The Hearing Aid: Need and Satisfaction

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THE NATURE AND PROCESS OF HEARING

The auditory system is a dichotic sensory receptor that serves both the biological and the emotional-intellectual needs of people. As a distance sense it plays an important role in maintaining an individual's homeostasis with her/his environment (Donnelly & Briskey, 1982; Silverman & Pascoe, 1978), inasmuch as one ear may concentrate on a signal while the other surveys the background for other messages and/or warnings. It meets the emotional-intellectual needs of a person as the receptor of speech, music and other kinds of non-verbal auditory signals.

Often, the two roles of hearing are active at the same time. As one is engaged in a telephone conversation, for example, her/his auditory system would still be "tuned" to monitoring the environment for "other" important messages, warning signals and the like. While much attention has been directed to the emotional-intellectual role of hearing for speech and language, little has been spent on the other more basic aspect. Very little has been written about the biological needs, or perhaps more appropriately, the biological impairment of hearing loss. Yet, it could be this aspect of hearing loss that causes the greatest handicap for certain individuals. For example, hearing-impaired persons who live alone may fear that a friend or relative will come to the door and leave when their knock is not heard.

Given that there is much to learn and quantify regarding hearing aid fitting and use, it seems appropriate to assume that a reasonable goal of hearing aid use would be to restore the auditory system to the best approximation of the original unimpaired state that the mechanism is capable of. It will be assumed, therefore, that unless contraindicated by medical, surgical, physical and/or related factors, usable binaural dichotic listening will be a goal of the hearing aid evaluation and fitting. Other considerations, such as financial, cosmetic and the like, belong in the decision making process of the client after being presented with the optimum (Donnelly, 1981; Killion, 1982; Zelnick, 1983).

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According to Lichlider (1951), interaural phase and intensitive difference judgments form the basis of localization of sound. Held (1955) demonstrated that the unique position of the ears "on the head" coupled with the ability to rotate the head and the role of the Central Nervous System (CNS) provide the individual with a basis for making judgments that is arbitrary in the truest sense of the word. In other words, what we do auditorily is learned and can be changed. Consider, for example, a man standing three feet from a horn at his right side, with the horn delivering a signal at 60 decibels. If over time the man begins to lose hearing, it is possible that the horn would sound as though it were farther away, until of course, the man looked. The man would begin to adjust his mental image to the reduced signal intensity based on his visual inspections. Held (1955) demonstrated quite effectively that this ability to adjust is present in all people.

Hearing impaired persons, then, have probably adjusted and readjusted and modified their reference points numerous times over the course of their losses and will probably have to do so again after being fitted with hearing aids. Most important, however, in this process is the fact that hearing aid users must be aware of the implications of this phenomenon when adjusting their aids. The hearing aid, in other words, could become like a pair of binoculars. Look through them one way and everything is far away; flip them around and everything is close up; yet, both must be taken in the perspective of reality. The CNS of the listener will use and process auditory signals most effectively when it is able to obtain maximum benefit for interaural phase and intensitive difference judgments; i.e., when the signals are dichotic and result from sequential listening while the head is free to move. Whenever possible, therefore, hearing aids should be placed on the head in a position that allows for the most normal separation of ears for localization judgments (Donnelly & Briskey, 1982; Killion, 1982; Schwartz, 1982).

In addition to localization benefits, the separation provided by binaural dichotic listening also assists in, or at least contributes to enhanced discrimination, by enabling listeners to place one ear at some angle to the speaker or source, while using their heads to some extent as a buffer between the source and some unwanted sound; yet, all the while using the other ear to monitor the environment. Reports from several sophisticated listeners, including this author, indicate that this ability is present even for persons with unilateral hearing losses when using ITE CROS instruments.

Optimum hearing, then, is obtained from binaural dichotic reception, as attested to by the increasing use of CROS and BiCROS fitting of hearing instruments. The initial and primary responsibility of a hearing aid "fitter" should be to determine the instrumentation necessary to restore maximum binaural hearing for an individual and, then, based on other non-auditory or dysacusic factors presented by the hearing-impaired individual, consider hearing aid alternatives.

SELECTIVE AMPLIFICATION

Unfortunately, many terms that would have useful meaning today bring with them connotations from the past that are not necessarily accurate or beneficial. The concept of "Selective Amplification" is one. As Hodgson (1977) points out this concept had an early association with hearing aid development. He further states that misconceptions led to erroneous conclusions and subsequent "shelving" of the approach. Today, however, when one speaks of selective amplification one is not advocating mirroring an audiogram or matching loss with equal amounts of amplification. Rather one might accept a more liberal interpretation provided by Silverman and Pascoe: "Selecting a suitable hearing aid is first a series of tests of adequacy in fundamentals, and then a series of judgments of intangibles or a series of compromises" (1978, p. 347).

Levitt (1982) looks at "frequency-selective amplification" as an aid to providing as much of the speech range as possible to an impaired ear. Selective amplification will be used here to mean that form of amplification which is recommended for a person after considering all factors related to providing maximum use of the individual's residual hearing, dynamic range and auditory needs. The term does not imply that one and only one hearing aid is best for the individual, but suggests that such amplification is a good start in the rehabilitative process. It assumes that adjustments and modifications will be made, that a trial period is necessary, and that rehabilitative audiologic techniques will be employed. In essence, selective amplification is a process similar to that which an audiologist completed when preselecting hearing aids for a comparative trial in a hearing aid evaluation (Berger & Millin, 1978; Donnelly, 1981; Millin, 1980; Schwartz, 1982).

Given the vagaries and current inadequacy of the comparative trial method of hearing aid evaluations (Donnelly, 1981; Killion, 1982; Silverman & Pascoe, 1978; Studebaker, 1982), certain assumptions must be made for determining need, selecting an instrument, and validating the fitting.

Determination of Need

Pure Tones (Threshold). Although most current authors seem to agree that there is more to consider than just the audiogram when determining need for amplification, several guidelines based on pure tones are available, including:

1. A pure tone average of greater than 35 dB in the better ear, for the frequencies of 500, 1000 and 2000 Hz (Davis, 1970; Martin, 1980).
2. A pure tone average of at least 30 dB in the better ear for the same frequencies (Berger & Millin, 1978; Carhart, 1946; Millin, 1980; Newby, 1979; Studebaker, 1982).

Speech (Threshold). Again there seems to be an agreement today, that specific scores are not as important as the total picture of auditory need, but the following have been identified:

1. Spondee thresholds of 20 to 40 dB have been listed as guides (Berger, Hagberg & Rane, 1979; Carhart, 1946; Donnelly, 1982; Martin, 1980; Newby, 1979; Schwartz, 1982), but one must wonder about the ease with which these figures have been quoted over the decades, particularly in light of the ANSI standard changes in 1969. The new reference did not seem to affect the way in which authors quoted guidelines despite the fact that the relationship between pure tone averages and spondee thresholds did not remain constant.
2. Spondee thresholds do not seem as important when considering steep-sloping, high frequency hearing losses (Briskey, 1981a; Briskey, 1981b; Dodds & Harford, 1968; Green & Ross, 1968; Harford & Barry, 1965; Newby, 1979).

Speech (Suprathreshold).

1. Word discrimination scores, while contributing countless articles debating their reliability and validity in hearing aid evaluations are, nevertheless, the most frequenly cited "predictors" of need (Binzer, 1983; Carhart, 1946; Chial & Hayes, 1974; Davis, 1970; Dirks, 1976; Levitt, 1982) and success (Berger, Hagberg & Rane, 1979; Green & Ross, 1968; Martin, 1980; Newby, 1979; Pascoe, 1975; Silverman & Pascoe, 1978; Stephens & Anderson, 1971).
2. Presentation level of word discrimination testing is an important factor in determining need and benefit from hearing aids (Chial & Hayes, 1974; Donnelly, 1981; Levitt, 1982; Martin, 1980; Millin, 1980; Newby, 1979; Pollock, 1983).

Pollock (1983), particularly, highlights the importance of presentation level when determining "real" need. She demonstrated that measures of word discrimination at most comfortable loudness level (MCL) or at other arbitrary sensation levels do not significantly correlate with an individual's handicap, when measured by an inventory of activities. Yet, measures of word discrimination at conversational level (CWDS: 40-50 dB HL) do. In addition, she noted that the difference between word discrimination scores obtained at MCL versus those obtained at conversational levels for a given individual point to areas of need for rehabilitative audiology. A person who, for example, has hearing levels better than 30 dB HL through 1kHz, but then rolls off dramatically and has less than normal CWDS (i.e., a WDS of less than 88 percent at conversational levels) and who needs or wants maximum hearing, for whatever reason, should be considered a candidate for those reasons. This would be particularly true if the difference between the individual's CWDS and WDS demonstrated an improvement of 12 percent or better. The *difference* between scores obtained at conversational level and those obtained at MCL or PB Max should be considered a more valid and reliable measure of an individual's need for amplification than pure tone average (Zelnick, 1983).

Although an individual may have a relatively good WDS, if that score was obtained at some level other than normal conversational levels, a hearing impairment is present. It should also be remembered that in some cases, such as steep sloping losses, what appears to be a less than normal WDS may be a function of the presence of low frequency residual hearing influencing the setting of the MCL, with the consequence of reduced discrimination being an artifact of the setting (Briskey, 1981a; Pascoe, 1975; Skinner, 1981).

Tolerance: (LDL/UCL).

1. Measures of tolerance appear to be returning to a place of prominence in hearing aid evaluations. Many authors (Berger, Hagberg & Rane, 1979; Berger & Millin, 1978; Cox, 1982; Dirks, 1982; Donnelly & Briskey, 1982; Levitt, 1982; Pascoe, 1975; Silverman & Pascoe, 1978; Stephens & Anderson, 1971) have noted the major problems associated with using the LDL as an indicator of setting the maximum output of a hearing aid. The problems, as in most of audiology, are related to: *Subjects* (Cox, 1982; Denenberg & Alshuler, 1976; Ritter, Johnson & Northern, 1979), *Stimuli* (Briskey, 1981a; Cox, 1982; Dirks, 1976; Staab, 1978), and *Interaction* or psychophysical procedures (Cox, 1982; Donnelly, 1981; Morgan, Wilson & Dirks, 1974).
2. The use of a Loudness Discomfort Level for speech is recommended as a cut-off point for HFA SSPL90 (Briskey, 1981a; Millin, 1980; Schwartz, 1982).
3. Similar scores also suggest the upper limit of dynamic range and the corresponding potential benefit from a hearing aid (Denenberg & Alshuler, 1976; Dirks, 1982; Levitt, 1982).

Slope of the Audiogram. Perhaps one of the most confounding issues facing the audiologist today when selecting amplification is the disparity found between the recommendations presented in the early literature and the varying needs of each hearing-impaired individual. By and large, the population seen today for hearing aid evaluations have sensorineural rather than conductive lesions. The sensory and/or neural damage presented does not respond to the relatively simple amplification requirements of the early (pre-stapedectomy) conductive population.

Greater attention must be given to the entire hearing instrument and coupling device than in the days when hearing aids were primarily simple amplifiers. The audiologist spends as much time today deciding on earmolds, vents, and tubing sizes as the entire hearing aid evaluation might have taken in the 40's and 50's. In "The Audiogram Connection", as Briskey (1981b) calls it, one is reminded that the contour of the audiogram will determine the earmold, which in turn will influence the hearing aid response selected for given hearing losses.

Hearing Aid Selection

Based on all of the above, it might be reasonable at this time to summarize the goals of the hearing aid selection process as follows:

> To select an instrument consisting of high frequency emphasis, low frequency emphasis or broadband response, that will when coupled to an individual's ear canal, with or without earmold and/or tubing and/or damping modifications, deliver to that individual the broadest spectrum of sound that can be managed effectively by that person's dynamic range, and that will improve speech discrimination while maintaining good sound quality, and be comfortable to use, cosmetically acceptable, and one that after a trial period is deemed worthy of purchase and use.

While these goals and the implications of their various components may seem beyond us at first, they are within our reach and are obtainable today. For many, however, that may mean deviating from our heritage. It may mean viewing and conducting the hearing aid evaluation in a way quite different from the way we learned or have been conducting it. At the risk of over-simplifying, it means no longer trying to compare the performance among pre-selected aids, when such has been demonstrated consistently to be counter-productive or at the least non-productive. It means assessing an individual's "real" needs, auditory functioning and potential, prescribing an instrument that meets these requirements, validating the results and employing appropriate rehabilitative audiologic techniques to assist the individual obtain maximum benefit from the hearing aid.

Validation and Satisfaction

The contribution of rehabilitative audiology to the validation of hearing aid selection and the use of amplification covers a broad spectrum that at times may seem contradictory or at least ambiguous, but generally is a combination of measurement and counseling. Often the role of the audiologist is minimal after making minor adjustments to the hearing aid. It appears that not everyone who uses amplification is in need of prolonged rehabilitative audiologic procedures. Quite the contrary, many need only minimal advice and counsel.

Rather than dwell on the process of validation, it should suffice to state that adequate techniques should be employed to demonstrate that the individual achieves an aided WDS commensurate with residual hearing when the signal is presented at conversational levels, that the individual's loudness discomfort level is not violated when using the aid, and that the sound quality is pleasant. In addition, ample time should be afforded the new hearing aid user to practice listening in a variety of conditions and environments. In brief, the person should be provided as much help as needed in adjusting to using the hearing aid as the audiologist deems necessary.

While to some it may seem that the hearing aid selection process and fitting is mechanical and lacking in rehabilitative audiologic procedures, it should be remembered that the orientation of this presentation is on the process. The process, however, is only important because it is people oriented. The process is different and needs to be discussed. It is obvious that much of it may be accomplished by a computer or computational techniques, but it is equally obvious that it is also professionally designed and directed.

As an example of the need for professional direction consider the following example. Recently, Binzer (1983) added thirty-eight cases to the 157 reported by Donnelly (1982) on client satisfaction with computer fit hearing aids. Binzer, however, added a new dimension to the previous study by selecting forty sequential names of persons who were previously fit with one manufacturer's hearing instruments. She then supplied the appropriate data for these subjects to the manufacturer's computer program and determined who had been fit according to the manufacturer's recommendations and who had not. In 15 of the 38 cases (two persons died before completion of the study) the computer recommended a different hearing aid than the one with which the client was fit, yet nine of these were among the eighteen who were "most satisfied" with their hearing aids. Of these, eight were previous users who wore their aids for more than eight hours per day. Of the six people who were classified as "mostly dissatisfied" with their hearing aid, five were new users, three of whom had elected to try monaural aids when the computer had recommended binaural!

While the computer program referred to above does not yet encompass all of the goals, or at least does not yet encompass adequate programmng to meet all of the goals discussed above, it does recognize most. One of the serious limitations of the program, at least according to the author, is the extreme conservative approach of the program in regard to binaural fittings. Yet even in light of this conservatism, three of the six who were considered "mostly dissatisfied" with their aids were those for whom the computer had recommended binaural fittings, but who had elected to purchase just one.

Even the briefest review of the hearing aid literature today should convince one that technological advances make hearing aids available to persons previously thought "unaidable". Research has demonstrated numerous advantages of binaural hearing, yet the same body of scientists have been unable to measure that advantage adequately for the hearing-impaired person when using a hearing aid. The traditions of audiology have cloaked the audiologist in a mantle of "consumer protector" that now seems to fly in the face of reality and seems to hinder the role of helper.

Audiologists, whether dispensers of hearing aids or not, must begin to recognize the real needs of their clients, recommend the optimum, and permit their clients to try and judge for themselves.

SUMMARY: HEARING AID FITTING CRITERIA

Pure Tones

1. Pure tone average (500-2000 Hz) of 30 dB or more.
2. Pure tone average of less than 30 dB, but steep slope (+12 dB/octave) beginning at 1000 or 1500 Hz.
3. Pure tone contour determines earmold:
   A. OPEN MOLD (IROS) if most hearing falls within the grid defined from 250 to 1000 Hz by 30 dB;
   B. HIGH FREQUENCY EMPHASIS MOLD if most hearing falls within the grid defined from 250 to 1000 Hz by 30 to 60 dB.

Speech

1. Spondee thresholds of 25 dB or more, especially when accompanied by CWDS of 86% or less.
2. Conversational Word Discrimination Scores of 86% or less, especially when accompanied by any of the above.
3. A difference score of +12% or better in PB Max or WDS over the score obtained at CWDS.
4. PB Max or WDS of 86% or less in the presence of any of the above.

Special Fittings

1. CROS:
   A. One normal ear and one non-functional ear;
   B. One normal ear and one ear with PB Max or WDS of 78% or less.
2. BiCROS: Better ear meets fitting criteria above and poorer ear meets criteria for CROS fitting.

SSPL90 - LDL

The high frequency average SSPL 90 output of a hearing aid should not violate an individual's Loudness Discomfort Level. In terms of hearing aid use it would be wise to measure LDL in a way that would indicate at what point an individual would not want to listen or to use an aid because the sound was too loud.

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