Late-Onset Auditory Deprivation

During the mid to late 1970s, my colleagues and I observed that many monaurally aided adults with bilateral symmetric sensorineural hearing impairment exhibited progressive deterioration over the years in suprathreshold speech-recognition ability in the unaided, but not the aided, ear. In contrast, we observed a lack of progressive deterioration in suprathreshold speech-recognition ability over the years in binaurally fitted adults with bilateral symmetric sensorineural hearing impairment. This phenomenon was termed “auditory deprivation.”

In the early 1980s, we presented several papers on this issue. Although the first report on auditory deprivation in adults was published in 1984, other published investigations on this topic did not begin to emerge until approximately 5 years later because of skepticism about the phenomenon of late-onset auditory deprivation associated with monaural amplification. Most of the studies on this topic have been retrospective. Only recently have prospective studies supporting the phenomenon of auditory deprivation appeared. This peer-reviewed special issue of the Journal of the American Academy of Audiology brings together a number of recent contributions to the study of the phenomenon.

Moore presents anatomic and physiologic evidence based on animal research as well as behavioral evidence based on human research of late-onset auditory deprivation and plasticity. Moore suggests that auditory deprivation associated with monaural amplification creates interaural asymmetry in auditory stimulation, which results in a decrement in suprathreshold speech-recognition ability in the unaided, as contrasted with the aided, ear. Webster’s response to Moore’s report draws parallels between recovery in suprathreshold speech-recognition ability with binaural amplification and recovery in function following unilateral vestibular deprivation.

Hurley presents the first prospective long-term time-series investigation of auditory deprivation and recovery in nine subjects with bilateral sensorineural hearing impairment. The results of his investigation indicate that, although the majority of his subjects with auditory deprivation demonstrated recovery with binaural amplification, a substantial minority of his subjects with auditory deprivation refused binaural amplification.

Boothroyd presents a remarkable case of auditory deprivation from monaural amplification and recovery with binaural amplification. Although the study was retrospective, repeated measures were obtained as in a longitudinal time-series design, and the effects of frequent withdrawal are shown. The withdrawal of amplification was related to the subject’s rejection of amplification rather than to the experimenter’s withdrawal of treatment. Boothroyd also demonstrated that his subject accepted monaural amplification of the right ear after years of monaural amplification in the left ear and repeated refusal of binaural amplification. He attributed the acceptance of monaural amplification in the right ear to the subject’s need for communicative survival when the left ear became nonfunctional. Hattori, in his response to Boothroyd, stated that he has found that children refuse binaural amplification after longstanding monaural amplification. Hattori noted that the significant difference between his patients and Boothroyd’s subject was the need for communication survival, which was present in Boothroyd’s subject, but not in Hattori’s patients.

Two studies on auditory deprivation in children are presented. Gelfand and Silman’s retrospective investigation on children with bilateral sensorineural hearing impairment and essentially moderate pure-tone averages revealed a decrement in suprathreshold speech-recognition score in the unaided ear over time of the monaurally but not the binaurally fitted
group, consistent with auditory deprivation from monaural amplification. Hattori’s prospective investigation on children with bilateral sensorineural hearing impairment and moderately severe to profound pure-tone averages revealed retarded growth, rather than a decrement in suprathreshold speech-recognition score over time in the unaided ear of the nonalternating monaurally, but not binaurally or alternating monaurally fitted group, also consistent with auditory deprivation associated with nonalternating monaural amplification. Based on these findings, it appears that the magnitude of hearing impairment in children influences whether the unaided ear of a child demonstrates retarded growth or decrement in suprathreshold speech-recognition score, associated with auditory deprivation from monaural amplification.

Hattori’s hypothesis that binaural or alternating monaural amplification yields greater stimulation of the auditory system than nonalternating monaural amplification is intriguing. His hypothesis was based on the finding that the improvement over time in suprathreshold speech-recognition score in both ears of the binaurally or alternating monaurally fitted group was greater than that in the aided ear of the nonalternating monaurally fitted group. This finding was corroborated by Boothroyd who demonstrated, in his case study, improvement in suprathreshold speech-recognition ability in both aided ears following the introduction of binaural amplification; no improvement in the aided ear occurred while the subject wore monaural amplification. These findings underscore the importance of binaural amplification.

Silverman and Emmer’s investigation represents the first study which documents auditory deprivation in unaided subjects with unilateral or asymmetric sensorineural hearing impairment. The finding of recovery with amplification in some of the subjects with unilateral or asymmetric loss suggests that amplification should not be disregarded in this group regardless of the speech recognition score in the poorer ear.

Hall’s report experimentally investigates the masking level difference (MLD) in eight adults with unilateral otosclerosis before stapedectomy surgery, 1 month postsurgery, and 1 year postsurgery. The results revealed an improved MLD over time in six of the eight subjects, consistent with recovery of binaural hearing in the affected ear. A central mechanism for this recovery or adaptation/plasticity was postulated. This report suggests that auditory deprivation from lack of stimulation may be associated with unilateral conductive hearing impairment in adults as well as with monaural amplification in adults with bilateral sensorineural hearing impairment.

Dieroff’s investigation also suggests the existence of auditory deprivation in adults with bilateral, essentially symmetric, conductive hearing impairment who were monaurally aided. Although the initial suprathreshold speech-recognition scores were not measured in Dieroff’s investigation, the known variables other than lack of amplification that could have resulted in a decrement in suprathreshold speech-recognition ability in the unaided ear were controlled.

Based on previous reports and the findings of the investigations in this issue, the clinician should be cautious about recommending monaural rather than binaural amplifications in persons with bilateral sensorineural hearing impairment, particularly children. Binaural amplification should be recommended at the initial hearing-aid fitting and patients should be counselled about the possibility of auditory deprivation with monaural amplification. Because recovery with amplification has been demonstrated in many subjects, clinicians should be encouraged to attempt binaural amplification (if binaural amplification was not provided at the initial fitting) in persons who were monaurally fitted, even if the suprathreshold speech-recognition scores are asymmetric. Although recovery with binaural amplification has been demonstrated in the majority of subjects, a significant minority do not show recovery and refuse binaural amplification.

One major unresolved issue for future research is the mechanism of auditory deprivation. It remains unclear whether the decrement in suprathreshold speech-recognition score results from anatomic or physiologic changes as suggested by Moore’s studies on deprivation and plasticity or from perceptual and psychologic factors. Preliminary data seem to suggest that the mechanism is physiologic. Research is also needed to clarify whether the auditory-deprivation effect results from restricted auditory input from lack of amplification or interaural asymmetry in threshold resulting from, for example, monaural amplification. The full range of auditory abilities affected by auditory deprivation should also be explored.

Shlomo Silman
Guest Editor