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Speech Perception Difficulty in Noise in Elderly

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Abstract

Speech in noise perception is one of the amazing functions of auditory system. Auditory system can utilizes different acoustic cues (pitch, temporal cues, and spatial cues) to separate one sound source from other simultaneous competing sound sources (auditory scene analysis). Therefore, subjects can focus on desired sound (mainly speech) and ignore other unwanted sounds (noise). It seems that old adults have especial challenges for hearing in noise. This challenge has been shown even in normal-hearing subjects and cannot be explained completely based on peripheral hearing status.

Keywords: Hearing in noise; Cognition; Auditory processing; Speech perception in noise; Auditory training; Elderly

Abbreviations: SIN: Speech-in-Noise; HINT: Hearing in Noise Test; BKB-SIN: Bamford-Kowal-Bench Speech-in-Noise; PSI: Pediatric Speech Intelligibility; LiSN-S: Listening and Spatialized Noise-Sentences.

Introduction

Understanding speech in background noise is hard for everyone, but especially for children with language-based learning impairments, individuals with hearing loss, and older adults (I can hear but I cannot understand what was said) [1]. They have particular difficulty understanding rapid speech, especially the rapidly-changing parts of speech contained in consonant-vowel transitions [2]. So older adults (over 65 years old) commonly report having speech understanding difficulty in presence of background noise or simultaneous competing sound sources [3]. Older adults have special problem in cocktail party effect [4]. Peripheral hearing lossexplains some of this difficulty but speech-in-noise (SIN) perception difficulty can be seenin older adults with normal audiometric thresholds [5,6]. Therefore, speech recognition performance especially in noise (signal to noise loss or SNR loss) cannot be predicted simply with audiogram. One of the factors affecting speech perception in noise is cognitive processing problems in older adults [3]. The ability to understand speech in noise is a product of a complex relation of sensory and cognitive factors. Three hypotheses explain the mechanisms of hearing in noise difficulties in elderly: peripheral, central, and cognitive processes [7]. It is said that even lifestyle factors are important for speech perception in noise in elderly (for example effects of exercise on overall health and cognitive health) [8].

It has been shown that older adults distracted more with semantic content of background noise or competing signals than younger adults, that is a cognitive factor [9]. Older adults who have experienced memory or attention deficits are more affected by hearing loss [10]. Aging may affect speech-in-noise perception and central auditory processing in individuals with and without hearing loss [3]. Speech perception in noise may also be affected by changes in central auditory processing. Aging affects the ability to process pitchcues [11] and temporal processing [5]. Pitch cue deficits make it difficult for an older adult to follow a single voice from simultaneous competing voices [12].

Older adults cannot use pitch cues for informational unmasking [13]. Temporal processing also changes with age. Decline in temporal resolution has been found in old age, not only in humans but also in animal studies[5], and gap detection threshold is used for measuring temporal resolution and it is

highly related to speech perception in noise [3,6]. Temporal processing is important for receiving and perceiving fast changing acoustic transitions in consonants [3,14]. Other temporal processing disorder (temporal resolution) in older adults is neural representation impairment of voice-onset-time contrasts [15]. Older adults have slower neural processing [1]. Subcortical representation of speech in old adults is different from young adults and this can cause speech perception difficulty in noisy environments/in competition [3].

Tests for Speech Perception in Noise

There are four main speech perception tests in noise, including the Bamford-Kowal-Bench Speech-in-Noise (BKB-SIN) test, Hearing in Noise Test (HINT), Listening and Spatialized Noise-Sentences test (LiSN-S), and the Pediatric Speech Intelligibility (PSI) test [16]. They are mainly used in children. HINT is a reliable and efficient measurement of speech perception in background noise. In addition, it provides a means for studying the benefits of separating the source of speech(signal) from the location of the noise (masker) [4].

Hearing in Noise Test (HINT)

HINT can assess speech understanding and functional hearing in quiet and in speech spectrum-shaped noise. There are ten-sentence lists with similar phonemic content [17-19]. Children are asked to correctly repeat the entire sentence. When testing in noise, the speech is fixed, typically at65 dBA, and presented from a loudspeaker at 0 degrees azimuth. The aim is finding subject intelligibility threshold (adaptive method). Noise maybe presented from the loudspeakers located at the front (0 degrees) or sides (90 or 270 degrees) of the child. The test was designed for use with any listener including those with normal hearing and hearing loss [16]. HINT has been developed in many languages and HINT-F (Farsi) is under development.

Speech perception in noise training

Auditory training results in perceptual enhancements (functional and behavioral changes) as well as plasticity in single neurons and neuronal populations [20]. There are few studies on speech in noise perception training. These studies indicate that speech innoiseperception can improve with training using words or sentences in artificial listening conditions but generalization to untrained materials or conditions cab be limited (training is specific to trained speech materials and noise type) [20,21].

In general, long-term auditory training (musical training) can improve speech perception under challenging conditions [22,23]. One of the programs for speech perception in noise training is Listening and Communication Enhancement (LACE). This program uses open-set speech materials presented in a variety of difficult listening conditions often encountered in real life [20]. There are other formal and informal training programs and plans. There is a need for developing beneficial training programs for elderly. This can improve their quality of life and overall health. Another program is "clEAR", a new customized training game for adults. Many people, even if they use a hearing aid, will still need to learn how to interpret a distorted auditory signal. This is especially true if they are trying to understand speech in a noisy environment, such as a busy restaurant. *clEAR™* will provide a unique tool for aural rehabilitation in adults [24].

Conclusion

Speech perception in noise is affected in elderly and this impairment can be result of a complex interaction between peripheral, central auditory and cognitive function. Speech perception difficulty in noise can lead to depression, isolation and low quality of life in elderly. Auditory training for this impairment in elderly is absolutely essential.

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