# Influence of Central Auditory Function on Perceived Amplification Benefits in the Elderly: Case Reports

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Four adults over the age of 65 who had received hearing aids from the Veterans Administration completed a Hearing Aid Performance Inventory and were administered a battery of tests to identify central auditory disorder at least 9 months after hearing aid fitting. No relation was found between perceived hearing aid benefit and central auditory function. Case histories are presented as well as a discussion of apparently contradictory findings in the literature.

Hearing aid candidacy is often determined on the basis of pure tone thresholds and speech discrimination scores (Byrne, 1982; Corso, 1977; Studebaker, 1982). Based on these measures, the elderly would appear to be good hearing aid candidates. However, older persons seem to experience more difficulty in adjusting to hearing aid use than younger individuals (Corso, 1977; Hayes & Jerger, 1979; Niemeyer, 1968). In fact, there is often a discrepancy between predicted benefit, as indicated by hearing test results, and actual benefit derived from hearing aid use among this population (Hayes & Jerger, 1979).

The difficulties experienced by the elderly could result from senescent changes in the central auditory nervous system (CANS) (Hayes & Jerger, 1979; Jerger, 1973; Jerger & Hayes, 1977; Niemeyer, 1968). While this assumption appears to be widely held, there have been few systematic investigations of the relationship between hearing aid satisfaction and CANS dysfunction.

McCandless and Parkin (1979) reported that individuals with CANS lesions wore their hearing aids less often than those with more peripheral lesions. They described central auditory disorders as characterized by altered integration, memory, confusion, and functioning in the time domain. They also reported that individuals with central problems frequently manifested disorientation, difficulty in performing conventional audiometric tests, and variable responses to standardized testing procedures. The CANS group tended to be older, and also exhibited peripheral hearing loss, but the loss tended to be less severe than in the peripheral group. Wear time was the only indicator of hearing aid use; benefit in specific listening situations was not reported.

Hayes and Jerger (1979) categorized their subjects' auditory dysfunction according to the difference between PB max (maximum score with monosyllabic phonetically-balanced word lists) and SSI max (maximum score on the Synthetic Sentence Identification Test when presented ipsilaterally with a 0-dB message-to-competition ratio). Jerger and Hayes (1977) and Shirinian and Arnst (1982) suggested that the more SSI max falls below PB max, the greater the degree of central dysfunction. The aided performance of Hayes and Jerger's (1979) elderly hearing aid wearers was assessed with synthetic sentences presented in the sound field at 60 dB SPL with speech competition presented at various message-to-competition ratios. Scores were significantly poorer among those with central dysfunction. The presence of a central component was a more important factor in limiting performance than was degree of loss of sensitivity. Hearing aid satisfaction and benefit outside the formal test situation were not assessed.

Because the successful use of amplification involves several variables, it can be defined and assessed in a variety of ways (Walden, 1982). The Hearing Aid Performance Inventory (HAPI) (Walden, Demorest, & Hepler, 1984) provides one means of measuring perceived benefit. This self-report questionnaire consists of 64 items that cover a wide variety of listening situations. Clients rate the degree of benefit provided by a hearing aid in situations including (a) noise or other distractions (Scale 1), (b) quiet, with the speaker in proximity (Scale 2), (c) reduced signal information (Scale 3), and (d) nonspeech stimuli (Scale 4).

The purpose of the present study was to examine the relationship between perceived hearing aid benefit and CANS function among elderly persons. In particular, we questioned whether persons with CANS involvement would report less overall benefit from their hearing aids as assessed with the HAPI, or if they would report that the aids are beneficial, but only in certain situa-

tions.

## METHOD

### Subjects

Subjects were four adult males who ranged from 66 to 72 years of age. All had received hearing aids from the Veterans Administration a minimum of nine months prior to being tested in this study. Each subject was screened using the Short Portable Mental Status Questionnaire (Pfeiffer, 1975). To ensure intact mental functioning, only subjects who obtained two or fewer errors on the 10-item questionnaire were included in the study. Otoscopy and tympanometry revealed middle ear function within normal limits in all subjects.

### Procedures

Testing was performed either on the aided ear or, in the event of binaural amplification, the ear with the better pure tone average. The untested ear was masked by speech noise when crossover of the speech signal was possible. Three speech perception tests were administered:

1. Performance-intensity functions were obtained for words by presenting recorded NU-6 half-lists (Auditec tapes) beginning at 50 dB HL and continuing through 90 dB HL (when subjects' tolerance levels permitted) in 10-dB steps. Scores were obtained at 10-dB increments below 50 dB HL if necessary to define the shape of the function.
2. This procedure was repeated with material from the Synthetic Sentence Identification test (SSI). Both the primary and the competing message were presented to the test ear at a 0-dB message-to-competition ratio. The Auditec recording of the SSI was used, providing 10 randomized versions of third-order synthetic sentences. Subjects called out the number of the sentence thought to have been presented from a list of the 10 synthetic sentences.
3. The Speech Perception in Noise (SPIN) test (Kalikow, Stevens, & Elliott, 1977) was presented at a 0-dB S/N at 40 dB SL.

Subjects were also required to complete the HAPI. The options for rating perceived benefit were *Very Helpful* (1), *Helpful* (2), *Very Little Help* (3), *No Help* (4), *Hinders Performance* (5), and *Does Not Apply* (6). Thus, the lower the number, the greater the perceived benefit from amplification. Items in which subjects marked category 6 (*Does Not Apply*) were treated as missing data in the analyses. Subjects were informed that their ratings would not jeopardize their future status in the Veterans Administration Department of Speech Pathology and Audiology. Testing was conducted in a double-walled, sound-treated booth. Total trial administration time for the complete test averaged 1-½ to 2 hours.

## RESULTS

Based on their PB max and SSI max scores, subjects were placed into one of two groups. If PB max and SSI max were within 20% of each other, the hearing loss was categorized as primarily peripheral, as suggested by Jerger and Hayes (1977). If PB max was greater than SSI max by 20% or more the loss was categorized as primarily central.

### Case 1

This 66-year-old man had a bilateral loss of hearing. See Table 1 for a summary of his test results. He had worn binaural in-the-ear hearing aids for 9 months. The better, test ear had a PTA of 37 dB HL with a sloping high-frequency hearing loss. This patient was classified as having a peripheral loss because only a 4% difference existed between his PB max and SSI max scores as shown in Figure 1. SPIN scores on high-predictability (PH) sentences were higher than on low predictability (PL) sentences, resulting in a large difference score (DF) and indicating that he could take advantage of contextual cues. His HAPI scores indicated general satisfaction with his hearing aids, particularly in quiet listening environments with the talker relatively close (Scale 2). Even in noisy situations (Scale 1) or situations with reduced information in the speech signal (Scale 3), this patient appeared satisfied with amplification. The only situation for which this patient reported no help from his hearing aids was in over-hearing a quiet conversation from another room.

**Table 1**
Mean PTA, SPIN, and HAPI Scores

| | SPIN | | | | HAPI Scales | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Subject | PTA[a] | PH[b] | PL[c] | DF[d] | 1 | 2 | 3 | 4 | Overall |
| 1 | 37 | 52 | 16 | 36 | 2.0 | 1.4 | 2.0 | 1.7 | 1.8 |
| 2 | 30 | 24 | 20 | 4 | 3.6 | 1.6 | 3.6 | 1.8 | 2.9 |
| 3 | 50 | 48 | 4 | 44 | 3.3 | 2.6 | 3.6 | 3.2 | 3.2 |
| 4 | 33 | 4 | 0 | 4 | 1.9 | 1.5 | 1.6 | 1.8 | 1.7 |

[a]Test Ear, three-frequency average in dB HL.
[b]High predictability test sentences (per cent correct).
[c]Low predictability test sentences (per cent correct).
[d]Difference between high-predictability and low-predictability test sentence scores.

### Case 2

This 71-year-old individual had a bilateral loss of hearing and had worn an in-the-ear hearing aid for 2 years. Test results are shown in Table 1 and Figure 2. This patient's PB-SSI max scores were good, indicating a primarily periph-

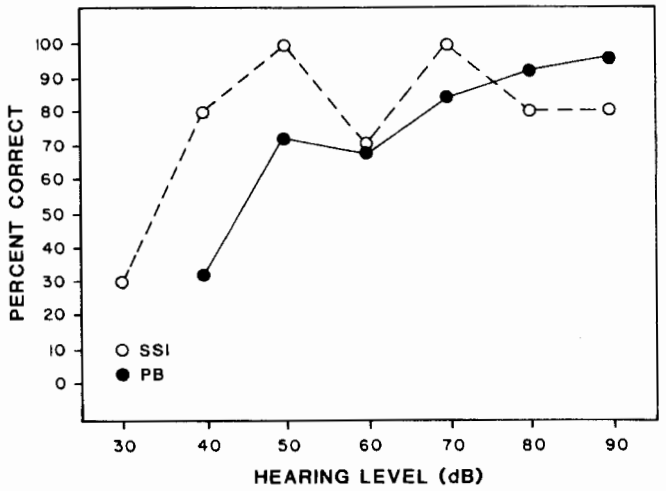


*Figure 1.* PB-SSI functions for Case 1, age 66 years, aided 9 months.

eral deficit. Scores on both the PH and PL items of the SPIN were very poor. This patient appeared to be satisfied with his hearing aid only in quiet listening situations (Scale 2) and when listening to nonspeech signals (Scale 4). Despite a peripheral deficit, this patient was very unsatisfied with his hearing aid in noisy situations (Scale 1) and when distance and/or visual cues were not ideal (Scale 3). In these situations, he often marked the *Hinders Performance* category of the HAPI. Overall scores for these two subscales ranged between *Very Little Help* and *No Help.*

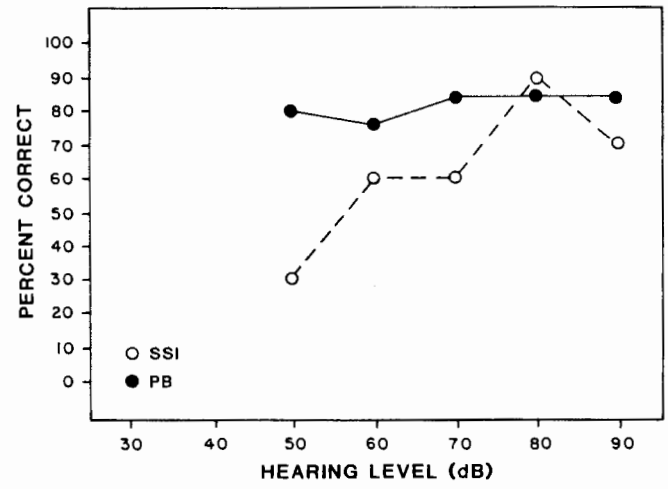


*Figure 2.* PB-SSI functions for Case 2, age 71 years, aided 1 year.

### Case 3

This 72-year-old male reported to have worn amplification "over 10 years" in one ear and for 4 years in the other. Test results are summarized in Table 1. He had a moderate-to-severe bilateral high-frequency hearing loss. A substantial PB-SSI max discrepancy for this subject can be seen in Figure 3, indicating a central deficit. His SPIN scores, although poor for both PH and PL items, indicated that his speech perception was aided by contextual cues. Overall and subscale HAPI scores indicated dissatisfaction with amplification in all situations, with greatest dissatisfaction under conditions of increased distance and/or reduced visual cues (Scale 3).

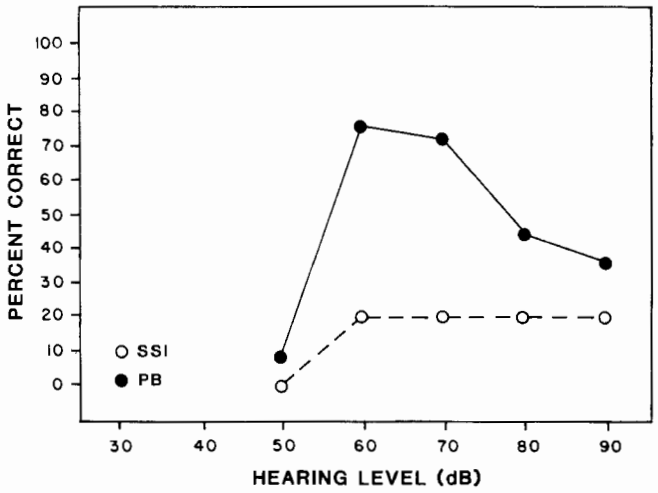


*Figure 3.* PB-SSI functions for Case 3, age 72 years, aided over 10 years.

### Case 4

This subject, aged 67 years, had normal hearing in the low frequencies and a moderate-to-severe loss in the high frequencies bilaterally. He had worn an in-the-ear hearing aid in the test ear for 2 years. Results, which are shown in Table 1 and in Figure 4, reveal a PB-SSI max discrepancy of 28%, suggesting a central dysfunction. SPIN scores were particularly poor, with no apparent advantage provided by contextual cues. Despite the evidence of central involvement, this subject appeared to be quite satisfied with amplification and rated his hearing aid as helpful, even in noisy situations.

## DISCUSSION

These four case histories are illustrative of the fact that there appears to be no relationship between perceived hearing aid benefit — as measured by

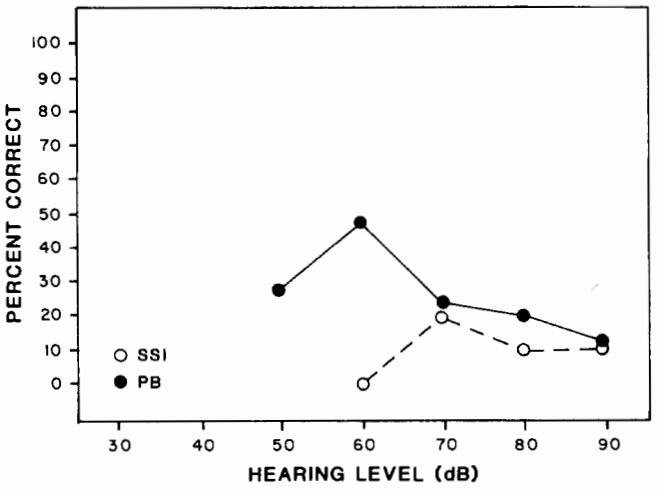


*Figure 4.* PB-SSI functions for Case 4, age 67 years, aided 2 years.

a self-report questionnaire — and central auditory function, as determined by PB-SSI max comparisons. These results may appear to be in conflict with previous studies regarding hearing aid performance and central auditory function.

The study conducted by Hayes and Jerger (1979) found that elderly subjects with a central component to their auditory deficits performed less well with amplification than those with only a peripheral deficit. As the central component increased, aided performance, especially in unfavorable listening conditions, systematically decreased. However, no information regarding mental alertness or central nervous system functioning of subjects was reported; therefore, general cognitive deficits may have been more prevalent in Hayes and Jerger's "central auditory group", — resulting in depressed hearing aid performance — than in subjects in the present study who were screened for mental functioning. Also, the Hayes and Jerger study was concerned with hearing aid performance in a clinical setting, rather than perceived hearing aid benefit.

Two factors may account for apparent discrepancies between the present study and the study by McCandless and Parkin (1979). In the latter, hearing aid acceptance was measured by total daily wear time; that is, the greater the wear time, the greater the assumed acceptance of the hearing aid. A successful fit was defined as 8 or more hours per day of using a hearing aid. The relationship between hearing aid wear time and hearing aid satisfaction, however, is debatable. Jensen and Funch (cited in Corso, 1977) found that, whereas only 44% of the elderly hearing aid users that they surveyed wore their aids 8 or more hours, 94% of them reported that they were satisfied with their aids.

The second factor is the definition of central auditory dysfunction in elderly

clients. In the present study a central auditory deficit was narrowly defined within solely audiologic criteria. An effort was made to rule out more global central deficits. Perhaps the findings of poor hearing aid acceptance in McCandless and Parkin (1979) may be less attributable to central auditory disorders than to a more global central deterioration or cortical dysfunction.

In the present study, individuals with a strong central component to their auditory deficits, presumably subject to perceptual distortions particularly in unfavorable listening conditions, appeared to be as satisfied with their hearing aids as their counterparts with a peripheral-only deficit. This may have been due to the auditory contact with the world that was provided by amplification. Ramsdell (1966) pointed out that hearing operates at three levels: (a) background, (b) warning, and (c) symbolic. Audiologists often emphasize hearing for social communication. Ramsdell emphasized the importance of the other two functions, stating that hearing loss may disconnect the individual from the world, possibly resulting in feelings of depression. For subjects with central dysfunction in the present study, the benefits derived from maintaining auditory contact with the world may have been enough to elevate their feelings of perceived benefit obtained from their hearing aids.

One may question the merit and validity of using questionnaires to determine patients' satisfaction with hearing aids. Walden et al. (1984) discussed two major problems with a self-report hearing aid performance inventory. One is a tendency to respond agreeably (or perhaps disagreeably) regardless of item content. However, Walden et al. pointed out that, although acquiescence may have played a role in their subjects' responses, there were systematic differences dependent on situation; therefore, acquiescence alone could not have accounted for patients' ratings. A second problem is that patients might have rated the difficulty of the situation described, rather than the benefit received from the hearing aid in that situation. Comments from patients of Walden et al. suggested that this was not typically the case.

Kapteyn (1977a) reported a low correlation between hearing aid satisfaction, as determined through a questionnaire, and certain audiologic characteristics such as degree of loss and speech discrimination ability. In a subsequent study (Kapteyn, 1977b), he interviewed subjects who had previously indicated dissatisfaction with their hearing aids. He concluded that, beyond actual benefits received from amplification, factors such as a poorly fitting earmold, feedback squeal, unpleasantness of loud sound, and difficulties in handling the aid also influenced satisfaction with a hearing aid. A number of psycho-social factors that may influence hearing aid satisfaction included acceptance of hearing impairment, original expectations for the hearing aid, social withdrawal as a consequence of age and/or hearing loss, family supportiveness, and personality characteristics. Hayes, Jerger, Taff, and Barber (1983) also cited factors such as earmold comfort, amplified noise, and personality as potentially contaminating. A hearing aid satisfaction questionnaire can provide a systematic way of obtaining information; however, be-

cause of the many variables that may influence a patient's perceptions of hearing aid benefit, clinicians should be cautious when interpreting responses.

Finally, it must be noted that all of the subjects in the present study were counseled regarding the potential benefits as well as limitations of amplification. This may have resulted in less disappointment and greater perceived benefit. A number of authors (Hayes, 1984; Hayes & Jerger, 1979; Otto & McCandless, 1982; Shirinian & Arnst, 1982) have pointed out that a central auditory component does not preclude, although it may limit, successful hearing aid use. These authors caution, however, that clients who appear to have a central component to their hearing loss should be counselled regarding realistic expectations for benefits from the hearing aid. We strongly endorse this recommendation.

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