

Impact of noise and reverberation on a child's speech perception



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Describe the potential impact of noise and reverberation on a child's speech perception. Is the impact similar to that seen in adults? Why/Why not?

In the real world, communication rarely occurs in a quiet and anechoic environment. In fact, most communication and learning occurs in noisy and reverberant conditions, and children have more difficulty understanding speech in such conditions, compared to adults (Neuman et al, 2010) due to the incomplete development of auditory processes in children. Speech perception is a complicated process that can be affected by many variables. Several studies have demonstrated that alteration of a speech signal by various everyday factors, such as reverberation and noise, can impair the ability of a listener to correctly recognize speech (Nabelek & Mason, 1981; Crandell & Smaldino, 2000).

Noise refers to any unwanted sound in the environment that interferes with hearing. The extent to which noise masks a speech signal is dependent on the relationship between its overall intensity and the overall intensity of the speech signal. This relationship is termed as the signal-to-noise ratio (SNR). Performance on speech perception tasks is best when the SNR of a listening environment is favorable (e. g., +10 dB). Performance on such tasks decreases as the SNR becomes less favorable (Crandell & Smaldino, 2000).

Reverberation refers to the reflections of a sound that persists in an enclosed environment after the initial stimulus, and is another factor that distorts speech signals (Crandell & Smaldino, 2000). It is measured in reverberation time (RT) which is the time required for a sound wave of a specific frequency to decay 60 dB after the signal ceases. Noise distorts a speech signal by

masking it, whereas reverberation alters the speech signal by smearing it in the temporal domain (Houtgast & Steeneken, 1973). The combination of noise and reverberation results in masking and distortion of speech, further reducing its intelligibility (Crandell & Smaldino, 2000; Finitzo-Hieber & Tillman, 1978). These acoustic distortions are present to some degree in daily listening environments (Helfer & Wilbur, 1990). Presence of noise in an acoustic environment masks the speech signal by blocking out the less intense portions of the signal (Helfer & Wilbur, 1990).

Different types of noise have varied effects on speech perception. Speech presented with broadband noise showed reduction in the perception of high frequency sounds. Narrow band noise presented along with speech showed lesser speech disruption when compared to that of BNB. Speech noise masks most frequencies in the speech produced, thereby reducing the quality of perception. Children show better speech performance in the presence of Multi talker babble when compared to the performance level in the presence of pink noise, while adults show similar performance levels in both.

Consonant phonemes contain less spectral energy than vowel phonemes, therefore consonant sounds are masked more than vowels. This results in a reduction in the redundancy of the acoustic and linguistic cues characteristic of speech.

Under degraded listening conditions, speech perception will be more affected in older adults due to impaired supra-threshold functions such as frequency, intensity and temporal discrimination (Cheesman et al., 1982).

Perception of speech depends on various auditory processes such as

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temporal resolution, ordering, discrimination, binaural processing, and integration. Most of these processes are developed in the later stages of life, therefore adults can process speech better even in the presence of noise. On the other hand, children may miss out information in the speech signal due to under-development of these auditory processes. When speech is presented in noise, rapid temporal changes of the background sounds mix with those changes in the speech signal. As a result, temporal cues in speech get distorted. The less-developed listening skill in children affects perception of speech in the presence of noise due to contamination of the speech signal with noise individuals. Temporal resolution is important for accurate understanding of speech in quiet and in adverse listening environments. Various studies have shown that both temporal resolution and speech understanding in noise significantly diminishes with advancing age. Speech understanding correlates with age, while temporal resolution correlates more with hearing.

Different types of background noise, often at high intensities are common in many settings (e. g., daycares, classrooms) experienced by children (Manlove et al., 2001). Increased noise levels have been shown to adversely affect children's speech perception (Crandell & Smaldino, 2000; Finitzo-Hieber & Tillman, 1978). Concerning attention, children's immature auditory selective attention skills contribute to their difficulties with speech-in-noise perception. Children have shorter attention span as compared to adults. Presence of background noise during speech makes it difficult for the child to pay attention to the speech signal and therefore affects speech perception. This includes both a failure to selectively attend to a target signal (Newman,

2009), and a tendency to listen across the frequency range rather than to the specific regions most likely to be informative (Werner, 2007). Adults can sustain attention for a longer period, therefore is less affected. Children are especially vulnerable to harmful effects of environmental noise, as cognitive functions are less automatized and thus more prone to disruption. The ability to recognize speech under conditions of noise or noise combined with reverberation improves until the teenage years (Johnson, 2000; Wightman & Kistler, 2005; Talarico et al., 2007; Neuman et al., 2010). Furthermore, children are less able than adults to make use of spectro-temporal and spatial cues for separation of signal and noise (Wightman et al., 2003, Hall et al, 2009).

A range of linguistic and cognitive factors to be responsible for children's difficulties with speech perception in noise: concerning the former, children are less able than adults to use stored phonological knowledge to reconstruct degraded speech input.

Children spend around 45-60% of their time at school engaged in listening (Rosenberg et al., 1999). Background noise along with speech affects higher-order cognitive processes involved in children's comprehension. Various noises in the classroom and reverberation due to the walls in the classroom can distort speech signals. Acoustic distortion of speech signal due to reverberation can have a direct effect on a child's learning as they cannot clearly perceive what is being said by the teacher, which can in turn lead to poor academic performance. Performance decrements in noisy classrooms are even more concerning for young children (i. e., <5 years) who show significantly worse speech perception in noise than older children (Jamieson <https://assignbuster.com/impact-of-noise-and-reverberation-on-a-childs-speech-perception/>)

et al., 2004). Adults are mostly engaged in conversations and can predict the signal using contextual information which cannot be done by children. Adults also tend to use coping strategies such as lip-reading, facial expressions and hand gestures to predict the spoken words, thus results in better speech perception. However, children cannot adopt these methods to improve their speech perception in the presence of background noise. Noise and reverberation impairs reading ability in children. Non-auditory tasks such as short-term memory, reading and writing are also impaired by noise.

Some of these assume that irrelevant sounds have automatic access to working memory, causing specific interference with the retention of cues to serial order (Jones et al., 1995) or—in case of speech—with the retention of phonological codes (Salame & Baddley, 1982).

The speech produced in a reverberant field will have varying sound pressure levels and phases as the direction of the sound waves reaching the receiver will be from multiple directions. Due to the incomplete development of auditory processes in children, the reverberated sound may be perceived as a distortion rather than a meaningful utterance. Elderly listeners often exhibit difficulty in perceiving speech, particularly in the presence of reverberation or background noise. This difficulty in speech perception may be due to deterioration in auditory (peripheral) or cognitive (central) mechanisms in the older adults due to aging. Reduced temporal processing in older adults also contributes to poor speech understanding abilities in elderly individuals compared to young individuals. Age-related differences in audibility is the principle factor responsible for poor speech perception in adults. Speech perception in older adults is often poorer when compared to <https://assignbuster.com/impact-of-noise-and-reverberation-on-a-childs-speech-perception/>

that of younger adults (CHABA, 1988; Sommers & Danielson, 1991). This is because, ageing affects the higher levels of speech processing where binaural summation occurs which might result in a lesser binaural advantage in the elderly as compared to young adults. Age-related deficits in frequency-resolution also plays a vital role in explaining the disproportionate difficulty that older adults have perceiving speech in noise (Lee & Humes, 1992). This is because broadening of auditory filters in elderly population would increase acoustic masking, making it more difficult for them to extract important phonetic information from the speech signal. A second fundamental change in cognitive processing with age is a reduced ability to inhibit task-irrelevant information (May et al., 1999). Older adults are less able than younger adults to attenuate and exclude extraneous background noise which results in impaired ability to perceive speech stimulus.

CONCLUSION

To recapitulate, it is evident that presence of noise and reverberation during speech impacts speech perception in children more than adults. Unlike adults, children cannot use different strategies like lip reading or facial cues to identify and integrate the speech signal. Incomplete development of auditory processes in children results in poor perception of speech which can ultimately have a negative impact on their academic performance. The standard SNR set up for classrooms have to be followed in order to avoid this in classroom where most learning occurs. Policy makers responsible for noise abatement should be aware of the potential impact of environmental noise on children's development.

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