Long-Term Recovery and No Recovery from the Auditory Deprivation Effect with Binaural Amplification: Six Cases

Stanley A. Gelfand*

Abstract

Six subjects who developed individually significant auditory deprivation effects associated with monaural amplification were tracked for 6.2 to 15.1 years from the time of their initial hearing aid fitting. Each subject received binaural hearing aids after the auditory deprivation effect became apparent and used binaural amplification for at least 4 years. The findings corroborate and expand upon existing case reports. Several general configurations of recovery and no recovery following the introduction of binaural amplification were identified: (1) cases in which auditory deprivation effects developed within about 2 years and recovered completely within about 2 years of binaural use; (2) cases with significant but incomplete recovery; and (3) cases in which the auditory deprivation effect took several years to develop and did not recover following several years of binaural amplification. Clinical implications of the results are proposed.

Key Words: Auditory deprivation, binaural amplification, monaural amplification, speech recognition, unaided ear effect

Silman et al (1984) demonstrated that an auditory deprivation effect may occur in adults when one ear regularly receives auditory input but the other ear is deprived of adequate auditory stimulation for a period of time. It is observed as a reduction in the speech-recognition ability of the understimulated ear. The auditory deprivation effect occurs in the unaided ear of patients with a bilateral sensorineural hearing loss (SNHL) who use monaural amplification. Their aided ears remain unchanged, as do both ears of similar patients using binaural amplification. This unaided ear effect has been repeatedly corroborated (Gelfand et al, 1987; Gatehouse, 1989, 1992; Stubblefield and Nye, 1989; Silverman, 1989; Silverman and Silman 1990; Silman et al, 1992, 1993; Hurley, 1993; Poole and Jerger, 1994).

Auditory deprivation effects also occur for the poorer ears of patients with asymmetric SNHLs (Silverman and Emmer, 1983), and an analogous phenomenon effect has been reported in patients with Meniere's disease (Hood, 1984, 1990).

The auditory deprivation effect is not limited to adults. Gelfand and Silman (1993) recently demonstrated that children with bilateral moderate SNHLs developed an auditory deprivation effect when using monaural hearing aids. Supportive findings were reported by Hattori (1993) for children with severe bilateral losses.

Studies that follow individual cases longitudinally provide insights about auditory deprivation effects that may not always be readily apparent from group studies. For example, it has been demonstrated that individually significant auditory deprivation effects can develop after as little as 2 years of monaural hearing aid use (Silman, et al, 1992; Hurley, 1993) or may take many years to develop (Silverman, 1989; Silverman and Silman, 1990; Hurley, 1993). Case studies have also revealed that at least some patients with auditory deprivation effects experience significant though usually incomplete recovery following the use of binaural hearing aids for some time (Silverman and Silman, 1990;
Providing amplification to the previously unaided ears of subjects with asymmetric sensorineural losses has also been found to reverse the auditory deprivation effect in some cases (Silverman and Emmer, 1993). Supportive evidence also comes from a case report by Boothroyd (1993) in which a child with a bilateral severe-to-profound loss was followed through young adulthood. This child used monaural amplification and had a very low speech-recognition score (SRS) in her unaided ear, which improved with the introduction of binaural amplification. This score worsened after she refused to continue using the second aid.

Burkey and Arkis (1993) compared the SRSs of patients who purchased binaural hearing aids after several years of monaural hearing aid use and then after about 1 year of binaural amplification. They concluded that the prevention of auditory deprivation is not a reason to recommend binaural hearing aids. This conclusion could only be supported if virtually all auditory deprivation effect cases would experience essentially complete recovery within a short time after the introduction of binaural hearing aids.

Even though recovery from the auditory deprivation effect due to the introduction of binaural amplification is an important issue with practical applications, it is still poorly understood. This report attempts to increase our knowledge regarding this issue by describing six subjects who were provided with binaural hearing aids after developing significant auditory deprivation effects. Each case was tracked for several years. These cases provide valuable information because details about the time course of auditory deprivation development and recovery are not affected by averaging across subjects. The current findings identify several broad categories of recovery/no recovery of the auditory deprivation effect following the introduction of binaural hearing aids. Clinical suggestions are offered based on these findings.

METHOD

The approach was a case-by-case longitudinal time-series study of subjects with significant auditory deprivation effects who subsequently received and used binaural amplification for a reasonably long period of time. A significant auditory deprivation effect was defined as an SRS that fell below the initial score obtained prior to the introduction of amplification by an amount that exceeded the 95 percent confidence limits (CLs) (Thornton and Raffin, 1978). Specifically, the time series for each subject included the period beginning with a preamplification evaluation, the initiation of monaural amplification, the duration over which a significant auditory deprivation effect developed, the introduction of binaural amplification, and 4 or more years of binaural hearing aid use. In order to accomplish this, it was necessary for the data to be collected in part retrospectively and in part prospectively. The retrospective aspect utilized the records of several subjects who were involved in a prior study (Gelfand et al., 1987), as described below. The prospective aspect involved tracking the progress of these subjects thereafter.

Subjects

The subjects were six adult males who ranged in age from 31 to 64 years at the time of their initial (preamplification) evaluations and who were tracked for time periods that ranged from 6.2 to 15.1 years from the time of their original monaural fittings. They were the six individuals among 48 monaurally fitted subjects used in an earlier study (Gelfand et al., 1987) who met both of the following criteria: (1) an individually significant auditory deprivation effect and (2) subsequent binaural amplification for at least 4 years.

All subjects had SNHLs of presumably cochlear origin based on the following criteria: (1) pure-tone averages (PTAs) for 500, 1000, and 2000 Hz and speech reception thresholds (SRTs) of ≥ 35 dB HL (ANSI 1969) for both ears; (2) no significant air-bone gaps (Studebaker, 1962) for both ears; (3) normal tympanograms and contralateral acoustic reflex thresholds within the 90th percentiles for cochlear impairments (Silman and Gelfand, 1981; Wiley et al., 1987; Gelfand et al., 1990) for both ears; (4) negative tone decay (Olsen and Noffsinger, 1974) for both ears; and (5) no history of neurologic or ear disease. Their SRSs were obtained with recorded, 50-word test lists (CID W-22 or NU-6) at 40 (±5) dB SL re: SRT at intervals over the period studied. The subjects reported using their hearing aids 8 or more hours per day over the course of the study.

RESULTS

Table 1 shows the subjects' initial air-conduction pure-tone thresholds, PTAs, SRTs, and SRSs, which were obtained when they were first fit with monaural amplification. Figures 1 to 6 show the SRSs over time for each subject.
Table 1 Initial Pure-tone Air-conduction Thresholds*, PTAs,* SRTs,* and SRSs† for Each Subject

| Subject and Ear | Frequency (Hz) | | | | | | | |
|                 | 250 | 500 | 1000 | 2000 | 4000 | 8000 | PTA | SRT | SRS | PTA | SRT | SRS | PTA | SRT | SRS | PTA | SRT | SRS | PTA | SRT | SRS | PTA | SRT | SRS | PTA | SRT | SRS | PTA | SRT | SRS |
| 1 Right | 25 | 25 | 35 | 50 | 40 | 75 | 37 | 35 | 96 | 37 | 35 | 96 | 37 | 35 | 96 | 37 | 35 | 96 | 37 | 35 | 96 | 37 | 35 | 96 | 37 | 35 | 96 | 37 | 35 | 96 | 37 | 35 | 96 |
| 1 Left† | 35 | 30 | 40 | 50 | 40 | 65 | 40 | 40 | 88 | 40 | 40 | 88 | 40 | 40 | 88 | 40 | 40 | 88 | 40 | 40 | 88 | 40 | 40 | 88 | 40 | 40 | 88 | 40 | 40 | 88 | 40 | 40 | 88 |
| 2 Right | 50 | 55 | 60 | 60 | 55 | 70 | 58 | 60 | 80 | 58 | 60 | 80 | 58 | 60 | 80 | 58 | 60 | 80 | 58 | 60 | 80 | 58 | 60 | 80 | 58 | 60 | 80 | 58 | 60 | 80 | 58 | 60 | 80 |
| 2 Left† | 60 | 50 | 55 | 55 | 70 | 75 | 53 | 60 | 92 | 53 | 60 | 92 | 53 | 60 | 92 | 53 | 60 | 92 | 53 | 60 | 92 | 53 | 60 | 92 | 53 | 60 | 92 | 53 | 60 | 92 | 53 | 60 | 92 |
| 3 Right | 35 | 40 | 50 | 50 | 70 | 75 | 47 | 50 | 86 | 47 | 50 | 86 | 47 | 50 | 86 | 47 | 50 | 86 | 47 | 50 | 86 | 47 | 50 | 86 | 47 | 50 | 86 | 47 | 50 | 86 | 47 | 50 | 86 |
| 3 Left† | 35 | 35 | 30 | 40 | 55 | 65 | 35 | 35 | 90 | 35 | 35 | 90 | 35 | 35 | 90 | 35 | 35 | 90 | 35 | 35 | 90 | 35 | 35 | 90 | 35 | 35 | 90 | 35 | 35 | 90 | 35 | 35 | 90 |
| 4 Right | 35 | 45 | 40 | 45 | 70 | 80 | 43 | 45 | 88 | 43 | 45 | 88 | 43 | 45 | 88 | 43 | 45 | 88 | 43 | 45 | 88 | 43 | 45 | 88 | 43 | 45 | 88 | 43 | 45 | 88 | 43 | 45 | 88 |
| 4 Left† | 30 | 45 | 50 | 55 | 80 | 80 | 50 | 50 | 90 | 50 | 50 | 90 | 50 | 50 | 90 | 50 | 50 | 90 | 50 | 50 | 90 | 50 | 50 | 90 | 50 | 50 | 90 | 50 | 50 | 90 | 50 | 50 | 90 |
| 5 Right | 45 | 50 | 60 | 55 | 80 | 80 | 55 | 55 | 82 | 55 | 55 | 82 | 55 | 55 | 82 | 55 | 55 | 82 | 55 | 55 | 82 | 55 | 55 | 82 | 55 | 55 | 82 | 55 | 55 | 82 | 55 | 55 | 82 |
| 5 Left† | 50 | 55 | 65 | 55 | 70 | 70 | 58 | 55 | 80 | 58 | 55 | 80 | 58 | 55 | 80 | 58 | 55 | 80 | 58 | 55 | 80 | 58 | 55 | 80 | 58 | 55 | 80 | 58 | 55 | 80 | 58 | 55 | 80 |
| 6 Right | 35 | 55 | 60 | 55 | 75 | 85 | 57 | 55 | 76 | 57 | 55 | 76 | 57 | 55 | 76 | 57 | 55 | 76 | 57 | 55 | 76 | 57 | 55 | 76 | 57 | 55 | 76 | 57 | 55 | 76 | 57 | 55 | 76 |
| 6 Left† | 40 | 55 | 60 | 60 | 65 | 70 | 58 | 60 | 72 | 58 | 60 | 72 | 58 | 60 | 72 | 58 | 60 | 72 | 58 | 60 | 72 | 58 | 60 | 72 | 58 | 60 | 72 | 58 | 60 | 72 | 58 | 60 | 72 |

*In dB HL (ANSI, 1969); †in percent.
†The ear that was aided while using monaural amplification.

Similar graphs are also shown for the subjects' PTAs in order to summarize their pure-tone sensitivity over the time period studied.

**Case 1**

This patient was 50 years old when he received his first hearing aid, which was a monaural fitting in the left ear. At that time, he had a bilateral SNHL for which the PTA was 37 dB HL and the SRT was 35 dB HL in the right ear, and the PTA and SRT were both 40 dB HL in the left ear.

Figure 1 shows this patient's SRSs over a period of 8.6 years beginning with the time when he first received the hearing aid for his left ear. His SRSs were 96 percent in the right ear and 88 percent in the left ear when he first received the hearing aid. Subsequent SRSs were considered significantly different from these initial scores if they fell below 86 percent for the right ear and 74 percent for the left, which are the lower cut-offs of the 95 percent confidence intervals (CIs) for these scores (Thornton and Raffin, 1978). Using this criterion, there were no significant changes in the SRSs over the 8.6-year period for the left ear, which was aided from the outset.

After 6 months of monaural hearing aid use, the unaided right ear's SRS fell to 86 percent, which is just within the 95 percent CI.
The SRS of the unaided ear fell below the 95 percent CL to 66 percent by 1.9 years after monaural amplification was initiated. Binaural amplification was introduced at this point. The SRS of the previously unaided right ear returned to 88 percent after only 10 months of binaural amplification (2.7 years on the graph) and remained at this level for the remainder of the 8.6 years tracked in this case.

There were no changes in the patient’s status that could account for any of the changes observed in his SRSs over time. This was also true for the other five subjects.

**Case 2**

Subject 2 was a 50-year-old male with a moderate-to-severe bilateral SNHL when he received a monaural hearing aid for his left ear. His initial PTAs were 58 dB HL for the right ear and 53 dB HL for the left ear, and his SRTs were 60 dB HL in both ears. He was followed for 14.1 years, beginning with the first fitting (Fig. 2). This patient’s initial SRSs were 80 percent and 92 percent for the right and left ears, respectively. The lower 95 percent CLs for these scores are 64 percent for the right ear and 78 percent for the left.

No significant SRS changes occurred for the left ear, which was aided over the entire period. The SRS of the unaided right ear decreased significantly to 48 percent 7 months (0.6 years) after monaural amplification was initiated and was 56 percent after 2.7 years. Binaural hearing aids were introduced at that time. The previously unaided right ear’s SRS returned to 84 percent within 1.2 years of binaural hearing aid use (3.9 years) and stayed within the 95 percent CI of the initial score thereafter.

**Case 3**

Subject 3 had a moderate-to-severe bilateral SNHL at age 64, when he began using monaural amplification on his left ear. At the time of the initial hearing aid fitting, his right and left ears had PTAs of 47 dB HL and 35 dB HL and SRTs of 50 dB HL and 35 dB HL, respectively. Figure 3 demonstrates that the difference between the losses of the two ears narrowed as the loss in the left (always aided) ear progressed slightly over the 6.2 year period, at the end of which the PTAs were 50 dB HL for the right ear and 47 dB HL for the left.

This patient had initial SRSs of 86 percent for the right ear and 90 percent for the left ear.

![Figure 2](image1.png)  
*Figure 2* Findings over time for subject 2. Data and symbols are the same as in Figure 1. (The time scale is not linear.)

![Figure 3](image2.png)  
*Figure 3* Findings over time for subject 3. Data and symbols are the same as in Figure 1. (The time scale is not linear.)
The lower 95 percent CLs for these initial scores are 70 percent for the right ear and 76 percent for the left ear.

As shown in Figure 3, the SRSs of the always-aided left ear did not change significantly over the next 6.2 years. The unaided right ear's score decreased only slightly after 0.9 years. However, it decreased significantly to 68 percent at 2.3 years and fell to 40 percent after 4 years of monaural hearing aid use. Binaural hearing aids were then introduced. The right ear's SRS remained unchanged at 44 percent after 4 months (4.3 years). It rose to 66 percent after 1.4 years of binaural amplification (5.4 years), which was still significantly below the 95 percent CL of the initial score. The right ear's SRS increased to 70 percent after 2.2 years of binaural usage (6.2 years), which is equal to the original score's lower 95 percent CL.

**Case 4**

Subject 4 obtained a monaural hearing aid for his left ear at age 54 years. He had a bilateral moderate SNHL with PTAs of 43 dB HL for the right ear and 50 dB HL for the left, and SRTs of 45 and 50 dB HL, respectively. His initial SRSs were 88 percent in the right ear and 90 percent in the left ear. The lower 95 percent CLs for these scores are 74 percent and 76 percent, respectively. The SRSs and PTAs obtained for this subject at various times are presented in Figure 4.

This subject's PTAs remained essentially unchanged for 11.7 years after the initial fitting. The SRSs of the always-aided left ear did not change significantly during this period. The SRS of the unaided right ear was unchanged 4.2 years after the initial fitting but fell significantly to 60 percent at 5.5 years. The unaided ear's score was 56 percent at 6.3 years, when binaural amplification was introduced. The SRS of the previously unaided ear increased gradually over the next 5.4 years and eventually rose to 74 percent, which is just within the 95 percent CI of the initial score.

**Case 5**

Subject 5 was a 31-year-old male with a moderate-to-severe bilateral SNHL who received a monaural hearing aid for his right ear. At that time, he had SRTs of 55 dB HL in both ears, with PTAs of 55 dB HL for the right ear and 58 dB HL for the left. This individual's initial SRSs were 82 percent in the right ear and 80 percent in the left ear, for which the lower 95 percent CLs are 66 percent and 64 percent, respectively. His
performance was monitored for 12.3 years after the initial fitting (Fig. 5).

This patient's SRSs remained essentially unchanged in both ears for 5.4 years following the initial monaural fitting of the right ear. The scores stayed the same for the remainder of the 12.3 years for the right ear, which always used a hearing aid. However, the SRSs of the unaided left ear fell below the 95 percent CL after 6.2 years of monaural amplification, at which point the score was 58 percent. Five months later (6.6 years), the left ear's SRS was 52 percent, and binaural amplification was begun at that time. As shown in Figure 5, the SRSs of the previously unaided left ear did not improve over the next 6 years even though the patient reported that binaural amplification was used over that period.

Case 6

Subject 6 had a moderate-to-severe bilateral SNHL when he began using a monaural hearing aid for his left ear at age 46 years. At that time, his right and left ears had PTAs of 57 dB HL and 58 dB HL, SRTs of 55 and 50 dB HL, and SRSs of 76 percent and 72 percent, respectively. The lower 95 percent CLs are 58 percent for the right ear and 54 percent for the left ear. Figure 6 displays his SRSs and PTAs obtained during six subsequent evaluations that took place over a period of 15.1 years following the initial hearing aid fitting.

The SRSs of the always-aided left ear did not fall below the initial score. These scores actually increased to and remained within the 80 to 88 percent range for all subsequent tests, several of which exceeded the upper 95 percent CL of 86 percent. The SRSs of the unaided right ear also did not decrease during the first 7.7 years of monaural hearing aid use but did drop significantly to 48 percent by 9.5 years. Binaural amplification was introduced at 10.2 years and was reportedly used regularly thereafter. However, the SRSs of the previously unaided ear failed to improve during the succeeding 4.9 years of binaural hearing aid use.

Comments

The data from subjects 1 and 2 corroborate the case reported by Silman et al (1992). Taken together, they demonstrate that (1) a significant auditory deprivation effect can develop within about 2 years of monaural hearing aid use, and (2) the SRS of the previously unaided ear can return to its original level within about 2 years after binaural amplification is introduced. Additionally, the cases described here reveal that an auditory deprivation effect can develop as quickly as 7 months after use of a monaural hearing aid (subject 2) and that essentially complete resolution can occur as quickly as 10 months after introducing binaural amplification (subject 1).

Binaural amplification provided subjects 3 and 4 with significant but incomplete resolution of their auditory deprivation effects over a period of several years. This course of improvement was also found in several cases reported by Silverman and Silman (1990) and Hurley (1993). Thus, significant but incomplete improvement of the SRS in the previously unaided ear appears to be a somewhat typical pattern of resolution of the auditory deprivation effect following the introduction of binaural hearing aids. However, the subjects with this pattern of resolution vary considerably in terms of (1) how long they used a monaural aid before a significant auditory deprivation effect developed and (2) the delay between introducing binaural amplification and the improvement of the SRS to within the initial CLs for the affected ear.

Subjects 5 and 6 had "delayed-onset" auditory deprivation effects taking 6 or more years
to develop and no resolution of the auditory deprivation effect following the introduction of binaural amplification, even after several years of use. These cases demonstrate that at least some auditory deprivation effects are not reversible.

Why did these two patients continue using binaural hearing aids for so many years in spite of unimproved SRSs in their affected ears? Clearly, binaural hearing aids must have been providing enough of an advantage in daily living compared to monaural amplification to justify their continued use. Even though binaural amplification failed to reverse the auditory deprivation effect, it did not mean that these patients were unable to derive any benefit from binaural stimulation. This point is supported by the fact that both of these patients had severe bilateral losses, with PTAs of about 60 to 65 dB HL.

It is perhaps noteworthy that the monaural fittings were in the left ear for five of the subjects (1–4, who experienced recovery, and 6, who had no recovery), and in the right ear for one of them (subject 5, who did not recover). However, there is no obvious reason why this breakdown of originally fitted ears should have affected the outcome.

Burkey and Arkis (1993) contended that the unaided ear effect can always be reversed by introducing binaural amplification, thus negating the need for initially fitting both ears to protect against the effect. However, the accumulating information from this and other carefully executed case studies contradicts this viewpoint. It is undeniable that recovery from the auditory deprivation effect can result from the subsequent introduction of binaural amplification. This is clearly shown here by Silverman and Silman (1990) and by Hurley (1993). However, these studies also show that binaural amplification does not reverse the auditory deprivation effect in every case, nor does it necessarily result in the complete resolution of SRSs to their initial values. In fact, the data reported by Burkey and Arkis (1993, Table 3) reveal that the SRS means for their poorer-hearing (mean PTA = 48.4 dB HL) subjects’ unaided ears fell from 88.6 percent initially to 73.8 percent after monaural amplification and then partially recovered to 81 percent after about 1 year of binaural use. Further, their less-impaired subjects (mean PTA = 34.4 dB HL) did not appear to experience any recovery on a group basis, as reflected by their mean SRSs of 96 percent initially, 83.8 post-monaural use, and 85.4 percent post-binaural use.

Moreover, the very possibility of reversing the auditory deprivation effect depends upon the acceptance of a binaural hearing aid by a patient who has been using one instrument. Additionally, several of Hurley’s (1993) subjects returned their second instruments even when binaural amplification resulted in a significant recovery from the auditory deprivation effect.

The cases reported here provide an existence proof of various patterns in the development and resolution of the auditory deprivation effect. At least one more category is represented by those who reject binaural amplification even though their unaided ear effects are reversed by its use, as reported by Hurley (1993). Thus, the auditory deprivation effect may not be a unitary phenomenon but rather a constellation of either related effects and/or different underlying effects that are provoked by similar conditions. For example, one possible set of explanations for the various findings would be to suggest that subjects 1 and 2 might reflect behavioral changes, that subjects 3 and 4 might exemplify physiologic effects that are reversible, and that subject 5 and 6 may be cases of physiologic changes that are not reversible. In any case, auditory deprivation development and recovery patterns appear to be disclosing that there is probably a greater degree of plasticity in the auditory system than previously supposed and that the potential for plasticity seems to extend well into adulthood. The similar precipitating conditions for each of the outcomes observed appear to involve asymmetry at the two ears. This might be due to differences in the amount or quality of the auditory input to the two ears (because of monaural amplification) and/or to the effects of an asymmetric hearing loss.

The concept that there may be a variety of different effects of asymmetry, which to date have been revealed as unilaterally reduced SRSs, suggests several lines of research, which might address (1) behavioral versus physiologic explanations for the auditory deprivation effect; (2) the parameters and underlying reasons for different patterns of development and recovery; (3) the parameters underlying the acceptance or rejection of binaural amplification after long-term monaural hearing aid use; and (4) the development of profiles characterizing patients who most likely will or will not develop auditory deprivation effects. Moreover, there appears to be a need to consider the use of auditory measures other than just the traditional SRS to describe and help explain the effects of auditory deprivation.
The existence of individual differences that are not yet fully known or understood highlights the importance of using individual subject studies to supplement more formal group designs in this area. Case material makes it possible to identify effects that are often obscured in group data. The cases reported here reveal that this is a problematic issue when studying auditory deprivation effects that vary widely with respect to the time frames over which they develop and resolve. Thus, individual subject data allow us to identify characteristics that would be averaged out in group data and that could potentially affect the criteria used for assigning subjects to groups.

Although the reasons for variability in the development and resolution of the auditory deprivation effect are unclear, several clinical implications of these and related findings are straightforward.

The best treatment for an auditory deprivation effect is to avoid it in the first place. Thus, binaural amplification should be the first consideration in cases of bilateral hearing loss. This does not imply that binaural hearing aids are best for every patient. A binaural fitting might be rejected due to any number of physical, behavioral, auditory, cognitive, emotional, or financial considerations. Of particular interest in this context is a study by Jerger et al (1993), who recently described a binaural interference phenomenon in which binaural performance is impaired by the participation of the poorer ear.

Even though regular audiologic follow-up is appropriate for any hearing-impaired individual, monitoring is all the more important for monaural hearing aid users so that an auditory deprivation effect can be identified as early as possible. This is essential because the case study data presented here have clearly demonstrated that an auditory deprivation effect can develop in as short a period as 7 months or after as long a period as years.

The appropriate strategy to follow when an auditory deprivation effect is observed is to introduce binaural amplification. In fact, unless there is a reason to discontinue use of binaural amplification, it may be prudent to encourage patients with auditory deprivation effects to continue using binaural amplification even if improved SRSs are not observed for quite some time. However, binaural amplification may not necessarily be the only approach. For example, the use of alternating monaural amplification (Hattori, 1993) may also be appropriate. There is a clear need for further research dealing with intervention approaches for auditory deprivation effects.

Acknowledgments. I would like to thank the editor-in-chief and three anonymous reviewers for their valuable suggestions. Portions of this material were presented at the Convention of the American Academy of Audiology, Richmond, VA, April-May 1994.

REFERENCES


Auditory Deprivation Effect/Gelfand


