Health behavior theories as predictors of hearing-aid uptake and outcomes

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Abstract

Objective: To understand hearing behaviors of adults seeking help for the first time through the application of two models of health behavior change: the transtheoretical model and the health belief model. Design: The relationships between attitudes and beliefs were examined relative to hearing-aid uptake and outcomes six months later. Study sample: One hundred and sixty adults completed the University of Rhode Island change assessment (targeting the transtheoretical model), and the hearing beliefs questionnaire (targeting the health belief model), as well as the hearing handicap inventory and the psychosocial impact of hearing loss scale, within two months of an initial hearing assessment. Six months later, participants completed these same questionnaires, while those who had taken up hearing aids also completed hearing-aid outcome questionnaires. Results: (1) Attitudes and beliefs were associated with future hearing-aid uptake, and were effective at modeling this behavior; (2) attitudes and beliefs changed following behavior change, and (3) attitudes and beliefs following behavior change were better predictors of hearing-aid outcomes than pre-behavior change attitudes and beliefs. Conclusion: A counseling-based intervention targeting the attitudes and beliefs assessed by the transtheoretical model and the health belief model has the potential to increase uptake of hearing health care.

Key Words: Rehabilitation of hearing impairment; health behavior; attitudes; beliefs; predictive validity

Acquired hearing impairment often goes untreated, and has been described as a major public health problem (Olusanya et al, 2014) for its prevalence and major negative consequences. Further, uptake of rehabilitative interventions is low. This however, is not unique to hearing impairment; it is observed among many other chronic health conditions. The factors associated with low intervention uptake for hearing loss overlap greatly with those seen for other conditions such as urinary incontinence, chronic pain, and low vision (see Saunders et al, 2012 for summary). Psychological variables such as personal beliefs, attitudes, and values regarding health and wellbeing, illness, and intervention options all play a role in an individual’s decision to seek and adhere to healthcare. Successful rehabilitative outcomes for adults with hearing impairment require cognitive and behavioral changes in the form of acknowledging a hearing disability, seeking professional help, and following through with recommendations for rehabilitation (Laplante-Levesque et al, 2013, 2015). For a better understanding of hearing health behavior it would be beneficial to frame these behaviors within theories linking psychological, social, and behavioral concepts (Saunders et al, 2012). The field of health psychology studies this complex interplay between health cognitions and behaviors, therefore it is appropriate to examine hearing healthcare behaviors through the lens of health behavior theories.

Two common health behavior theories are the transtheoretical stages of change model (TTM, Prochaska & DiClemente, 1983) and the health belief model (HBM, Rosenstock, 1966). The TTM is an integrative framework for understanding how individuals and populations progress toward adopting and maintaining health behavior change for optimal health. It uses stages of change to integrate processes and principles of change from across major theories of intervention. This model emerged from a comparative analysis of leading theories of psychotherapy and behavior change.
The TTM includes the following concepts: six stages of change, ten processes of change, the pros and cons of changing, self-efficacy, and temptation. The stages of change in the TTM are: (1) Precontemplation (problem denial or lack of awareness), (2) Contemplation (problem awareness and ambivalence regarding the pros and cons of change), (3) Preparation (intention to change behavior in immediate future with some behavioral steps already taken), (4) Action (healthy behavior acquisition or modification), (5) Maintenance (sustained healthy behavior and relapse prevention), and (6) Termination (no temptation to relapse) (Prochaska & DiClemente, 1983). People can either be described as being in a specific stage, or a person’s stages of change profile can be made based on their level of agreement with each of the stages. According to the TTM, a person likely to engage in health behavior change displays low Precontemplation and high Contemplation, Preparation, Action, Maintenance and Termination scores.

The HBM is based upon six constructs that influence the likelihood that people will take action to prevent, screen for, or control health conditions (Rosenstock, 1966). It proposes that value and expectancy beliefs guide behaviors. In other words, people are more inclined to change behavior when they believe that doing so might reduce a threat that is probable, and that would have severe consequences if it occurred. The six constructs of the HBM are: (1) Perceived susceptibility (feeling of being vulnerable to a condition and the belief of being at risk of acquiring the condition), (2) Perceived severity (belief in the seriousness of the health and social consequences incurred if affected by the condition), (3) Perceived benefits (belief that an intervention will result in positive benefits), (4) Perceived barriers (barriers believed to be needed to be overcome to effectively conduct an intervention), (5) Perceived self-efficacy (belief in one’s ability to use and gain benefit from an intervention), and (6) Cues to action (prompts to take action, which could be internal, such as symptoms of a health problem, or external such as communication from healthcare providers, other people, or media) (Janz & Becker, 1984). According to the HBM, a person likely to engage in behavior change perceives high severity, susceptibility, benefits, cues for action and self-efficacy, and few barriers.

Previous studies have shown that the attitudes and beliefs described by the TTM and the HBM are predictive of hearing behaviors (van den Brink et al, 1996; Wallhagen, 2010; Meyer & Hickson, 2012; Laplante-Lévesque et al, 2013; Saunders et al, 2013; Hickson et al, 2014). This study examines whether the TTM and HBM provide complementary information about hearing health behaviors, and whether, in combination, they can shed further light on hearing health behaviors (hearing-aid uptake) and hearing-aid outcomes. The rationale for this focus is that while the TTM maps an individual’s readiness for change, it does not attempt to examine why an individual is at a particular stage of change. The HBM, on the other hand, describes an individual’s predisposition to behavior change, although it does not suggest specific strategies for promoting health behavior change. Applying the two models in tandem could yield further insight into determinants of hearing health behaviors, and provide direction for developing behavior change strategies.

In the initial stages of this work, we examined the attitudes and beliefs of adults who had sought hearing help for the first time (Saunders et al, 2016). We determined that degree of hearing impairment was associated with the constructs of the TTM and the HBM, and that participation restriction, degree of hearing impairment, and the HBM constructs of perceived benefits, barriers and self-efficacy were significant predictors of stages of change. In this continuation of our work, we have followed up with participants to examine the relationships between hearing-related attitudes and beliefs at the time of initial hearing help seeking and hearing behaviors (hearing-aid uptake) and hearing-aid outcomes six months later.

Methods

Participants

Adults aged 55–89 were recruited within two months of seeking hearing help for the first time (attending an initial hearing assessment) in the Portland, Oregon area. All had functional oral and written English. At baseline, 182 individuals completed questionnaires. Of these, fifteen individuals (8%) were lost to follow-up, thus data from 167 participants were included. One hundred and fifty six participants (93%) were male veterans who had received their audiometric evaluation at the Veterans Administration (VA) Portland Health Care System Audiology service. Of the remaining participants, five (3%) were female veterans, three (2%) were male non-veterans, and three (2%) were female non-veterans. The six non-veterans were recruited from local audiology clinics. Participants were required to have the ability to complete the questionnaires independently. The mean age of participants was 69.3 years (SD = 7.5 years; Range: 50–89 years). By the six-month follow-up date, 120 (72%) had taken up hearing aids, and 47 (28%) had not. Table 1 provides additional participant demographic and audiometric data. As a group, participants had mild to moderate hearing loss, mild to moderate hearing handicap, the majority did not work, had self-referred for a hearing test, and had noticed hearing difficulties for more than five years.

Measures

All measures are described below, with additional information in the source reference and in Saunders et al (2016).

Hearing handicap inventory for the adults/elderly (HHI; Ventry & Weinstein, 1982; Newman et al, 1990).

The 25-item HHI assesses the social and emotional consequences of hearing impairment. Participants 64 years and younger completed the HHI for adults (HHIA) (Newman et al, 1990), whereas participants 65 years and older completed the HHI for the elderly (HHIE) (Ventry & Weinstein, 1982). Total score on the HHI can range from 0 to 100, with higher scores indicating greater hearing handicap/disability.
Table 1. Baseline participant audiometric and demographic data.

| Variable                        | Mean (SD), Range |
|---------------------------------|------------------|
| 4F-PTA (dB HL) Left ear         | 35.5 (14.0), 5–72.5 |
| Right ear                       | 36.3 (13.7), 7.5–76.3 |
| Baseline HHI Total score        | 35.3 (24.3), 0–100 |
| Baseline PIHLS Total score      | −0.44 (0.77), −3.0–2.92 |
| Work status n (%)               |                 |
| Full-time                       | 13 (7.1)         |
| Part-time                       | 32 (17.6)        |
| Volunteer                       | 39 (21.4)        |
| None                            | 98 (53.8)        |
| Prompted hearing test           |                 |
| Self                            | 115 (63.2)       |
| Family/friends                  | 37 (20.3)        |
| Doctor                          | 17 (9.3)         |
| Other                           | 13 (7.1)         |
| Duration of hearing difficulty  |                 |
| No difficulties                 | 15 (8.2)         |
| <1 year                         | 10 (5.5)         |
| 1–5 years                       | 49 (26.9)        |
| >5 years                        | 108 (59.3)       |

Psychosocial impact of hearing loss scale (PIHLS; adapted from Day & Jutai, 1996).

The PIHLS is an adaptation of the psychosocial impact of assistive devices scale described below. It consists of 26-items assessing the impact of hearing loss on competence (perceived functional capability, independence and performance), adaptability (inclination or motivation to participate socially and take risks), and self-esteem (self-confidence, and emotional wellbeing). Responses are made on a seven-point scale that ranges from −3 to +3 indicating maximum negative impact and +3 indicating maximum positive impact. The mid-point, zero, indicates no impact. An average total score is computed by summing the total points and dividing by 26. Higher scores indicate less negative impacts of hearing.

University of Rhode Island change assessment (URICA; McConnaughy et al, 1983).

In the present study, original items of the URICA (McConnaughy et al, 1983) were adapted for hearing health behaviors. The adapted URICA consists of 24-items that assess readiness for change on three eight-item scales: precontemplation, contemplation, and action. Points obtained on each scale are summed yielding precontemplation, contemplation, and action scores that can range from 8 to 40. For each scale, a higher score indicates greater agreement with the TTM construct being assessed. In addition to these scores, each participant can be assigned to a stage of change based on the scale on which the participant has the highest score. If a participant has identical scores on more than one scale, the stage most advanced (furthest away from precontemplation) is assigned.

Hearing beliefs questionnaire (HBQ, Saunders et al, 2013).

The HBQ was used to assess the six constructs of the HBM: Perceived susceptibility, perceived severity, perceived benefits, perceived barriers, perceived self-efficacy, and cues to action. Each HBQ item consists of a statement to which participants indicate their agreement on an 11-point scale. The scale is anchored at 0 points (completely disagree), 5 points (no opinion) and 10 points (completely agree). Mean scores on each construct are computed by summing the points obtained on each scale and dividing by the number of items in that scale. Scores on each scale can range from 0 to 10, with higher scores on all scales are indicative of greater likelihood of engaging in a health behavior.

International outcome inventory for hearing aids (IOI-HA; Cox & Alexander, 2002).

The IOI-HA is a seven-item questionnaire that assesses hearing-aid outcomes on seven dimensions: use, benefit, residual activity limitation, satisfaction, residual participation restriction, impact (of hearing impairment) on others, and quality of life. For each item, respondents select from one of five verbal descriptors of outcomes, with the poorest outcomes scored as 1, and best outcome scored as 5. Scores on each item were summed to generate an IOI-HA Total score that ranges from 7 points to 35 points, with a higher score indicating better hearing-aid outcomes.

Psychosocial impact of assistive devices scale (PIADS; adapted from Day & Jutai, 1996).

The PIADS is a 26-item self-rating scale on which participants rate the impact a rehabilitative intervention has on their competence (perceived functional capability, independence and performance), adaptability (inclination or motivation to participate socially and take risks) and self-esteem (self-confidence, and emotional wellbeing). As with the PIHLS, for each item, responses are made on a 7-point scale that ranges from −3 to +3. For all but three reverse scored items, −3 indicates maximum negative impact and +3 indicates maximum positive impact. The mid-point, zero, indicates no impact. An average total score is computed by summing the total points and dividing by the number of items in each scale. Higher scores indicate more positive impacts of a hearing aid.

Procedures

The VA Portland Health Care System Institutional Review Board and Research and Development committees approved this study. Participants received a $10 gift card for each of the two sets of study questionnaires they completed.

Participants provided verbal consent by telephone. The veteran participants provided permission to access their audiometric data in their electronic chart record. The six non-veteran participants were asked to send a copy of their audiometric data and all did so. Following verbal consent, participants received by mail the HHI, PIHLS, URICA, and HBQ to complete, along with a postage-paid envelope. Six months later, participants were contacted via telephone and asked whether they had acquired hearing aids. They were also sent a second set of questionnaires to complete, along with a postage-paid envelope. Participants who had not acquired hearing aids completed the same set of questionnaires as at baseline. Participants who had acquired hearing aids completed the HHI, URICA, and HBQ, the IOI-HA, and the PIADS in place of the PIHLS. Six months was selected as the follow-up period because it was considered sufficient time for motivated individuals to have sought help, and acquired and used hearing aids.

Analyses

IBM SPSS v22 was used for all statistical analyses. Chi-square analyses were used to examine the association between URICA stage of change and hearing health behavior (whether or not a
participant had acquired hearing aids) six months later. Analyses of variance (ANOVAs) were used to compare the attitudes and beliefs of individuals who did and did not acquire hearing aids. When applicable, post-hoc analyses were completed using Bonferroni correction for multiple comparisons. Pearson correlations were used to examine the association between attitudes and beliefs and hearing-aid outcomes. Logistic and multiple linear regression analyses were used to model hearing health behavior (uptake of hearing aids) and hearing-aid outcomes, respectively using demographic, audiometric, URICA, and HBQ scores as predictor variables. Variance inflation factors (VIF) were used to examine collinearity between predictors, with a threshold for further investigation of collinearity set to a VIF value of 5.0. Finally, changes in attitudes and beliefs between baseline and six-month follow-up were examined using chi-square analyses for URICA stage of change, and ANOVAs for URICA scale and HBQ scores.

Results

Relationships between attitudes and beliefs at baseline and hearing behavior (hearing-aid uptake) at follow-up

Table 2 is a cross tabulation of baseline URICA stage of change and whether or not an individual had taken up hearing aids by the six-month follow-up. Less than 15% of participants in the precontemplation stage had acquired hearing aids by follow-up, as compared with almost 80% of those in the action stage. Chi-squared analysis showed this distribution to differ significantly from expected. Furthermore, as seen from Figure 1, participants who had taken up hearing aids (light bars) had lower precontemplation scores and higher contemplation and action scores than participants who had not taken up hearing aids (dark bars). An ANOVA showed a significant main effect of behavior ($F = 117.1$, $p < 0.001$), with paired comparison post-hoc testing confirming significant differences on all three scales. In other words, participants took up hearing aids within the six-month study period were, at baseline, more ready to change than participants who did not.

A similar pattern of results was seen for the HBQ data (Figure 2), such that individuals who had taken up hearing aids at follow-up had significantly higher perceived severity ($F = 9.96$, $p = 0.002$), benefits ($F = 6.2$, $p = 0.014$), and cues to action ($F = 5.70$, $p = 0.018$) scores than those who had not taken up hearing aids, which according to the HBM would be associated with more likelihood of behavior change.

In addition to these differences in attitudes and beliefs, ANOVAs showed that relative to participants who did not take up hearing aids, those who took up hearing aids were significantly older (70.4 years vs. 66.4 years, $F = 10.4$, $p = 0.002$), had poorer hearing (left and right ear average 4F-PTA: 39.5 dB HL vs. 23.5 dB HL, $F = 74.0$, $p < 0.001$), and reported their hearing to cause more hearing handicap (HHI total score: 41.6 vs. 15.0, $F = 58.1$, $p < 0.001$) and negative impacts (PIHL: $-0.54$ vs. $-0.1$, $F = 9.7$, $p < 0.001$).

Table 2. Percentage and number of participants who did and did not take up hearing aids (HAs) as a function of their baseline URICA stage of change, along with the result of a Pearson chi-square analysis.

| Stage at baseline   | Participants % (n) | Took up HAs % (n) | Did not take up HAs % (n) | Pearson $\chi^2$ |
|--------------------|--------------------|------------------|--------------------------|-----------------|
| URICA precontemplation | 4.2 (7)           | 14.3 (1)         | 85.7 (6)                 | 23.0            |
| URICA contemplation  | 16.2 (27)         | 51.9 (14)        | 48.1 (13)                | $p < 0.001$     |
| URICA action        | 79.6 (133)        | 79.7 (106)       | 20.3 (27)                |                 |
Additionally, more of these individuals self-referred for a hearing test (69.2% vs. 53.2%, $\chi^2 = 13.4$, $p = 0.004$), and they had noticed hearing difficulties for longer (70.0% vs. 34.0% had noticed difficulties for $>5$ years, $\chi^2 = 39.7$, $p < 0.001$).

**Modeling hearing behavior (hearing-aid uptake) at follow-up**

Binary logistic regression was used to model hearing behavior (hearing-aid uptake). Age, 4F-BEA, reported duration of hearing difficulty and baseline scores on the HHI, URICA, and HBQ were used as potential predictors, and the results are shown in Table 3. Hearing-aid uptake was associated with a higher 4F-BEA (i.e. greater hearing impairment), and having a higher URICA action score. When examining odds ratios, other predictors are also seen to be important. Specifically, the odds of taking up hearing aids decreased by about half for each 1-point decrease on the HBQ benefits scale (0.586) and HBQ self-efficacy scale (0.586), the odds of taking up hearing aids were doubled (2.198 times) for each 1-point increase in score on the URICA action scale, and were 1.181 times greater for each 1-dB increase in 4F-BEA. The predicted probability values generated by the logistic regression analyses were used to plot the histogram shown in Figure 3. The upper panel presents the predicted probability values of all participants who did not take up hearing aids ($n = 47$), the lower panel is for all participants who did take up hearing aids ($n = 120$). A dashed vertical line has been superimposed upon the figure at the predicted probability value ($p = 0.5$) that optimally differentiates participants who did and did not take up hearing aids. The model correctly classified 97% of participants who took up hearing aids and 88% of participants who did not.

**Table 3.** Results of binary logistic regression modeling hearing-aid uptake from age, duration of hearing difficulty, 4F-BEA, HHI, URICA (precontemplation, contemplation, and action scales) and HBQ (susceptibility, severity, benefits, barriers, self-efficacy, and cues to action scales) scores. The significant predictors ($p<0.05$) are in bold font.

| Predictor                  | $\beta$ | $\chi^2$ | $p$ values | Odds ratio |
|----------------------------|---------|----------|------------|------------|
| Age                        | 0.066   | 0.741    | 0.389      | 1.068      |
| Duration hearing difficulty | 0.077   | 0.038    | 0.845      | 1.080      |
| 4F-BEA                     | 0.166   | 6.631    | 0.010      | 1.181      |
| HHI total score            | 0.040   | 2.162    | 0.141      | 1.041      |
| URICA precontemplation     | 0.249   | 2.277    | 0.131      | 1.283      |
| URICA contemplation        | -0.001  | 0.000    | 0.993      | 0.999      |
| URICA action               | 0.787   | 12.433   | <0.001     | 2.198      |
| HBQ susceptibility          | -0.078  | 0.083    | 0.773      | 0.930      |
| HBQ severity               | 0.232   | 1.206    | 0.272      | 1.262      |
| HBQ benefits               | -0.534  | 2.593    | 0.107      | 0.586      |
| HBQ barriers               | 0.242   | 0.735    | 0.391      | 1.274      |
| HBQ self-efficacy          | -0.534  | 3.188    | 0.074      | 0.586      |
| HBQ cues to action         | 0.261   | 0.910    | 0.340      | 1.298      |
| Constant                   | -35.863 | 10.336   | 0.001      | 0.000      |

**Figure 3.** Histogram of the predicted probability of hearing-aid uptake (lower panel) and no hearing-aid uptake (upper panel) using age, four frequency better-ear average, reported duration of hearing difficulty and baseline scores on the hearing handicap inventory, University of Rhode Island change assessment, and hearing beliefs questionnaire as predictors.

**Relationships between attitudes and beliefs at baseline and hearing-aid outcomes at follow-up**

Total IOL-HA scores of the 120 individuals who had taken up hearing aids by the six-month follow-up were high (mean = 28.7, SD = 4.8), and PIADS scores were positive (mean = 0.87, SD = 0.80), indicating good hearing-aid outcomes for the group as a whole.
The results of Pearson correlations between attitudes and beliefs (URICA and HBQ scores) at baseline and follow-up, and hearing-aid outcomes (IOI-HA and PIADS) are shown in Table 4. The associations between the IOI-HA and follow-up attitudes and beliefs were stronger than between IOI-HA and baseline attitudes and beliefs. This did not hold for the PIADS, in fact the opposite was the case for some variables (HBQ severity and URICA action scores).

**Modeling hearing-aid outcomes at follow-up**

Hearing-aid outcomes measured by the IOI-HA and the PIADS was modeled with forward stepwise multiple linear regression. Two regression analyses were conducted for each outcome measure. In one regression analysis, baseline HHI, URICA, and HBQ scores, along with age and 4F-BEA were used as potential predictors. In the other, follow-up HHI, URICA, and HBQ scores, along with age and 4F-BEA, were used as potential predictors. VIFs ranged from 1.000 to 1.928 in all analyses, thus collinearity among the potential predictors was not a problem.

The results, seen in Table 5, showed that follow-up URICA and HBQ scores were more effective at modeling hearing-aid outcomes than baseline URICA and HBQ scores. About one-third of the total variance in IOI-HA and PIADS were explained using follow-up URICA and HBQ scores. Better hearing-aid outcomes as measured with the IOI-HA were associated with having higher action and self-efficacy scores combined with lower susceptibility and precontemplation scores. Better hearing-aid outcomes as measured with the PIADS were associated with lower precontemplation scores in combination with poorer hearing sensitivity, more reported hearing handicap and a higher benefits score.

**Associations between changes in attitudes and beliefs and hearing behavior (hearing-aid uptake) at follow-up**

It is of interest to know whether there were changes in attitudes and beliefs between baseline and follow-up at six-months, and whether those changes were associated with hearing-aid uptake. To this end, baseline and follow-up URICA and HBQ scores of each participant

**Table 4.** Pearson correlations between attitudes and beliefs (URICA and HBQ scores) at baseline and follow-up, and hearing-aid outcomes (IOI-HA and PIADS). To adjust for multiple analyses only correlations with an associated $p < 0.001$ were considered to be statistically significant. Statistically significant correlations are indicated in bold font.

| Variable                | Baseline correlation with IOI-HA (r-value) | Follow-up correlation with IOI-HA (r-value) | Baseline correlation with PIADS (r-value) | Follow-up correlation with PIADS (r-value) |
|-------------------------|-------------------------------------------|--------------------------------------------|------------------------------------------|-------------------------------------------|
| URICA precontemplation  | -0.252                                    | -0.443                                     | -0.297                                   | -0.396                                    |
| URICA contemplation     | 0.166                                     | 0.320                                      | 0.375                                    | 0.393                                     |
| URICA action            | 0.240                                     | 0.465                                      | 0.375                                    | 0.363                                     |
| HBQ susceptibility      | -0.035                                    | -0.117                                     | 0.127                                    | 0.073                                     |
| HBQ severity            | 0.015                                     | -0.130                                     | 0.319                                    | 0.242                                     |
| HBQ benefits            | 0.143                                     | 0.151                                      | 0.344                                    | 0.371                                     |
| HBQ barriers            | -0.138                                    | -0.329                                     | -0.140                                   | -0.140                                    |
| HBQ self-efficacy       | 0.175                                     | 0.363                                      | 0.008                                    | 0.048                                     |
| HBQ cues to action      | 0.125                                     | 0.268                                      | 0.212                                    | 0.260                                     |

**Table 5.** Multiple linear regression analyses modeling hearing-aid outcomes as assessed with the IOI-HA and PIADS.

| Predictor variable | $\beta$-value | Adjusted $r^2$ | % variance explained | $p$ values |
|--------------------|---------------|----------------|----------------------|------------|
| **Outcome variable:** IOI-HA total score modeled from baseline scores | | | | |
| Baseline URICA precontemplation | -0.252 | 0.055 | 6.3 | 0.006 |
| Total variance explained | | | | 6.3 |
| **Outcome variable:** IOI-HA total score modeled from follow-up scores | | | | |
| Follow-up URICA action | 0.270 | 0.210 | 21.7 | 0.011 |
| Follow-up HBQ self-efficacy | 0.248 | 0.278 | 7.3 | 0.002 |
| Follow-up HBQ susceptibility | -0.185 | 0.296 | 2.4 | 0.019 |
| Follow-up URICA precontemplation | -0.240 | 0.321 | 3.0 | 0.024 |
| Total variance explained | | | | 34.4 |
| **Outcome variable:** PIADS total score modeled from baseline scores | | | | |
| Baseline URICA action | 0.245 | 0.133 | 14.1 | <0.001 |
| 4F-BEA | 0.273 | 0.207 | 8.0 | 0.001 |
| Baseline HHI total | 0.198 | 0.233 | 3.2 | 0.017 |
| Total variance explained | | | | 25.3 |
| **Outcome variable:** PIADS total score modeled from follow-up scores | | | | |
| Follow-up URICA precontemplation | -0.253 | 0.151 | 15.8 | 0.003 |
| 4F-BEA | 0.259 | 0.231 | 8.6 | 0.001 |
| Follow-up HHI total | 0.214 | 0.291 | 6.5 | 0.012 |
| Follow-up HBQ benefits | 0.200 | 0.320 | 3.4 | 0.018 |
| Total variance explained | | | | 34.3 |
were compared. The majority of participants (75%) remained at the same URICA stage of change between baseline and follow-up. However, some participants progressed to a more advanced stage of change (6% of those who did not take up hearing aids, and 10% of those who did), and some regressed to a less advanced stage of change (32% of those who did not take up hearing aids, and 10% of those who did). These between-group differences in change were statistically significant ($\chi^2 = 15.5, p = 0.004$). URICA scale scores showed a significant main effect of change over time ($F = 16.73, p < 0.001$), but no interaction between change over time and whether or not a hearing aid was acquired ($F = 1.71, p = 0.192$), indicating that URICA scores did not change as a function of hearing health behavior.

Comparison of baseline and follow-up HBQ scores showed no significant change over time ($F = 0.38, p = 0.537$). However, there was a significant interaction between change over time, HBQ scale, and whether or not a participant took up hearing aids ($F = 6.24, p = 0.013$). Table 6 shows HBQ scores at baseline and follow-up for those who did and did not take up hearing aids, along with the results of post-hoc comparisons for each HBQ scale separately. The HBQ scores of participants who did not take up hearing aids remained largely unchanged between baseline and follow-up, with the exception that their HBQ barriers score increased, i.e. individuals in this group perceived more barriers at follow-up than at baseline. In contrast, scores on four of the six HBQ scales changed significantly among individuals who took up hearing aids. Severity and barriers scores decreased, while self-efficacy and cues to action scores increased. These data indicate that taking up hearing aids resulted in positive attitude change toward hearing and hearing aids.

### Discussion

The TTM and HBM were used here as the framework for examining relationships between hearing-related attitudes and beliefs, and hearing-aid uptake and outcomes at follow-up six months later. The majority (72%) of first-time help seekers in this study took up hearing aids within the six-month follow-up period. This is considerably higher than typically found in other studies (Yueh et al, 2010; Meyer et al, 2011) and may be because almost all participants in the study were veterans and thus were eligible to receive hearing aids through the VA health care system. Seventy percent of these individuals reported having experienced hearing difficulties for more than five years—which is the typical duration people wait after noticing hearing difficulties before seeking help (Davis et al, 2007; Fischer et al, 2011), thus their behavior may not be very different to that of other populations with hearing impairment. The individuals who acquired hearing aids had more hearing impairment and reported more hearing difficulties than the individuals who did not acquire hearing aids. Again, this is in line with other studies conducted in non-veteran populations (van den Brink, 1996; Gussekloo et al, 2003; Helvik et al, 2008; Laplante-Levesque, 2012; Meyer & Hickson, 2012).

Previous research supports the notion that attitudes and beliefs are predictive of the hearing behaviors of help-seeking and hearing-aid uptake (van den Brink, 1996; Wallhagen, 2010; Meyer & Hickson, 2012; Laplante-Levesque et al, 2013; Saunders et al, 2013; Hickson et al, 2014). Specifically, the perception of support from significant others, more benefits than barriers toward amplification, being unable to cope with hearing loss, high self-efficacy regarding hearing health, and external cues to action are all associated with an increased likelihood of consulting a health professional about hearing and/or adopting hearing aids. This study lends further support to this in that individuals who took up hearing aids were significantly more ready for change than individuals who did not, and they had more favorable attitudes measured by the HBQ in the form of higher severity, benefits and cues to action scores. In addition, self-efficacy and benefits were significant predictors of whether or not an individual acquired hearing aids.

| Table 6. HBQ scores at baseline and at six-month follow-up separated by whether or not an individual took up hearing aids. Baseline and follow-up scores that differ significantly are shown in bolded font. |
|-------------------------------------------------------------|------------------|------------------|
| **HBQ susceptibility**                                       | Did not take up hearing aids n = 47 | Took up hearing aids n = 120 |
| Baseline                                                   | Mean (SD)        | F-value p values | Mean (SD)        | F-value p values |
| 6-month follow-up                                          | 7.1 (1.3)        | 1.10             | 7.5 (1.6)        | 0.01             |
| **HBQ severity**                                           | 7.3 (1.5)        | 0.300            | 7.5 (1.4)        | 0.988            |
| Baseline                                                   | 6.1 (2.2)        | 0.01             | 7.2 (2.0)        | 7.18             |
| 6-month follow-up                                          | 6.1 (2.1)        | 0.981            | 6.7 (2.3)        | 0.008            |
| **HBQ benefits**                                           | 7.0 (1.8)        | 0.02             | 7.7 (1.6)        | 1.15             |
| Baseline                                                   | 7.0 (1.6)        | 0.889            | 7.6 (1.6)        | 0.285            |
| 6-month follow-up                                          | 7.3 (1.6)        | 4.64             | 3.4 (1.8)        | 30.27            |
| **HBQ barriers**                                           | 3.5 (1.6)        | 0.037            | 2.5 (1.6)        | <0.001           |
| Baseline                                                   | 3.1 (1.6)        |                   |                   |                   |
| 6-month follow-up                                          | 6-month follow-up |                   |                   |                   |
| **HBQ self-efficacy**                                      | 5.8 (1.4)        | 0.01             | 5.3 (2.1)        | 20.0             |
| Baseline                                                   | 5.8 (1.6)        | 0.971            | 6.3 (2.1)        | <0.001           |
| 6-month follow-up                                          | 6-month follow-up |                   |                   |                   |
| **HBQ cues to action**                                     | 8.1 (1.3)        | 0.11             | 8.7 (1.3)        | 8.84             |
| Baseline                                                   | 8.2 (1.6)        | 0.742            | 9.0 (1.0)        | 0.004            |
| 6-month follow-up                                          | 6-month follow-up |                   |                   |                   |
The individuals who took up hearing aids showed generally positive outcomes from their hearing aids. The mean IOI-HA total score was 28.7 out of a possible maximum of 35, with scale scores ranging between 4.0 and 4.4 out of a maximum of 5. This is typical of IOI-HA scores seen among veteran and non-veteran populations (Cox et al, 2003; Smith et al, 2009). Likewise, the mean total PIADS score was >0.8 points, which again is similar to that shown in prior work in which the PIADS was used to assess hearing-aid outcomes (Saunders & Jutai, 2004; Saunders et al, 2009; Saunders & Forsline, 2012).

Attitudinal change seemed to follow hearing-aid uptake in that the HBQ severity, barriers, self-efficacy, and cues to action scores of those who took up hearing aids became more positive at follow-up, while the HBQ scores of those who did not take up hearing aids remained unchanged at follow-up. There was one exception to this—the barriers scores of individuals who had not taken up hearing aids were higher (more negative) at follow-up than at baseline. These data indicate that taking up hearing aids resulted in positive attitude change toward hearing and hearing aids. This emphasizes the importance of encouraging individuals with hearing impairment to seek help and try hearing aids because, as has been noted elsewhere, some negative expectations about hearing aids are proven unwarranted once an individual uses hearing aids (Saunders & Jutai, 2004).

The regression analyses that modeled hearing-aid outcomes explained about one-third of the variance, the majority of which was explained by the attitudes and beliefs assessed with the URICA and HBQ. This leaves two-thirds of the variance unaccounted for. The findings of other studies have shown many non-attitudinal factors, including unaided and aided speech understanding and benefit (Humes et al 2003; Brännström et al, 2014), manual dexterity (Kumar et al, 2000), and cognitive ability (Arehart et al, 2013)—none of which were measured here—to influence hearing-aid outcomes; thus it is reasonable to assume that the variance explained by the URICA and HBQ would be additional to that explained by these other factors.

A comparison of findings from the URICA and HBQ provides important insight into the interplay between the TTM and the HBQ. URICA stage of change and URICA scores at baseline differentiated those who did and did not acquire hearing aids (Table 2 and Figure 1), but URICA scores did not differentially change over time (i.e. changes in URICA scores from baseline to follow-up did not differ by whether or not participants acquired hearing aids). The HBQ, on the other hand, was less effective at differentiating those who did and did not acquire hearing aids at baseline, but HBQ scores changed differentially with behavior (Table 6). This suggests that the TTM as assessed using the URICA offers valuable insight to the stage of change that an individual is at, while the HBM assessed using the HBQ offers insight into reasons why the individual is at a particular stage of change. Together, they can provide guidance for development of behavior change strategies, as further described below. The interplay between cognitions (attitudes and beliefs, often driven by knowledge and experience) and behaviors is apparent from the data. While URICA scores did not change as a function of hearing health behavior (hearing-aid uptake), HBQ scores did. Attitudes and beliefs as measured by the HBM changed differently according to the behavior displayed (taking up hearing aids versus not taking up hearing aids). Participants who did not take up hearing aids perceived more barriers to doing so six months later. This change cannot be driven by direct experience. It can however be driven by vicarious experience or by other cognitive processes such as a reframing following the decision not to take up hearing aids so as to avoid cognitive dissonance. Participants who took up hearing aids perceived fewer barriers and severity, but greater self-efficacy and cues to action, most likely as a result of direct experience with hearing aids. Still, much remains to be understood regarding the nature of this interplay. How behavioral experience shapes attitudes and beliefs and how decisions shape attitudes and beliefs is of interest for the successful rehabilitation of people with hearing impairment.

Limitations

The study has four limitations worthy of mention. First, the population was predominantly a veteran sample, which has been shown by Cox et al (2005) to differ from the general public in terms of their expectations about hearing aids. Additionally, many veterans are eligible for audiologic services through the VA Health Care System. However, this study uncovered attitudinal changes over time, and it is most likely that the attitudes and beliefs of Veterans are no more or less changeable than those of the general public. Second, a number of participants (n = 68) had normal hearing, as defined by having a three-frequency pure-tone average (mean (0.5, 1.0, and 2.0 kHz) <25 dB HL in both ears. It is likely that some of these individuals were told they did not need hearing aids and thus did not take up hearing aids. Note, however, that all but nine of these individuals had hearing loss at 4 kHz and above, presumably reflecting noise-related damage, which likely explains why 30 of these individuals with ‘normal hearing’ had taken up hearing aids by the six-month follow-up. Indeed, the HHI scores of the individuals with normal hearing took up hearing aids (HHI mean = 41.9, SD = 24.8) were significantly higher (t = 5.04, p < 0.001) than those of the individuals with normal hearing who did not take up hearing aids (HHI mean = 12.4, SD = 24.8). Third, there are not yet any data available for the HBQ and URICA that indicate the degree to which scores must differ to indicate ‘clinically’ significant differences, thus all interpretation here relies on statistically significant differences. As further data are collected using these instruments, it will be possible to determine these values. Finally, the health behavior theories that were the foundation of this work may not adequately portray health behavior change. Here, we have focused on the stages of change of the TTM, but we have not incorporated all of the TTM’s constructs. Whether stages of change should be described as categories or on a continuum is worthy of debate (Littell & Girvin, 2002). The linearity of the different stages has also been questioned, with some people suggesting that the readiness distance between the stages varies (Sutton, 2005). Furthermore, the evidence is mixed concerning stage-specific processes of change, the validity of a stage-based conceptualization of behavior change and, if discrete stages exist, the extent to which they are amenable to accurate measurement (Bridle et al, 2005). The HBM is mostly known for its description of the cost versus benefits analysis that supports decisions. However, the HBM may over-simplify how people represent health and health-related changes, with the HBM portraying individuals as rational decision makers and minimizing social and affective influences. Overall, the two health behavior theories used in this study to describe hearing-aid uptake and outcomes, the TTM and the HBM models, focus on conscious and rational factors supporting behaviors. Little emphasis is put
on automatic motivational processes such as emotions and habits, which may also play an important role in supporting behaviors.

**Clinical implications**

The findings that baseline URICA stage of change was strongly associated with hearing-aid uptake, and that attitudes improved following hearing-aid uptake, has direct clinical application. The provision of counseling targeting attitudes that reflect readiness for change, or alternatively, that facilitate change from a less advanced stage of change to a more advanced stage could increase the uptake of hearing healthcare. Indeed, the results of this study have informed the development of a counseling-based intervention targeting the constructs of the TTM and HBM to optimize hearing healthcare attitudes and beliefs and promote help-seeking in individuals with hearing difficulties. This effectiveness of this counseling-based intervention is being evaluated in an ongoing study.

**Summary and Conclusions**

In this study, the constructs of the TTM and HBM were applied to understanding hearing health behaviors. It was shown that: (1) attitudes and beliefs were associated with future hearing health behaviors, and were effective at modeling those later behaviors; (2) attitudes and beliefs change positively following behavior change, and (3) attitudes and beliefs following behavior change are better predictors of hearing-aid outcomes than are attitudes and beliefs at the time of initial hearing help seeking. Because a relationship exists between attitudes and later hearing health behaviors, it is concluded that a counseling-based intervention targeting the attitudes preventing behavioral change has the potential to increase uptake of hearing health care. Such an intervention based on the constructs of the TTM and HBM has been developed and its effectiveness is being investigated.

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