J Am Acad Audiol 1:116-119 (1990)

Clinical Forum

The Separability of Central Auditory and Cognitive Deficits: Implications for the Elderly

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Abstract

After viral encephalitis a 40-year-old man showed both central auditory deficit and severe cognitive deficits. The asymmetric central auditory deficit was revealed by speech audiometry. The effect could be explained neither by peripheral sensitivity loss nor by cognitive status. Results highlight the separability of central auditory and cognitive deficits. Implications for the elderly are discussed.

Key Words: Central auditory deficit, cognitive deficit, aging, speech audiometry, central auditory processing disorder (CAPD), encephalitis, synthetic sentence identification (SSI), dichotic sentence identification (DSI)

The argument that central auditory processing disorder is present in many elderly hearing-impaired individuals is based on the similarities between their speech audiometric deficits and the analogous deficits of individuals with known lesions of the central auditory system. Such deficits have been observed on a variety of monotic and dichotic listening tasks (Cf., Arnst, 1982; Bergman et al, 1976; Dubno et al, 1984; Kirikae et al, 1964; Konkle et al, 1977; Marston and Goetzinger, 1972; Orchik and Burgess, 1977; Otto and McCandless, 1982; Schmitt and Carroll, 1985; Shirinian and Arnst, 1982).

In the case of a young adult with a circumscribed brain lesion, confirmed by imaging or surgery, it is not difficult to relate such speech audiometric deficits to the concept of central auditory processing disorder. There is confirmation that the central auditory system is indeed involved, and the typically unilateral nature of the deficit effectively rules out concomitant cognitive deficit as an explanation for the poor performance on the various speech audiometric tasks.

In the case of the elderly, however, such straightforward arguments can seldom be made. Confirmation of a central lesion through imaging or surgery is usually lacking, the effect is typically bilateral, and there is often concomitant cognitive decline (Cerella et al, 1980; Craik, 1977; Salthouse, 1982). Because of these ambiguities some investigators have questioned whether the speech audiometric deficits of the elderly might not be explained solely by cognitive deficit (Working Group on Speech Understanding and Aging, 1988). If performance on speech audiometric tests depends on such cognitive factors as memory and speed of mental processing, for example, and if such factors have declined in the elderly subject, then it is not necessary to invoke the concept of central processing disorder to explain the poor speech audiometric scores. It is just as plausible, the argument goes, to explain the poor speech audiometric performance on the basis of declining cognitive skills.

The counter argument, of course, is that performance on speech audiometric tests does not necessarily place a heavy burden on cognitive

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processing, and that, in any event, there is little evidence to support the argument that the cognitive deficits of the elderly necessarily influence their ability to perform on speech audiometric tests (Jerger et al, 1989).

We had occasion to evaluate a patient whose findings speak directly to these issues. Following encephalitis a comparatively young man showed both auditory and relatively severe cognitive deficits. We were able to ask to what extent the cognitive deficits could be invoked to explain the auditory test results.

CASE REPORT

History

The patient is a 40-year-old man. At the age of 37 he developed headaches, nausea, numbness of the upper extremities, weakness, and disorientation. He was admitted to the emergency room where he was found to have spiking temperatures and disorientation. He responded only to his name. CT scan, chest x-ray, and facial films were all normal. EEG showed slowing, maximal in the frontal and anterior temporal regions. Lumbar puncture showed a high white count with a differential slanted toward lymphocytes. Cerebrospinal fluid protein was high at 274. Titers for St. Louis encephalitis, toxoplasmosis, cytomegalovirus, cryptococcus, histoplasmosis, and Western equine encephalitis were all negative. VDRL was negative. The patient was discharged with a diagnosis of probable viral encephalitis. However, mental status continued to deteriorate and within 2 weeks he was readmitted. The patient now had quadriparesis, and responded only to painful stimulation. He was incontinent of bowel and bladder. He was then treated with intravenous acyclovir for probable herpes encephalitis, and showed significant improvement in cognitive status. He was then referred to a Transitional Living Center for physical, occupational, and speech therapy.

Neuropsychological Status

A neuropsychological examination was carried out at the time of admission to the Center. The results of this evaluation indicated severe difficulties with attention and speed of mental processing. He was unable to make significant progress on a serial verbal learning task and showed severe difficulties with cross-modality, auditory-visual learning. The examining psychologist noted, in addition, problems in short-term visual and verbal memory and visual-spatial orientation, and observed that virtually every measure of intellectual and social functioning had been affected to some extent. The patient was judged to be totally disabled with respect to his capacity to perform in any type of gainful employment.

The neuropsychological examination was repeated at the time of the present visit. Results were unchanged. Strengths were observed in premorbid global intelligence and in language function, but attention, speed of mental processing, verbal memory, and visual spatial memory were all significantly impaired.

Auditory Status

The patient was referred to the Audiology Service of The Methodist Hospital because of a persistent complaint of difficulty in hearing on the left ear dating from his illness. The patient reported particular difficulty at the movies and when using the telephone on the left ear. His wife reported a more pervasive hearing problem impacting most aspects of daily living.

Figure 1 summarizes the result of the basic audiometric evaluation. The pure tone audiograms showed low-frequency sensorineural loss in both ears, slightly greater in the left ear. Average pure-tone thresholds (average of 500, 1000, and 2000 Hz, or PTA_1) were 18 dB on the right ear and 31 dB on the left ear, a difference of 13 dB. At 4000 Hz, however, hearing sensitivity was within normal limits in both ears. On immittance audiometry we noted normal results on the right ear and abnormal results on the left ear. On the right ear the tympanogram and the acoustic reflex thresholds were within normal limits. On the left ear, however, although the tympanogram was normal, the corssed reflex threshold was missing at 4000 Hz and the uncrossed threshold was elevated at 1000 Hz. On conventional speech audiometry we observed a striking interaural asymmetry. On the right ear the phonemically balanced word (PB) score at 80 dB HL was 90 percent, but on the left ear PB scores were 44 percent at 60 dB HL and only 24 percent at 80 dB HL. The performance versus intensity (PI) function for synthetic sentences (SSI) at a message-to-competition ratio (MCR) of 0 dB reached a maximum of 100 percent on the right ear but only 10 percent on the

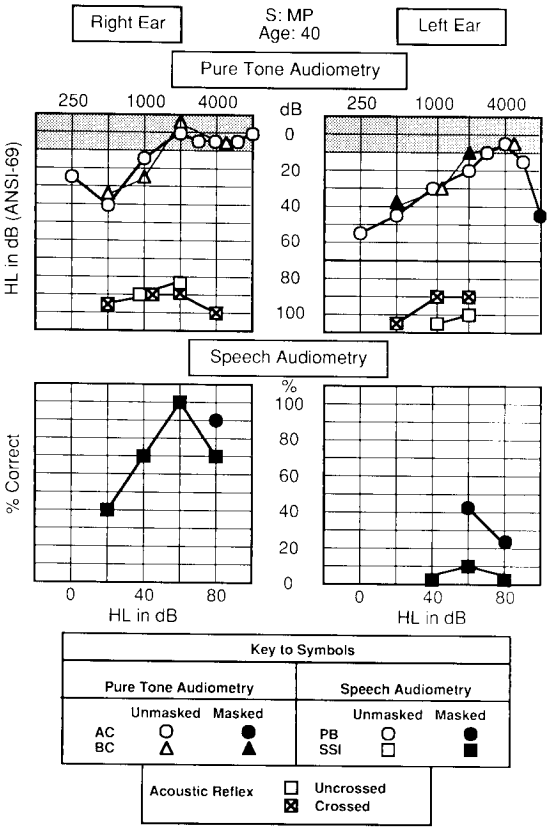

Figure 1 Pure-tone and speech audiometric data in a 40-year-old man, 3 years after an attack of viral encephalitis.

left ear. At +10 dB MCR, however, the SSI score was 100 percent in both ears.

In order to determine whether these speech audiometric scores could be explained on the basis of the sensitivity loss revealed by the pure-tone audiogram, we consulted previously established norms for the expected range of PB_{max} and SSI_{max} scores in patients with cochlear hearing loss (Yellin et al, 1989). For this patient's left ear the PTA_2 (average of HTLs at 1000, 2000, and 4000 Hz) was 18 dB. For this degree of peripheral sensitivity loss, the 98 percent confidence interval for the PB_{max} extends from 100 to 71 percent. Thus the observed PB_{max} score of 44 percent was well below the expected minimum score explainable by peripheral sensitivity loss. Similarly, for this patient's left ear the PTA_1 (average of HTLs at 500, 1000, and 2000 Hz) was 31 dB. According to the Yellin norms, however, the 98 percent confidence interval for the SSI max, for this degree of PTA_1, extends from 100 to 55 percent. Thus the observed SSI max score of 10 percent is well below the minimum SSI score explainable by peripheral sensitivity loss. It could be argued, however, that because of the steeply upward sloping audiometric configuration on the left ear, it would be more appropriate to gauge SSI abnormality in relation to PTA_0, the average of 250, 500, and 1000 Hz. Since the Yellin norms do not consider this case, we searched our clinic records for patients with audiometric configurations similar in degree and slope to that of the present patient. We found six patients with definite or probable Meniere's disease whose audiograms all were slightly worse than the left-ear audiogram of the present subject over the frequency range from 250 to 1000 Hz. In this series of six patients the SSI_{max} score ranged from 40 to 80 percent, a range well above our subject's left ear SSI score of 10 percent.

The dichotic sentence identification test (Fifer et al, 1983) was administered twice, first in a focused attention mode, then in a divided attention mode. In the focused mode the patient was instructed to report only the sentence heard on the pre-cued ear. The pre-cued ear was alternated in five-sentence blocks over the entire list of 30 sentence pairs. In the divided attention mode the patient was instructed to report both sentences heard in any order. Ear difference scores (30%) were the same in the two modes. Scores in the focused-attention mode were 100 percent on the right ear and 70 percent on the left ear. In the divided attention mode, performance decreased symmetrically by 10 to 90 percent in the right ear and 60 percent in the left ear. Figure 2 displays these dichotic sentence identification (DSI) scores graphically. The possibility that this 30 percent ear difference is due to the difference in peripheral sensitivity on the two ears can be ruled out by the fact that, at an MCR of +10 dB, the SSI score was 100 percent in both ears.

DISCUSSION

This patient had a very real auditory complaint involving the left ear. His problem could not be explained on the basis of peripheral hearing sensitivity loss, since the audiometric difference between ears (PTA_1) was only 13 dB. Speech audiometry, moreover, demonstrated a central auditory processing disorder on the left side. The PB_{max} score was only 44 percent, the SSI_{max} score was only 10 percent, and the DSI test showed a 30 percent deficit on the left

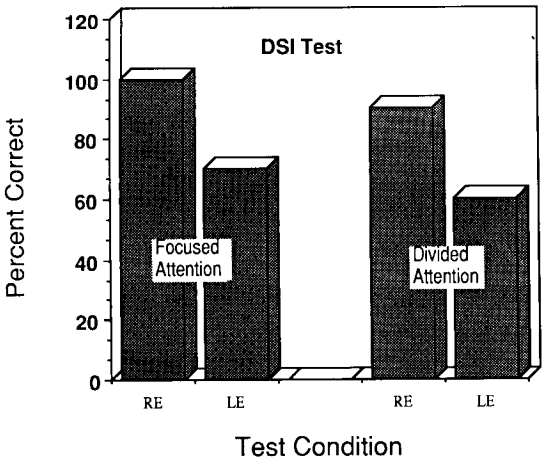

Figure 2 Results of Dichotic Sentence Identification Test administered in two modes; focused attention and divided attention.

ear. None of these speech audiometric deficits could be explained by either the degree or the configuration of the audiometric loss on the left ear.

What makes this central auditory processing disorder so interesting is that it could be demonstrated by conventional speech audiometric techniques in spite of severe cognitive deficits. These deficits, moreover, were in areas which, it has been previously suggested, render the interpretation of speech audiometric findings equivocal. In this particular patient we suggest that his cognitive deficits in attention, speed of mental processing, short-term visual and verbal memory and visual-spatial orientation cannot be invoked to explain the poor speech audiometric scores from the left ear, since these same cognitive deficits had no apparent effect on speech audiometric scores from the right ear. If this patient's severe cognitive problems were going to affect speech audiometric scores, then they should, necessarily, affect speech audiometric scores no matter to which ear the speech materials are presented. But scores for PB_{max} (92%), SSI_{max} (100%), and DSI (100%) scores were normal on the right ear.

We conclude, therefore, that it is possible to demonstrate central auditory deficits by means of the conventional speech audiometric measures reported here, even in the presence of severe cognitive deficits. Such a conclusion has clear implications for the elderly. In these patients the combination of both central auditory and cognitive deficits can be so common that some investigators have wondered whether the apparent auditory deficit could not be entirely explained by the cognitive deficit. While such may indeed be the case in some elderly patients, the present data argue that it need not always be the case. The present case report demonstrates that central, specifically-auditory, effects may coexist with cognitive deficits, and that the two can be measured separately.

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