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Hearing aid satisfaction: What does research from the past 20 years say?

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Abstract

Hearing aid satisfaction is a pleasurable emotional experience as an outcome of evaluation of performance. Many tools have been designed to measure the degree of satisfaction overall, or along the dimensions of cost, appearance, acoustic benefit, comfort, and service. Various studies have used these tools to examine the relationships between satisfaction and other factors. Findings are not always consistent across studies, but in general, hearing aid satisfaction has been found to be related to experience, expectation, personality and attitude, usage, experience, type of hearing aids, sound quality, listening situations, and problems in hearing aid use. Inconsistent findings across studies and difficulties in evaluating the underlying relationships are probably caused by problems with the tools (e.g., lack of validity) and the methods used to evaluate relationships (e.g., correlation analysis evaluate association and not causal effect). Whether satisfaction changes over time and how service satisfaction contributes to device satisfaction are unclear. It is hoped that this review will help readers understand current satisfaction measures, how various factors affect satisfaction, and the way satisfaction is measured and may be improved to yield more reliable and valid data.

Introduction

Satisfaction, according to the Oxford Advanced Dictionary (2000), is the good feeling that one has achieved something or when something that one wanted to happen does happen. Satisfaction has been variably described in the American Heritage Dictionary of the English Language (1996) as the fulfillment or gratification of a desire, a need, or an appetite; a pleasure or contentment derived from such gratification; and a source or means of gratification. Similarly, Oliver (1997) defines satisfaction as a pleasurable fulfillment in that the consumer feels that his or her needs, desires, and goals have been fulfilled in a pleasurable manner. Satisfaction is thus an emotional and pleasurable experience, that confirms that something right has happened and provides a driving force to sustain the effort that yields this feeling.

Tse (1988) defined consumer satisfaction as "the consumer's response to the evolution of the perceived discrepancy between prior expectations and the actual performance of the product as perceived after its consumption". Oliver (1981) further described satisfaction "as an evaluation of the surprise inherent in a product acquisition and/or consumption experience.... Satisfaction is the emotional reaction following a disconfirmation experience (an evaluation of performance against expectations) which acts on the base attitude level and is consumption-specific". Overall, satisfaction is commonly described as a pleasurable emotional experience, as an outcome of product performance evaluation against expectations.

Satisfaction is crucial to the whole hearing aid fitting process and its importance in audiology is evidenced by the fact that it is frequently included as a measure of outcome (Cox and Alexander, 1999; Dillon et al, 1999; Kochkin, 2000a). Satisfied hearing aid users are often frequent users and sources of referral for other people with hearing impairment (Kochkin, 2000a). Allen and Rao (2000) and the National Research Council (1999) also

stated that satisfaction is necessary although not sufficient for a customer to be loyal. Customer satisfaction and loyalty directly affect customer retention. Thus, it is important to investigate the nature of hearing aid satisfaction and how audiologists can achieve higher satisfaction for their clients.

A number of researchers have found that most hearing aid users are satisfied with their hearing instruments (Kochkin 1990; Sinclair and Goldstein, 1991; Kochkin, 1992; Bentler et al, 1993; Humes et al, 2002a; Humes et al 2002b). For example, the two Kochkin studies reported more than 50% of users were generally satisfied with their hearing aids. Kochkin (1996a), and Billie et al (1999) have found that more than 66% of participants were satisfied or very satisfied. In the study by Scherr et al. (1983), 91% of respondents rated hearing aid performance satisfactory or excellent. Souza et al. (2000) also found high overall satisfaction among hearing aid users. Hosford-Dunn and Halpern (2000) found that the overall satisfaction rating reached 71%. The average participant in the Cox and Alexander (2001) study was “considerably satisfied”.

The studies mentioned thus far have all been conducted in the United States. Hearing aid users in other countries are also quite satisfied. In three separate Australian studies, 71 to 97% of users reported feeling satisfied or very satisfied with hearing aids (Dillon et al, 1991a; Dillon et al, 1997; Hickson et al, 1999). Purdy and Jerram (1998), and Jerram and Purdy (2001) found 70 to 76% of New Zealand hearing aid users satisfied with their hearing aid experience. Similarly, over 68% of British, German and Danish users were satisfied with their hearing instruments (Gatehouse, 1994; Stock et al, 1997; Parving, 2003). These results for general satisfaction are encouraging to note, and the hope is that by studying the elements that underlay satisfaction, we can help our clients to be even more satisfied.

This paper reviews 45 studies on hearing aid satisfaction under five main sections:

(1) Current hearing aid satisfaction measures,

(2) Methodologies of hearing aid satisfaction studies,

(3) Findings on the effect of intrinsic factors on satisfaction,

(4) Findings on the impact of extrinsic factors on satisfaction, and

(5) Problems with hearing aid satisfaction measures.

In the first section, two commonly used hearing aid satisfaction measurement tools, will be described: the Satisfaction with Amplification in Daily Life (SADL) (Cox and Alexander, 1999) and the MarkeTrak Satisfaction Survey (or MarkeTrak). In the second section, methodologies used in studies on hearing aid satisfaction are summarized in the text and Table 4. Due to the vast number of measures used in various studies, readers are advised to refer to Table 1 for abbreviations used. In the third and forth sections, results from studies concerning how various intrinsic and extrinsic factors relate to satisfaction are discussed (see Table 5 and Table 6 for summaries). While general conclusions are drawn from studies, conflicting findings are noted. Shortcomings related to hearing aid satisfaction measures and suggestions on how these measures can be improved are covered in the last section.

Current hearing aid satisfaction measures

In the literature, overall hearing aid satisfaction has consistently been related to the dimensions of cost, appearance, acoustic benefit, comfort, and service (Cox and Alexander, 1999; Kochkin, 2000a). To date, only two hearing aid satisfaction measures have been somewhat "standardized": the Satisfaction with Amplification in Daily Life (SADL; Cox and Alexander, 1999) and the MarkeTrak Satisfaction Survey (or MarkeTrak). The items in the SADL assess hearing aid satisfaction in four subscales (Table 2):

1. <u>Positive effect</u> items evaluate improvement in performance and psychological benefit. Cox and Alexander (2000) concluded from previous studies that this "domain appears to be the largest single contributor to variance in overall satisfaction (p. 370)".

2. Service and cost items tap dispenser competence, cost and product dependability;
3. Negative features items relate to problems in noise, feedback and telephone use.
4. Personal image items are related to appearance.

Item development, test-retest reliability, and validity measures of the SADL were evaluated by Cox and Alexander (1999, 2000), and Hosford-Dunn and Halpern (2000) confirmed its factor structure. Participants are asked to rate the hearing aid on a seven-point scale, with descriptors equal interval apart (Cox and Alexander, 1999). The descriptors are "not at all", "a little", "somewhat", "medium", "considerably", "greatly" and "tremendously" with accompanying scores of 1 to 7. Composite scores are calculated for each of the four subscales and for the full scale (global score). Interestingly, individuals are never asked to rate satisfaction directly. Even so, Cox and Alexander (2001) found that scale and subscale scores were related to satisfaction in general.

The MarkeTrak, which has surveyed the largest samples among all hearing aid satisfaction measures, has been conducted five times since 1989, and different versions are referred to as MarkeTrak I to V (Kochkin, 1990; Kochkin, 1992; Kochkin, 1996a; Kochkin, 1996b; Kochkin, 1997a; Kochkin, 1997b; Kochkin, 1998; Kochkin, 1999; Kochkin, 2000a; Kochkin and Rogin, 2000). The current MarkeTrak surveys overall hearing aid satisfaction and satisfaction in three main categories. Items in the categories are grouped on an a priori basis, as follows:

1. Product Feature items examine areas like fit or comfort, reliability, use in noisy situations and battery life. There are 20 statements.
2. Listening Situations consist of 14 statements that tap listening in small groups, restaurant, car etc.
3. The Service factor is made up of six statements (e.g., quality of service, knowledge of dispenser).

There are 40 items. A five-point Likert scale of "very satisfied", "satisfied", "neutral", "dissatisfied" and "very dissatisfied" is used for response categories.

Participants are asked to evaluate their level of satisfaction for each statement. Results obtained from all respondents of a survey serve as norms to which subgroups of respondents or respondents of future surveys can be compared. These results are often reported as percentages of respondents being satisfied with each item. Although the MarkeTrak has been conducted about five times over the past 15 years, no data on reliability and validity has been reported. Nevertheless, it has been regarded as one of the most informative satisfaction measures. Its advantage rests on extensive sampling, and provision of data for comparison across various characteristics at different times.

The SADL and the MarkeTrak measure similar constructs, mainly dealing with listening and benefit in various situations, sound quality, cost, reliability of the product and services obtained. Value, as measured under the Product Feature category on the MarkeTrak, refers to the performance of hearing aids relative to price and perceived performance. Thus, value, together with reliability of the hearing aid, are related to the Service and Cost subscale of the SADL. The Service factor of the MarkeTrak is also assessed under the Service and Cost subscale of the SADL. Items from the MarkeTrak that evaluate problems in hearing aid use, such as feedback, are reflected in the SADL's Negative Feature subscale. Sound quality and listening in multiple situations on the MarkeTrak are similar to the SADL's Positive Effect subscale. Humes et al (2002b) found global SADL scores on a population with one month of hearing aid use experience comparable to MarkeTrak IV norms. Global MarkeTrak IV scores correlated moderately with global SADL scores ($r = .75$, $p < .01$), but less with SADL subscale scores ($r = .42$ to $.62$, ps$< .01$)

Other studies have employed hearing aid satisfaction measures (e.g., Stock et al, 1997) that have not been evaluated as extensively as the MarkeTrak and the SADL. Table 3

lists descriptions of a few common hearing aid satisfaction measures and Table 4 provides a list of all hearing aid satisfaction measures used in the studies reviewed in this paper. Nonetheless, these studies have revealed important findings about how hearing aid satisfaction relates to many factors such as type of hearing aid, sound quality, listening environment, benefit, experience and attitude, expectation, counseling, and usage. These findings are summarized in Tables 5 and 6 and will be discussed in the following three sections. The Appendix contains information on the research methodologies, aims and findings of these studies.

Methodologies of hearing aid satisfaction studies

A total of 45 studies were reviewed. Table 4 summarizes the types of hearing aid satisfaction measures in the various studies. General satisfaction was measured in 32 studies; satisfaction in specific aspects (e.g., cost, reliability, performance) was measured in 19 studies. Most studies used a categorical scale, although sometimes the categorical scale was associated with a numeric scale. For example, the SADL employs seven-point categorical scale of this kind.

Depending on the location where the study was conducted, different measures were used. For example, many studies from the United States employed the MarkeTrak or the SADL. These are the most commonly used measures, appearing nine and five times in the studies described here. Eight Australian studies used the Hearing Aid User's Questionnaire (HAUQ), while other countries used a mix of measures.

Because satisfaction is a perception, self-report measures are used to assess it. Other outcomes such as benefit, problems, usage, service, disability, handicap, are measured by using either self-report or objective tools such as speech recognition tests and pure-tone thresholds.

Table 4 also summarizes the demographic details of participants in the various studies:

- Most studies were conducted in the United States, with a small proportion from Australia, Europe and New Zealand. Most studies were performed on a participant pool of less than 200; however, a few studies were very large scale, with data collected mostly with the MarkeTrak Satisfaction Survey (e.g., Kochkin 2000a). Studies by Dillon et al (1999) and Parving et al (2003) included more than 4000 and 14000 participants, respectively.
- Most participants were elderly with a mean age of 65 or above.
- Four studies examined satisfaction in new users, a few studies compared results from experienced and new users (e.g., Cox and Alexander, 2000; Kochkin, 2000a), but others did not discriminate between these two types of users (e.g., Gatehouse, 1994; Hickson et al, 1999). A few other studies evaluated experienced users only (e.g., Newman and Sandridge, 1998).
- Whether participants had binaural fitting was not stated in most studies and we assume that no differentiation between these participants was made.
- Ten studies focused on particular styles of instruments, others reflect results from various styles. Three studies reported satisfaction with digital hearing aids. Participants have various degrees of loss but direct comparison cannot be made across studies as some studies have reported average hearing level only (i.e., Gatehouse, 1994; Brooks and Hallam, 1998), and some reported hearing in the better ear (e.g., Brooks and Hallam, 1998; Purdy and Jerram, 1998).
- Test intervals were specified in 25 studies, spanning from 1 or 2 weeks to 4 years post fitting, with the majority assessing satisfaction in the first year. With the exception of the studies by Bentler et al (1993), McLeod et al (2001), and Humes

et al (2002a), all were cross-sectional investigations. The Appendix details research studies on hearing aid satisfaction.

The studies can be divided into three categories according to their purposes:

(1) Development and validation of the measurement scales (i.e., Cox and Alexander, 1999, 2001; Hosford-Dunn and Halpern, 2000; Humes et al, 2002b),

(2) Investigation of how various factors relate to satisfaction (40 studies, e.g., Baumfield & Dillon, 2001), and

(3) Dispenser evaluation of client satisfaction (i.e., Kirkwood, 2001).

To investigate whether various factors relate to satisfaction, within participant (four studies) or between participant comparisons (18 studies) were conducted in some studies. The within-participant comparisons were made between hearing aids (e.g., Billie et al, 1999) or between certain intervals post fitting (e.g. Humes et al, 2002a) and did not show a significant difference in satisfaction attributable to the type of hearing aids used or the duration of hearing aid use. Most between-participant studies showed a significant difference attributable to the variables studied. The aims of the studies were:

1. To compare results to normative data from average hearing aid users (e.g., Jedidi, 1994),
2. To compare short and long term satisfaction (e.g., McLeod et al, 2001),
3. To compare satisfaction for different types of devices (e.g., Kochkin, 1996a),
4. To compare satisfaction between two groups of new users (e.g., Kochkin, 1997a),
5. To compare satisfaction obtained with measures taken at different times (e.g., Kochkin, 2000a),
6. To evaluate the effect of counseling on satisfaction (e.g., Norman et al, 1994), and

7. To compare satisfaction scores using different methods of measurement (Dillon et al, 1991a).

Other studies investigated these relationships by using various statistical methods like conjoint analysis (i.e., Meister et al, 2001), correlation analysis (e.g., Dillon et al, 1997), hierarchical configuration frequency analysis (CFA), (i.e., Stock et al, 1997), logistic regression (e.g., Purdy and Jerram, 1998), and regression analysis (e.g., Gatehouse, 1999).

Despite these differences in the populations accessed, measures used, measurement scale, aims of the studies, and sample size, somewhat consistent findings were reported. The following sections document findings from these studies under the categories of intrinsic and extrinsic factors. Statistical analysis was not used in all satisfaction studies, thus, comparing results presents difficulties. Arbitrary rules were applied to draw conclusions for this review. A significant effect was concluded if most studies showed an effect of the variable on satisfaction. When statistical analysis was reported in the study, the variable effect is interpreted with caution if most studies yielded low statistical significance (e.g., correlation coefficient of less than .25). No variable effect is concluded when statistical significance could not be demonstrated in most studies. Findings are deemed inconclusive if strong evidence was not presented, or if contrastive findings were reported.

Intrinsic factors that may affect satisfaction

Many factors potentially affect satisfaction. Among them, some are inherent to the hearing instrument user (intrinsic factors), and others are externally caused (extrinsic factors). The intrinsic factors include:

1. Age, gender, and other demographic data,
2. Hearing loss,
3. Self-perceived disability and handicap,
4. Hearing aid experience,

5. Expectation of hearing aids,
6. Attitude and personality, and
7. Hours of aid usage.

The following sections discuss the reported effects of each variable in detail. Table 5 also summarizes these findings.

Age, gender and other demographic data

Demographic data are often collected, and the effect of such personal characteristics on satisfaction has been evaluated in eight studies. While Hosford-Dunn and Halpern (2001) found age had a small but significantly negative effect on global satisfaction ($r_s = -.18$, $p < .005$) and Positive Effect score of the SADL ($r_s = -.22$, $p < .005$), none of the other studies found a significant relationship between age and satisfaction (Kochkin, 1992; Bentler et al, 1993; Gatehouse, 1994; Norman et al, 1994; Brooks and Hallam, 1998; Hickson et al, 1999; Jerram and Purdy, 2001). One may argue that a difference in results among studies does not really exist, as the study with findings that show negative effects did not show a high correlation between age and satisfaction. Increased age and hearing difficulty together are related to greater satisfaction with benefit, cost and service and with image related issues (Hosford-Dunn and Halpern, 2001). Studies that have investigated gender effects have mostly found none (Hickson et al, 1999; Jerram and Purdy, 2001). Female participants were slightly more satisfied than male participants in the study by Brooks and Hallam (1998).

Besides age and gender, other demographic characteristics such as whether living alone or with others and socioeconomic status, have not been found to be related to satisfaction (Gatehouse, 1994; Norman et al, 1994; Hickson et al, 1999; Jerram and Purdy, 2001).

In summary, age, gender and other demographic data exhibit no impact or minimal effect on satisfaction.

Hearing loss

Although a person's degree of hearing loss would seem logically to be related to satisfaction with amplification, 9 out of the 14 studies reviewed here have not found a significant relationship between hearing loss and hearing aid satisfaction (Scherr et al, 1983a; Hutton and Canahl, 1985; Bentler et al, 1993; Gatehouse, 1994; Norman et al, 1994; Dillon et al, 1997; Brooks and Hallam, 1998; Jerram and Purdy, 1998; Hickson et al, 1999). Studies by Dillon et al (1999), and Hosford-Dunn and Halpern (2001) found otherwise. Kochkin (1992, 1997b, 2000a) found results varied with listening situations. Dillon et al (1999) found a moderate correlation ($r = -.45$, $p < .05$) between three frequency average loss and aid satisfaction, such that greater hearing loss was related to increased satisfaction.

Hosford-Dunn and Halpern (2001) found those with greater loss experience less satisfaction for Negative Feature subscales of the SADL ($r_s = -.29$, $p < .001$) because they have more problems with feedback and background noise. Hearing loss also correlated with the Positive Effect subscale score of the SADL, suggesting persons with more severe loss have greater satisfaction with benefit. However, when other factors such as experience and daily use were considered, the degree of loss alone lost its influence on satisfaction. Instead, it interacted with these factors to affect all SADL subscale scores, except Service/Cost.

Although Kochkin (1992) found more users with severe impairment were satisfied with aid performance than those with mild loss (58.5% versus 55.6%), the difference was not significant. Of interest is that, the percentage of satisfied users decreased to 49% when the loss became profound. In a later study using the same questionnaire, Kochkin (1997b) found users with mild loss were more satisfied with hearing aids overall than those with more severe degree of loss. This was for directionality; and use in restaurants, concerts/movies and phone.

According to Kochkin (2000a), those with a profound loss rated aids more satisfactory (66%) overall than the "mild" loss group (48%). However, the profound loss group rated the hearing aids lower than the mild loss group on 15 attributes, especially on perceived benefit, fit and comfort, ability to hear soft sounds, ability to localize, feedback and most listening situations. The mild loss participants rated hearing aids lower on impact on quality of life, likelihood of repurchase, likelihood of recommending hearing aids to a friend, hours worn, perception of benefit and one-on-one situations. Thus, degree of loss has a differential influence on satisfaction depending on the aspect being measured.

Differences in findings across studies are probably related to homogeneity of degree of loss among participants. A sample with larger range of hearing loss such as Dillon et al (1999) and Kochkin (2002) may be more apt to show a relationship between loss and satisfaction. Also, differences in findings may be related to the measurement of general versus aspect-specific satisfaction and whether satisfaction was measured as an aggregate score of items in a scale. Listening in one situation may prove satisfactory, but not in other situations. Overall, there is conflicting evidence as to whether degree of hearing impairment affects satisfaction. Although most studies did not show hearing loss related to satisfaction; those that did show a relationship, the correlations were low.

Other than the degree of loss, progression and cause of loss are also of interest. Stock et al. (1997) found that progression of loss did not make a difference to satisfaction; however, those with hearing loss from illness or accident tended to be more satisfied. Bentler et al (1993) reported that the configuration of loss did not change satisfaction.

Hearing Disability and handicap

Most research has not found that self-reported disability and handicap predict satisfaction (e.g., Gatehouse, 1994; Norman et al, 1994; Dillon et al, 1997; Spitzer,1998; Baumfield and Dillon, 2001; Humes et al, 2001). The subscores and total scores of a revised

version of the Hearing Performance Inventory (HPI-38) a hearing disability and handicap measure (Lam et al, 1983), accounted for less than 8% of the variance of satisfaction scores in a study by Bentler et al (1993). Stock et al (1997) found that severity of self-reported unaided hearing problems was not related to satisfaction, and whether the hearing problem bothered a person exhibited a very low but significant correlation ($r = -.14$, $p < .05$) with satisfaction. Hosford-Dunn and Halpern (2001) found perceived hearing difficulty increased the Positive Effect score of the SADL ($r_s = .25$, $p < .005$). Perceived difficulty also affected other SADL domains but not Negative Features. Perceived difficulty interacted with greater loss causing higher Global SADL score. Thus, the above studies revealed a low or non-existent relationship between satisfaction and reported hearing disability or handicap.

Two studies have found disability and handicap related to satisfaction. Kochkin (1997b) reported that participants with milder disabilities were more likely to derive satisfaction with the ability to tell direction of sounds, and hearing in some situations, such as large groups, restaurants, concerts/movies, and telephone. Dillon et al (1991b) also found that hearing disability and handicap, as measured by a modified Hearing Handicap Inventory for the Elderly (HHIE) (Ventry and Weinstein, 1982), correlated with overall satisfaction rating ($r > .50$, $ps < .05$).

Because different measures were used to evaluate disability and handicap, it is difficulty to compare results across studies, especially when findings conflict. Studies that do support a relationship between satisfaction and disability/handicap suggest it is not a strong one; therefore, the relationship is inconclusive.

Hearing aid experience

Despite low correlation coefficients, five studies that have considered experience have found that individuals with previous experience have greater satisfaction than new users. Bentler et al (1993) and Jerram and Purdy (2001) are the only exceptions. Cox and Alexander

(2000) used the Expected Consequence of Hearing Aid Ownership (ECHO) and the SADL to measure expectation and satisfaction and found new users reported less satisfaction than anticipated. New users with higher prefitting expectations reported greater psychological and psychoacoustic benefit ($r = .51$, $p < .05$). Experienced users often are more realistic about the performance of hearing aids and are more satisfied. They require a shorter time to adjust to the reproduction of sounds from hearing aids (Kapteyn, 1977). Parving and Philip (1991) found that prior hearing aid experience was associated with higher daily use and satisfaction. General satisfaction was reported by 69% of experienced users versus 45% of new users.

Kochkin (2000a) also found that overall satisfaction for new users about was 9% lower than for experienced users. New users rated 16 MarkeTrak V items lower, including impact of aid on life (21% lower), recommendation of aid to others (12% lower), likelihood of repurchase (10% lower) and hearing aid reliability (10% lower). Hosford-Dunn and Halpern (2001) found experienced users reported less satisfaction with feedback ($r_s = -.30$, $p < .001$) and Negative Feature subscale of the SADL ($r_s = -.23$, $p < .005$). However, Jerram and Purdy (1998) were not able to find a relationship between experience and satisfaction.

In summary, the evidence indicates that experienced users are more satisfied than new users and there are a number of possible explanations for this:

(1) New users often have slightly better hearing sensitivity than experienced users (Parving and Philip, 1991; Cox and Alexander, 2000; Kochkin, 2000). Although this factor alone may not affect satisfaction, it may interact with other factors to reduce or enhance satisfaction. For example, Hosford-Dunn and Halpern (2001) found experienced users who had more severe loss and used hearing aids of more advanced technology had poorer satisfaction with encountered problems. Experienced users with a greater degree of loss and

were wearing smaller aids tended to be more satisfied with appearance of the aid.

(2) It can be argued that experienced users may have more positive support from family members and are more motivated to wear the aids (Jacobson et al, 2001), and motivation increases satisfaction (Hickson et al, 1999).

(3) Anxiety may reduce the amount of satisfaction for new users. Such clients are often concerned about a range of issues including the cost, finding the "best" hearing aid and the right professional to select the aid, whether the aid will be beneficial. (Kricos et al, 1991). Anxiety related to these concerns is unlikely to bother experienced users.

(4) High satisfaction among experienced users may also reflect fewer problems in manipulating the hearing aid and earmold (Parving and Philip, 1991).

(5) The time it takes to get used to hearing instruments correlated significantly but negatively with satisfaction ($r = -.34$, $p < .05$) (Stock et al, 1997). Users who take less time to adjust to amplification are more satisfied; those who need more time are less satisfied. Perhaps experienced users have accepted their hearing loss, need less time to adjust to the aid/s, and are better adapted to hearing aid use.

(6) Because experienced consumers tend to use hearing aids more frequently (Parving and Philip, 1991) and usage is related to satisfaction, the increase in satisfaction may well be an effect of higher usage.

(7) Data from consumer research suggests that experienced users of durable goods have expectations that match actual performance. While new users may have high expectations (Cox and Alexander, 2000), Bentler et al (1993) found post-fitting expectations are closer to actual performance. Thus, experienced users

are less likely to have unrealistic expectations or be surprised by problems encountered. Therefore, experienced users are often more satisfied. Issues about expectations are revisited in detail in the next section.

Expectation

Five studies examine the relationship between expectation and satisfaction. While Norman et al (1994) found expectation and satisfaction unrelated, and Gatehouse (1994) and Jerram and Purdy (2001) found prefitting expectation minimally related to hearing aid satisfaction, other studies found stronger relationships between expectation and satisfaction (e.g., Ziecheck, 1993; Cox and Alexander, 2000). Gatehouse (1994) found expectation accounted for only 1.4% of the variance of satisfaction when benefit was accounted for. Ziecheck (1993) measured pre-fitting expectation by using an expectation questionnaire designed by Kricos et al (1991) on communication in different situations, feedback, noise annoyance sound quality, cosmetics, ease of use, cost and upkeep, benefit; and overall satisfaction. About 93% of the high expectation participants reported satisfaction, contrasting with 75% of the low-medium expectation participants ($p < .05$). These findings coincide with Schum's (1999) report that those with higher prefitting expectations about hearing aid performance in noise reported more hearing aid benefit postfitting. Oliver and DeSarbo (1988) found that although consumers with low expectations may be pleasantly surprised by a high performance product, the resulting satisfaction is not as high as when the participants had high initial expectations.

Cox and Alexander (2000) found expectation and satisfaction with some domains relate, such as psychological and psychoacoustic benefit, but other domains of expectation, such as service and cost, did not relate to satisfaction because of several outlier responses from individuals who either expected much and became very dissatisfied, or expected little but were very satisfied with their instruments. This observation does not necessarily mean

that satisfaction cannot be predicted from expectation; rather, it highlights the importance of considering other factors that affect the relationship between expectation and satisfaction in an unpredictable fashion. Cox et al also found that prefitting expectations vary tremendously between participants, but do not change over time. Ziecheck's (1993) findings concur with these results.

Although individuals with low expectations are less satisfied, these seem to be the minority, as Kricos et al, (1991) found 87% of participants with high expectations. The participants were elderly persons who had never used hearing aids and they had the following expectations:

1. Cosmetics: 77% of respondents expected hearing aids to be visible, and only 29% suggested this would affect their decision to get an aid.
2. Acoustics: 85% expected feedback; 67% to 75% expected others' voices – and sounds in general – would be natural, sounds might be too loud, and soft sounds to be heard; and 53% expected their own voice to sound natural.
3. Communication benefit: over 92% expected speech to be easy to hear and understand, to hear better in church, and that the aid would improve their confidence; and 58% thought that the aid would help hearing in noisy restaurants.
4. Comfort: 78% expected the aid to be comfortable, and 54% expected a plugged-up feeling.
5. Ease of use: over 77% thought that the aid should be easy to insert and remove, and that the controls to be easy to use. While 62% of the participants expected the battery to be difficult to see, 41% thought it would be difficult to insert.
6. Cost and upkeep: Participants were expecting the aid to cost from $20 to $1500 (US). About half of the participants (45%) thought that the price was just right and 36% thought it was too high. None felt that the cost was too little. They

thought that batteries would last between a few hours to 2 years and most (76%) thought that a package of batteries would cost less than $5. While replacement was expected on average every 4.3 years, expected instrument life varied from 6 months to an indefinite period. Participants expected repairs from every 6 months to no repairs at all.

Overall, many new users have pre-fitting expectations of hearing aid performance that are considered to be high (Kricos et al, 1991; Schum, 1999; Cox, 2000). New users also expected more in the various aspects (Personal Image, Positive Effect, Negative Features, Service/Cost) measured by the SADL (Cox, 2000). Perhaps that is what draws them to getting amplification. In fact, Garstecki and Erler (1998) suggested that individuals with low expectations often rejected a hearing aid recommendation; however, unrealistically high expectations also seemed to cause problems with acceptance of amplification.

Whether expectation changes over time is uncertain. Cox and Alexander (2000) found expectation to be stable over time, but Bentler et al (1993) found a reduction over time, that resulted in perceived improvement in performance relative to expectations. Expectations prior to and after hearing aid fitting may also differ because of experience with usage. Experience modifies one's expectation so that it matches actual performance. Changes in expectation over time may affect how expectation relates to satisfaction.

Findings from these studies do not consistently show that high expectation is associated with greater satisfaction. There is no consistent data showing that the method of measurement, whether measuring satisfaction in general, as a composite score or in specific situations, made a difference. Those studies reporting a relationship were conducted at 1 month and 12 months post-fitting (e.g., Ziecheck, 1993; Cox, 2000) while those not reporting a relationship were done between 3 to 8 months post-fitting (Gatehouse, 1994; Norman et al, 1994; Jerram and Purdy, 2001). It should be noted that if expectation changes over time, then

the time when expectation and satisfaction are measured might influence the results. No clear pattern is observed in the small number of studies conducted to date. Expectation is probably influenced by attitude and personality. In fact, personality has been found to relate to satisfaction and this phenomenon is discussed in the next section.

Attitude and personality

Six studies on attitude and personality were reviewed. These studies were relatively recent and dated from 1994 onwards. Individuals who are self-motivated to get hearing aids are often more satisfied (Hickson et al, 1999). Although Hickson et al and Jerram and Purdy (2001) did not find attitude towards rehabilitation or adjustment to loss a significant factor influencing satisfaction, Brooks and Hallam (1998), Stock et al (1991), and Gatehouse (1994) found a small relationship.

According to Gatehouse, attitude towards hearing aids accounted for 6.8% of the variance of satisfaction. Stock et al (1991) found that the degree of embarrassment from wearing hearing instruments correlated directly with satisfaction rating ($r = -.25$, $p < .05$). Those who are less embarrassed are 1.5 times more likely to be satisfied. Similarly, Brooks and Hallam (1998) found certain attitudes, such as distress/inadequacy, don't want/need aid, reduced the odds of being satisfied, and minimizing hearing loss increased the likelihood of satisfaction.

Another study using the SADL revealed four items were related most to general satisfaction of hearing aids (Cox and Alexander, 2001). These items were about getting hearing aid/s being worth the trouble, in the person's best interest, the dependability of the hearing aid/s, and the knowledge of the dispenser. Of interest was that, items describing the actual use of hearing aids, such as feedback, telephone use, speech understanding, were not as important in predicting satisfaction. This observation highlights the importance of a person's attitude.

Personality also appeared to outweigh audiological variables in determining satisfaction in the Gatehouse (1994) study. Persons with depression, who feel less in control, and are more obsessed tended to experience greater satisfaction (r = -.28, -.27 and .39, ps < .001). These variables accounted for more variance of satisfaction than other audiological (e.g., degree of loss, frequency resolution, temporal resolution) and biological factors (e.g., age, gender). Thus, attitude towards hearing aids and personality appear to have small but significant effects on satisfaction.

Hearing aid usage

With the exception of the studies by Bentler et al (1993), Spitzer et al, (1998), Hickson et al (1999), Baumfield and Dillon (2001), Hosford-Dunn and Halpern (2001) and Humes et al (2001), all 12 other studies examining the relationship between hearing aid use and satisfaction have yielded significant findings. A range of correlations have been reported between usage and satisfaction (r = -.24 to .66, ps< .05) in various studies (Brooks, 1985; Brooks, 1990; Gatehouse,1994; Norman et al, 1994; Dillon et al, 1997; Stock et al, 1997; Brooks and Hallam, 1998; Purdy and Jerram, 1998; Dillon et al, 1999 ; Jerram and Purdy, 2001).

Dillon et al (1991b) found that satisfaction correlated more highly with aid use (r = .66, p < .05) than a range of other measures, such as aid benefit, aid problems, and service satisfaction. Brooks (1985) found that most of those who used hearing aids for over two hours daily were satisfied and that most of those with low satisfaction ratings were also low-level users. Findings from Salomon et al (1988) supported this conclusion. Kochkin (1997b) found that those who are “very dissatisfied” have a 33% probability of using their devices 4 or more hours daily, whereas those who are “very satisfied” have a 92% probability of such daily aid use.

A significant relationship is found between usage and satisfaction in many studies, but Dillon et al (1999) stressed that many satisfied clients use their aids for a small amount of time; those who never used their aids reported satisfaction as well. For example, Kochkin (1997b) found those who wore aids for less than 1 hour daily were just as satisfied as those wearing aids 2 to 5 hours daily. Salomon et al (1988) and Hickson et al (1999) reported the same phenomenon.

Differences in findings may be related to the measurement method. Aid usage can be measured in terms of average daily hour usage, and frequency of use (e.g. always, often). Regular use in situations with greatest perceived needs may more appropriately reflect satisfaction than hour usage (Hickson et al,1999). It can also be argued that hearing aid use data should be interpreted with care as dissatisfied users and non-users often do not participate or tend to drop out from the studies. For example, in Brooks' (1985) study, 49% of non-users did not provide satisfaction ratings; those who did all indicated dissatisfaction. Also, accuracy of these data is affected by how well the person remembers and how the data is collected; overestimation of use time is common (Brooks, 1979). The most accurate data is obtained from data-logging devices (Taubman et al, 1999), although some errors still occur with this technique when hearing aids have been accidentally turned on while not being worn. Use may interact with other factors to influence satisfaction. For example, Hosford-Dunn and Halpern (2001) found frequent users of small or high technology instruments have higher satisfaction overall.

Summary of the relationships between intrinsic factors and satisfaction

Among the intrinsic variables examined, expectation, and attitude and personality, have small effects on satisfaction such that higher expectation and certain attitudes (e.g., embarrassment) enhance satisfaction. Motivated individuals are more satisfied. Previous aid experience and higher usage positively influence satisfaction. Age, gender, and demographic

data do not affect satisfaction. How satisfaction relates to hearing loss, disability and handicap is unclear.

Extrinsic factors that may affect satisfaction

The effects of various extrinsic factors have been examined in the literature, most commonly dealing with:

1. Types of instrument.
2. Listening situations.
3. Benefit.
4. Sound quality.
5. Problems.
6. Counseling.

Results from studies examining these factors are discussed in the following sections and are summarized in Table 6. Conclusions on the relationships between satisfaction and these variables are drawn whenever possible, but consistent supportive evidence is not always present, as illustrated below and in the table.

Types of hearing instrument

Individuals who use instruments that are newer, contain more advanced technology, such as multiple memories and microphones, or using completely-in-the-canal (CIC) devices are more satisfied than general hearing aid users.

New hearing aids

Kochkin (1996b) found that individuals using new (less than 1 year) hearing aids were more satisfied (71%), compared to general users (53%). Users of new aids were more satisfied in general and in areas like clarity of tone/sound, use in noise, value, performance in large groups, performance in restaurants and performance in a car than users of older hearing aids. The general satisfaction figure had improved from the findings in 1991 in which 66.5%

of new instrument users were satisfied. In another survey of 13,000 hearing aid owners, Kochkin (1997b) found 63% of users of hearing instruments less than 1 year old were more satisfied with the aids' performance, compared to 54% of all respondents who had a range of years of experience using hearing aids. Similarly, Kochkin (1999) found in surveys conducted in 1991 and 1994 that more users of hearing aids less than 1 year old were satisfied than general hearing aid owners.

While new hearing aid users report greater satisfaction, it is uncertain whether the improvement is related to high performance characteristics. The following section elaborates on this issue.

High-performance programmable or digital hearing aids

In the past, attempts were made to improve benefit and satisfaction by the use of different hearing aid circuits, especially those for noise reduction. However, they did not seem to improve satisfaction (Bentler et al, 1993). With the introduction of high performance hearing aids, the picture may be changing. Jerram and Purdy (2001) found high performance hearing instruments enhanced satisfaction. Jedidi (1994) also found a programmable hearing aid yielded satisfaction ratings higher than MarkeTrak norms (Kochkin, 1993). Programmable users rated 14 out of 19 items higher than MarkeTrak III norms. Higher satisfaction ratings were recorded for ease of changing batteries; adjusting volume and cleaning; listening on telephone, outdoors, in small and large groups; and one-to-one conversation. Programmable users were more satisfied with dispensers in all aspects surveyed.

Kochkin (1996a) concluded that instruments with multiple microphones and memories contributed significantly to satisfaction. He also found that programmable devices yielded higher satisfaction than MarkeTrak III norms, the majority of whom had analog aids. Programmable aids resulted in higher satisfaction in outdoor situations. Satisfaction on fit and

comfort, ease of battery change and battery life was not superior. Similarly, in the MarkeTrak V survey, users of programmable instrument recorded 16% higher satisfaction ratings than hearing aid users in general (Kochkin, 1999, 2000a). Programmable aid users were more satisfied in 37 of the 45 items surveyed, including comfort with loud sounds, feedback, small group, worship, warranty, telephone, performance in noise, listening in multiple environments, value, quality of life, benefit, and reliability. They were more likely to recommend the dispenser and aids to others, and to repurchase the aids.

Multiple memory is a feature that resulted in greater satisfaction for listening in different situations than single memory. A hearing aid which satisfied wearers in only one of the ten surveyed situations had an overall satisfaction rating of 15%; and the instruments that could satisfy users in all ten listening situations yielded a rating of 92% (Kochkin, 1996a). A hearing instrument that can satisfy users in more situations also yields higher overall satisfaction ratings.

The reported increase in satisfaction with high-performance aids does not only reflect users' points of view; dispensers have also noted greater user satisfaction with high performance aids. About 78% of dispensers reported digital instrument users were more satisfied than those wearing advanced nondigital instruments (Kirkwood, 2001). Greater user satisfaction was noted in sound quality, listening comfort, understanding speech in noise, understanding speech in quiet, and preventing feedback.

In two within-participant studies (Billie et al, 1999; Parving, 2003), the advantage of digital hearing aids over analog ones disappeared. Participants gave very similar satisfaction ratings to an analogue and a digital hearing aid. Also, equal number of participants rated either of these aids satisfactory. It seems within-participant experimental comparisons of hearing instruments do not show a programmable/digital advantage, but between-participant

designs show a significant effect. These two within-participant studies only measured general satisfaction, while other studies often assessed aspect specific satisfaction.

The number of independent processing channels has not been found to alter satisfaction. Newman and Sandridge (1998) examined satisfaction in a within-participant design study by using three different types of hearing instruments, ranging from a single-channel linear device to seven-channel non-linear digital aids, and failed to identify statistical differences in satisfaction rating using the MarkeTrak Satisfaction Survey. Hosford-Dunn and Halpern (2001) attributed the lack of effect of independent processing channels to how technology was classified and how the data was analyzed.

While high performance instruments appear to improve satisfaction in some studies, the increased satisfaction may well be a placebo effect. Participants in most of the studies that showed digital instruments yielding higher satisfaction had not been blinded to the type of technology. In fact, Weber et al (1999) suggested that the high cost of digital instruments may bias the individuals so that self-reported degree of satisfaction is greater without improved perceived ease of communication.

Style of hearing aids

Although the CIC devices used in the following studies only had single channel and memory facilities, they received higher ratings than the MarkeTrak V norms on 15 variables, most notably on visibility, comfort with loud sounds, use in noisy situations and in 8 of the 13 listening situations surveyed (Kochkin, 2000a). CIC instruments were rated lower on battery life and ease of volume adjustment. Behind-the-ear (BTE) devices yielded lower satisfaction on the ability to hear soft sounds, directionality, and in difficult listening situations, although satisfaction on battery life was higher. Invisible ITC's yielded higher overall satisfaction (0% to 10%) than ITC, ITE or BTE that are more visible.

Similarly, compared to BTE and ITE instruments, Hosford-Dunn and Halpern (2001) revealed that smaller instruments (CIC and in-the-canal) improved satisfaction with Personal Image items ($r_s = .25$, $p < .001$) and Global Satisfaction of the SADL, and reduced dissatisfaction with the Negative Feature score ($r_s = .31$, $p < .001$). CIC users were more satisfied with telephone use and appearance than those wearing other styles of hearing aids. Baumfield and Dillon (2001) found that prior to fitting, preference for ITE/BTE hearing aids did not correlate with satisfaction, but cosmetic preference after use was related to satisfaction level ($r_s = .48$, $p < .05$). Among the various factors studied, such as, use, performance, and benefit, cosmetic preference was the only one correlated with satisfaction. Overall, cosmetic appearance is an important area to consider when evaluating satisfaction.

Although ITC hearing aids are smaller than ITE devices, they may not yield greater satisfaction. Similarly, ITE aids may not yield higher satisfaction than BTE styles. In fact, in an older MarkeTrak study, ITE devices attracted more satisfaction than canal aids (57% versus 54%) although the difference was small and no statistical analysis was performed (Kochkin, 1992). Sinclair and Goldstein (1991) found BTE and ITE users have similar degree of satisfaction. A study by Stock et al (1997), found that individuals wearing BTE aids in Germany were more satisfied than BTE users in the United States. The authors did not offer an explanation for this unexpected difference. However, there are more BTE than ITE users in Germany and less BTE users in the United States. It may be that BTEs are cosmetically more acceptable to Germans. Perhaps also the BTE users had more severe hearing losses and were able to benefit more in some aspects from amplification than the ITE users.

In summary, compared to other hearing aids, most studies have found that newer programmable/digital and CIC devices yield higher satisfaction ratings in many situations. Newer programmable/digital devices seem to satisfy users in multiple environments while small aids are appreciated for their “invisibility”. It must be noted here that statistical analysis

was not always performed and that significant correlations, when demonstrated, were not high and varied with situations. The next section contains a discussion on how listening in various environments influences satisfaction.

Types of listening conditions

People with hearing impairment often experience hearing problems greater than could be predicted from the audiogram (Pavlovic, 1984; Gustafsson and Arlinger, 1994), a fact that was attributed to difficulties associated with distortion in the auditory system (Plomp, 1978). Varying degrees of satisfaction are demonstrated, depending on situations in which people are listening with aids (Kochkin, 1996a, 1997b, 2000a). Many studies have shown a higher percentage of participants reporting satisfaction in quiet than in noise (Scherr et al, 1983; Dillon et al, 1991; Sinclair and Goldstein, 1991; Kochkin, 1996a; Stock et al 1997; Jerram and Purdy, 1998; Spitzer, 1998; Humes et al, 2001). For example, Stock et al reported participants were most dissatisfied with performance in noise. Scherr et al found 85 to 89% of participants were satisfied with hearing aid performance for watching television and conversing in quiet. The percentage of satisfied respondents decreased to 67% in church/lecture, 65% in restaurants, followed by 45% in meetings. Parties and noisy settings were satisfactory for 38% and 25% of participants, respectively.

Speech understanding ability in various situations is weakly correlated with satisfaction (Stock et al, 1997; Purdy, 1998; Meister et al, 2001). Brooks (1990) reported a higher correlation between performance and satisfaction ($r = .75$, $p < .05$). In addition, those users who are satisfied with performance in quiet are also more satisfied with performance in noise ($r > .41$, $p < .05$). Although one-on-one conversation and television have been rated the two most important situations for people with hearing impairment and listening in quiet yields greater satisfaction, listening in noise has been found to be the most powerful predictor

of hearing aid satisfaction (Spitzer, 1998). The same issue was rated topmost to improve in hearing aids (Kochkin, 1992; Stock et al, 1997; Cox and Alexander, 1999).

Results from the studies reported here support the concept of situation dependent satisfaction, that is, reported satisfaction differs for different listening conditions. Conversation in noise is difficult, but may have greater effect on satisfaction than easy listening situations.

Hearing aid benefit

Satisfaction with hearing aid performance is not the same as hearing aid benefit; and 17 studies on the relationship between benefit and satisfaction have yielded conflicting results. The effect of benefit on satisfaction seemed to depend on the way benefit was measured and the measurement tool used. Benefit can be assessed using self-report or objective measures. Most studies that have used self-report measures showed significant effect of benefit on satisfaction. Benefit can be measured at one point in time or on a subtractive basis – the differential scores obtained prefitting and postfitting. Significant correlations of .50 to .83 ($p < .05$) between self-report benefit and satisfaction have been noted in most studies (Dillon et al, 1991b; Sinclair and Goldstein, 1991; Gatehouse, 1994; Norman et al, 1994; Brooks and Hallam, 1998). Purdy and Jerram (1998), and Spitzer (1998) found weaker correlations ($r < .31$, $ps < .05$).

Objective measures, such as articulation index-based audibility, real ear insertion gain, and speech results, have often failed to show a relationship between benefit and satisfaction. A study by Souza et al (2000) found that achieving good audibility with hearing aids did not improve satisfaction. They attributed this lack of a relationship between satisfaction and benefit to the differences in volume control settings between use in a in daily situations and those used in the clinic environment. Also, audibility has a stronger impact on

communication ability in quiet, which as discussed earlier affects satisfaction to a lesser extent than communication in noise. Similarly, Baumfield and Dillon (2001) did not find proximity of real-ear insertion gain to NAL-R target a factor influencing satisfaction. Perhaps these measures are not sensitive indicators of benefit.

Half of the studies that have evaluated benefit by using subtractive scores do not show a relationship between benefit and satisfaction (e.g., Baumfield and Dillon, 2001; Humes et al, 2001), whereas the other half do (e.g., Purdy and Jerram, 1998; Jerram and Purdy, 2001). Dillon et al (1997) argued that the use of difference scores, which is the basis of this technique, yields greater error variance. The difference score often does not exceed the test-retest confidence interval for a significant difference.

Whether benefit is found to have a significant effect on satisfaction also appears to depend on the measures used (Scherr et al, 1983; Dillon et al, 1997; Dillon et al, 1999; Baumfield and Dillon, 2001). Some measures may not be sensitive enough to record the benefit (Hutton and Canahl, 1985). For example, Baumfield and Dillon (2001) were not able to find a relationship between satisfaction and benefit measured using the HAUQ, but satisfaction was moderately correlated with the shortened version of the Hearing Aid Performance Inventory for the Elderly (SHAPIE, Dillon, 1994). In the study by Scherr et al, the proportion of satisfied respondents was higher when there was benefit for monosyllabic word identification, but improving speech reception thresholds did not result in improved satisfaction.

In summary, considering the number of studies with contrastive results on the effect of benefit on satisfaction, a conclusion cannot be drawn about the relationship between benefit and satisfaction. Self-reported benefit seems to relate to satisfaction, but benefit measured objectively does not. Another issue related to self-reported benefit is perceived sound quality and the following section discusses research findings on this topic.

Sound quality

The advantage new/high performance instruments offer seems to be improved sound quality, as reported in 7 of the 9 studies described here. Kirkwood (2001) reported that 89% of dispensers said their clients were more satisfied with the sound quality of digital instruments than nondigital aids. Kapteyn (1977) surveyed 150 hearing aid owners and noted that overall satisfaction with a hearing aid was best predicted by self-rating sound quality, including the naturalness of sound. It should be noted here that participants in that study were not asked to rate satisfaction per se, but frequency of use and "goodness" and “badness”.

Hearing aids sold nowadays have broader bandwidths and less distortions (Killion, 1997) and sound quality issues, although still important, may take on a different perspective. Even so, Bentler et al (1993) found 21.2% of variance in satisfaction could be accounted for by the inclusion of nine bipolar pairs of sound quality descriptors. Music quality, clarity of voice and sounds not being too loud improve satisfaction (Stock et al, 1997). Naturalness of sound also contributes to satisfaction ($r = .46$, $p < .01$; Spitzer, 1998). Users who are more satisfied tend to be more concerned about sound quality (Meister et al, 2001). In contrast to these studies, Baumfield and Dillon (2001) and Humes et al (2001) were not able to establish a relationship between preference for sound quality and satisfaction rating.

Sound quality is also improved by binaural hearing. Kochkin (2000a) found an overall improvement in satisfaction for binaural users. Binaural advantage was more apparent for directionality, audibility of soft sounds, sound of voice and performance in difficult listening situations. Findings from Sinclair and Goldstein (1991), and Kochkin (1992) also suggested higher satisfaction among binaural than monaural instrument users.

On the whole, improving sound quality contributes to higher levels of satisfaction.

Problems

While self-reported benefit and sound quality improve satisfaction, problems experienced may reduce usage and satisfaction. Problems that are commonly reported include feedback, telephone use, manipulation of aid, and comfort. The top 10 reasons for not using hearing aids, according to Kochkin (2000b), are shown below. The percentage of respondents suggesting each reason is listed in the bracket. As respondents could give more than one reason, the percentages do not add up to 100%.

1. Poor benefit from hearing aids (29.6%)
2. Background noise or noisy situations (25.3%).
3. Fit and comfort (18.7%).
4. Negative side effects of hearing aids including comfort, wax buildup in ear, infection in ear etc (10.9%).
5. Price and cost of repairs (10.3%).
6. Don't need help (8.0%).
7. Hearing aid is broken (7.8%).
8. Sound quality is poor (6.3%).
9. Unspecified (6.0%).
10. Volume control adjustment (4.9%).

In another study by Kochkin (1997b), over 82% of participants were satisfied with fit/comfort of hearing aids, followed by ease of volume adjustment, reliability, frequency of cleaning, visibility, and clarity (over 61%). While the satisfaction rating on ongoing expenses was low (47%), only 13% of participants rated it dissatisfactory.

Significant correlations of .25 to .42 ($ps < .05$) between reported problems and satisfaction have been reported. Dillon et al (1999) found that the most common problem was with own voice quality, followed by feedback and manipulation of controls. A stepwise

regression analysis revealed that mold/shell comfort was the most significant problem variable influencing satisfaction, accounting for 67% of the variance.

Brooks and Hallam (1998) also reported satisfaction negatively impacted by problems in managing aids, such as insertion and manipulation ($r_s = -.25$, $p < .05$) and with comfort and noise ($r_s = -.42$, $p < .05$). Spitzer (1998) showed satisfaction related to appearance of aids ($r = -.38$, $p < .01$), fit of aids (r - =.37, $p < .01$) and background noise ($r = -.34$, $p < .01$). Feedback continues to be an issue influencing satisfaction according to Stock et al. (1997) ($r = -.31$, $p < .05$) and Spitzer (1998) ($r = -.40$, $p < .05$). The number of repairs negatively influences satisfaction on dependability of the aid ($r = -.32$, $p < .001$), the number of hearing aid changes during trial has a negative effect on satisfaction of appearance ($r_s = -.20$, $p < .005$) (Hosford-Dunn and Halpern, 2000). Despite most studies reporting that use problems have an effect on satisfaction, Dillon et al (1997) did not find this effect.

Thus, a good way to ensure satisfaction is to avoid client problems in the use of volume control, earmold comfort, manipulation of aid, and feedback. As reported by Stock et al (1997), hearing aid users are 1.5 times more likely to be satisfied if there is no problem using the aid. Brooks and Hallam (1985) also found users with no problems in use and operation were almost twice as likely to be satisfied. Overall, despite 9 our of 10 studies reporting an impact of use problems on satisfaction, the effect of these factors on satisfaction is not great as indicated by low correlation coefficients.

Cost

Cost can deter an individual from obtaining hearing aids and potentially influence satisfaction. Surprisingly, the effect of cost on satisfaction has rarely been studied but satisfaction between selfpaying and nonpaying individuals has been compared. Clients from private practices who had self-purchased their aids were slightly more satisfied with problems

encountered, as measured by Negative Feature scale of the SADL, than average hearing aid users (Hosford-Dunn and Halpern, 2000). Cost directly influenced the SADL's Positive Image Scale ($r_s = .19$, $p < .001$). Hearing aid paid for by a third party resulted in higher satisfaction than a free aid given to Veterans Administration patients (Cox and Alexander, 2001). These studies seem to indicate that self-paying clients are more satisfied in some aspects but the effect is small.

Counseling

Counseling about expectations and various aspects of aid use is frequently conducted in the rehabilitation process. Brooks (1989) found that the level of satisfaction was higher at 4 months and at 4 years postfitting among those clients who received counseling about specific aspects of their needs. Norman et al (1994) did not find prefitting general informational counseling about hearing aids useful in improving satisfaction. Hosford-Dunn and Halpern (2001) reported that the total number of visits and time spent had no bearing on satisfaction. As the various studies did not specify the type of information offered in counseling, it is difficult to compare results. Overall, because only 3 studies are available and the data conflicts, whether counseling improves satisfaction cannot be readily concluded.

Summary of findings on how various factors relate to hearing aid satisfaction

The previous discussion highlighted the fact that both intrinsic and extrinsic factors influence satisfaction. Among the intrinsic factors,

1. Users who wear hearing aids more, expect more, are experienced, or are more motivated about using hearing aids, tend to be more satisfied.
2. The relationship between satisfaction and the degree of hearing loss, disability and handicap, is inconclusive.

3. Age, gender, and other demographic factors do not significantly affect satisfaction.

Among the extrinsic variables,

1. Hearing aids that have better sound quality yield higher satisfaction. CIC users seemed more satisfaction in certain situations.
2. Listening in noise is the most difficult and the least satisfactory situation. Aids that are able to meet needs in multiple situations yield higher satisfaction.
3. The effect of benefit on satisfaction depends on the situations measured and the type of measures. Subjective benefit positively influences satisfaction ratings; objective benefit measures do not show an effect.
4. Problems in hearing aid use have some negative effects on satisfaction.
5. The effect of cost and counseling on satisfaction has not been determined.

Although a number of factors have been shown to relate to satisfaction, we must be cautious in interpreting the data because the correlations are at best moderate in strength. There are problems associated with how satisfaction is measured. Some of these problems were discussed above and the following section will review general problems related to these studies.

Problems with hearing aid satisfaction measures

Some general issues make data from hearing aid satisfaction studies susceptible to conclusions that are misleading. These issues are:

1. Uncertain causal and intersectional relationships between satisfaction and other variables.
2. The measurement of satisfaction suffers from methodological shortcomings.
3. Validity has not been established.

4. The effect of service satisfaction on hearing aid/device satisfaction has not been established.

As hearing aids are both health care and consumer products, it is helpful to expand our examination of problem issues to include findings from satisfaction research in these areas.

Uncertain causal and intersectional relationships between satisfaction and other variables

Although a number of factors have been shown to correlate with hearing aid satisfaction, a causal relationship has not been established. Further, various factors may interact to yield a different effect. For example, increased use was found to relate to many factors, including increased awareness of hearing handicap (Brooks 1989), greater pre-fitting expectations and perceived benefit (Ziecheck, 1993), and satisfaction (Brooks 1990). Can hearing aid usage interact with one of these factors to improve satisfaction? Findings from consumer satisfaction research also suggest that expectation may interact with performance so that when performance is better than expected, satisfaction is enhanced; when performance is poorer than expected, customers may be dissatisfied.

The failure to establish an interrelationship is related to the type of measures used, sample size and statistical methods. For example, separate tools are used to assess the relationship between usage and satisfaction. A better way to establish a causal effect is by having participants report what leads to increased satisfaction. This method will yield important individual (qualitative) information that may be time-consuming to obtain or analyze.

To examine interactional effects, a large sample size is required for statistical analysis to be valid. Traditionally, we have used correlation or regression analysis to evaluate the relationship between satisfaction and other factors. Correlation analysis evaluates the degree

that two variables covary. Data must be interval, normally distributed and do not covary in ways other than linearly. For example, if an item solicits the same rating from most participants, the covariance between the variables is not enough to yield significant results. This item, however, may be very important in determining satisfaction.

Regression analysis has similar data requirements as correlation analysis. Causality is implied, not measured. Regression analysis differentiates factors that are stronger predictors of satisfaction but does not account for the importance of these factors in influencing satisfaction. Once the first variable has been identified, other variables would contribute very little to the regression model. When two variables are strongly related, colinearity may cause wrong conclusions to be drawn. Thus, findings from these analyses may not show the whole picture.

Allen and Rao (2000) suggested combining principal component analysis (PCA) or factor analysis with structural equation modeling (SEM) to confirm hypothesized causal relationships and build dependence and interdependence models, as did Humes (2003). SEM techniques have been applied in consumer satisfaction and other healthcare research but not in audiology. Overall, causal and interactional effects need to be established in order to identify the combination of factors that optimize satisfaction.

The measurement of satisfaction suffers from methodological shortcomings

The measurement of hearing aid satisfaction suffers from many methodological shortcomings that are related to how the measures are conducted and how satisfaction is rated.

Type of satisfaction measured

In essence, hearing aid satisfaction has been assessed in three ways:

1. The hearing aid user gives a rating of satisfaction in general.

2. The hearing aid user evaluates satisfaction in specific situations.
3. Ratings in specific situations are combined into scales and composite scores are used for comparison or evaluation.

There are advantages and limitations to each method. First, general satisfaction measures give an overall picture of outcome but are not useful for adjustment of the fitting (Dillon et al, 1997) or for troubleshooting (Cox and Alexander 1999). Satisfaction is not clearly defined and individuals use different criteria in judging whether or not they are satisfied with a given aid. A decision may be made based on the feature of the hearing aid fitting process that is most prominent or most important to the individual. Hutton and Canahl (1985) expressed similar concerns and suggested that it is not possible to show construct validity when single-item satisfaction is measured.

Asking the user to evaluate the aid in specific situations will yield information that can be used to adjust the aid properly to optimize satisfaction (Cox and Alexander, 1999). This method also highlights problem areas for counseling. However, this process may be more time consuming and the situations evaluated may not be exhaustive or may be irrelevant to the user. Clients are assumed to be able to distinguish between specific types of healthcare, but Ware et al (1983) argued that items that are supposed to measure interpersonal quality of care have a high correlation with those measuring technical quality, suggesting that these scales may not be measuring separate constructs. The technical nature and complexity of the care process may make evaluation of quality difficult (Marshall et al, 1993). Although an individual who is satisfied with product performance in specific situations is likely to be satisfied in general, no research has been conducted on how these attributes relate to overall hearing aid satisfaction.

The third method requires development of a psychometrically sound measurement tool. Such a tool will allow clinicians to compare the results to established norms but will still

suffer from some of the same limitations as the first two methods. That is, not all items in a scale are relevant to the user. Composite scores neither reflect the importance of each item, nor overall satisfaction because individuals do not mathematically summate satisfaction to specific aspects. Nonresponse to some items also affects the calculation of scale scores, leading to data wastage. Overall, all three methods have their advantages and limitations. Studies on how these measures relate are required.

Items measured may not be important to the persons concerned

Most satisfaction measures, including the SADL and MarkeTrak, evaluate satisfaction in areas such as feedback, comfort, dispenser service, price, and listening ability in noise. These items were generated by audiologists or in consultation with experienced hearing aid users. These volunteers were likely to be satisfied users or were motivated in some way to want to contribute to research. Those who are truly dissatisfied are non-users who comprise 16% of hearing aid owners in the MarkeTrak V respondent sample. Problems associated with dissatisfaction are not resolved and many non-users are unlikely to participate in research to suggest means to help them. While poor benefit may be the most important reason for nonuse (reported by 29.6% of non-users), less than 5% of nonusers reported feedback, poor dispenser service or had problems with stigma as reasons for nonuse (Kochkin 2000b). These latter items should not receive equal weighting to other items in evaluating satisfaction. Experienced users may also be biased by product exposure – hindsight bias, a concept that will be addressed later – so that some items may not be appropriately applied to new users.

Open-ended surveys illicit responses that are self-relevant because the importance of an event is related to the likelihood of report; however, aspects that are potentially crucial may be left out. Locker and Dunt (1978) advocated using both methods to provide a comprehensive picture of care. To date, no open-ended surveys on hearing aid satisfaction has been reported.

Measurement scale

The kind of scale used to measure satisfaction also leads to questionable results. Satisfaction has been assumed to be a continuum, with “very dissatisfied” to “very satisfied” as opposite ends (Kapetyn, 1977; Kochkin, 1997; Kochkin, 2000). For example, a five-point Likert scale of "very dissatisfied", "dissatisfied", "neutral", "satisfied" and "very satisfied" is used in the MarkeTrak survey (Kochkin, 2000). However, this concept has not been proved valid. In fact, satisfaction may not be an antonym of dissatisfaction; they may co-exist. Maximizing satisfaction is not the same as eliminating dissatisfaction (Babin and Griffin, 1998). For example, use in noisy situations, large group and leisure activities attracted dissatisfaction ratings from more than 41% of respondents, while the same individuals may be satisfied with the instrument in other situations (Kochkin, 2000). Treating dis/satisfaction as one construct may reduce the discriminant validity of a measurement. Most research thus far has focused on satisfaction only. Factors leading to dissatisfaction may be diagnostically more important to study than those leading to satisfaction.

Often different scales are used, making comparison across studies difficult. Meaning can not be easily derived from satisfaction scores obtained: Is 70% with a standard deviation of 10% worse than 80%? Is 70% equivalent to “satisfied”?. Scales with descriptors are common, as are numeric scales (see Table 4). For example, Cox and Alexander (2000) used “not at all”, “a little”, somewhat”, “medium” considerably”, “greatly” and “tremendously” to examine the degree of satisfaction, while MarkeTrak employs a 5-point Likert scale. Satisfaction has been measured using scales that have as few as three intervals to as many as 20 intervals. Scores of 0 to 100 have also been used.

In a study by Dillon et al (1997), aid satisfaction was measured using two different types of scales (four response alternatives versus a score of 0 to 100); these scales were only moderately correlated ($r = .53$, $p < .01$). Both scales were correlated with results from a

modified version of the PHAP and the SHAPIE; but satisfaction based on the numeric scale correlated with results from the Client Oriented Scale of Improvement (COSI), while the descriptor scale did not. Thus, different scales may potentially influence results and the validity of data obtained.

Rating accuracy

We have assumed that participants have made genuine evaluations of these items without considering the possibility of nonevaluation (i.e., not all participants have evaluated some or all of the items). Questionable results are obtained if participants give ratings according to what they think they would hear (perhaps due to lack of experience with specific items) or attempt to please the examiner or avoid retribution, not their actual experience. Some individuals may not be able to assess current situations accurately. Hearing aid users often use their markedly deficient unaided hearing (Ross and Levitt, 1997) to evaluate satisfaction; and ratings are dependent upon other situational and personal variables. For example, Walden et al (1984) commented that it is quite common for clients to exaggerate their difficulties when they are first seen and then to exaggerate the improvement at the final evaluation. In addition, participants may not be able to remember previous experience very well. These problems add to the error of measurement.

Neutral or non-responses are quite common

The interpretation of data becomes problematic when a large number of participants select a “neutral” rating or elect not to respond. Careful examination of the data from Kochkin (2000) revealed that for most domains measured, 10 to 30% of the respondents rated their satisfaction as "neutral". The category receiving the highest rating was dispenser service (about 90% of participants were satisfied). Items with highest "neutral" ratings (>40%) were feedback, on-going expenses, value, and listening in car and workplace. More than 30% of participants gave neutral ratings to frequency of cleaning, packaging, warranty, comfort with

loud sounds, directionality, sound quality, and listening in restaurant, concert/movie and large group. It could be argued that those who remain neutral are really not very happy with hearing aid performance or they would have stated it.

Similarly, accuracy of data is contaminated by nonresponses. Response rate to mailed healthcare satisfaction questionnaires has been reported at about 60 to 70%, and the response rate of hearing aid satisfaction survey is expected to be about the same. Brooks (1985) reported that 27% of participants did not answer the question about satisfaction; the percentage increased to 49% among non-users. Parving and Philip (1991) found 14% of participants not providing satisfaction ratings; and 35% of new users did not give satisfaction ratings in contrast with 8% of experienced users.

The cause of nonresponses among new and nonusers is unknown and may be worth investigation. For healthcare research, those who are less satisfied (Nguyen et al, 1983) and have attained lower educational standing, income and employment are less likely to respond (Draper and Hill, 1996). In contrast, Ware et al (1983) reported more satisfied patients were less likely to return a satisfaction questionnaire. The discrepancies are probably related to the type of healthcare being evaluated, whether the patients believe that the responses provided would modify the care they receive and the outcome, and the reasons causing their dissatisfaction. Cox and Alexander (2000) found nonrespondents to the SADL expected more in Positive Effect and less in Negative Feature domains. Whether these participants would report satisfaction differently from other respondents could not be evaluated. Thus, those who responded to satisfaction questionnaires may not represent a randomly selected sample. Their responses may be positively biased.

As dissatisfied patients may drop out of a research study and missing survey data may make analysis difficult, especially when scores are aggregated from multiple items, sampling at an early stage, cross-sectional sampling and use of telephone surveys have been suggested

to combat low response rate.

Measures of satisfaction are not sensitive

Many of the satisfaction measures used to date are not sufficiently sensitive (Dillon et al, 1999) and have ceiling effects. Compared with other measures, the statistical power of a measure like the MarkeTrak is substantially higher because of the large sample size. Ratings from satisfaction scales, such as the Personal Image subscale of the SADL, are often skewed to the positive end (Cox and Alexander, 2000). This problem is also common among other healthcare satisfaction measures (Nguyen et al, 1983; Hall and Dornan, 1988; Draper and Hill, 1996). Positive skewing occurs when clients blamed themselves for the problems they experienced (Meredith and Wood, 1994) or questionnaire items focus on the provider or. Alternatively, clients may want to please the investigator or fear retribution. A restricted range of scores may cause variables to correlate in small magnitudes when they should not, or causes the data to fail the requirements for some statistical measures such as the Pearson product moment correlation analysis. Comparisons with other measures become less sensitive and differentiation of those who are completely satisfied from ones who are not becomes difficult.

Evaluations of the relationships between satisfaction and other factors are contaminated by problems associated with the use of difference scores. Measures that involve subtraction of scores (e.g., unaided from aided) to derive a difference score (e.g., benefit) require a substantial difference in raw scores between tests to yield a significant outcome. While Baumfield and Dillon (2001) commented that errors in data collection accumulate, Peter et al (1993) summarized problems related to difference scores:

1. As the reliability of either or both component score decreases, the reliability of the difference score decreases. Difference scores may demonstrate spurious relationship with other measures.

2. Responses to the same measure on two occasions are related, reducing the correlation between the difference scores and other measures of interest. As the correlation between the component scores becomes larger, the reliability of the difference score also decreases.
3. When one of the components used in calculating a difference score is consistently greater in value than the other, the variance of the difference score is likely to be restricted. As the value of the difference score increases, so does the variance of the difference score. Distribution of the data becomes nonnormal, and many types of statistical analyses cannot be performed.

To avoid problems with difference scores, Peter et al (1993) recommended using direct comparisons in that questions are rephrased to describe how one component adds incrementally to the prediction of satisfaction beyond another component. This method has better psychometric properties, is less taxing on respondents (because they respond to only half as many items), and produces favorable empirical results. It allows consumers to combine their thoughts as they wish rather than forcing an arbitrary combination rule on them, thus reducing the sensitivity of measurements.

Best timing for measuring satisfaction has not been established

It has been reported that as users acclimatize to hearing instruments, benefit stabilizes at about 6 weeks to 3 months post-fitting (Dillon et al, 1991; Dillon et al, 1997; Horwitz and Turner, 1997; Surr et al, 1998). Findings from three studies (Brooks, 1990; Bentler et al, 1993; Humes et al, 2002b) suggest stable long-term satisfaction ratings. Bentler et al (1993) found satisfaction correlated ($r = .72$, $p < .001$) and remained quite stable from 6 months to 12 months post-fitting. Humes et al, (2002b) also found significant correlations among satisfaction ratings measured at 1, 6 and 12 months postfitting. Satisfaction ratings did not change over a 2-year period, although satisfaction was slightly higher at 1 year compared to 1

month postfitting. Comparing SADL scores from two groups of users at 2 weeks and 1 year postfitting, McLeod et al (2001) concluded that global satisfaction scores obtained at 2 weeks postfitting do not predict long-term satisfaction.

Although satisfaction measured at different times may be correlated, its relationship with other factors may change over time. In fact, Marshall et al (1993) found patient satisfaction changes over time. Mittal et al (1999) reported that attribute weights in determining overall satisfaction change over time due to experience with the product. How satisfaction relates to expectation may change due to hindsight bias which occurs when exposure to a product causes a bias in the recall of prepurchase expectation so that postpurchase expectations change to match actual performance (Anderson and Sunol, 1993; Zwick et al, 1995). Hindsight bias is more likely to occur when the performance is poor, a positive outcome is desired and a product is easy to evaluate (Zwick et al, 1995). Thus, the effect of expectation on satisfaction should not be measured postpurchase because it may disappear (Halstead, 1999).

Overall, the best timing for measuring satisfaction and how satisfaction relates to other variables over time needs documentation. Tracking satisfaction longitudinally will supplement data on acclimatization and may lead to new ideas about how to improve satisfaction.

Satisfaction not directly measured

In the SADL, ratings of satisfaction per se are not obtained, but hearing aid performance and the reactions to these are evaluated. Six of the items of the SADL evaluate satisfaction on a more emotional level: best interest to obtain aid, worth the trouble, improve self-confidence, others notice loss more, less capable and content with appearance. Two statements deal with the perceived competence of the dispenser and the cost of the aid. Three statements mix performance with affect: pleased with performance, frustrated with

background sound, and bothered by feedback. Satisfaction is an emotional experience as a result of performance evaluation; although performance contributes to satisfaction, it is not equivalent to satisfaction. Satisfaction is an affect while performance requires cognitive judgment. Although Cox and Alexander (2001) found SADL scores correlate with general satisfaction, the significance of the relationship does not necessarily imply that the SADL is measuring satisfaction.

Reliability and validity has not been established

An evaluation tool must be reliable and valid (Nunnally, 1978; Schow and Gatehouse, 1990; Hyde 1999) but most satisfaction measures have not been evaluated in any detail (e.g., Hutton and Canahl, 1985). The different types of reliability that need to be established are described in the following list:

1. Internal consistency reliability deals with relationships among scale items (Hyde 1999) and can be estimated using inter-item correlations or inter-item covariance. The Cronbach's alpha is the most popular means of estimating item homogeneity. A coefficient alpha of .7 to .9 is considered to be acceptable (Kline, 2000).
2. Alternate form reliability concerns whether results are repeatable when different forms of the same test are used. Items on the forms are similar but not identical, causing a reduction in reliability, especially if alternate forms are not administered in the same occasion. Large measurement errors are suggested if correlation between alternate forms is much lower (e.g., by .20) than coefficient alpha (Nunnally, 1978).
3. Scoring reliability between different methods of test administration is needed if more than one method of scoring is used and compared. A correlation coefficient of at least .7 is suggested.

4. Test-retest reliability must be established if results are to be compared over time or between treatments. This is measured by correlating the scores of the same tests administered on the same participants in two separate occasions. When a retest is administered too close in time to the first test, participants may remember previous ratings, which inflates the reliability of the measure. When repeated tests are too far apart, natural changes in participants may reduce reliability. Kline (2000) recommends administrations spaced 3 months apart. More stringent reliability is required for assessment of an individual's rating than is required for a group. Correlation of scores between test and retest should not be less than .8 (Kline, 2000).

Perfect agreement in repeated measures, or measures using alternate forms or scoring methods, is indicated by a correlation coefficient of + 1 and complete disagreement occurs when the coefficient is -1. Coefficient of 0 suggests no correlation. In reality, these correlations are never perfect because there are errors in measurement, ratings may vary due to changes in subjects' experience. Other factors that may contribute to poor reliability include poor instruction, irrelevance of items, guessing, poor attention to the task, and small sample size (Nunnally, 1978; Kline, 2000).

Reliability is a prerequisite for validity, though a reliable test may not be valid. The American Educational Research Association (1999) refers to validity as a unitary concept, as the degree to which all the accumulated evidence supports the intended interpretation of test scores for the proposed purpose. To put it simply, a test is valid if it measures what it claims to measure (Kline, 2000). Traditionally, we have referred to various types of validity but the American Educational Research Association refers to types of validity evidence in its 1999 standards. The various types of validity evidence are:

1. Criterion relationships refer to how well an assessment relates to another measure of the same construct (Erdman, 1994). Criterion validity is composed of concurrent and predictive validity (Schow and Gatehouse, 1990). Concurrent validity reflects whether the measured results are similar to those obtained using other well-established tests. A correlation coefficient of .75 or better suggests good concurrent validity, given the benchmark or criterion measure is also a reliable and valid test (Kline, 2000). Predictive validity addresses whether results successfully predict membership, for example, satisfied versus dissatisfied users. Predictive validity is determined by correlation analysis and very often only modest correlations of .3 to .4 are observed (Nunnally, 1978; Kline, 2000). The difficulty again relates to whether a good criterion measure is available and two correlated tests may not suggest that one predicts results of the other.
2. Convergent and divergent evidence is the extent to which a test measures a specific construct, such as satisfaction, or what is conventionally referred to as construct validity. Convergent evidence refers to positive correlations among different tests that supposedly measure the same construct. Divergent evidence is supported by negligible correlations with measures of different constructs (Demorest and Dehaven, 1993). Construct validity can not be tested but ensured by defining clearly the domain assessed (Ventry and Weinstein, 1982) and the items in the measure should be relevant, appropriate and diverse (Hyde, 1999). The hypothesis behind the formulation of the measure should by supported by other validity measures. How well the subscales correlate should be consistent with the structure that underlays the development of the scale.
3. Content evidence refers to the extent to which items adequately represent the domain to be assessed (Erdman 1994; Hyde, 1999; Kline, 2000). Content validity

is a facet of construct validity because when the target domain is defined, the construct of the measure is also important to consider (Hyde, 1999). Content also refers to the themes, wording, format of items, tasks and administration methods. Content validity cannot be readily tested but ensured by careful test construction (Nunnally, 1978). That is, the nature of the questions must be representative of daily situations (Ventry and Weinstein, 1982). Experts or hearing-impaired people often evaluate these items during their development for appropriateness, relevance and importance. However, as mentioned, some test items may still prove irrelevant to some individuals despite careful construction.

4. Face validity is related to content validity (Hyde, 1999). A test item must be clear and match the purpose of the evaluation and thus, appear to be valid on a superficial level.
5. Incremental validity indicates whether a test adds to the diagnostic value of other existing tests. Overall satisfaction reflects a global assessment of such things as performance, problems, cost, and service. The addition of satisfaction assessment for various situations will reveal which situation is most satisfactory and which is less. While the incremental value of a test is often philosophical based, statistical procedures like linear regression analysis may help identify variables that are stronger predictor of, say satisfaction, than others (Kline, 2000).
6. Validity generalization refers to whether evidence of validity can be generalized to a new situation without further study of validity in that new situation (American Educational Research Association, 1999). Validity generalization is improved with a larger sample size and careful sampling, for example, including participants of various demographic characteristics, sampling at different time

intervals, and is evaluated by changing the criterion measure, the predictor variable, or the type of assessment tools.

7. Consequences of test findings help validate a test when, for example, results of a hearing aid satisfaction measure lead to identification of issues that will result in improvement of satisfaction when they are dealt with. That is, the anticipated benefit of the test has been realized (American Educational Research Association, 1999).

In summary, a valid instrument must be constructed carefully, considering administrative procedures, scoring methods and scaling, how items of a construct relate to each other, how a construct relates to other tests of similar or different purposes, how well it predicts a criterion, and whether the benefit of its administration is realized. The evidence leading to validity evolves as the test instrument is being used to generate new data. The instrument should be modified based on the evidence and areas that require further study should be identified.

The development of most satisfaction measures was based on clinical observation and experimental findings specific to the field of audiology; however, they often have not been evaluated for reliability and validity. Among these measures, the SADL and the MarkeTrak have been evaluated most extensively.

The SADL has been evaluated in terms of reliability, validity, internal consistency and test-retest reliability. It appears to have high face and content validity as all the items were generated and evaluated by a focus group of hearing impaired people. All items were also rated important to hearing aid users. Items were aggregated into subscales using factor analysis and these subscales match the conventional concepts about various domains of hearing aid satisfaction, suggesting adequate construct validity.

Cox and Alexander (2001) found the SADL a valid means of assessing satisfaction by correlating the subscale scores to general satisfaction. Hosford-Dunn and Halpern (2000) also confirmed the factor structure and validity of the SADL. Concurrent validity is established (Humes et al, 2002b). However, as discussed, satisfaction was never mentioned in the items. Could participants be responding to factors contributing to satisfaction but not satisfaction itself? If the latter is true, then the SADL may have violated the requirement for construct, content and face validity as a satisfaction measure.

The MarkeTrak has not been evaluated for reliability or validity. Statements in each domain were grouped on an a priori basis and internal consistency has not been evaluated. Nonetheless, MarkeTrak has provided important insight into hearing aid satisfaction. Results are more representative of the general population than any other surveys, because the survey was sent to all hearing aid users instead of individuals who attended a particular clinic or residing in a certain geographic region. Although the MarkeTrak survey has not been evaluated for validity, predictive validity could be implied by comparing satisfaction results against other measures such as quality of life, repurchase intent, recommendation of dispenser to others, and hearing aid use, that were obtained at the same time.

While validity measures have been reported for the GHABP (Gatehouse, 1999), no reliability and validity evaluation has been reported for satisfaction measures other than those mentioned in this section. Table 3 also summarized reliability and validity measures for some common hearing aid satisfaction measures.

The effect of service satisfaction on hearing aid/device satisfaction has not been established

Most studies focus on device satisfaction, it is also important to consider satisfaction with service received, as it often determines whether clients would recommend, or purchase,

new hearing aids from the same dispenser. It is likely that service satisfaction affects aid satisfaction. In fact, it may not be possible for a user to separately evaluate satisfaction in these aspects. Satisfaction ratings are likely biased by how well the users were treated and not what they could hear from the hearing aids in a true sense. How device and service satisfaction relate to each other has rarely been investigated except by Dillon et al, (1997), Dillon et al (1999) and Humes et al (2001). Dillon et al (1999) found satisfaction with dispensers correlated with satisfaction with hearing aid features and listening conditions (r = .53, $p < .05$). Findings from Dillon et al (1997), and Humes et al (2001) supported this notion ($r > .31$, $ps < .01$; and $r = .42$, $p < .05$ respectively).

Overall, not many studies have examined service satisfaction and of those that have report high satisfaction, suggesting a ceiling effect (Dillon et al, 1997; Hosford-Dunn and Halpern, 2000; Humes et al, 2002a). For example, Kochkin (1997) found that over 79% of new instrument (less than two years old) users were satisfied with dispenser service whether it was professionalism, knowledge, quality of service, explanation of maintenance of aids, explanation of what to expect from aids, or post purchase service. Service satisfaction may also vary depending on the type of hearing aids used. For example, compared to MarkeTrak III norms, users of programmable hearing aids were more satisfied with their dispensers in all aspects surveyed (Jedidi, 1994). Therefore, studies on service satisfaction and how it relates to device satisfaction are essential.

Summary of problems in hearing aid satisfaction research and possible solutions

Although the correlations between satisfaction and other factors have been examined, causal/interactional relationships may be better evaluated using statistical measures like structural equation modeling. Open-ended questions may reveal data more relevant to hearing aid users. Methods of improving response rate and reducing neutral ratings should be

attempted. To ensure accurate results, more sensitive, reliable and valid measures should be implemented. Difference scores should be avoided. The effect of satisfaction in specific aspects on overall satisfaction, dissatisfaction and its causes, and the effect of service satisfaction on device satisfaction are important to investigate. Longitudinal studies are needed to track changes in satisfaction over time and to investigate other factors that may contribute to satisfaction ratings.

Conclusion

Studies have shown that users are quite satisfied with their hearing aids. Factors such as experience, expectation, personality and attitude, usage, experience, the type of hearing aids, sound quality, listening situations, and problems in hearing aid use are related to hearing aid satisfaction. However, causal and interactional relationships have not been established. To date, only the SADL and the MarkeTrak hearing aid satisfaction measures have been evaluated somewhat for reliability and validity. They have similar constructs but employ different rating scales, making comparison across studies difficult.

We are often evaluating what we know as the common concerns of hearing aid users and have applied traditional means such as correlation analysis to examine satisfaction. We have neglected some of the very important methodological issues. It is hoped that this review will help us understand current satisfaction measures, how various factors affect satisfaction, and lead to a discussion of how we may improve the way we measure satisfaction to yield more reliable and valid data. In addition, hearing instruments are both consumer and healthcare products, but they have never been examined as such. Findings from the massive literature on these approaches should shed new light on satisfaction with hearing aids and on how satisfaction should be measured.

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Table 1. A list of abbreviations used in text and tables.

Abbreviations	Full name
A	Analog hearing aids
ABI	Aid Benefit Interview, a predecessor of GHABP
Adv. Tech.	Devices with advanced technology
AGCi	Input compression
AGCo	Output compression
All	All degrees of hearing loss or all types of hearing aids
AP	Analog and/or programmable hearing aids
APHAB	Abbreviated version of the Profile of Hearing Aid Benefit
Attitude/personal.	Attitude or personality
Ben.	Benefit
BTE	Behind-the-ear hearing aid
C	Categorical scale
C	Categorical scale
CIC	Completely-in-the-canal hearing aid
COSI	Client Oriented Scale of Improvement
D	Digital hearing aids
Digital	Digital hearing aids
Disab./handi.	Disability or handicap
E	Experienced users
Exp	Experience
G	General measure of satisfaction
GAS	Goal attainment scale

Table 1. A list of abbreviations used in text and tables (cont'd).

Abbreviations	Full name
GHABP	Glasgow hearing aid benefit profile
HAF	Hearing aid fitting
HARQ	Hearing Attitudes in Rehabilitation Questionnaire
HASS	Hearing Aid Satisfaction Survey (a modified version of MarkeTrak IV)
HAUQ	Hearing aid user's questionnaire
HDABI	Hearing disability aid benefit inventory
HHIE	Hearing Handicap Inventory for the Elderly
HPI	Hearing performance inventory
PHAP	Profile of Hearing Aid Performance
PI	Personal Image subscale of the SADL
Pre-fit counsel.	Counseling given prior to hearing aid fitting.
Pre-fit expect.	Expectation
S	Satisfaction
SADL	Satisfaction with Hearing Aid Performance
SC	Service/Cost subscale of the SADL
SHAPIE	Shortened version of the Hearing Aid Performance Inventory for the Elderly
SNHL	Sensorineural hearing loss
Sp	Measures of satisfaction in specific situations
Type sit.	Types of listening situations
Use prob.	Problems in usage
y	Year/s

Table 2. **Summary of items in the four subscales of the SADL**

Subscales	No. items	Items
Positive Effect	6	• Compared to using no hearing aid at all, does your hearing aid(s) help you understand the people you speak with most frequently? • Are you convinced that obtaining your hearing aid(s) was in your best interest? • Does your hearing aid(s) reduce the number of times you have to ask people to repeat? • Do you think your hearing aid(s) is worth the trouble? • Does wearing your hearing aid(s) improve your self-confidence? • How natural is the sound from your hearing aid?
Service and Cost	2	• How competent was the person who provided you with your hearing aid(s)? • How pleased are you with the dependability (how often it needs repairs) of your hearing aid(s)?
Negative Features	3	• Are you frustrated when your hearing aid(s) picks up sounds that keep you from hearing what you want to hear? • Are you bothered by an inability to turn your hearing aid(s) up loud enough without getting feedback (whistling)? • How helpful is your hearing aid(s) on MOST telephones with NO amplifier or loudspeaker?

Table 2. **Summary of items in the four subscales of the SADL (cont'd)**

Subscales	No. items	Items
Personal Image	3	• Do you think people notice your hearing loss more when you wear your hearing aid(s)? • Do you think wearing your hearing aid(s) makes you seem less capable? • How content are you with the appearance of your hearing aid(s)?

Table 3. Descriptions of common hearing aid satisfaction measures

Measure	No. of satisfaction items / scales	Type of rating scale	Comments
MarkeTrak IV or HASS (e.g., Kochkin, 2000a, Humes et al, 2001)	40 items in 3 scales on Product Feature, Listening Situations, Service	5-point Likert scale of 'very satisfied' to 'very dissatisfied'	Scales set a priori, not evaluated for validity
SADL (e.g., Cox and Alexander, 1999)	14 items in 4 scales: Positive Effect, Service and Cost, Negative Features, Personal Image and yield global score	7-point continuum of 'not at all' to 'tremendously'	Items generated by aid users & aggregated using factor analysis. Factor structure confirmed. Validity as correlation with overall satisfaction.
HAUQ (e.g., Dillon et al, 1999)	Single item general satisfaction measure	4-point Likert scale of 'very satisfied' to 'very dissatisfied'	Not evaluated for validity or reliability
GHABP & Aid Benefit Interview (e.g., Humes et al, 2001)	The final version contains satisfaction evaluation of 4 standard and 4 self-nominated situations, and one overall measure	4 to 5 alternatives of 'not satisfied at all', 'to 'delighted with the hearing aid for this situation', overall satisfaction from 0 to 100	Importance-ranked situations selected to maximize ability to distinguish outcome. Internal consistency & test-retest reliability evaluated

Table 4. Summary of demographic data, test interval and satisfaction measures.

	Demographics / device				Time	Satisfaction measure							
Study	**Exp**	**Loss**	**Style**	**Type**	**m**	**Type**	**MT**	**SADL**	**ABI**	**HAUQ**	**GHABP**	**I/O**	**Scale**
Baumfield & Dillon (2001)	N	Mi,Mo	BTE,ITE			G				√			C
Bentler et al (1993)	E,N	Mi,Mo	BTE,ITE		6,12	G						√	C/Nu
Billie et al (1999)	E	All	BTE	A,P,D	3-4	G						√	C
Brooks & Hallam (1998)	N	Mo			3,9	G						√	C/Nu
Brooks (1990)			BTE		4	G/Sp						√	Nu
Cox & Alexander (1999)	E,N	All				Sp		√					C
Cox & Alexander (2000)		All			12-14	Sp		√					C
Cox & Alexander (2001)	E,N	All		A,P	3-48	G/Sp		√					C
Dillon et al (1991)					3	G				√			C
Dillon et al (1997)		All			2-3	G				√		√	Nu
Dillon et al (1999)	E,N		BTE,ITE		1,3	G				√			C/Nu
Gatehouse (1994)		Mo			6-8	Sp			√				C

Table 3. Summary of demographic data, test interval and satisfaction measures (cont'd).

	Demographics / device				Time	Satisfaction measure							
Study	**Exp**	**Loss**	**Style**	**Type**	**m**	**Type**	**MT**	**SADL**	**ABI**	**HAUQ**	**GHABP**	**I/O**	**Scale**
Hickson et al (1999)		Mi,Mo	BTE,ITE, ITC	A,P	3-9	G				√		√	C
Hosford-Dunn & Halpern (2000)	E	All			12	Sp		√					C
Hosford-Dunn & Halpern (2001)			All		13	Sp		√					C
Humes et al (2001)	E,N	Mi,Mo	BTE,ITE			Sp	√				√		C
Humes et al (2002a)*	E,N	Mo	ITE	A,P	1,6, 12,24	G/Sp	√				√	√	C
Humes et al (2002b)*	E,N	All	ITC		1	Sp	√	√					C
Hutton & Canahl (1985)	N		ITE		2	G						√	C/Nu
Jedidi & Estelami (1994)	E		ITE	A		Sp	√						C
Jerram & Purdy (2001)	E,N	Mi,Mo			3	G						√	C/Nu
Kirkwood (2001)						G/Sp						√	C

Table 3. Summary of demographic data, test interval and satisfaction measures (cont'd).

	Demographics / device				Time	Satisfaction measure							
Study	**Exp**	**Loss**	**Style**	**Type**	**m**	**Type**	**MT**	**SADL**	**ABI**	**HAUQ**	**GHABP**	**I/O**	**Scale**
Kochkin(1990)						G	√						C
Kochkin (1992)						G	√						C
Kochkin (1996a)			All	A		G/Sp	√						C
Kochkin (1996b)	E,N		All			G	√						C
Kochkin (1997b)	E,N	All	BTE,ITE, ITC			G/Sp	√						C
Kochkin (2000a)	E,N			A		G/Sp	√						C
McLeod et al (2001)	E,N	Mo	CIC		1,12-24	Sp		√					C
Meister et al (2001)	E,N		BTE,ITE			G						√	C
Newman & Sandridge (1998)	E	All	BTE	A,P,D	1	Sp	√					√	C
Norman et al (1994)		All			3	G						√	C/Nu

Table 3. Summary of demographic data, test interval and satisfaction measures (cont'd).

	Demographics / device				Time	Satisfaction measure							
Study	**Exp**	**Loss**	**Style**	**Type**	**m**	**Type**	**MT**	**SADL**	**ABI**	**HAUQ**	**GHABP**	**I/O**	**Scale**
Parving (2003)	E,N	Mo	BTE,ITE, ITC			G						√	C
Parving et al (1991)	E,N	All	BTE,ITE	A	4-6	G						√	C
Purdy & Jerram (1998)	E,N	Mo				G						√	C/Nu
Salomon et al (1988)	E,N	Mi,Mo				G						√	C
Scherr et al (1983)		Mi,Mo	BTE,ITE			G						√	C/Nu
Sinclair et al (1991)	E,N		BTE	A	1-36	G						√	C
Souza et al (2000)	E,N	All	All		1,12	G/Sp		√				√	C/Nu
Spitzer (1998)*	E,N	All			6	G/Sp						√*	C
Stock et al (1997)						G						√	C
Ziechek (1993)	N	All			1	G						√	C/Nu

Legend: All = all degrees of hearing loss or all types of hearing aids, A = analog hearing aids, BTE = behind-the-ear hearing aids, C = categorical scale, CIC = completely-in-the-canal hearing aids, D = digital hearing aids, E = experienced users, G = general measure of satisfaction, ITC = in-the-canal hearing aids, ITE = in-the-ear hearing aids, I/O = assessment of satisfaction via an interview or other tools, M = number of months post-fitting, Mi = mild loss, Mo = moderate loss, N = new users, Nu = numeric scale, P = programmable hearing aids, Sp = measure of satisfaction in specific situations

* Satisfaction measures used in Spitzer (1998) and in Humes et al (2001; 2002a; 2002b) are called Hearing Aid Satisfaction Survey (HASS) but they refer to different surveys. The one used in Humes et al studies were in fact a modified version of the MarkeTrak.

Table 5. Summary of research findings on how various intrinsic factors influence hearing aid satisfaction.

Studies	**Age**	**Sex**	**Other**	**Loss level**	**Disab./ handi.**	**Exp.**	**Pre-fit. Expect.**	**Attitude/ personal.**	**Aid Use**
Baumfield et al (2001)					No				No
Bentler et al (1993)	No			No	Small	No			No
Brooks & Hallam (1998)	No	Small		No				Small	Yes
Brooks (1985)									Yes
Brooks (1990)									Yes
Cox & Alexander (2000)						Yes	Mix		
Cox & Alexander (2001)								Yes	
Dillon et al (1991b)					Yes				Yes
Dillon et al (1997)				No	No				Yes
Dillon et al (1999)				Yes					Yes
Gatehouse (1994)	No		No	No	No		Small	Small	Yes
Hickson et al (1999)	No	No	No	No				Mix	No
Hosford-Dunn & Halpern (2001)	Mix			Mix	Mix	Mix			No
Humes. Et al (2001)					No				No
Hutton & Canahl (1985)				No					

Table 5. Summary of research findings on how various intrinsic factors influence hearing aid satisfaction (cont'd).

Studies	**Age**	**Sex**	**Other**	**Loss level**	**Disab./ handi.**	**Exp.**	**Pre-fit. Expect.**	**Attitude/ personal.**	**Aid Use**
Jerram & Purdy (2001)	No	No	No	No		No	Small	No	Yes
Kochkin (1992)	No			Mix					
Kochkin (1997b)				Mix	Mix				Yes
Kochkin (2000a)				Mix		Mix			
Norman et al (1994)	No	Small /mix	No	No	No		No		
Parving et al (1991)						Yes			
Purdy & Jerram (1998)									Yes
Salomon et al (1988)									Yes
Scherr et al (1983)				No					
Spitzer (1998)					No				No
Stock et al (1997)					Mix	Yes		Small	Yes
Ziechek (1993)							Yes		
Conclusion	**No**	**No**	**No**	**Mix**	**Mix**	**Small**	**Small**	**Small**	**Yes**

Legend: Factors examined: Disab./handi. = disability or handicap, Exp. = experience, Pre-fit expect. = expectation, and Attitude/personal. = attitude or personality.

Effect code: Small = the factor has minimal effect on satisfaction, Mix = mixed findings from the study/studies depending on the measures used, No = the factor has no effect on satisfaction, and Yes = the factor affects satisfaction.

Table 6. Summary of research findings on how various extrinsic factors influence hearing aid satisfaction.

Studies	**New aid**	**Adv. tech.**	**Style**	**Type sit.**	**Ben.**	**Sound quality**	**Use prob.**	**Cost**	**Pre-fit. counsl.**
Baumfield et al (2001)					Mix	No	Yes		
Bentler et al (1993)		No			Yes	Yes			
Billie et al (1999)		No							
Brooks et al (1998)					Yes		Yes		
Brooks (1989)									Yes
Brooks (1990)				Yes					
Cox & Alexander (2000)								Mix/ small	
Dillon et al (1991b)				Mix	Yes		Yes		
Dillon et al (1997)					Mix		No		
Dillon et al (1999)					Mix		Yes		
Gatehouse (1994)				Yes	Yes				
Hosford-Dunn et al (2000)							Yes	Mix/ small	
Hosford-Dunn et al (2001)		No	Yes						No
Humes. et al (2001)				Mix	Mix	No			
Hutton et al (1985)					No				
Jedidi et al (1994)		Mix							
Jerram et al (2001)		Yes	No	Mix	Yes				

Table 6. Summary of research findings on how various extrinsic factors influence hearing aid satisfaction (cont'd)

Studies	New aid	Adv. tech.	Style	Type sit.	Ben.	Sound quality	Use prob.	Cost	Pre-fit. counsl.
Kirkwood (2001)		Yes							
Kochkin (1992)						Yes			
Kochkin (1996a)	Mix	Mix		Mix					
Kochkin (1996b)		Mix		Mix					
Kochkin (1997b)	Mix			Mix			Yes		
Kochkin, 1999	Mix	Mix							
Kochkin (2000a)*		Mix	Mix	Mix		Mix			
Meister et al (2001)				Small		Yes			
Newman et al (1998)		No							
Norman et al (1994)					Yes				No
Parving (2003)		No							
Purdy et al (1998)				Small	Yes				
Scherr et al (1983)				Mix	Mix				
Sinclair et al (1991)		No		Mix	Yes	Yes			
Souza et al (2000)					No				
Spitzer (1998)				Mix	Yes	Yes	Yes		
Stock et al (1997)				Small /Mix	Yes	Yes	Yes		
Conclusion	**Mix**	**Mix**	**Mix**	**Mix**	**Mix**	**Mix**	**Yes**	**Mix**	**Mix**

Table 6. Summary of research findings on how various extrinsic factors influence hearing aid satisfaction (cont'd)

Legend: Factors examined: Adv. tech. = devices with advanced technology, Type sit. = types of listening situations, Ben. = benefit, Use prob. = problems in usage, and Pre-fit counsel. = counseling given prior to hearing aid fitting.

Effect code: Small = the factor has minimal effect on satisfaction, Mix = mixed findings from the study/studies depending on the measures used, No = the factor has no effect on satisfaction, and Yes = the factor affects satisfaction.

Appendix. Summary of research studies on hearing aid satisfaction.

Study	Participant details	Aims	Measures used	Conclusion
Baumfield & Dillon (2001)	29 Australians, mild to moderate symmetric loss, AGCo BTE & ITE of similar electroacoustic characteristics, mean age 71y, new users	Relationship among proximity of insertion gain to NAL-R target, aided speech results, attitude, performance, satisfaction, benefit, use, problems, aid choice, & ease of aid management.	Objective measures: Insertion gain at HAF; Speech Perception In Noise Test at 3 & 6 weeks post HAF. Self-report measures: At HAF, style preference; GAS for unaided difficulty, & acceptance of problem. GAS for aided difficulty, use, help & satisfaction; style preference , HAUQ for problems; & SHAPIE for performance at post HAF.	• Cosmetic reasons correlated with satisfaction. • Satisfaction with BTE correlated with GAS & SHAPIE benefit, & HAUQ problem (e.g., volume control, earmold discomfort). • Satisfaction with ITE correlated with SHAPIE benefit & HAUQ problem (e.g., volume control, earmold discomfort, feedback, positioning/removing the device).
Bentler et al (1993)	65 Americans; mean age 63y; 66% male; mild- moderate loss; 60% new & 80% full time user; 70% ITE, 29% BTE; 84% monaural; adaptive compression & filtering, frequency dependent AGCi, Zeta, or no noise reduction	Whether effectiveness can be measured self-reportedly & changes over time; & whether changes vary with degree & configuration of loss, experience, circuit type or use.	Self-report measures: At pre- &, 6m & 1y post HAF: HPI, Expectation Checklist (Seyfried, 1990), sound qualitative judgment using 9 bipolar pairs, At 6m & 1y post HAF: degree of satisfaction (1= not, 2 = a little, 3 = moderately, 4 = very, 5 = totally)	• Mean satisfaction = 3.4 –3.5. Satisfaction correlated & no change at 6m & 1y. 85% moderate or better satisfaction at 6m & 1y. • Age, experience, configuration & degree of loss, use or circuit no effect on satisfaction. 9 bipolar pairs of sound qualify descriptor contributed 22% of variance of satisfaction. Main reason for satisfaction: overall benefit (50.8% of variance), B in noise (14.3%), comfort of aid (6.3%).

Appendix. Summary of research studies on hearing aid satisfaction (cont'd).

Study	Participant details	Aims	Measures used	Conclusion
Billie et al (1999)	25 Americans, ≥ 6m use (≥ 6 hours/day), median age 72y, majority female, SNHL, most experienced using BTE - 16 used binaural aids	Comparison of usage, self-report performance, satisfaction, preference, speech of digital vs. analog aid.	Self-report measures: Final interview at 6-9 weeks. Objective measures: At pre-HAF, thresholds, word recognition in quiet at MCL. At >1 week post HAF, word recognition.	• No difference in speech recognition between 2 aids. • "Very satisfied" or "satisfied": 68% with digital vs. 72% analog • Equal number of participants rated satisfaction of either aid higher, equal satisfaction rating by 10
Brooks & Hallam (1998)	135 new British users, mean age 74y, mean loss 46 dB HL in better ear, 98% monaural	Relationship among age, gender, hearing level, attitude to acquired hearing loss and hearing aids, use, benefit, and satisfaction.	Self-report measures: At 3 & 9m pre & post HAF, HARQ, Hearing Aid Review, use, benefit, feeling towards aid, difficulty in manipulation, aid unhelpful, satisfaction on 10-point scale (dichotomized for analysis) & psychosocial benefit. Objective measures: Thresholds at pre-HAF	• Satisfaction related to frequency of use, listening benefit, aid unhelpful, psychosocial benefit, and difficulty in management. • Absence of distress & not wanting an aid decreased the odds of benefit satisfied. Minimization increased the odds of satisfaction. • Age, sex, hearing, HARQ subscales, & distress/inadequacy no effect on satisfaction.
Brooks (1985)	437 British, BTE users (45% female, median age 68y, 50 dB loss; 55% male, median age 65y, 47 dB loss); 82 were interviewed	Evaluation of factors determining usage and satisfaction among non or minimal users.	Self-report measures: Reaction to, worries about, & handling of aid; stigma; health; family relationship; ability to obtain help; usage; performance; reasons for non-use; & satisfaction from 1 being "total dissatisfaction" to 10 "complete satisfaction"	• 27% respondents did not respond to question on satisfaction • Most (98%) used aid > 2hour/day reported satisfaction vs. 72% of those with < 2 hour/day usage • Non-users had low satisfaction & half of these did not rate satisfaction.

Appendix. Summary of research studies on hearing aid satisfaction (cont'd).

Study	Participant details	Aims	Measures used	Conclusion
Brooks (1989)	200 new users, 55% female: 100 counseled matched in age (mean 71-72y), sex & loss (mean 41-42 dB HL) with 100 not counseled.	Examination of factors affecting usage.	Self-report measures: Questionnaire on motivation, expectations, acceptance (stigma), withdrawal from social situations, relationship with others, awareness of loss & its effect on others	• Satisfaction of those counseled > those not counseled at 4m & 4y post-HAF.
Brooks (1990)	61 British, NHS BTE, 28 of these participated in repeatability measure	Evaluation of reliability and repeatability of a self-report outcome measure.	Self-report measures: At 4m post HAF, Hearing Aid Review on usage, performance in 5 situations, & satisfaction on a scale of 1-10 At 2 weeks after first measure, Hearing Aid Review repeated.	• None with low performance are fully satisfied in any situation. satisfaction correlated with performance & use. • Needs of those with high satisfaction were met in many situations; & those with low satisfaction are poorly or not fully met. • Satisfaction ratings repeatable.
Cox & Alexander (1999)	Item development: 257, 58% men, age 70-79y (mean 75), > 1y use (8-16 hours/day), moderate to severe hearing difficulty. Test-retest reliability: 104 of original participants (similar demographics).	Development of the SADL. Examination of test-retest reliability.	Self-report measures: Items developed via literature review & interview. Factor structure & item selection via principal component analysis. Test-retest reliability examined average 23 weeks later.	• 15 items composing 4 factors (PE, SC, NF, PI) were selected. • Good internal consistency and test-retest reliability. • Normative values and critical differences were obtained.

Appendix. Summary of research studies on hearing aid satisfaction (cont'd).

Study	Participant details	Aims	Measures used	Conclusion
Cox & Alexander (2000)	Americans, age 60-89y; 4 studies: (1) 139 experienced users (≥ 4 hours/day, >1y use), (2) 67 mostly male new users (mild-moderate sloping SNHL), (3) 57 of those in study 2 (same demography) & (4) 39 of those in Study 2	Studies examining: (1) Expectations of experienced users, (2) Expectations of experienced vs. new users, (3) Stability of expectations (4) Relationship of expectations to HAF outcome	Self-report measures: ECHO and SADL administered pre-HAF and 12-14m post HAF.	• New users: higher expectations overall & in other aspects that often are not met. • Expectations on SC, NF, PI did not predict satisfaction. Expectation of PE correlated with SC satisfaction. • Expectations no change over time although they vary randomly. • Expectation and satisfaction probably influenced by other factors
Cox and Alexander (2001)	196 American: 103 men (mean age 69y) & 79 women (mean age 72y), bilateral mild-severe SNHL, 77% had moderate-moderately severe difficulty, used aid 3m->4y (median 10m, 86% 4-16 hours/day), 44% binaural & various styles.	Validation of the SADL against a single item general satisfaction	Self-report measures: 20 participants each from 13 private practice clinics >3m post HAF; General satisfaction measured with 5-point Likert scale "very satisfied", "satisfied", "neutral", "dissatisfied", & "very dissatisfied".	• 73% satisfied/very satisfied. Ratings similar to Cox & Alexander (1999) except current NF ratings higher, same factor structure (4 factors). Good internal consistency for full scale, low for SC & PI subscales. • Satisfaction of users with third party paid aid > VA clients. • PE, SC & NF ratings affect general satisfaction; PI no effect.

Appendix. Summary of research studies on hearing aid satisfaction (cont'd).

Study	Participant details	Aims	Measures used	Conclusion
Dillon et al (1991b)	105 Australians in 4 groups with different measures administered at initial appointment in which communication needs were assessed	Relationship between outcomes measured as a reduction of handicap, goal achievement, use, benefit, problems and satisfaction.	Self-report measures: At first, each group assessed by none or either of GAS, Hearing Difficulties Index (HDI, a revised HHIE). Later, tests administered using different methods (interview, phone, mail). HAUQ for all at 3m post HAF.	• 97% satisfied, 2% not satisfied at final appointment. • 96% satisfied and 3% not satisfied at 3m post HAF. • Satisfaction correlated with usage, benefit, problems, social handicap & emotional handicap
Dillon et al (1997)	98 Australians, mean age 71y, mostly mild to moderate bilateral presbycusic SNHL, non-paying.	Relationship between benefit & satisfaction	Self-report measures: COSI & HHIE pre- & 5-7 weeks post HAF. Modified PHAB Intelligibility & comfort, SHAPIE, HAUQ, & 2 questions with finer scale (0-100) on satisfaction to aid & service at 3m post HAF	• Mean satisfaction towards aid = 87 & service = 97 (median 90 & 100 respectively). Satisfaction not change over time. Service satisfaction strong ceiling effect. • Satisfaction related to SHAPIE; modified PHAB intelligibility; & HAUQ use, benefit & service satisfaction. Satisfaction not related to loss, disability/handicap or problem.
Dillon et al (1999)	4421 Australian, 56% new users, 97% AGC-o programmable 1-channel BTE (33%) or ITE (57%)	Relationship among loss, usage, benefit, problems, aid & service satisfaction	Self-report measures: COSI (from 1770 participants) at pre-HAF & >1m post HAF, HAUQ for all participants at 3m post HAF	• Satisfaction related to 3 frequency average hearing, usage, benefit, problems, service satisfaction, & COSI improvement

Appendix. Summary of research studies on hearing aid satisfaction (cont'd).

Study	Participant details	Aims	Measures used	Conclusion
Gatehouse (1994)	309 British, mean age 66y, 54% female, mean 48 dB HL, 60% monaural	Relationship among biological & audiological data; Hearing Disability & Aid Benefit Interview, performance and Benefit in speech identification, personality & satisfaction	Self-report measures: At pre HAF, personality; motivation to seek help; expectation; attitude towards aid; frequency, degree & psychosocial effect of hearing. At 6-8m post HAF, satisfaction, disability, benefit, & use. Objective measures: At pre-HAF, temporal & frequency resolution, word identification, level for "just follow conversation" in quiet & noise, response time for identifying whether a sentence is silly, SNR for correct word identification in a sentence. At 6-8m post HAF, same as above & subtractive benefit.	• Satisfaction score 68.2 out of 100. • Among disability measures, only expectation, frequency resolution & attitude related to satisfaction. Among personality variables, greater satisfaction was related to depression, feeling less in control & obsession. Benefit greater effect than use on satisfaction. Greater satisfaction for those with more benefit in "just follow conversation" in quiet. • Satisfaction not related to biological & audiological data, anxiety, phobia, or sickness. • Among all factors, only hysteria/locus of control, obsession, depression, attitude, and expectation accounted for some variance of satisfaction.
Hickson et al (1999)	52 Australians, mean age 63y, mild to moderate SNHL, 86% BTE user.	Relationship among satisfaction, benefit, motivation, attitude to rehabilitation & residential situation.	Self-report measures: APHAB, HAUQ at 3-9m post HAF	• 92% very satisfied or satisfied; self-motivation in getting aid increased satisfaction. • Satisfaction unrelated to age, gender, degree of loss, attitude to rehabilitation & residential situation.

Appendix. Summary of research studies on hearing aid satisfaction (cont'd).

Study	Participant details	Aims	Measures used	Conclusion
Hosford-Dunn & Halpern (2000)	282 Americans from private practice, mean age 75, mostly mild to severe SNHL, 45% new users	Examination of psychometric properties & validity of SADL. Comparison of SADL scores to norms (Cox & Alexander, 1999).	Self-report measures: SADL at 1y post HAF.	• Satisfaction of private practice participants with NF > SADL norms. • Confirmed factor structure & validity of SADL. Global score = 71. Very high service satisfaction.
Hosford-Dunn & Halpern (2001)	282 Americans fitted at a private practice	The relationship of SADL scores to intrinsic & extrinsic variables	Self-report measure: SADL at 1 y post HAF	• Intrinsic variables (age, perceived difficulty, loss) correlated with PE satisfaction; extrinsic factors (SC) correlated with PI satisfaction; intrinsic & extrinsic factors related to NF satisfaction but not SC satisfaction. Perceived difficulty affects SADL except NF satisfaction. CIC users more satisfied. Variables interacted to affect satisfaction. • Usage, technology, time spent & number of visits had no effect on satisfaction.

Appendix. Summary of research studies on hearing aid satisfaction (cont'd).

Study	Participant details	Aims	Measures used	Conclusion
Humes et al (2001)	173 above age 60 (mean 73y), bilateral symmetrical mild-to-moderately severe flat or gently sloping SNHL, college level, 71% live with spouse, 57% involve in daily social activities, 60% new users; linear with AGCo ITE matched NAL-R targets within 15 dB.	Identification of components of hearing aid outcome measures	Self-report measures: Post HAF: HAPI, HHIE, HASS, GHABP, HDABI, sound quality judgment on speech and music Objective measures. CUNY-Nonsense Syllable Test & Connected Speech Test binaurally and monaurally in soundfield to each ear in quiet & in noise. Unaided measures at 2 weeks post HAF; aided at 1m	• Satisfaction score similar to GHABP norms (Gatehouse, 1999); "reasonably satisfied" for 4 prescribed conditions. • HASS satisfaction similar to MarkeTrak V norms. Dispenser items correlated with aid features or listening conditions. • Subjective benefit & satisfaction explained 22.7% of variance of outcome. HASS and GHABP satisfaction did not correlate with speech recognition, objective benefit for soft/conversational speech, speech at high levels in noise, usage, reduction of handicap & sound quality.
Humes et al (2002a)	134 Americans, mean age >72y, 70% male, >63% new users, moderate high frequency loss; linear ITE Class D AGCo, maximum output control, low-cut, ± 10-15 dB of NAL-R target	Longitudinal study on changes of aid satisfaction & usage up to 2y post HAF	Self-report measures: At 1m, 6m, 1y, 2y post HAF: usage diary, usage portion of GHABP & HDABI, HASS, satisfaction items from GHABP	• HASS: aid satisfaction rating about 4 = generally satisfied & dispenser satisfaction rating = 4-4.5 = very satisfied • GHABP: satisfaction rating = 3-3.5 = reasonably to very satisfied. • HASS & GHABP consistent data • Satisfaction at 1m, 6m & 1y correlated. satisfaction slightly reduced at 1m compared to 1y post HAF but generally quite stable over 2y

Appendix. Summary of research studies on hearing aid satisfaction (cont'd).

Study	Participant details	Aims	Measures used	Conclusion
Humes et al (2002b)	43 Americans; flat to sloping mild to profound SNHL; mean age 75.3; 62.7% male; 69.8% new users; 2-channel WDRC ITC set using Unifit, volume control	Comparison of satisfaction measured by SADL & MarkeTrak IV survey	Self-report measures: SADL & MarkeTrak IV at 1m post HAF	• Global MarkeTrak IV correlated with global SADL scores, less with SADL subscale scores. Global SADL rating of 5 = considerably satisfied. Global MarkeTrak IV rating of 4.15 = satisfied. • More satisfaction with NF & less with PE than in Cox & Alexander (2001) & Hosford-Dunn & Halpern (2000).
Hutton & Canahl (1985)	743 Americans (different n for the measures), post-lingual loss, new users,	Examination of the relationship among hour usage, portion of time worn, benefit in different situations, satisfaction	Self-report measures: At 6 weeks pre & post HAF, usage, dissatisfaction (7-point from "always" to "never"), handicap & benefit. Subtractive HPI benefit. Objective measures: Better ear hearing thresholds.	• Benefit in various situations & average hearing loss did not relate to satisfaction
Jedidi & Estelami (1994)	781 American experienced programmable users, mean 12 hours/day use, mostly ITE & retired	Comparison of satisfaction of users with a programmable aid to MarkeTrak norms.	Self-report measures: MarkeTrak satisfaction survey mailed to programmable aid users.	• Satisfaction of programmable users >MarkeTrak norms in 14/19 items (e.g., listening in various situations, reliability, feedback, dispenser service).

Appendix. Summary of research studies on hearing aid satisfaction (cont'd).

Study	Participant details	Aims	Measures used	Conclusion
Jerram & Purdy (2001)	162 New Zealanders, mild to moderate SNHL, mean age 70, 62% experienced users, 41% monaural.	Relationship of use, satisfaction & benefit to loss, adjustment to age, gender, expectation, experience, type of clinic, style & 1 vs. 2 aid, employment, technology & gain characteristics.	Self-report measures: 20-point satisfaction scale with 0 being "very, very dissatisfied" and 20 "very, very satisfied"; modified APHAB; Adjustment items of CPHI; attitudes measured by factor 1 of HARQ; pre-HAF expectation. Prior to & at 10weeks post HAF.	• Higher satisfaction related to benefit in listening situations, greater use and with multiple memory aids. • Satisfaction not related to demographic data, expectation, adjustment to loss or other aid characteristics.
Kirkwood (2001)	252 American and Canadian dispensers, 93% dispense digitals.	Comparison of dispenser rating of client satisfaction with digital & directional instruments to client satisfaction with analog aids.	Self-report measures: Satisfaction rated in 4 point scale of "much more satisfied with aid", "somewhat more satisfied with aid", "equally satisfied", and somewhat or much less satisfied with aid".	• "Somewhat" or "much" more satisfied with digitals by 78% respondents overall; & comfort, feedback, speech in quiet & noise & sound quality by >31% respondents. Directional microphone improves satisfaction in same situations. Greatest digital advantages = feedback, sound quality, flexibility & listening in noise.
Kochkin (1990)	1128 users	Investigation of aid satisfaction	Self-report measures: MarkeTrak sent to NFO panel balanced to the latest US census info on market size, age & size of household, income.	• 58% satisfied with aid, 20.4% dissatisfied.

Appendix. Summary of research studies on hearing aid satisfaction (cont'd).

Study	Participant details	Aims	Measures used	Conclusion
Kochkin (1992)	Over 1399-2323 American users, age 2-68, 40-53% new users, surveyed over 3y	Comparison of characteristics between users & non-users. Investigation of effect of aids, style, severity of loss, type of dispenser on satisfaction	Self-report measures: MarkeTrak (satisfaction survey) administered in 1989, 1990, 1991 to NFO panel balanced to the latest US census info on market size, age of household, size of household, income.	• >54% satisfied or very satisfied. • Age no effect on satisfaction. Satisfaction ratings of severely > mildly & profoundly impaired users although ratings are not statistically different; female > male; ITE > ITC users; binaural = monaural users;. • Satisfaction to audiologists > hearing instrument specialists > doctors.
Kochkin (1996a)	3289 Americans, age 67-73y, >½ hour/day use (mean 10–12 hours), 55-84% binaural; aid cost USD 804–1861, 4 classes (base on no. of channels & memories) divided into 13 groups according to styles (n = 964-1256 each).	Comparison of satisfaction of programmable vs. general users. Related satisfaction to usage; quality of life; likelihood of repurchase aid & from dispenser, & recommending aids to friends; benefit	Self-report measures: Manufacturers sent MarkeTrak (overall satisfaction; 34 aspect specific satisfaction items on product features, performance & value, performance in listening situations, dispenser service) to consumers at 90d-2y after purchase (mean 1y). APHAB	• Satisfaction of programmable users (overall satisfaction 66–90%) > MarkeTrak norms. Higher satisfaction for outdoor, usage, multiple environment using multiple memory & microphones but not consistently in noise
Kochkin (1996b)	2327 Americans, 29% new users	Evaluation of how age of instruments affects satisfaction.	Self-report measures: MarkeTrak sent to NFO panel balanced to the latest US census info on market size, age & size of household, income.	• Overall, 53.4% satisfied, 20% dissatisfied. • Satisfaction with new aids of less than 1y old > 1991 results

Appendix. Summary of research studies on hearing aid satisfaction (cont'd).

Study	Participant details	Aims	Measures used	Conclusion
Kochkin (1997b)	Americans, mean age 68; 59% male; mean 9.4 hour/day daily use (74% ≥4 hours); 82% bilateral loss; 65% binaural; 59% had hearing problem most of the time; 76% had difficulty in noise; 5% reported mild loss, 47% moderate, 40% severe, 7% profound; 30% new users; 15% BTE, 41% ITE, 44% ITC	Comparison of satisfaction among users of aid 1 & 2y old. Related satisfaction to likelihood of repurchase same brand, from dispenser & recommending aid to friends; daily usage; disability; & quality of life.	Self-report measures: MarkeTrak (overall satisfaction; & satisfaction in 34 aspects: product features, performance & value, performance in listening situations dispenser service). APHAP. HHIE-satisfaction.	• Satisfaction of new aid > average users overall; in restaurants, noise & car; large groups; clarity; value. satisfaction of mild loss > average users in restaurants & concerts/movies; directionality, on phone. Same satisfaction for users of ≤ 1 or 2-5 hour/day but "very dissatisfied' users have lower probability of ≥ 4 hours/day use than "very satisfied" users. • Disability no effect on satisfaction. • Highest satisfaction: dispenser service, one-on-one situation, fit/comfort. Least in unfavorable conditions (e.g., groups)
Kochkin (1999)	1632-2720 Americans, 65% age >65y (mean 66-68), 63% male, 29-53% first time users	Examination of instrument market & demography of non-owners & users. Comparison of satisfaction in new & older device users.	Self-report measures: MarkeTrak results from 1981, 1991, 1994, 1997	• Overall, 53-58% respondents are satisfied. No difference over the years. • 63-70% users of aid < 1y old satisfied vs. 58-60% users of aid < 4y old. • Satisfaction of programmable users > non-programmable ones

Appendix. Summary of research studies on hearing aid satisfaction (cont'd).

Study	Participant details	Aims	Measures used	Conclusion

Kochkin (2000a)	2720 American instrument owners (½ with aid < 6y old, majority binaural, non-programmable aids), ½ are users.	Comparison of overall and aspect specific satisfaction across surveys taken in 3 year intervals. satisfaction related to degree of loss, benefit, experience, type of aids & telecoil.	Self-report measures:
			MarkeTrak results from 1991, 1994 & 1997 (daily hour usage; impact on quality of life; likelihood of repurchase aid, repurchase from dispenser, & recommending aids to friends).
			APHAB. Based on data from 1997, related satisfaction to benefit from number of listening situations, style, degree of loss, experience, whether aid was programmable, telecoil
				• 54% satisfied.
				• Satisfaction
				  • No difference in aids < 5y old across years.
				  • Improves with increasing no. of situations with satisfactory hearing.
				  • Of CIC users greater on 15 variables (e.g., visibility, some situations) but low on battery life & volume adjustment; of BTE users lower on soft sounds, directionality & difficult situations; more on battery life.
				  • Of binaural > monaural users overall; in difficult situations; soft sounds etc.
				  • Of programmable > average users satisfaction overall & in other items (e.g., comfort with loud sounds, performance in noise, reliability).
				  • Of experienced > new users overall & in 16 items (e.g., reliability).
				  • Of profound > mild loss users overall, but less on 15 items (e.g., soft sounds, benefit, fit/comfort, feedback).
				  • Higher with telecoil in 8 items (e.g., phone, feedback, outdoor).
				• Benefit, sound quality, reliability, value, multiple environment listening & fit/ comfort = most effect on satisfaction.

Appendix. Summary of research studies on hearing aid satisfaction (cont'd).

Study	Participant details	Aims	Measures used	Conclusion
McLeod et al (2001)	Australians; moderate loss, experienced & new, non-paying, 50 participants for 2 weeks & 160 for 1y groups (similar age mean 76y, monaural %), same model AGCo ITC	Relationship between satisfaction measured at 2 weeks and 1y post HAF. Does short-term satisfaction predict long-term satisfaction?	Self-report measures: SADL at 2 weeks (group 1) or 1-2y post HAF (group 2)	• SADL PE, SC, NF & global satisfaction ratings at 2 weeks > 1 y post HAF. PI rating not significantly different, thus effect of aid on this aspect stabilizes faster. • 1y group ratings similar to SADL norms except NF slightly higher. • Satisfaction at 2 weeks did not predict long-term satisfaction.
Meister et al (2001)	93 German mean age 61y; 31% employed; 53% female; 29% monaural; 54% BTE, 46% ITE; 9% new users; 6% < 1 hour use daily, 21% 1-4 hour, 20% 4-8 hour and 53% > 8 hours	Using Conjoint analysis, examined importance of 6 attributes to overall preference.	Self-report measures: performance in Gothenburg Profile situations & satisfaction on 6-point scale of perfect to insufficient for 8 hypothetical aid with different descriptions of speech perception, handling, feedback, sound quality & localization.	• Speech perception considered the most important. Sound quality was considered more important, and speech perception in quiet rated less important by those with lower satisfaction. Performance & satisfaction weakly related • 78% satisfied
Newman & Sandridge (1998)	25 Americans; mild to moderate sloping loss; experienced, fitted with BTE of 1 channel linear, 2 channel nonlinear or 2 channel digital; mean age 69y; 38% monaural	Relationship among benefit, use, satisfaction and cost-effectiveness	Self-report measures: APHAB, & HHIE pre- & 1m post-HAF. MarkeTrak & preference at 1m post HAF Objective measures: At 1m post HAF, Speech Perception In Noise test, real-ear measurement based Articulation Index	• No difference in satisfaction among the aids. • Relationship between satisfaction & other measures not examined.

Appendix. Summary of research studies on hearing aid satisfaction (cont'd).

Study	Participant details	Aims	Measures used	Conclusion
Norman et al (1994)	2 British groups matched for sex, age (>65y) & loss (mild to severe): 48 with and 47 without pre-HAF counseling on family support, motivation, effect of loss, attitude, communication difficulties. No difference in other demographic data.	Effect of living condition, age, gender; degree of loss, disability & handicap; expectation; pressure from others to seek help & pre-HAF counseling on satisfaction, usage, benefit & performance.	Self-report measures: At 3m post HAF, performance as "very good", "good", "average", "poor" or "useless"; usage; satisfaction from 0 (totally dissatisfied) to 9 (totally satisfied); benefit as a differential of aided and unaided difficulty weighted for the no. of occurrence of each situation in a typical week.	• Satisfaction related to usage & benefit. • Age, gender, hearing loss, disability, handicap, whether live alone, expectation, pressure, & pre-HAF counseling have no effect on satisfaction.
Parving (2003)	14325 Danish, median age 72y (18-97), 44.9% male; 55.7% traditional aid, any style aid, monaural. No significant difference in age, gender or type of aid between respondents & non-respondents (n=6297).	Comparison of traditional & digital devices in terms of satisfaction with dispenser & aid, use, ability to manipulate aid & need for additional appointments	Self-report measures: At 3-4m post HAF, questionnaire on satisfaction, usage, ability to manipulate the device, satisfaction with dispensary & need for follow-up appointment. satisfaction rated as "very satisfied", "satisfied", "less satisfied", & "not satisfied".	• Proportion of satisfied or very satisfied users of traditional (71.4%) & digital (68.1%) aids not statistically different. • 96.2% of traditional & 97.3% of digital users were satisfied with the dispensary. • No statistical difference in proportion of low- vs. high-cost digital device users who are satisfied with aids (about 68%) & service (about 96%).

Appendix. Summary of research studies on hearing aid satisfaction (cont'd).

Study	Participant details	Aims	Measures used	Conclusion

Parving et al (1991)	138 Danish; 117 female, 21 male; median age 93y; various degrees of loss; 75% experienced users, 25% new users; 70% monaural; 87% BTE, 6% ITE, 4% body-worn	Investigation of domiciliary situation, self-report visual capacity, handling, use, benefit, satisfaction & dissatisfaction. Effect of experience on use, handling & satisfaction.	Self-report measures: Questionnaire soliciting information on benefit, use, handling, satisfaction, domiciliary situation, & visual capacity. Mailed 4-6m post HAF.	• 9% not satisfied
				• Compared to new users:
				  • More experienced users are satisfied (69% vs. 45%).
				  • Less experienced users are dissatisfied (8% vs. 12%) & did not rate satisfaction (35% vs. 8%)
				• Age & demographics not effect satisfaction.

Purdy & Jerram (1998)	67 of mean age 65y, 12 of mean age 59y, New Zealanders, moderate loss in better ear, 40% monaural, 3m-50y use.	Relationship among performance, usage & satisfaction. Validation of APHAP on New Zealanders.	Self-report measures: PHAP, APHAP, usage & general satisfaction on 20-point scale from "very very dissatisfied" to "very very satisfied".	• Mean satisfaction 14.2. • Satisfaction related to usage, PHAB benefit, reverberation & background noise scales of modified APHAP
Salomon et al (1988)	71 Danish, 37 male, mild to moderate loss in 3 groups (median age 72y) - 26 new users, 25 experienced users (4-30y of use) & 20 non complainers (age, sex & living area matched to first 2 groups)	Comparison of audiological profile of new users, experienced users and non-complainers	Self-report measures: socioeconomic status, aging factors, health, mental function & emotional reactions, relationship with others, general satisfaction with life & hearing, communication ability, daily handicap; aid performance, usage, activities & interests. Objective measures: Speech discrimination, lip-reading ability, thresholds.	• Aid satisfaction related to usage but not with general satisfaction with life

Appendix. Summary of research studies on hearing aid satisfaction (cont'd).

Study	Participant details	Aims	Measures used	Conclusion
Scherr et al (1983)	377 Americans, mean age 61y, mild-to-moderate loss (mean 30 dB HL) 94% monaural BTE	Investigation of satisfaction in listening situations & whether satisfaction relate to household, speech reception & word identification	Self-report measures: Satisfaction as "excellent" "satisfactory", "somewhat helpful", or "of little or no use". Objective measures: Speech materials unspecified	• 91% participants rated aid satisfactory or excellent, regardless of hearing level. • Aid satisfactory in quiet, church/lecture, TV, restaurant, noisy setting, party and meeting. satisfaction rating in quiet > noise
Sinclair et al (1991)	330 American veterans, mean age 66.4y, 90d-3y post HAF, 61.6% BTE, 57.8% monaural	Evaluation of the relationship among satisfaction, benefit & use.	Self-report measures: 8-item measure on benefit, satisfaction & use on a 5-point scale from "extreme satisfaction/benefit" to "no satisfaction/benefit"	• 71% selected first 2 categories of satisfaction, 12% last 2 categories. • Satisfaction correlated with benefit. • Satisfaction of BTE = ITE users • Satisfaction of binaural > monaural users.
Souza et al (2000)	115 Americans, mean age 65y, majority male, mild-profound SNHL, speech discrimination > 87% bilaterally, 46% new users. Various styles, peak clipping (8%) or AGCo (92%) analog device.	Investigation of the relationship among self-rated communication ability, audibility, aid use, adherence to aid use, and satisfaction.	Self-report measures: Usage, SADL & satisfaction (10-point from "least" to "high") at 1y post HAF. APHAB at pre- & 1m post- HAF. Objective measures: Real ear measurement based Articulation Index at 1m post HAF.	• 75.5% of participants rated satisfaction ≥ 7. • Satisfaction rating did not correlate with aided audibility or increase in audibility due to amplification.

Appendix. Summary of research studies on hearing aid satisfaction (cont'd).

Study	Participant details	Aims	Measures used	Conclusion
Spitzer (1998)	87 American veterans, mild to profound loss; new & experienced users; various types of loss, binaural & monaural; mostly age >65; divided into 3 groups: very satisfied, satisfied & dissatisfied	Relationship between hearing handicap & satisfaction. Determination of usefulness of measures in quality improvement assessment & factors predictive of satisfaction	Self-report measures: HHIE, HAAS mailed at 6 months post HAF	• 46% very satisfied, 45% satisfied, 9% dissatisfied – no difference in usage • Satisfaction grouping correlated: • Lowly with HHIE Social, & not with Emotional Scale or total HHIE score • With helpfulness (e.g., tension/stress reduction, group, sound quality) • With problems in feedback, fit, appearance & noise.
Stock et al (1997)	674 Germans obtained aid in the past 5y completed whole questionnaire, 170 others responded to 6 questions, 80% above age 60 (<10->90), 13y wait between onset and time getting aid, 73.6% gradual loss.	Investigation of the relationship among cause & progression of loss, hearing difficulty, aided ability, usage, clarity, directionality, loudness, benefit, problems & satisfaction.	Self-report measures: 49-item post HAF questionnaire on age; degree, onset, progress & cause of loss; hearing ability; use; subtractive benefit; time taken to adapt to aid, embarrassment; suggestions for manufacturers. satisfaction rated as "very satisfied", "more or less satisfied", "not very satisfied", & "dissatisfied".	• From 674 participants: 69.6% more or less, or very satisfied. • Greater satisfaction when one had to strain to hear, loss due to accident/illness or bothersome. Benefit, no use problem & not feeling embarrassed → satisfaction 4.5, 2, 1.5 times more likely. satisfaction correlated with hearing in quiet, in noise, on phone; good music quality, hearing other sounds, directionality, clarity & sounds not too loud. satisfaction not related to progress of loss, aided or unaided hearing ability. • Dissatisfied in noise or in situations of poor sound quality (e.g., telephone).

Appendix. Summary of research studies on hearing aid satisfaction (cont'd).

Study	Participant details	Aims	Measures used	Conclusion
Ziechek (1993)	30 Americans divided into high (16) and low-medium (14) expectation groups, age 64y, new users	Investigation of whether expectations were met; performance, daily usage & satisfaction; the effect of expectations on use, performance and satisfaction.	Self-report measures: At pre-HAF, expectation, comfort, ease of care & use, communication benefit & appearance. At 1m post HAF, PHAP, expectations, usage, overall satisfaction on a scale of 1-7 from "not at all" to "very much" & whether expectations were met.	• High expectation group: higher aid usage, more satisfaction although self-report performance was similar.

Note: AGCi = Input compression, AGCo = Output compression, A = Analog hearing aids, APHAB = Abbreviated version of the Profile of Hearing Aid Benefit, BTE = Behind-the-ear hearing aid, CIC = Completely-in-the-canal hearing aid, COSI = Client Oriented Scale of Improvement, Digital = Digital hearing aids, GAS = Goal attainment scale, GHABP = Glasgow hearing aid benefit profile, HAF = Hearing aid fitting, HARQ = Hearing Attitudes in Rehabilitation Questionnaire, HASS = Hearing Aid Satisfaction Survey, HAUQ = Hearing aid user's questionnaire, HDABI = Hearing disability aid benefit inventory, HHIE = Hearing Handicap Inventory for the Elderly, HPI = Hearing performance inventory, ITC = In-the-canal hearing aid, ITE = In-the-ear hearing aid, m = Month/s, NF = Negative Feature subscale of the SADL, PE = Positive Effect subscale of the SADL, PHAB = Profile of Hearing Aid Benefit, PHAP = Profile of Hearing Aid Performance, PI = Personal Image subscale of the SADL, S = Satisfaction, SADL = Satisfaction with Amplification in Daily Life, SC = Service/Cost subscale of the SADL, SHAPIE = Shortened version of the Hearing Aid Performance Inventory for the Elderly, SNHL = Sensorineural hearing loss, y = Year/s.