

## **Classroom Acoustics IV: Speech perception of normal-hearing and hearing-impaired children in classrooms**

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**Abstract:** The present investigation examined the speech-perception abilities of children with normal hearing and children with hearing impairment in various classroom environments. Speech perception was assessed at different teacher-student distances via nonsense syllables, monosyllabic words, and sentences. The acoustical environments varied as a function of reverberation time, early reverberation time, early to late energy ratios, loudness (or relative strength), speech transmission index, background noise levels, and signal to noise ratios. Normal-hearing populations included children, aged 5-15 years, who were progressing normally in school; learning-disabled children; children with central auditory processing deficits; articulatory- and/or language-disordered children; children with developmental delays and/or attention deficits; and children for whom English is a second language. Hearing-impaired populations consisted of children with minimal-to-severe degrees of bilateral and unilateral, sensorineural or conductive hearing loss.

The speech-perception abilities of an adult control group were also obtained. Results indicated that each of the aforementioned populations obtained poorer speech-perception scores in the classroom environments than adult listeners. Moreover, adult-like speech perception was not obtained until approximately 15 years of age. Data will be discussed in view of developing appropriate classroom acoustics for pediatric listeners with normal hearing and hearing impairment.

### **PURPOSE**

The acoustical environment of a classroom is a critical factor in the psychoeducational and psychosocial achievement of children with hearing impairment. Specifically, a review of prior literature indicates that inappropriate levels of classroom noise and/or reverberation can deleteriously affect not only speech perception, but also reading/spelling ability, behavior, attention, concentration, and academic achievement in children with even minimal degrees of sensorineural hearing loss (1-7). Additional research, however, has isolated a number of populations of children with normal-hearing sensitivity who also experience greater speech-perception difficulties in the classroom environment than has traditionally been suspected (7, 8). These "normal-hearing" populations include the following: young pediatric listeners (<13-15 years' old); children with conductive hearing loss or a history of recurrent otitis media; learning-disability children; children with central auditory processing deficits; articulatory- and/or language-disordered children; children with minimal degrees of sensorineural hearing loss (pure-tone sensitivity from 15 to 25 dB HL); unilaterally hearing-impaired children; children with developmental delays and/or attention deficits; and children for whom English is a second language.

The purpose of the present investigation was to further examine the speech-perception abilities of normal- and hearing-impaired children in various classroom acoustical environments. Speech perception was assessed with nonsense syllables, monosyllabic words, and sentences. The acoustical environments varied as a function of reverberation time, early reverberation time, early to late energy ratios, loudness (or relative strength), speech transmission index, background noise levels, and signal to noise ratios.

### **METHODS**

Speech perception was assessed in a number of varying classroom environments. In these settings, nonsense syllables, monosyllabic words, and sentences were presented via a calibrated tape recorder (83 dB SPL at 3 inches) through a loudspeaker that closely approximated the directional characteristics of the human voice. The source was placed at the front of the classroom where the teacher might frequently stand. The child's task was to repeat the stimuli presented or to circle the correct word on an answer sheet. On each speech-recognition form, the location/position of the child in the

room (distance from speaker, position in the classroom, etc) was documented. Children consisted of young pediatric listeners (5-15 years' old); children with conductive hearing loss or a history of recurrent otitis media; learning-disability children; children with central auditory processing deficits; articulatory- and/or language-disordered children; children with minimal degrees of sensorineural hearing loss (pure-tone sensitivity from 15 to 25 dB HL); unilaterally hearing-impaired children; children with developmental delays and/or attention deficits; and children for whom English is a second language. An adult control group also received the experimental tapes. Statistical analyses examined the relationship between the architectural design of the room, acoustical measures, observational measures (obtained in parts I-III of this presentation) and the speech-perception data obtained in the different pediatric populations.

## RESULTS AND DISCUSSION

Overall, the results from this investigation indicated the following: (1) each of the pediatric populations obtained poorer speech-perception scores than the adult control group; (2) children with sensorineural hearing loss obtained the poorest perception scores across the pediatric populations tested; (3) speech perception in typical classroom environments did not reach adult-like performance until the age of approximately 15 years; and (4) decreased teacher position significantly improved speech-perception scores in all acoustical environments. These data will be discussed in view of developing appropriate classroom acoustics for normal-hearing and hearing-impaired pediatric listeners. These data will also be discussed in terms of how they relate to architectural information, acoustical measures, and observational measures obtained in parts I-III of this presentation.

## REFERENCES

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