Self-Perception of Hearing Ability as a Strong Predictor of Hearing Aid Purchase

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Abstract

Background: Hearing threshold data are not particularly predictive of self-perceived hearing handicap or readiness to pursue amplification. Poor correlations between these measures have been reported repeatedly. When a patient is evaluated for hearing loss, it is common to collect both threshold data and the individual's self-perception of hearing ability. This is done to help the patient make an appropriate choice related to the pursuit of amplification or other communication strategies. It would be valuable, though, for the audiologist to be able to predict which patients are ready for amplification, which patients require more extensive counseling before pursuing amplification, and which patients simply are not ready for amplification regardless of the audiometric data.

Purpose: The purpose of this study was to evaluate the following question for its potential usefulness as a determinant of patient readiness for amplification: "On a scale from 1 to 10, 1 being the worst and 10 being the best, how would you rate your overall hearing ability?"

Research Design: The test–retest reliability and the predictive value of the question, based on final hearing aid purchase, were evaluated in a private practice setting.

Study Sample: Eight hundred forty hearing-impaired adults in the age range from 18 to 95 years.

Collection and Analysis: Data were collected retrospectively from patient files.

Results and Conclusion: Results were repeatable and supported the use of this question in similar clinical settings.

Key Words: Hearing aids, hearing aid purchase, self-perception

Abbreviations: FPS = Faces Pain Scale; HHIE = Hearing Handicap Inventory for the Elderly; HPI = Hearing Performance Inventory; ICC = intraclass correlation; NRS = Numerical Rating Scale; PTA = pure-tone average; SDS = Simple Descriptor Scale; SHI = Social Hearing Handicap Index; VAS = Visual Analogue Scale; VRS = Verbal Rating Scale

Hearing threshold data are not particularly predictive of self-perceived hearing handicap or readiness to pursue communication solutions including amplification. Poor correlations between objective and subjective measures have been reported by many researchers (Weinstein and Ventry, 1983; Brainerd and Frankel, 1985; Hawes and Niswander, 1985). Weinstein and Ventry (1983) found a correlation of $r = 0.61$ between pure-tone average (PTA) and scores on the Hearing Handicap Inventory for the Elderly (HHIE). The HHIE was developed by Ventry and Weinstein (1982) to evaluate the psychosocial effects of hearing loss on the elderly population. Brainerd and Frankel (1985) looked at the relationship between PTA and the Social Hearing Handicap Index (SHI) and found a correlation of $r = 0.35$. The SHI (Ewerston and Birk-Nielson, 1973) is a self-assessment scale that provides a handicap percentage. A correlation of $r = 0.54$ was reported between PTA and the revised Hearing Performance Inventory (HPI [Hawes

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and Niswander, 1985]). The revised HPI (Lamb et al, 1983) is a shortened version of the HPI developed by Giolas, Owens, Lamb, and Schubert (1979), which assesses handicap by evaluating a wide variety of listening situations. Although audiometric data are important when determining candidacy for amplification and the appropriate hearing aid fitting, they are not the only factor in this decision. For a full review of this research, see Bentler (2006).

Due to the lack of near-perfect correlation between audiometric thresholds and self-perception, when an audiologist evaluates a patient it is common also to ask for the individual's self-perception of communication abilities and difficulties. In other words, both pieces of information are important in the pursuit of communication solutions for the patient. The audiologist attempts to use the combination of these data to help the patient make an appropriate choice related to the pursuit of amplification or other communication strategies. Although the typical questionnaire-based self-perception data that are collected guide the audiologist in advising the patient as to the need for amplification and desired features, these data generally have not been used to predict the patient's readiness for pursuing amplification. It would be valuable for the audiologist to be able to predict which patients are ready to investigate the use of amplification right away, which patients require more extensive counseling in order to make the decision to pursue treatment, and which patients simply are not ready for amplification regardless of the audiometric data and amount of counseling provided.

Although a great deal of research currently is devoted to patient success with amplification, the fact remains that individuals cannot be successful with amplification if they do not receive it. A small percent of individuals who could benefit from hearing aids actually pursue them. The question posed in this study may aid in identifying levels of readiness for amplification.

The purpose of the present study was to identify a question that can determine patient readiness for amplification. This study was reviewed and approved by the University of Pittsburgh Institutional Review Board. The test–retest reliability of this question and the predictive value of the question based on final hearing aid purchase were evaluated. Patients were asked to rate their overall hearing ability on a scale from 1 (worst) to 10 (best). The goal of this question is to evaluate patient readiness to pursue treatment; this simple question is not designed to take the place of formal questionnaires that will assist the audiologist in feature and technology recommendations or measures that might predict ultimate success with amplification. Its intended use is to quantify patient readiness for amplification.

Rating scales are commonly used when evaluating patients reporting pain and often involve the use of one of the following scales: Visual Analogue Scale (VAS), Faces Pain Scale (FPS), Verbal Rating Scale (VRS)/Simple Descriptor Scale (SDS), and Numerical Rating Scale (NRS [Paice and Cohen, 1997; Bolton and Wilkinson, 1998; Rodriguez et al, 2004]). When using the VAS, patients are shown a horizontal line with anchors at each end (no pain to worst pain possible [Bolton and Wilkinson, 1998]). The FPS is similar to the VAS, consisting of seven line-drawn faces matched with scores (0–6) and descriptors (no pain to worst possible pain [Rodriguez et al, 2004]). When using the NRS and the VRS/SDS, patients are provided with numeric (0–10, no pain to worst pain possible) or descriptive (adjectives describing different levels of pain) anchors, respectively.

In each case, patients are asked to identify their level of pain using the rating scale provided. Statistically significant correlations have been reported among the NRS, VAS, and VRS (Bolton and Wilkinson, 1998); the VAS and NRS and the VAS and SDS (Paice and Cohen, 1997); and the NRS, VAS, and FPS (Rodriguez et al, 2004). Paice and Cohen and Rodriguez, McMillan, and Yarandi found that the majority of the subjects preferred the NRS over the other scales to rate their pain levels.

Rating scales also are used for tinnitus assessment. Patients are asked to rate self-reported severity, loudness, annoyance, interference, and sleep disturbance (Hallam and Jakes, 1985; Gerber et al, 1985–1986; Wilson and Henry, 2000). The rating scale evaluated in this study (1–10) is similar to the NRS often used to evaluate pain intensity.

METHOD

The clinical audiologists at Audiological Consultants of Atlanta created a question to ask their patients for the purpose of determining the likelihood of hearing aid purchase. The purpose of this question was to qualify the time that should be devoted to patient counseling (i.e., Is the person ready to move ahead without significant time devoted to counseling, will time be well spent in counseling with this patient, or is the patient unwilling to move ahead at this time regardless of the amount of time spent counseling?). The following question was administered verbally by an audiologist to all patients visiting this clinic for the past several years: "On a scale from 1 to 10, 1 being the worst and 10 being the best, how would you rate your overall hearing ability?" The 1 and 10 ratings were the only anchors given to the patients. The audiologists recognized trends in the relationship between patients' hearing ability and the purchase of hearing aids. It was of interest to examine whether the analysis of this

simple patient self-rating scale, hearing ability, and the final outcome of receiving or not receiving hearing aids would provide valuable information about counseling efforts and patient readiness for amplification. This analysis was designed to quantify this relationship and to provide needed psychometric data related to the question being used. To determine the clinical utility of this question, the reliability and predictive value of the question were evaluated using two different subject groups. Data were collected retrospectively from patient files. No other subjective questionnaires were completed by the patients. Patients had a combination of sensorineural, conductive, and mixed hearing loss.

Reliability

In order to evaluate whether the answer to the question "On a scale from 1 to 10, 1 being the worst and 10 being the best, how would you rate your overall hearing ability?" was repeatable within subjects, data were extracted from 40 randomly selected patient files. A sample size greater than or equal to 30 is suggested because this is the point where the value of the sample correlation coefficient becomes stable. With a sample size greater than or equal to 30 the estimated results are getting closer to the true population correlation, and the width of confidence intervals for the true population correlation decreases (Gay and Airasian, 2000).

Files from 16 males (aged 37–89) and 24 females (aged 32–87) were included in this analysis. The group had an average PTA of 33 dB for the right and left ears. The answer to the question "On a scale from 1 to 10, 1 being the worst and 10 being the best, how would you rate your overall hearing ability?" was recorded for each participant on two separate occasions. The question was read verbally to patients. A visual scale was not provided. The first rating was obtained at the hearing aid discussion, and the second rating was obtained two weeks later either at the hearing aid fitting appointment or by phone for patients who did not pursue amplification.

Predicting Amplification Readiness and Counseling Needs

Data used for this part of the study were obtained from 802 patients (females aged 18–97 and males aged 18–95) seen in the clinic for the first time during a four-year period. Less than 10 percent of the subjects had a significant asymmetric hearing loss (i.e., >30 dB between ears at two contiguous frequencies). The question "On a scale from 1 to 10, 1 being the worst and 10 being the best, how would you rate your overall hearing ability?" was read orally to patients at the initial audiologic evaluation, and responses were recorded by the audiologists in the patients' charts. None of these individuals had previously worn amplification. Along with patient self-rating, left and right air-conduction thresholds (0.5–8 kHz) and hearing aid outcome (yes = purchased a hearing aid, no = did not purchase a hearing aid) were used in the data analysis. It was impossible to fully track hearing aid outcome for all patients because it is possible that some patients received hearing aids from another clinic. For the purposes of these data all patients who did not receive hearing aids from Audiological Consultants of Atlanta were marked as "nonpurchasers." It is unlikely that all individuals labeled as "nonpurchasers" purchased hearing aids elsewhere; therefore, given the large number of individuals, the data should be indicative of purchasers and nonpurchasers.

RESULTS

Reliability

An intraclass correlation (ICC), which is a test of difference and correlation, was used to evaluate the test–retest reliability of the question used in this investigation for the first set of subjects (n = 40). For this situation, the ICC (2,2) procedure was used, which means that the second ICC model was used and two ratings were included. This is the appropriate method to use since two self-assessment ratings were obtained for each subject, and the intent is to generalize to ratings given by the clinic patients at other time points (Shrout and Fleiss, 1979). An ICC of 0.835 was obtained between the first and second ratings. The following labels have been revised from Landis and Koch (1977) to classify reliability ratings: 0.00 to 0.10—virtually none, 0.11 to 0.40—slight, 0.41 to 0.60—fair, 0.61 to 0.80—moderate, and 0.81 to 1.0—excellent (Shrout, 1998). Therefore, the question used in this investigation revealed excellent test–retest reliability, which indicates that it can be used in a clinical setting to obtain reliable self-perceived hearing ability ratings. Table 1 lists the first and second ratings, and Table 2 shows the difference between ratings. The majority of the participants (n = 25) did not change their rating from the first to the second time they rated their hearing ability. An additional 12 participants did not change their rating by more than one category. Figure 1 shows the distribution of subject ratings.

Predicting Amplification Readiness and Counseling Needs

The relationship between self-perceived hearing ability and purchasers or nonpurchasers of hearing

Table 1. Frequency Distribution of First and Second Ratings

Rating	Number of Subjects	
	1st Rating	2nd Rating
1	0	0
2	0	0
3	1	1
4	7	4
5	13	14
6	9	8
7	5	6
8	3	4
9	2	3
10	0	0
Total	40	40

aids was examined in the second part of the study with data from 802 individuals visiting the clinic. Figure 2 illustrates that the majority of patients who arrived for a hearing evaluation in this practice rated their hearing loss as a "5," which was also the case for the patients in the reliability portion of the study (Table 1). Correlation coefficients for different PTAs (i.e., left/right 0.5, 1, 2 kHz; left/right 1, 2, 3, 4 kHz; and left/right 4, 6, 8 kHz) were completed in an attempt to identify the highest correlation between the audiometric findings and hearing aid purchase decision. Pearson *r* values ranged from 0.56 to 0.61. The right-ear 1, 2, 3, 4 kHz average yielded the strongest correlation ($r = 0.61$) and is shown in Figure 3. For each rating (1–10) the box plots of the PTAs of the group are provided. The lower boundary of each box represents the 25th percentile, and the upper boundary represents the 75th percentile. The vertical length of the box (i.e., the shaded area) represents the interquartile range, which means that 50 percent of all data points are within the box. The horizontal line inside the box indicates the median value. Lines (aka whiskers) are drawn from the edges of the box to the largest and smallest values falling outside of the box that are within 1.5 box lengths. Data points between 1.5 and 3 box lengths from the upper or lower edge of the box are called outliers and are designated with a dot. The wide range of each box plot reveals that the self-rating does not correspond well with the amount of hearing loss. In fact, the ranges for the PTAs are similar for ratings 3 through 8, yet the decision to purchase hearing aids is divergent among those individuals who assigned these self-ratings.

Table 2. Frequency Distribution of Difference between Ratings

Difference between Ratings	Number of Subjects ($N = 40$)
−1	4
0	25
1	8
2	2
3	1

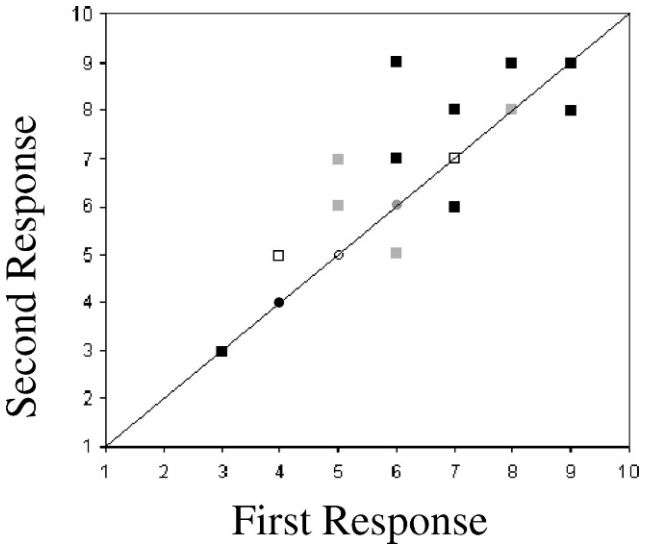

Figure 1. Comparison of first vs. second self-perception ratings for 40 subjects. Symbols falling on the diagonal line indicate no change between test and retest rating ($n = 25$). Number of patients with each combination of responses: ■=1 patient, ■=2 patients, □=3 patients, ●=4 patients, ●=5 patients, ○=9 patients.

It is only at the extremes (rating of 1 or 10) where the PTA data are less variable and in closer agreement with the self-perception (either no hearing loss or severe hearing loss) and therefore are in closer agreement with the decision to pursue amplification. Figure 3 illustrates that 100 percent of the individuals

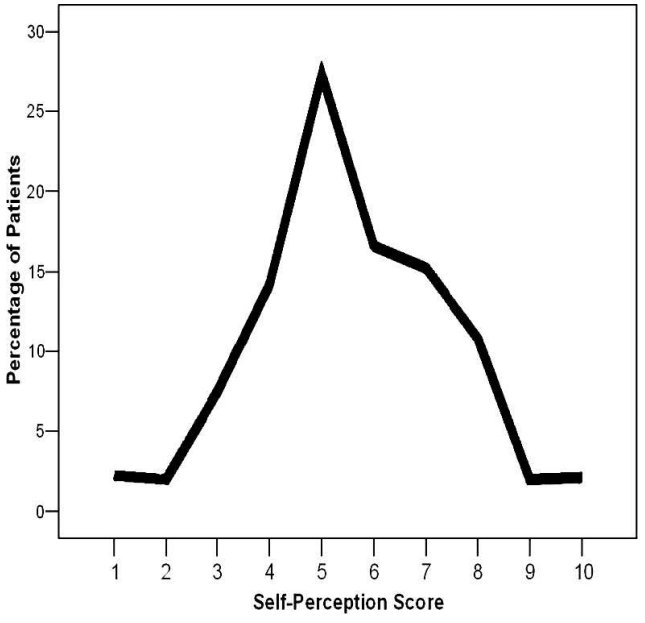

Figure 2. Distribution of self-perception scores ($N = 802$).

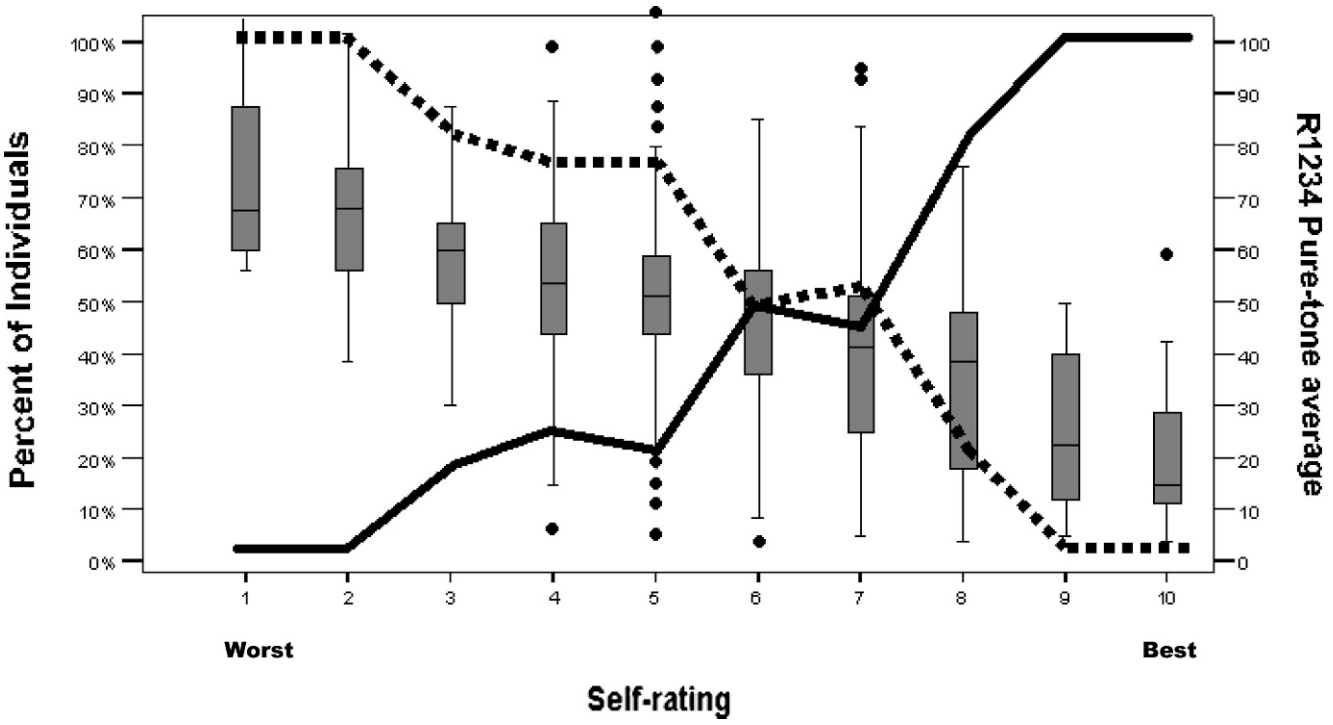

Figure 3. Individuals receiving/not receiving amplification based on self-rating of difficulty (where 1 is the individual perception of the poorest hearing with a great deal of difficulty and 10 is the best self-perception of hearing with no difficulty).
---Percent of individuals receiving hearing aids.
—Percent of individuals not receiving hearing aids (left-side ordinate label).
Box plots: Right-ear pure-tone average of 1000, 2000, 3000, and 4000 Hz (right-side ordinate label).

rating their hearing ability as a 1 or 2 (worst or close to worst) pursued amplification. None of the individuals (0%) rating their hearing ability as 9 or 10 (best or close to best) pursued amplification. Individuals with a rating of 3–5 have an approximately 78–82 percent rate of pursing amplification. Individuals with a rating of 8 have an approximately 82 percent rate of not pursing amplification. Approximately 50 percent of the individuals producing a rating of 6 or 7 pursued amplification, and 50 percent did not. These data support the predictive value of this question.

Logistic regression analysis also was performed on the same data, with perceived hearing ability as the independent variable and use of a hearing aid (1 = used, 0 = did not use) as the dependent variable. The results of the analysis in terms of coefficients are in Table 3. The results provide rather strong evidence that as perceived hearing ability increases, the probability of using a hearing aid decreases. Using these coefficients, the probability of using a hearing aid can be estimated to be

$$p = \frac{e^{4.733861 - .7549989x}}{1 + e^{4.733861 - .7549989x}}$$

where x represents the perceived ability of the person. This relationship is shown graphically in Figure 4.

The results of the analysis in terms of the odds ratio are in Table 4. The odds ratio of 0.47001 means that as self-perception increased by one unit, the odds of using the hearing aid decreased by a factor of 0.47001. For example, the odds of an individual using a hearing aid with a perceived ability of 2 is estimated to be 0.47001 times the odds of an individual with a perceived ability of 1.

Diagnostic tests, as generally suggested by Hosmer and Lemeshow (2000), were also performed. These included plots of change in Pearson chi-square value (ΔX^2_j) vs. estimated probability of using a hearing aid, of change in deviance (ΔD_j) vs. estimated probability of using a hearing aid, and of the Pregibon influence

Table 3. Results of the Logistic Regression Analysis of Self-Perceived Hearing Ability and Purchase Decision in Terms of the Coefficients

Variable	Coefficient	Std. Err.	*z*	*P* > |*z*|	[95% Conf. Int.]	
Self-Rating	−0.7549989	0.1518052	−4.97	0.000	−1.052532	−0.4574663
constant	4.733861	0.9461933	5.00	0.000	2.879356	6.588366

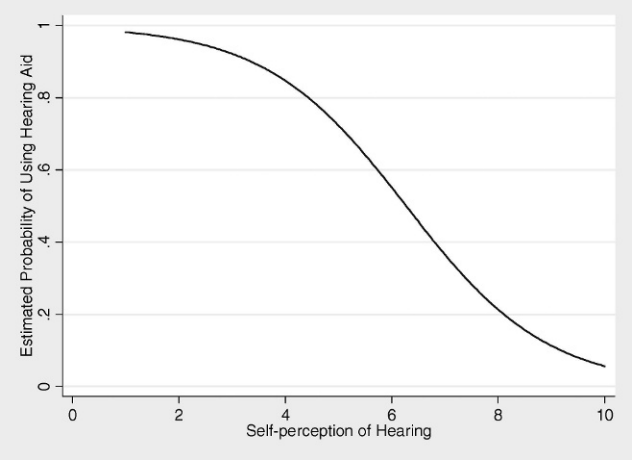

Figure 4. Probability of using a hearing aid vs. self-rating of hearing ability.

statistic ($\Delta\beta_j\Delta\hat{\beta}_j$) vs. estimated probability of using a hearing aid. None of the additional tests showed any covariate patterns as having any undue influence. The Hosmer and Lemeshow (2000) goodness-of-fit test indicated good model fit ($X^2_{(6)} = 5.30$, $p = .5055$).

DISCUSSION AND CONCLUSIONS

When patients visit an audiology clinic, there is little correlation between the objective audiologic test results and the way they assess or perceive their own hearing ability. The data from this study are consistent with numerous studies in the past that have shown a lack of relationship between hearing threshold data and self-perceived hearing difficulties (Weinstein and Ventry, 1983; Brainerd and Frankel, 1985; Hawes and Niswander, 1985). Someone with a significant degree of hearing loss, according to an audiometric exam, who perceives little to no hearing difficulty (e.g., upper part of the box plot on the self-perceived rating of 8 in Figure 3) may decide not to pursue treatment options. On the other hand, someone who exhibits a mild degree of hearing loss but perceives difficulty may pursue treatment (e.g., lower part of the box plot on the self-perceived rating of 3 in Figure 3). These results are similar to those found by Cox and Alexander (2000), which showed no relationship between hearing thresholds and self-assessed hearing problems when new users were asked to rate hearing ability as none, mild, moderate, or severe without hearing aids.

Cox and Alexander (2000) found that new users most often rated their hearing as moderate. The present study revealed that, on average, individuals who have never used amplification seeking a hearing test and hearing aid advice from this private practice setting had a rating of "5" and that approximately 75 percent of patients with average ratings will buy a hearing aid. Based on this, audiologists working in private practices similar to this one should expect to sell hearing aids to the majority of their "average" patients. It would be interesting to investigate whether this is a typical profile for those individuals first pursuing hearing assistance or if this is unique to this private practice environment. This question cannot be answered based on the current data set, which is a limitation of this study, as these results cannot be generalized beyond the private practice.

Ideally, this self-rating system would inform the audiologist as to how much time/effort is appropriate to put into counseling a patient on possible treatment options by indicating how likely the individual is to seek treatment in the near future. Data from this study reveal that the majority of individuals reporting a 1–5 on this scale will most likely pursue amplification (approximately 75 to 100%) while individuals reporting a rating of 8–10 most likely will not (approximately 80 to 100%). Individuals with a rating of 6 or 7 probably need the most information to make an informed decision about getting help.

The question "On a scale from 1 to 10, 1 being the worst and 10 being the best, how would you rate your overall hearing ability?" may have clinical utility when evaluating a patient for amplification. For the participants in this study, the answer to this question facilitated dividing patients into groups of individuals very likely to pursue amplification (ratings of 1–5) or very unlikely to pursue amplification (ratings of 8–10) and a group who clearly needed more information prior to making a decision (ratings of 6 and 7). One could imagine designing different counseling programs for each of these groups. The individuals producing ratings of 8–10 might be provided with brochures that would lead them back to the clinic when they are ready to pursue treatment. Individuals with ratings of 1–5 could move more quickly into questions related to feature selection for amplification to ensure that the technology is matched to their lifestyle and hearing loss. The individuals indicating ratings of 6–7 would require the more traditional hearing aid discussion in order to help them understand what they are missing

Table 4. Results of the Logistic Regression Analysis in Terms of Odds Ratio

Variable	Odds Ratio	Std. Err.	*z*	*P* > |*z*|	[95% Conf. Int.]	
Self-Rating	0.4700111	0.0713501	−4.97	0.000	0.349053	0.6328852

and to start to form realistic expectations for potential amplification options.

Future research on this topic in different settings, including other private practices as well as private hospital clinics and Veteran's Administration hospitals, would provide data that could be generalized to larger groups. Another follow-up to this study would extend these results outside of the audiology clinic to consumers in the general public who have not yet visited an audiologist to find out their purchase intent. This pattern might be quite different from the pattern exhibited by those who have at least made the decision to visit the clinic.

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