original HARQ Pressure to be Assessed scale had high loadings on the *social pressure* scale. At the same time however, two items from the original HARQ Aid Not Wanted scale: *I don't consider it important to be assessed for a hearing aid* and *My hearing is not so bad that I need a hearing aid* had neg-

Table 2. Derived scales and factor loadings of Hearing Aid Rehabilitation Questionnaire hearing items.

Items according to Hallam and Brooks scales (loadings)	Functionality	Social hearing
Personal distress		
1. It sometimes depresses me when I cannot follow a conversation (0.57)	0.85	-
2. I dread meeting new people since becoming hearing impaired (0.59)	0.47	0.59
3. I find myself avoiding company because conversation is too much effort (0.71)	0.55	0.58
4. In a conversational group I keep quiet for fear of saying the wrong thing (0.67)	0.66	-
5. When several people are chatting, it bothers me that I often lose the thread of the conversation (0.67)	0.75	-
6. It really upsets me when I realise I've got the wrong end of the stick in conversation (0.70)	0.61	-
7. By and large I am able to hear without difficulty (-0.51)	-0.86	-
8. I can hear well enough when I really concentrate (-0.50)	-0.70	-
9. My poor hearing sometimes makes me feel really inadequate (0.71)	-	0.76
10. My hearing loss makes me feel isolated from other people (0.74)	-	0.74
11. I have to admit that deep down I feel restricted by my hearing loss (0.67)	-	0.63
Minimization of hearing loss		
1. I think I've overcome any hearing difficulties I might have through my own efforts (0.49)	0.50	-
2. Difficulty in hearing is not of major concern to me at the moment (0.46)	-0.69	-
3. My hearing problems are really quite minor (0.41)	-0.70	-
4. By and large I am able to hear without difficulty (0.44)	-	-
5. I've come to regard whatever hearing difficulties I may have as a problem not worth bothering about (0.76)	-	-
6. Hearing is not a serious problem for me (0.52)	-	-
Hearing loss stigma		
1. When you have hearing difficulties, other people ignore you (0.55)	-	0.67
2. As I see it, I am less of a person because of my hearing difficulty (0.62)	-	0.65
3. I am sure that some people think I am stupid (0.73)	-	0.71
4. I get the feel that other people find it a strain to talk to me (0.54)	-	0.70
5. Some people avoid me because of my hearing ability (0.72)	-	0.75
Total explained variance: 57.9%	36.1	30.8
Cronbach's α	0.85	0.84

ative loadings on the *social pressure* scale indicating either an absence or refusal to acknowledge pressure to be assessed.

In the present study, the items from the original HARQ Positive Expectation scale were dropped from the analysis because they gave problems when estimating the polychoric correlation coefficients. These items had high percentages of unusable responses, which makes sense as the content is specifically formulated for persons in the process of considering hearing aid uptake. These items also lack appropriateness for the hearing aid users in our sample in that they are experienced hearing aid users and therefore responses would be based on experience rather than expectation. Hallam and Brooks¹⁸ saw this scale as an over-estimation of the positive effects of a hearing aid. The fact that our aided group scored slightly lower for this original HARQ scale than the other two groups reflects having experienced adjustment to using a hearing aid. Nevertheless, given the results reported by Jerram and Purdy¹⁹ this aspect of hearing rehabilitation should be included in a screening setting. Of the three items in this scale there is only one item, which does not contain a reference to time for adjustment to hearing aid use. This item: *I expect to hear as easily with a hearing aid as I did before* might be appropriate for screening purposes. The *aid stigma* scale appears to measure stigma, and the fact that it correlates negatively with hearing impairment only in the non-hearing impaired group may indicate acceptance, there being persons in this group approaching a level of hearing impairment warranting hearing rehabilitation. This relation between hearing impairment and a reduction in negative attitudes towards hearing aids was further supported by the fact that this relation was strongest within the normal group with no impairment and within the unaided group with moderate impairment according to the WHO classification. This notion appears

to be further supported by the findings of Jerram and Purdy¹⁹ who found no relation between HARQ hearing aid stigma scores and hearing aid outcome, suggesting that hearing aid stigma is less manifest when further along on the patient journey. Our findings may also suggest that increasing hearing impairment may reduce hearing aid stigma in some individuals allowing them to benefit from hearing aid fitting at relatively lower levels of hearing impairment.

The *aid unwanted* scale is a measure of reluctance and thus a barrier to hearing aid uptake, and this is underlined by the fact that within the hearing impaired but unaided group, the *aid unwanted* scores were highest. There was also a high correlation between the VAS hearing scale and the *social pressure* scale within this group, indicating that persons scoring high on this scale may receive relatively more suggestions from others regarding their hearing ability. *Social pressure* may then be a motivator for transition into Manchaiah's⁷ movement stage.

Hallam and Brooks¹⁸ established the factor structure of the HARQ with a sample of 164 first-time hearing aid candidates ranging in age from 36-96 years (mean=74.2, SD=10.4), with 92% of the sample being age 60 or more. Our study group has a similar age distribution even though we only included persons aged 55 and more but differs regarding hearing (aid) status as it was our intent to mimic a screening population. However the HARQ items were originally formulated for persons seeking hearing rehabilitation and thus those persons who are experiencing difficulties in hearing. Thus some HARQ items are out of context for persons not experiencing those difficulties. This is precisely what Hyde¹⁷ was warning when he emphasized the need to examine existing measures relative to purpose, context and responsiveness.

The HARQ was developed as a supplementary tool in the hearing aid rehabilitation process. It is then not surprising that a somewhat differ-

Table 3. Derived scales and factor loadings of Hearing Aid Rehabilitation Questionnaire hearing aid items.

Items according to Hallam and Brooks scales (loadings)	Aid stigma	Social pressure	Aid unwanted
Hearing aid stigma			
1. I think the behind-the-ear aids are really quite small and inconspicuous (-0.53)	-	-	-
2. If I wear aid, people will probably think I'm a bit stupid (0.63)	0.70	0.40	-
3. It would embarrass me to have to wear a hearing aid (0.61)	0.40	0.53	0.54
4. I think people react differently to you when you are wearing a hearing aid (0.60)	0.68	-	-
5. I would stand out in a crowd wearing a hearing aid (0.67)	0.79	-	-
6. I think that if you wear a hearing aid people tend to ignore you (0.72)	0.68	-	-
7. Many people don't know how to react to you when you have a hearing aid (0.66)	-	-	-
8. It would make me feel old to wear a hearing aid (0.65)	0.80	-	-
9. From what I know, hearing aids don't help a great deal (0.52)	-	-	0.77
Aid not wanted			
1. I don't really want a hearing aid (0.74)	-	-	0.71
2. I think that wearing a hearing aid would help me when meeting strangers (0.56)	-	-	0.72
3. I am willing to try a hearing aid but don't think an aid will be of much help to me (-0.71)	-	--	0.58
4. I don't consider it important to be assessed for a hearing aid (0.72)	-	-0.59	-
5. My hearing is not so bad that I need a hearing aid (0.72)	-	-0.73	-
Pressure to be assessed			
1. I feel I have been pressured into having my hearing assessed (0.85)	-	0.71	-
2. I have come about my hearing in order to please someone else (0.79)	-	0.72	-
3. It is due to pressure from my family or friends that I am having my hearing assessed (0.86)	-	0.78	-
Total explained variance: 56.4%	20.6	25.7	10.2
Cronbach's α	0.62	0.61	0.49

Table 4. Mean (SD), median (range) of derived scale sum scores, according to sample hearing group and World Health Organization hearing classification.

	Functionality Mean (SD) Median (min, max)	Social hearing Mean (SD) Median (min, max)	Aid stigma Mean (SD) Median (min, max)	Social pressure Mean (SD) Median (min, max)	Aid unwanted Mean (SD) Median (min, max)
Total sample	17.1 (5.7) 15 (11, 33)	12.8 (3.9) 11 (10, 29)	7.8 (2.3) 7 (6, 16)	10.2 (2.4) 9 (7, 19)	7.2 (2.0) 7 (5, 13)
Sample group classification*					
Normal	13.8 (3.1) 13 (11, 26)	12.2 (3.2) 11 (10, 23)	8.0 (2.2) 7 (6, 14)	8.9 (1.2) 9 (7, 13)	7.4 (1.6) 7 (5, 12)
Unaided	17.1 (5.6) 16 (11, 32)	12.7 (3.7) 12 (10, 24)	7.8 (2.1) 7 (6, 14)	9.8 (2.0) 9 (7, 15)	8.0 (2.2) 8 (5, 13)
Aided	21.6 (5.4) 22 (11, 33)	13.7 (4.7) 12 (10, 29)	7.6 (2.5) 6 (6, 16)	12.5 (2.2) 12 (8, 19)	6.2 (1.8) 5 (5, 12)
WHO classification					
≤25 dB	13.9 (3.2) 13 (11, 26)	12.4 (3.2) 11 (10, 21)	8.2 (2.4) 7 (6, 14)	8.9 (1.4) 9 (7, 15)	7.4 (1.6) 7 (5, 12)
26-40 dB	15.7 (4.5) 14 (11, 27)	11.7 (2.4) 11 (10, 21)	7.5 (1.8) 7 (6, 13)	9.9 (2.3) 9 (7, 17)	7.2 (1.8) 7 (5, 12)
41-60 dB	20.6 (6.0) 21 (11, 32)	13.9 (4.4) 12 (10, 26)	7.8 (2.6) 6 (6, 16)	11.5 (2.3) 11 (7, 18)	7.1 (2.4) 6 (5, 13)
>60 dB	24.4 (6.5) 25 (13, 33)	16.9 (6.9) 15 (10, 29)	8.6 (3.0) 8 (6, 16)	12.0 (3.0) 12 (7, 19)	6.8 (2.1) 7 (5, 11)

*Groups: normal, non-hearing impaired; unaided, hearing impaired without hearing aid; aided, hearing aid.

Table 5. Correlations scale sum scores with objective (best ear pure tone average) and subjective hearing (visual analogue scale).

Factor	Hearing outcome	Entire sample	Normal	Unaided	Aided
Functionality	BEPTA 1, 2, 4 kHz	0.569**	0.011	0.389**	0.288*
	BEPTA 0.5, 1, 2, 4 kHz	0.563**	0.088	0.362**	0.277*
	WEPTA 0.5, 1, 2, 4 kHz	0.559**	0.174	0.336**	0.275*
	Asymmetry	-0.109	-0.157	-0.072	0.059
	VAS	-0.611**	-0.371**	-0.481**	-0.453**
Social hearing	BEPTA 1, 2, 4 kHz	0.258**	-0.149	0.139	0.426**
	BEPTA 0.5, 1, 2, 4 kHz	0.262**	-0.097	0.114	0.411**
	WEPTA 0.5, 1, 2, 4 kHz	0.203**	-0.156	0.076	0.353**
	Asymmetry	0.090	0.126	0.000	0.188
	VAS	-0.280**	0.005	-0.308*	-0.383**
Aid stigma	BEPTA 1, 2, 4 kHz	0.001	-0.311**	0.144	0.233
	BEPTA 0.5, 1, 2, 4 kHz	-0.018	-0.271*	0.052	0.178
	WEPTA 0.5, 1, 2, 4 kHz	-0.032	-0.238*	-0.029	0.248
	Asymmetry	0.099	0.142	0.129	0.021
	VAS	0.009	0.099	0.018	-0.185
Social pressure	BEPTA 1, 2, 4 kHz	0.501**	0.027	0.223	0.042
	BEPTA 0.5, 1, 2, 4 kHz	0.481**	0.118	0.221	-0.018
	WEPTA 0.5, 1, 2, 4 kHz	0.482**	0.110	0.252	-0.042
	Asymmetry	-0.111	-0.015	-0.092	0.014
	VAS	-0.414**	-0.147	-0.347**	0.074
Aid unwanted	BEPTA 1, 2, 4 kHz	-0.086	0.045	0.184	0.076
	BEPTA 0.5, 1, 2, 4 kHz	-0.103	0.022	0.152	0.015
	WEPTA 0.5, 1, 2, 4 kHz	-0.094	0.118	0.118	0.024
	Asymmetry	0.020	-0.149	-0.086	0.137
	VAS	0.050	-0.028	-0.073	-0.125

BEPTA, best ear pure tone average; WEPTA, worse ear pure tone average; VAS, visual analogue scale. Asymmetry: absolute difference PTA 0.5, 1, 2, 4 kHz left/right ears. P: * < 0.05; ** < 0.005.

ent factor structure emerged when applied to individuals not seeking rehabilitation. This result should be considered a positive finding since the objective of the present study is to determine if there are items which can be applied in a heterogeneous sample, rendering usefulness in a screening process which will by the very nature of screening include persons with normal hearing or, in any case, not consciously experiencing hearing difficulties such as persons in Manchaiah's⁷ pre-awareness stage of the patient journey.

The inclusion of hearing aid users in this study could be questioned given that the objective is to develop tools for assessment in screening. The fifth of the seven stages of Manchaiah's patient journey⁷ is rehabilitation. Thereafter follow the stages evaluation and resolution, the latter being the stage of satisfied hearing aid use. Gianopoulos *et al.*²⁹ performed a follow up of 166 persons who had been fitted with a hearing aid as a result of a hearing screen and found that only 43% were still using it after 8-16 years. Through interviews it was determined that 47 of the 66 persons who were not using their aids were still willing to try a new aid, indicating that hearing screening should be extended to unsuccessfully rehabilitated hearing aid owners.

It is extremely relevant how hearing impairment is defined. At the time of our study Dutch policy provided reimbursement for hearing aid fitting when the pure tone average for the frequencies 1, 2 and 4 Hz exceeded 35 dB in the better ear. When the WHO classification is applied our sample results in 83 persons in the category *slight hearing impairment* of which 34 are in our *unaided* and 32 in our *aided* group. The scale scores either increased or decreased monotonically relative to the WHO hearing impairment classification four scales providing validity. The only exception was the *aid stigma* scale, which did not appear to vary monotonically according to classification. Nevertheless for some ranges of hearing impairment there is a relation indicating that hearing aid stigma as a barrier to hearing rehabilitation may be moderated by increasing hearing impairment.

It is interesting to remark that the percentage of persons with asymmetry exceeding 10 dB was much greater in the hearing aid group suggesting that asymmetric hearing impairment may trigger help-seeking behavior.

The cross-sectional design of the present study hinders making conclusive remarks about the use of the HARQ to assess the individual's progress along the patient journey. A longitudinal study would provide information as to how these various aspects of hearing experience and willingness to start hearing rehabilitation interact and influence the individual. In a longitudinal study, the use of the SADL and ECHO are to be considered. Although we had included the positive expectation scale items of the HARQ, they could not be used to define a scale and thus were not included in the final analysis. The SADL and ECHO questionnaires include more items facilitating quantification of this domain which would be particularly useful in a longitudinal study where these questionnaire responses can be compared before and after hearing aid fitting.

At the same time it should be remarked that answering a questionnaire regarding hearing and hearing aids, is in itself an intervention as it may encourage the individual to take action or at least to be more receptive to action in the direction of hearing rehabilitation.

Conclusions

The process of becoming hearing impaired is often a gradual one. We have shown here that hearing functionality and social limitations can be assessed with elements of the HARQ. Furthermore, barriers to hearing uptake can be quantified with items addressing pressure to be assessed and hearing aid stigma. Thus clearly these derived scales

would supplement audiological assessment in hearing screens, to assess receptivity of hearing impaired individuals to the process of rehabilitation and identify an individual's location on the patient journey. In particular, the scales developed here may provide more clues to understand the relatively unknown early stages of the hearing impaired patient journey.

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