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Gregory J. Spirakis

(ABSTRACT)

The purpose of this study was to investigate the stability of hearing aid benefit, as measured by the Abbreviated Profile of Hearing Aid Benefit (APHAB; Cox & Alexander, 1995), between three months post hearing aid fitting and at next the annual audiological re-evaluation. The annual re-evaluation was at least, and as close to nine months as possible, after the previous audiological. The maximum time between the two evaluations was 18 months. Thirty-six hearing aid patients participated in this study. The participants were both male and female, and were fitted monaurally or binaurally with hearing aid(s). All participants had sensorineural hearing loss with no ongoing or permanent conductive or retrocochlear pathology. The APHAB scale was administered at the three month hearing aid check (HAC) and again at the annual audiometric re-evaluation. Analysis of covariance (ANCOVA), with length of time between the three month hearing aid check (HAC) and the next audiological re-evaluation as a covariate, was used to examine the main effects of time of administration and subscale [e.g., ease of communication (EC), reverberant conditions (RV), background noise (BN), and aversiveness of sounds (AV)] and their interactions. Results revealed a significant reduction in the mean benefit scores between the 3-month HAC and annual re-evaluation APHAB administration. It is hypothesized that the causal factor of the decrease in benefit in the EC, RV, & BN are multifactorial. These reductions in benefits may be do to the Hawthorne effect, unrealistic hearing aid benefit expectations by the participants, or a heightened expectation of hearing aid benefit due to the financial expense. It should also be noted, however, that using the 90% confidence interval for “true” clinical benefit, 21 of the participants maintained stable benefit over the course of the study. Finally, although not statistically significant, the fourth APHAB scale, aversiveness of sounds (AV), improved over time.

INTRODUCTION

In recent years, the hearing aid industry has seen significant improvements in hearing aid technology, from linear, to compression, too more advanced circuits (Kuk, 1998). While these improvements have resulted in higher levels of patient satisfaction, the financial costs have also increased (Kochkin, 1996; Kochkin, 2000). These increased costs have been coupled with an increased demand from government agencies, third party payers, and our patients themselves for demonstration of the efficacy of hearing aid intervention (Abrams & Hnath-Chisolm, 2000).

There are numerous studies available in the literature supporting the efficacy of hearing aid intervention (e.g., Cox & Alexander, 1992; Horwitz, 1995; Larson, 2000). In addition, hearing aid use has been shown to be relatively cost-effective. For example, Mulrow, et al. (1990), in a well-controlled randomized clinical trial, found that intervention with monaural hearing aids costs only $200.00 per hearing quality adjusted life year (HQALY) gained.

The quantification of cost-effectiveness in terms of quality adjusted life years gained is a commonly used approach by health economists (Abrams & Hnath-Chislom, 2000). The method involves measuring clinical changes with either a disease specific or generic self-report instrument that assesses an individual’s post intervention functioning over the lifetime of that individual. Of concern in the present study was whether or not clinical changes measured with a widely used disease specific self-report instrument, the Abbreviated Profile of Hearing Aid Benefit (APHAB; Cox & Alexander, 1995), remain stable over time.

The stability of initial intervention outcomes as measured using self-report techniques has been investigated in many other areas of health care (e.g. Burton, Wright, & Richards, 1979; Holtzman, Chen & Kane, 1998; Kane et al, 1998). Part of the impetus for such evaluations comes from a need on the part of government agencies, health maintenance organizations (HMOs), and other third party payers to determine the point of time, post-intervention, at which a reliable measure of cost-effectiveness can be made. That is, if an immediate post-intervention clinical outcome self-report measure differs from a measure made at one year post intervention, then which benefit measure should be used in deciding whether a particular treatment/approach is cost-effective relative to other treatments/approaches for either the same, or different diseases and disorders?

There are several potential reasons why the measurement of the self-report of clinical outcomes may change over time. For example, significant increases in measured benefit may arise because the patient is adjusting or acclimatizing to the treatment effects. Indeed acclimatization to the use of amplification has recently received a great deal of interest in the audiological literature (e.g. Cox, Alexander, Taylor & Gray, 1996; Gatehouse, 1992; Gatehouse, 1993; Saunders & Cienkowski, 1997). The results of these studies are equivocal. Significant decreases in benefit may also occur, with one possible reason being that initial benefit scores were influenced by a phenomenon such as the Hawthorne effect (Carey, 1967).

The Hawthorne effect is well-known psychological phenomenon. It addresses the effect on research outcome caused by a subject's awareness that he is being studied. From 1927 to 1933 the Western Electric Company conducted a productivity study in their Hawthorne plant near Chicago. The company brightened the lights in the plant and then measured productivity, which had increased. The company then dimmed the plant's lights and again measured productivity, which again increased. It was hypothesized that the outcome, increased productivity, was not related to the controlled experimental factors but to the fact that the employees were aware that they were being studied, thus the "Hawthorne effect". Subject behavior changed simply because of experimenter attention, rather than the experimental changes made. In a health care model, patients may perceive benefit and score higher on outcome measures simply because of the recent attention paid them by the health care provider. For example, the attention given to the patient by the audiologist, the acquisition of a new hearing aid, and the spoken or implied benefit surrounding the patient's experience, may combine to elevate the patient's self-perceived benefit scores.

There are several studies in the literature whose findings indicate that initial self-report of hearing aid benefit may be higher relative to long-term benefit. For example, Taylor (1993) conducted a longitudinal study to assess the self-reported benefit received by 58 elderly new hearing aid users. The group consisted of both male and females participants. Thirty-seven participants were fit monaurally and 21 were fit binaurally. The self-report measurement tool used was the Hearing Handicap Inventory for the Elderly (HHIE; Ventry & Weinstein, 1982). Administration of the HHIE was conducted at 3, 12, 24, and 52 weeks post fitting. Results indicated a significant decrease in perceived handicap up to 12 weeks, followed by a significant increase in perceived handicap after the 12 week administration which remained consistent out to the 52 week administration. Similarly, Malinoff & Weinstein (1989) studied a group of 25 elderly new hearing aid users who were fit monaurally. The HHIE was administered at 3, 12, and 52 weeks following initial fitting. As with the Taylor (1993) study, a significant reduction in self-perceived handicap was apparent after the 3-week administration followed by an increase in self perceived handicap in the following administrations of HHIE.

There are also reports in the literature, however, suggesting that self-report benefit measures remain stable over time (e.g., Brooks, 1989; Henrichsen, Noring, Linderman, Cristensen, & Paving, 1991; Schum, 1992). Both Brooks (1989) and Schum (1992) reported that self-report of hearing aid benefit, as measured by questionnaires other than HHIE, were stable for at least one year. Both studies were similar in that they examined the self-report benefit in participants who were fit both monaurally and binaurally. Participants were both new and experienced hearing aid users.

Given these conflicting results regarding the stability of self-report of hearing aid benefit, further research appears warranted. The present study was concerned with the stability of hearing aid benefit, as measured by the APHAB (Cox & Alexander, 1995) from the 3-month HAC to the next annual audiological re-evaluation (i.e., 12-18 months after previous evaluation). In APHAB, the patient answers the 24 predetermined questions prior to receiving a hearing aid(s), and then again following the hearing aid fitting. The difference in scores with and without the use of hearing aid(s) is considered the measure of benefit. There are four categories in which benefit is calculated: ease of communication (EC), listening in background noise (BN), listening in reverberant conditions (RV), and aversiveness of sounds (AV). The APHAB can be administered in a paper-and-pencil format or by computer.

Despite the common use of APHAB to measure hearing aid benefit, no study to date has examined the stability of APHAB benefit scores at one year or longer of hearing aid use. Thus the purpose of this study was to measure hearing aid benefit stability, utilizing APHAB, during two routine aid appointments: (1) a 3-month hearing aid check (HAC); and, (2) the next annual audiologic re-evaluation.

METHODS

Participants

Initially the records of 48 patients at Central Florida Speech and Hearing Center in Lakeland, Florida were examined to obtain data for n = 36. This n was determined appropriate for the purposes of this study through power analysis (Borenstein, Rothstein, & Cohen, 2000). Demographic data for these individuals is shown in Table 1. All participants had sensorineural hearing loss, with no permanent or ongoing conductive pathology. Although some patients exhibited asymmetric hearing losses, the possibility of retrocochlear pathology had previously been ruled out. None of the patients had any known psychiatric or cognitive disability. All patients could read and complete the APHAB without assistance. Of the 36 patients, 22 were fit binaurally, and 14 were fit monaurally. Monaural fittings were typically done with participants of the Florida Medicaid program as the program routinely only approves payment for one hearing aid (n = 12). Only two of the participants (#24 & #35) were not Medicaid monaural fittings.

For inclusion in this study patients' records also needed to indicate: (1) no significant change in hearing (e.g. no more than a 10dB HL shift in hearing for the PTA of 500, 1000, 2000, and 4000Hz.; (2) hearing aid(s) remaining within manufacturers' specifications; and (3), no significant changes in real ear insertion gain (REIG) measures from the three month HAC to the next annual audiologic re-evaluation. Visual inspection of target REIG measures were made to insure hat the target was unchanged from annual audiologic re-evaluation back to the time of the original fitting. A change in REIG was defined as being greater than 10dBSPL at any one frequency (i.e., 500, 1000, 2000, or 4000Hz.).

While records for 48 patients were examined, given these guidelines, only 36 met criteria. The reasons for not meeting criteria were as follows: seven patients exhibited a significant change in hearing in one or both ears, five patients exhibited significant problems with hearing aid(s) output not meeting manufactures specifications as evidenced by electroacoustic analysis.

TABLE 1. Demographics data for study participants

Subject	Gender	Age	# of aids	Mo. Aid	R PTA	L PTA	R Sp	L Sp	Circ.	Ear
1	1	55yrs	1	14	36dB	33dB	84%	92%	2	1
2	1	68	2	13	40	43	88	88	2	3
3	1	47	1	18	56	54	80	84	2	1
4	1	64	1	17	44	42	72	76	1	2
5	2	86	2	13	61	54	72	76	1	3
6	2	79	2	18	36	57	92	80	2	3
7	1	52	2	13	55	53	76	72	1	3
8	1	76	2	14	59	65	80	56	2	3
9	2	42	1	14	28	55	92	76	2	2
10	1	58	2	13	75	55	60	72	1	3
11	1	80	2	12	63	63	68	68	1	3
12	2	55	1	17	78	75	72	68	5	1
13	2	66	1	13	48	43	72	80	2	2
14	1	79	2	17	58	74	44	32	3	3
15	1	79	2	13	56	46	72	92	1	3
16	2	83	2	12	74	81	60	44	1	3
17	2	74	2	14	44	44	72	72	2	3
18	1	75	2	14	36	38	84	92	2	3
19	1	74	2	15	63	51	84	84	2	2
20	2	75	1	17	66	40	64	88	5	1
21	2	82	2	15	56	50	84	80	2	3
22	1	62	1	14	61	65	72	68	2	1
23	1	77	2	12	51	45	64	72	2	3
24	1	76	2	13	85	40	0	60	4	2
25	1	62	1	15	55	54	80	68	2	1
26	2	79	2	12	46	43	76	84	1	3
27	2	79	2	16	41	34	60	72	1	3
28	2	81	2	12	35	34	80	56	1	3
29	2	93	2	16	54	53	80	80	2	3
30	1	60	1	15	65	84	76	62	2	2
31	2	80	2	17	65	38	32	92	2	2
32	1	74	1	15	46	44	56	40	2	2
33	2	80	1	13	49	45	80	88	2	2
34	2	43	1	12	59	55	88	80	2	1
35	2	78	1	12	70	51	44	52	2	2
36	1	79	2	13	58	59	80	84	2	3

Gender -- male = 1, female = 2; # of aids – 1 = monaural, 2 = binaural; Mo. Aid = number of months following hearing aid fitting that APHAB was re-administered; R PTA = Right ear pure tone average of 500, 1000, 2000, & 4000Hz.; L PTA = Left ear pure tone average of 500, 1000, 2000, 4000Hz.; R Sp = Right ear word recognition score; L Sp = Left ear word recognition score; Circ. = type of hearing aid circuit, 1=AGC O, 2=WDRC-D, 3=Programmable, 4= Programmable Dual Microphone, 5=AGC O power B

Abbreviated Profile of Hearing Aid Benefit (APHAB)

The APHAB was used to obtain self-perceived benefit scores. Scores were calculated for each of the four subscales: Ease of Communication (EC), Reverberation (RV), Background Noise (BN), and Aversiveness (AV). These scores indicated a percentage of benefit in the respective subscales. The first three subscales, EC, RV, and BN, are known as the "speech communication" subscales. These subscale benefit scores are reported in the form of a positive percentage (i.e., 10%, 20%, 30%). The fourth subscale, Aversiveness (AV), quantifies an individual's negative reaction to aversive environmental sounds. This subscale is reported in a negative percentage (i.e., -10%, -20%, -30%).

These positive and negative scales can sometimes be confusing to the reader and warrant further clarification. On the EC, RV, and BN, the higher the difference score the greater the benefit (i.e., 30% score indicates greater benefit in one of the scales than a 15% score). In the AV subscale, the greater the negative number, the greater the "problem" with aversive environmental sounds (i.e., -30% AV indicates a greater problem with aversive environmental sounds than a –15% AV score).

Instrumentation

Pure tone and speech audiometry were completed on all participants using a calibrated (ANSI, 1996) Grason Stadler 16 clinical audiometer. A calibrated (ANSI, 1987) Grason Stadler 33 Middle Ear Analyzer was used to assess middle ear function of all participants. A calibrated (ANSI, 1997) Fonix 6500 hearing aid analyzer and real ear test system was used to electroacoustically evaluate all hearing aids and perform all real ear testing.

Procedure

The procedures reported were those routinely employed with hearing aid patients at the Central Florida Speech and Hearing Center. They begin with a complete audiologic evaluation administered to all patients prior to hearing aid fitting. These evaluations included air and bone conduction pure tone thresholds, speech reception thresholds and word recognition scores, immittance, and acoustic reflex testing.

Following the initial audiological evaluation, hearing aid selection was completed by one of two experienced clinical audiologists. Hearing aids were selected using the Desired Sensation Level (DSL $_{I/O}$) prescriptive method (Cornelisse & Seewald; 1995) in order to meet the patients' audiological and communication needs. Patients were typically fit binaurally unless they were Medicaid recipients, which provides for only a monaural fitting. Hearing aids were dispensed at two weeks following initial evaluation and the unaided APHAB data was obtained immediately prior to hearing aid fitting. During the fitting, a real ear insertion gain (REIG) was obtained. A 30-day follow-up hearing aid check appointment was provided to each individual. Any necessary acoustic or shell modification changes were made at that time. If modifications were needed for the acoustic characteristics, another REIG was obtained.

Patients returned to the clinic at three months post-fitting and completed the aided portion of the APHAB. They were allowed to see their unaided responses when making their judgments. Although usually unnecessary, if the hearing aid needed further adjustments for acoustic reasons, they were performed and another REIG was obtained during this visit.

Patients who provided data for this study received a complete audiologic re-evaluation at a minimum of one-year and a maximum of 18 months post initial hearing evaluation. The same audiological tests conducted at the initial evaluation were performed. In addition, electroacoustic analysis of the hearing aids was performed in the hearing aid analyzer to ensure that they were performing within ANSI tolerances for manufacturers' specifications (ANSI, 1996). REIG were also again obtained. As previously noted, inclusion of a patient's data in this study involved no changes in hearing, hearing aid performance or REIG. Individuals were then re-administered the aided APHAB under the same condition as at the three month HAC appointment.

Patients were not allowed to see their 3-month aided scores but were allowed to see the initial unaided scores. All responses (unaided and aided, at 3-months HAC and at the annual re-evaluation) were input into commercially available software to obtain benefit scores for analysis.

It should be noted that the first administration of the "aided portion" of APHAB at three months is untraditional and would be considered late according to the literature (Cox, 1997). This literature calls for administration at approximately two weeks after hearing aid fitting when the patient has had time to accommodate the new instrument. As part of the standard clinical protocol at the Central Florida Speech and Hearing Center, two weeks was believed to be too early to accurately measure true hearing aid benefit. We find that within the first 30 days many of the patients may be focusing more on mechanical concerns such as fit, feel, proper insertion, and volume control, to give an accurate benefit score. The literature does suggest for other self-report questionnaires (e.g., HHIE), the peak time to measure benefit is at 12 weeks (e.g., Taylor, 1993, Malinoff & Weinstein, 1989). For these reasons and clinical scheduling issues, the three month hearing aid check was chosen as the administration time for aided APHAB measures.

It is also important to note that, the second administration of the aided APHAB measure took place at 12-18 months post fitting. Admittedly, the authors would have preferred that all perspective participants be evaluated at the same time post fitting. However, due to clinical scheduling issues and patient availability for hearing re-evaluation, this six month range could not be avoided. Finally, given that the first APHAB aided administration was three months past hearing aid fitting and the annual re-evaluation 12-18 months post hearing aid fitting, the length of time between the two aided APHAB administration was 9-15 months.

RESULTS

This study was designed to examine the long-term stability of APHAB measured hearing aid benefit over a 9-15 month period. The APHAB benefit scores for each participant at each administration are shown in Table 2. Two analyses of covariance (ANCOVA) were conducted to examine this issue. In both analyses, the time from hearing aid fitting to second administration of APHAB, expressed in months, was used as the covariant. The first ANCOVA examined the stability of the three positive APHAB benefit scores: EC, RV, and BN. The second examined the stability of the negatively reported score, AV. The mean length of time between the two APHAB administration was 14.25 months (SD=1.88, with a range of 9-15 months).

TABLE 2. The APHAB benefit scores for each participant at each administration

	3-month HAC APHAB				Annual Re-evaluation APHAB			
Subject	EC	RV	BN	AV	EC	RV	BN	AV
1	10.30	12.30.	8.30	33.20	10.30	8.60	2.20	31.20
2	35.30	54.30	25.60	-28.80	33.20	50.30	23.30	-22.50
3	50.20	29.50	60.50	-50.00	45.50	41.30	22.80	54.20
4	25.90	8.80	6.30	-37.00	20.90	9.00	10.20	-37.00
5	46.00	22.30	35.30	-40.30	56.50	3.70	35.20	-40.80
6	49.50	45.50	31.50	-68.50	51.70	53.70	50.20	-57.80
7	62.30	56.00	39.20	-58.20	62.30	51.80	43.30	-31.20
8	41.80	27.00	41.70	-43.80	39.70	20.80	31.20	-2.20
9	56.20	49.70	60.30	-56.00	64.50	52.00	45.70	-35.50
10	22.70	24.20	20.90	-16.10	28.80	20.00	10.60	-30.50
11	41.30	2.00	4.20	-18.50	51.70	-28.70	6.30	-16.40
12	11.80	-2.90	14.30	3.80	55.70	1.40	6.00	14.50
13	64.30	32.80	33.00	2.00	60.30	27.20	33.00	-56.00
14	29.50	47.20	31.00	-20.70	27.30	40.50	16.00	-6.20
15	47.80	54.80	37.20	-74.70	27.40	16.10	-17.30	-58.50
16	37.00	2.20	28.80	4.50	29.00	24.50	34.80	-34.00
17	31.50	27.30	21.00	-27.20	14.70	27.30	29.30	-8.30
18	-8.30	-.20	8.50	-24.50	-12.30	8.20	8.50	-18.00
19	60.20	14.30	33.00	-14.80	41.30	6.20	-6.20	14.30
20	39.50	4.50	45.70	-48.20	-16.20	6.70	20.80	-58.70
21	6.00	37.00	4.20	-8.30	24.50	47.50	18.80	-22.30
22	11.80	43.00	32.80	-40.20	73.70	77.70	78.20	-9.50
23	35.70	47.20	34.80	-1.80	29.30	33.80	34.80	-2.20
24	35.29.	29.90	10.00	-30.70	22.00	-8.20	-4.20	-8.30
25	29.20	37.20	24.50	-41.50	8.30	10.30	1.80	-27.00
26	41.70	43.30	46.00	17.00	43.80	31.30	29.00	18.80
27	44.00	62.20	37.20	-68.30	47.70	47.30	20.70	-43.50
28	18.30	6.20	40.00	1.80	-65.20	-7.90	2.50	-50.50
29	12.80	56.30	39.70	-15.70	22.70	43.30	45.80	-1.80
30	82.30	84.50	84.70	-7.80	20.30	47.00	26.70	-30.80
31	45.80	48.70	59.80	-35.20	45.80	26.70	20.50	-6.20
32	37.50	8.30	10.50	.20	-4.20	-6.20	-6.20	-23.00
33	5.80	31.30	18.30	1.80	-5.80	23.30	26.70	-14.80
34	59.50	54.20	55.70	-14.50	61.30	53.80	61.70	-12.30
35	22.30	34.70	30.50	20.30	22.30	36.50	38.80	24.50
36	41.80	37.30	53.80	-1.70	48.20	45.70	49.50	-6.40

EC = ease of communication, RV = reverberant conditions, BN = background noise, AV = aversiveness of sounds.

Figure 1 shows the mean EC, RV, and BN benefit scores (+/- 1 standard error) as measured at the 3-month HAC and at the annual re-evaluation. It can be seen at the re-evaluation administration of APHAB the mean benefit scores were less than at the 3-

month administration for all subscales. Indeed, the results of the ANCOVA revealed the main effect of time was statistically significant (F (1,35) = 5.45, p = .02, MSE = 475.07). The mean 3-month score collapsed across the three subscales of EC, RV, and BN was equal to 33.59 and at the annual re-evaluation was 26.67. Neither the main effect of subscale (F (2,70) = 1.44, p = 244, MSE = 319.82) nor the interaction between time and subscale were significant (F (2,78) = 0.51, p = .60, MSE = 102.59). This suggests that the decrement in mean APHAB score from 3-months HAC to annual re-evaluation was due to changes in all three domains.

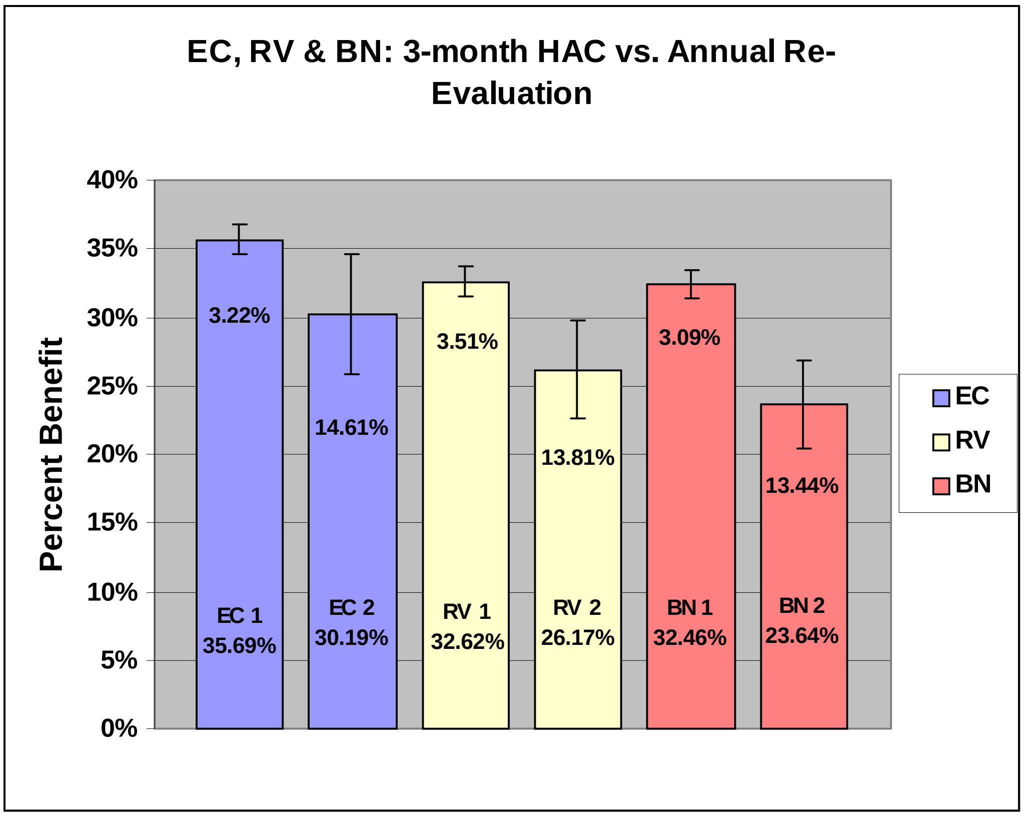

Figure 1. The mean and standard error of EC, RV, and BN benefit scores as measured at 3-month HAC and at the annual re-evaluation.

The next issue addressed was whether or not there was a change over time in the AV subscale. Figure 2 shows the mean 3-month and 12-18 month scores (+/- 1 standard error). It can be seen that there was a change in mean score, with sounds apparently being perceived as less aversive the longer hearing aids were used. Although the mean score improved, the change was not statistically significant ($F = (1,35) = 1.10$, $p = .24$, MSE = 385.65). Thus, it is not clear whether or not the apparent decrease in aversiveness is a true phenomenon.

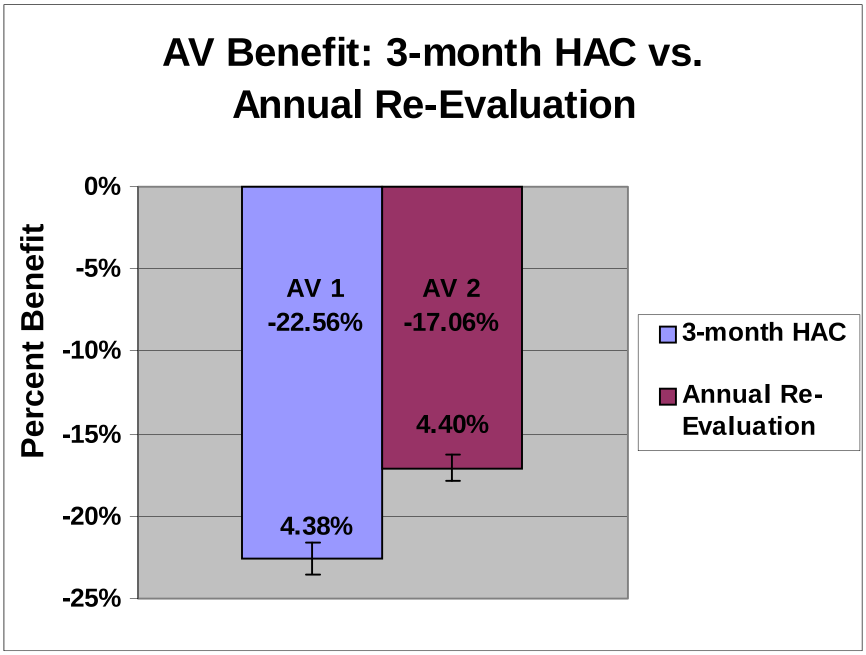

Figure 2. The mean and standard error of AV scale as measured at the 3-month HAC and annual re-evaluation

Another way to examine the data was to determine the number of individuals who received clinical benefit using the 90% and 96% confidence intervals (CI) for true changes in scores as provided by Cox & Alexander (1995). For the 90% CI, all three communication subscale benefit scores (i.e., EC, RV, and BN) must equal or exceed +5 points for a determination of "true" benefit. For the 96% CI, the same three benefit scores must equal or exceed 10 points. Table 3 shows the number of participants out of the 36 who would be classified as demonstrating clinical benefit using each confidence interval at each test administration.

Table 3. Number of participants exhibiting "true" clinical benefit changes from 3-month HAC to annual re-evaluation APHAB administration

Administration	96% Confidence Interval	90% Confidence Interval
3-month HAC APHAB	25	30
Annual re-evaluation APHAB	22	23

As would be expected, more participants were classified as having demonstrated "true" clinical benefit at both administration times using the 90% CI than using the 96% confidence interval. Using the 90% CI, seven participants moved out of the clinical benefit category from the 3-month HAC to the annual re-evaluation administration. When using the 96% CI, only three fewer individuals demonstrated benefit at annual re-evaluation as compared to the 3- month HAC.

Using the chi square procedure, the data for each CI were examined for changes in the proportions classified as receiving benefit versus not receiving benefit as a function of time of administration. Using the 96% CI, the difference in proportions was not significant (X^2 (1) = 3.50, p = .46). When examining the proportions of individuals classified as having hearing aid benefit versus no benefit at the 90% CI, the difference approached significance (X^2 (1) = 3.50, p = .06). This may be interpreted to suggest that clinical outcomes will be more stable over time when a more stringent criterion is used for determining "true" clinical benefit.

It is important to note that two individuals who were not classified as receiving benefit using the 90% and the 96% CI's at three months, demonstrated benefit using both confidence intervals at the annual re-evaluation. Both of these individuals were female and were fit binaurally. One was 82-years old (participant #21) and the other 83-years old (participant #16). The 83-year old exhibited a severe to profound symmetric hearing loss with fair word recognition scores, consistent with the degree of hearing loss. She was fit with hearing aids using automatic gain control (AGC). The 82-year old exhibited a mild-to-moderate symmetric hearing loss with good word recognition scores. She was fit with wide dynamic range compression circuitry (WDRC). The major change in benefit for the 83-year old was in the RV subscale, while for the 82-year old the improvements were in the EC and BN subscales. Thus, there was little consistency between relevant known characteristics of these two women which might account for their increased APHAB scores at the annual re-evaluation.

A review of Table 4, which shows each participant's APHAB scores, reveals that nine individuals had "unstable" benefit (participant #'s 1, 5, 15, 19, 24, 25, 28, 32, & 33). That is, they exhibited "true" clinical benefit, using the 90% CI and/or the 96% CI at the 3-months but not at the annual re-evaluation APHAB administration. It can also be seen that 21 individuals maintained or had "stable" benefit (participants # 2, 3, 4, 6, 7, 8, 9, 10, 13, 14, 17, 22, 23, 26, 27, 29, 30, 31, 34, 35, & 36). In addition there were four individuals who never exhibited any clinically significant benefit (participants # 11, 12, 18, & 20).

TABLE 4. Comparison of Stable Benefit, Unstable Benefit, and No-Benefit Group Demographics

Group	N	Age	Male	Female	R PTA	L PTA	R Sp	L Sp
Stable	21	68.3	11	10	53dB	52dB	71%	73%
U. StB	9	74.1	6	3	54dB	44dB	67%	72%
No Bn.	4	71.3	2	2	61dB	54dB	72%	79%

Stable = Stable benefit group, U. Stb = Unstable benefit group, No Bn. = No benefit group, Age = mean age, R PTA = pure tone average of 500, 1000, 2000, & 4000Hz., L PTA = pure tone average of 500, 1000, 2000, & 4000Hz., R Sp = right ear word recognition score, L Sp = left ear word recognition score.

A comparison of gender between the Stable benefit and No-benefit group revealed the distribution of males vs. females was similar in both groups (i.e., 11 males vs. 10 females, 2 males vs. 2 females respectively). The Unstable group, however, had more male participants than female ones (i.e., 6 males vs. 3 females). The mean ages participants in of the Stable, Unstable, No-benefit groups were 68.3, 74.1, and 71.3 years old, respectively. The age data for the three groups were compared using independent t-tests and no significant differences were found.

Examination of the mean pure tone average (PTA) data for each group revealed that PTAs were essentially the same between ears only for the stable benefit group. Both the Unstable and No-benefit groups exhibited better pure tone averages in the right as compared to the left ear. Finally, independent t-tests comparing right and left ear word recognition scores within groups and across groups revealed no statistically significant differences.

Table 5 shows the number of individuals in each group with each type of hearing aid fitting (i.e. monaural vs. binaural) and the distribution of hearing aid circuits among the three groups. First, it can be seen that in the Stable benefit group more individuals were fit binaurally than monaurally. In the Unstable and No-benefit groups, however, more individuals were fit monaurally. Collapsing the data for these two groups and comparing it to the Stable benefit group using the chi-square procedure, however, revealed that this difference in proportions of binaural and monaural fits was not reliable (X^2 = 1.54, f = .21).

Table 5. Comparison of hearing aid fitting and circuitry in Stable Benefit, Unstable Benefit, and No-benefit groups.

Group	n	Mon	Bin	AGCo	WDRC	Prog	PDM	AGCo Power
Stable	21	9	12	5	15	1	0	0
U. Stb	9	6	3	3	5	0	1	0
No Bn	4	3	2	1	1	0	0	2

Stable = Stable benefit group, U. Stb = Unstable benefit group, No Bn = No benefit group, Mon = monaural fitting, Bin = binaural fitting, AGCo = automatic gain control output, WDRC = wide dynamic range compression, PDM = programmable Dual-Microphone, AGCo Power = automatic gain control output power circuit class B.

In terms of the distribution of circuits across the groups, it can be seen in Table 5, that this was quite varied. However, the circuit fit most frequently in the Stable and Unstable benefit group was the WDRC-D. Interestingly, only two AGCO power B circuits were used within this study, both were fit to participants in the No-benefit group.

In summary, there are few observable differences among the groups of individuals demonstrating Stable, Unstable and No Benefit. In addition, those few differences that were observed, such as with PTA and type of hearing aid fitting, were not statistically significant.

<u>Effects of Gender and Type of Hearing Aid Fitting on APHAB Scores</u>

Although the main purpose of this study was to examine the overall stability of APHAB scores over time, the data also allowed for examination of the possible effects of several other factors such as gender and type of hearing aid fitting on the stability of scores.

Effect of Gender

Table 6 shows the mean EC, RV, BN, & AV scores (+/- 1 standard error) as a function of gender at the 3-month HAC and at the annual re-evaluation administration of the APHAB scores. An examination of the three communication subscale scores (i.e., EC, RV, & BN) revealed that there was little difference in mean scores as a function of gender at either administration time. Indeed the results of an ANCOVA (Table 7) revealed that neither the main effects of gender or subscale were significant. As expected, however, this analysis revealed a significant main effect of time. None of the interactions were significant.

Table 6. Mean APHAB scores (+/– 1 standard error) for each APHAB subscale as a function of gender at 3-month HAC and the annual re-evaluations

	3-month HAC				Annual Re-evaluation			
Gender	EC	RV	BN	AV	EC	RV	BN	AV
Male (SE)	36.46 (4.65)	32.58 (5.13)	29.86 (4.79)	-25.12 (5.64)	30.19 (4.92)	23.37 (5.93)	17.45 (5.30)	-12.10 (5.81)
Female (SE)	34.82 (4.57)	32.66 (4.91)	35.37 (3.78)	-19.70 (6.93)	30.19 (8.25)	29.29 (4.70)	30.55 (3.72)	-22.61 (6.60)

EC = ease of communication, RV = reverberant conditions, BN = background noise, AV = aversiveness of sounds.

Table 7. Analysis of Covariance for speech communication APHAB subscales over time as a function of Gender

Source	Df	Ms	F	*p*
Gender (G)	1	778.27	.47	.49
Error	33	1632.12		
Time (T)	1	2477.86	5.17	.02
Error	34	479.04		
Subscale (S)	2	411.57	1.30	.27
Error	68	315.43		
G x T	1	340.19	.710	.40
Error	34	479.03		
G x S	2	469.09	1.48	.23
Error	68	315.43		
T x S	2	48.06	.46	.63
Error	68	104.38		
G x T x S	2	41.98	.40	.67
Error	68	104.38		

An examination of the AV scores in Table 6 reveals that at the 3-month HAC APHAB administration, the mean AV score was poorer for men than for women. At the annual re-evaluation administration the results were reversed, with poorer (more negative) AV score for women than men. Indeed, the mean AV score for men improved approximately 13% over time, while for women there was actually a slight decrease in mean scores of approximately 3%. The results of an ANCOVA, for these data (Table 8) revealed that this interaction approached significance (p = .08).

Table 8. Analysis of Covariance for the Aversiveness APHAB subscale over time as a function of Gender

Source	Df	Ms	F	*p*
Gender (G)	1	98.78	.09	.75
Error	33	1020.07		
Time (T)	1	458.47	1.26	.26
Error	34	363.50		
G x T	1	1138.82	3.13	.08
Error	34	363.50		

Effects of Monaural vs. Binaural Hearing Aid fitting

Within the study twenty-two of the participants were fit with hearing aids binaurally and fourteen were fit monaurally. Table 9 shows the mean EC, RV, BN, and AV scores (+/- 1 standard error) as a function of monaural vs. binaural fitting at the 3-month HAC and at the annual re-evaluation administration of the APHAB. An examination of the three communication subscales scores (i.e., EC, RV, and BN) revealed that there was no statistically significant main effect for monaural vs. binaural fittings for the three communication subscales. Indeed, the results of ANCOVA (Table 10) revealed that neither the main effects of monaural vs. binaural fitting or subscale were significant. As expected the main effect of time was significant and again no interactions were significant.

Table 9. Mean APHAB scores (+/- 1 standard error) for each subscale at 3-month HAC and annual re-evaluation administration for Monaural vs. Binaural fittings

Fitting	EC	RV	BN	AV	EC	RV	BN	AV
Mon.	36.18	30.74	34.67	-16.99	29.77	27.73	26.31	-12.85
SE	6.28	6.35	6.32	7.57	7.97	6.51	6.40	8.85
Bin.	35.37	33.82	31.06	-26.11	30.45	25.17	21.94	-19.75
SE	3.58	4.19	3.17	5.32.	5.74	4.78	3.97	4.59

EC = ease of communication, RV = reverberant conditions, BN = background noise, AV = aversiveness of sounds.

Table 10. Analysis of Covariance for communication APHAB subscales over time as a function of monaural vs. binaural hearing aid fitting

Source	Df	Ms	F	*p*
M vs. B	1	59.10	.03	.85
Error	33	16.53.91		
Time (T)	1	2333.47	4.78	.03
Error	34	488.03		
Subscale (S)	2	380.94	1.16	.31
Error	68	1.16		
M vs. B x T	1	34.38	.07	.79
Error	34	488.03		
M vs. B x S	2	95.70	.29	.74
Error	68	326.41		
T x S	2	51.21	.49	.61
Error	68	103.94		
M vs. B x T x S	2	56.78	.54	.58
Error	68	103.94		

Although not statistically significant, it is interesting to note that the AV subscale indicated greater benefit at both the 3-month HAC and the annual re-evaluation APHAB administration for those participants fit monaurally. Results of ANCOVA (Table 11) revealed that neither the main effects of monaural vs. binaural, or subscale were significant. The AV benefit for those participants fit monaurally and binaurally did decrease over time.

Table 11. Analysis of Covariance for APHAB AV subscale over time as a function of monaural vs. binaural hearing aid fitting

Source	Df	Ms	F	*p*
M vs. B	1	1720.44	1.77	.19
error	33	970.93		
Time (T)	1	471.56	1.18	.28
error	34	396.37		
M vs. B x T	1	21.23	.05	.81
error	34	396.37		

DISCUSSION

The main purpose of this study was to examine the stability of APHAB scores over time. The impetus was two fold. First it is known that government agencies, third party payers, and HMOs are calling for increased accountability by all health care practitioners. Studies have been conducted in areas such as hip replacement, stroke, and congestive heart failure (Holtzman et al., 1998; Kane et al., 1998) suggesting that initial benefit measures may decrease over time. Thus, one question that may be posed to the field of audiology is the stability of our own benefit measures as they apply to the use of amplification.

In the current study, the results suggest that there was a loss of benefit from the 3-month administration of APHAB to the annual re-evaluation post-fitting administration of APHAB. These results would be in agreement with previous studies (e.g., Taylor, 1993; Malinoff & Weinstein, 1989) that indicated a decrement in benefit when measured long term. Talyor (1993) and Malinoff and Weinstein (1989) both used the HHIE self-report benefit questionnaires measured at several post-fitting intervals, including the 12 week and 52 week periods. The 12 week period is roughly equivalent to the 3-month HAC time in the present study and the 52 week period is essentially equivalent to the annual re-evaluation in time. The most pertinent similarity between these two studies and the current study is that group mean self-report benefit decreased over time.

One possible explanation for the decrease in APHAB benefit scores over time is related to the Hawthorne effect. It is possible that the attention paid to the participants during the initial evaluations and hearing aid fitting made them feel special or important. If this occurred then it is possible that there was a temporary elevation in perceived benefit. As time passes, the Hawthorne effect subsides. When the participant returned for the annual re-evaluation administration of the APHAB, then it is possible that his responses were more related to actual "treatment effects" of the hearing aid. If this is the case, then the latter measurement may be more representative of the participant's actual benefit from intervention with hearing aids(s)

Other factors that could influence the reduction of benefit over time are unrealistic expectations of hearing aid benefit by the participant and heightened expectation of hearing aid benefit due to the financial expense, or a combination thereof. This aspect of heightened expectation affecting measured success of intervention is addressed by Burton et al., (1979) who examined patients' expectations in relation to outcome of total hip replacement surgery. In this study, patients expressed generally high expectations for good outcome following surgery. Only 55% had their expectations fulfilled. Despite this, 86% claimed the operation to be successful. When questioned more closely, however, patients noted a certain amount of displeasure about the outcome. Further analysis revealed that when the sample was split into two groups those who had "fulfilled" and "unfulfilled" expectations, significant differences were noted in that the self-perceived quality of life. The "fulfilled" group reported greater quality of life than that enjoyed by the "unfulfilled" group. The finding suggests that the notion of "expectations" can influence reported self-perceived benefit. It should be noted that any of these factors (e.g., Hawthorne effect, heightened/unrealistic expectations of the patient) might persist even in the presence of appropriate pre- and post-fitting counseling.

Given the finding that self-reported hearing aid benefit decreases over time from the initial 12 week to the later 52 week administration, the concern of the third party payers and government agencies regarding long term stability of hearing aid benefit must be addressed. First, although benefit did decrease over time within this study, 21 participants maintained stable long term benefit. Second, however, it appears that the 96% CI, as opposed to the 90% CI, provides a more stable measurement of "true" benefit. While more participants demonstrated initial benefit at the 90% CI as compared to the 96% CI, a greater number of them "lost" that benefit at the annual re-evaluation testing. That is, the number of people classified as receiving "true" clinical benefit was more similar at the 3-month HAC and the annual re-evaluation when the more stringent, 96% CI criteria is used. Given that stability is the focus of agency oversight, the 96% CI data would be more appropriate for analyzing long term hearing aid benefit. Selecting the 96% CI, however, will likely mean fewer patients demonstrating benefit shortly following the hearing aid fitting.

In addition to the primary findings, certain observations regarding the effects of gender and monaural vs. binaural hearing aid fittings on benefit and stability were of interest. The first was the interaction between gender and time for the AV subscale. Although the interaction approached significance, it was of interest to note that at the 3-month APHAB administration, the mean AV scale was poorer for men than for women. At the annual re-evaluation the results were reversed with the women demonstrating poorer performance and the men demonstrating slightly improved scores. This finding may be interpreted to suggest that the male hearing aid patients adapted to aversive noises over time while their female counterparts did not. Before such a conclusion can be drawn, however, further investigation with a larger number of subjects should be conducted to confirm whether or not this gender difference does exist.

Another interesting issue related to the results obtained on monaural versus binaural hearing aid fittings and their effect on the three communication benefit scales. There were no statistically significant differences in the three benefit scales between the monaural and binaural fitting groups over time. One might expect the binaural group to demonstrate higher communication benefit scores. However, in the literature there are studies that report equal benefit or perhaps better between monaural and binaural fittings (Chimiel & Jerger, 1996; Chimiel, Jerger, Murphy, Pirozzolo & Tooley-Young, 1997; Hurley, 1999; Jerger, Alford, Lew, Rivera & Chimiel, 1995). These authors have evaluated auditory deprivation, the preference of the elderly, their increased performance with monaural amplification, and the underlying neuropsychological explanation for these phenomena. In general, the results suggest that age-related changes in interhemispheric transfer of auditory input via the corpus collosum underlie the preference for monaural amplification. This phenomenon may have been the causal factor for the essentially equal communication benefit scores exhibited between those participants fit monaurally and those fit binaurally in the present study.

Prior to drawing conclusions from this study certain limitations need to be considered. First, it should be noted that the study was underpowered to sufficiently consider the effects of gender and monaural vs. binaural hearing aid fitting on the long term stability of the APHAB. Thus, any interpretation of the data for these factors should be made with caution. Second, the study did not account for hearing aid experience amongst the participants. Therefore, possible factors between experienced hearing aid users and first time users were not controlled. Accordingly, it is recommended that future research address intersubject factors such as gender, type of hearing aid fitting, and level of experience of hearing aid use.

With these cautions in mind, however, the following conclusions may be drawn:

(1) the APHAB is an appropriate measure of long term hearing aid benefit.

(2) while there was a decrease in mean benefit over time, the majority of participants continued to demonstrate “true” long term benefit over time for the communication subscales.

(3) using the APHAB scores at a three month administration time incorporating a 96% CI demonstrated long term stability and should be sufficient to measure long term benefit.

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