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Perception of Dynamic Acoustic Patterns by an Individual with Unilateral Verbal Auditory Agnosia

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Previous studies have found that subjects diagnosed with verbal auditory agnosia (VAA) from bilateral brain lesions may experience difficulties at the prephonemic level of acoustic processing. In this case study, we administered a series of speech and nonspeech discrimination tests to an individual with unilateral VAA as a result of left-temporal-lobe damage. The results indicated that the subject's ability to perceive steady-state acoustic stimuli was relatively intact but his ability to perceive dynamic stimuli was drastically reduced. We conclude that this particular aspect of acoustic processing may be a major contributing factor that disables speech perception in subjects with unilateral VAA.

Key Words: verbal auditory agnosia; pure word-deafness; speech acoustics; speech perception; auditory perception.

INTRODUCTION

An individual with verbal auditory agnosia (VAA), or pure word-deafness, is unable to perceive spoken language in the absence of a significant hearing impairment (Goldstein, 1974; Benson, 1996). His reading, spontaneous writing, and speaking abilities are relatively preserved. Since verbal auditory agnosia is a relatively rare disorder, studies reporting findings on this disorder have been mainly case reports. The pathology of VAA, according to Benson (1996, p. 304), ''involves the primary auditory cortex (Heschl's gyrus) or connections between the thalamus and this area.'' However, reported

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cases indicate that VAA could have resulted from either cortical or subcortical, unilateral or bilateral brain lesions (e.g., Kanshepolsky, Kelley, & Waggener, 1973; Saffran, Marin, & Yeni-Komshian, 1976; Auerbach, Allard, Naeser, Alexander, & Albert, 1982; Buchtel & Stewart, 1989; Kazui, Naritomi, Sawada, & Inoue, 1990; Godefroy, Leys, Furby, Reuck, Daems, Rondepierre, Debachy, Deleume, & Desaulty, 1995). Auerbach et al. (1982) suggested that there might be two different types of VAA: one is prephonemic in nature due to bilateral temporal lobe lesions and the other phonemic in nature due to left unilateral lesions because the former could be explained by deficits in the temporal auditory acuity observed in these patients while the latter could not. A review of the literature on unilateral VAA, however, indicates the following: on the one hand, hearing acuity, as defined by the ability to perceive static pitch, timbre, and loudness and even sound localization, is adequate in these right-handed individuals with left temporal lobe lesions; therefore, the speech-perception deficits observed cannot be readily explained by the normal or near-normal hearing acuity (e.g., Gazzaniga, Glass, Sarno, & Posner, 1973; Albert & Bear, 1974; Denes & Semenza, 1975; Saffran, Marin, & Yeni-Komshian, 1976). On the other hand, the ability to process various other aspects of acoustic signals may be impaired in these individuals, which may account for in part, if not all, the speech-perception deficits observed (Albert and Bear, 1974; Saffran *et al.,* 1976). For example, Albert and Bear (1974) found that their subject had a significant deficit in auditory temporal processing for both linguistic and nonlinguistic acoustic signals. On a nonlinguistic click-fusion task, he consistently fused two clicks at intervals of 15 ms while the normal controls were able to distinguish them as two at 1- to 3-ms separations. On a linguistic task, they found that if they reduced the speaking rate to 1/3 of the normal rate, the subject's comprehension significantly improved. One interesting observation was reported in several studies that investigated VAA involving either left unilateral or bilateral lesions. That is, the subjects were able to perceive simple vowels but not CV or CVC syllables (e.g., Denes & Semenza, 1975; Auerbach *et al.,* 1982; Kazui *et al.,* 1990; Godefroy *et al.,* 1995). These findings indicate that (1) prephonemic processing may also be affected in the VAA associated with left unilateral lesions and (2) the ability for processing steady-state acoustic information (such as vowels) vs the ability for processing rapidly changing acoustic information (such as formant transitions) may be differentially affected in these individuals.

The acoustic signal of speech is characterized by rapid temporal changes in fundamental frequency, intensity, and spectral properties. The ability to understand spoken language or speech thus requires the ability to process the temporal variations in the acoustic signal of speech. If one's ability for processing such variations is impaired, his or her ability to process spoken language or speech is limited. The reverse, however, is not necessarily true. Intact auditory processing ability may not guarantee intact comprehension