Tone in Noise Detection In Children With A History Of Temporary Auditory Sensory Deprivation

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Abstract

Introduction: Otitis media with effusion (OME) resulting in conductive hearing loss (CHL) is one of the most common childhood hearing disorders in the United States. Tinnitus detection thresholds were lower (more sensitive) in older children achieving tone detection at lower signal to noise ratio (greater sensitivity) than younger children (Fig 4). Children in both groups showed little or no threshold elevation in the roving level condition compared to a task with no roving masker.

Methods and Materials

Children between the ages of 4 and 7 years, with and without a history of OME, were recruited. Experimental sessions were conducted in a standard, double walled acoustic booth with acoustic stimuli presented diotically through calibrated headphones (TDH 49-P). A graphical user interface was used to estimate TIN detection thresholds for a 1000 Hz tone embedded in 1000-3000 Hz band of noise. Each trial consisted of a TIN stimulus and a noise-only standard stimulus, presented in random order, separated by a 200 ms silent interval. Subjects were instructed to respond left or right depending on whether the tone occurred during the first or second stimulus interval, respectively (Fig 1). The signal-to-noise ratio was varied according to a two-down one-up tracking procedure until the subject’s threshold was reached (Fig 3). The spectrum level of the noise was either 40 dB (fixed level) or randomly selected across intervals over a 20 dB range centered on 40 dB (roving level). The use of roving levels favors the use of envelope cues for performance of the task.

Children with and without CHL had significantly lower TIN detection thresholds than children with normal hearing. Children with CHL were too impaired to detect or track envelope cues in noise.

Conclusion: In summary, we have provided evidence for the development of TIN detection cues shifted from envelope to energy cues. Very little is known about the pattern of cues that are important during early development, either in normal hearing children or in those with a history of CHL. These findings provide more information about the types of cues that normal hearing children would use to detect tones in noise (TIN). In healthy adult listeners, diotic detection appears to rely on a combination of both energy and temporal cues, but when energy cues are made unreliable using a roving-level task, thresholds are barely affected, suggesting that temporal cues dominate this task. In older adults with hearing loss, detection cues shifted from envelope to energy-related cues. If this is true, then there is a potential for measurable deficits in children with temporary CHL due to OME on tone in noise detection. Our results indicate that TIN detection continues to mature through early childhood. Listening strategies are similar between children with temporary hearing loss during the developmental period and children with no history of hearing loss.

References

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Discussion

This is the first study in human children to investigate the effects of early-onset conductive hearing loss due to OME on tone in noise detection. Our results indicate that TIN detection continues to mature through early childhood. Listening strategies are similar between children with temporary hearing loss during the developmental period and children with no history of hearing loss. This is in contrast to older adults with hearing loss, who tend to shift from a frequency-based listening strategy to one that relies more on energy level differences.

Temporal cues, including fine structure and overall envelope structure have been increasingly recognized as key factors that the auditory system would result in measurable deficits on tone in noise detection. Our results indicate that TIN detection continues to mature through early childhood. Listening strategies are similar between children with temporary hearing loss during the developmental period and children with no history of hearing loss. This is in contrast to older adults with hearing loss, who tend to shift from a frequency-based listening strategy to one that relies more on energy level differences.

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