Abstract

Executive function (EF) constitutes multiple cognitive components thought to be involved in the regulation and control of purposeful and goal-directed behaviors. EF deficits can lead to the inability to perform everyday tasks. These deficits are exacerbated in complex auditory environments. Previous work suggests individuals with cochlear implants (CIs) perform worse on measures of EF, specifically tasks assessing working memory (WM), than individuals with normal-hearing (NH). The present study aims to understand factors likely to contribute to the gap in performance between CI and NH listeners. Participants completed the NIH-Toolbox List Sort WM Test. All individuals with CIs and half of the NH group were presented the auditory-visual stimuli; the other half of the NH group was presented visual-only stimuli. Results show that the NH auditory-visual group had the highest mean scores, indicating that auditory input provided important augmentative information for WM. These findings may impact habilitation after cochlear implantation. For example, there may be a benefit from including training of EF in therapy to enhance both auditory and neurocognitive mechanisms.

Working Memory (WM), Cochlear Implant (CI) & Speech in noise understanding

• Working memory (WM): a component of executive function that involves the conscious storage, manipulation and integration of information.
• Deficits in WM can indicate problems processing incoming information, of which is vital for speech understanding.
• Listening to speech in multi-source auditory environments can be challenging, especially for individuals who use CIs and listen to speech through a degraded electrical signal.
• In complex environments, individuals with CIs must work extra hard to decode and interpret a speech signal due to the degraded information that they receive through their processor. This in turn may leave fewer available resources for things like remembering, paying attention to, and processing of speech (i.e. aspects of WM).

Aims of the present study

• To better understand factors that contribute to the gap in performance on measures of WM between individuals with CIs and with NH.

1. Mode of presentation of stimuli

(a) Individuals with NH will have the highest performance when stimuli is delivered in both an auditory + visual modality, compared to one modality alone, due to the redundancy of information, and (2) Individuals with CIs will perform lower (i.e. worse performance) on the WM task than NH participants, in the auditory + visual group, due to degraded auditory input delivered through the CI.

2. Onset of deafness

It is hypothesized CI users with early acoustic experience will have better WM than those with congenital hearing loss because early development of the WM system is more like that of the NH group.

Results & Discussion

Participants:

Group

Normal Hearing (NH)  
Cochlear Implant (CI)  
Auditory + Visual stimuli  
Visual-only stimuli

N=9  
N=9  
N=7

*All individuals in the NH group passed a hearing screening indicating thresholds >25 dB HL at octave frequencies between 250-8000 Hz, in both ears.

**All but two individuals with CIs had congenital hearing loss.

Testing Measures:

1. Kaufman Brief Intelligence Test, Second Edition (KBIT-2)⁶

• Non-verbal intelligence quotient (IQ)

2. NIH Toolbox⁶

• List Sort Working Memory Test (Age 7-12.1)  

For all participants, in all groups, non-verbal IQ scores fell within, or above, the normal range.

Future Directions & Clinical Implications

• Our goal is to further examine groups of CI users with both congenital and acquired hearing loss, in both modalities, in order to better understand the role of early acoustic experience in the development of the WM system.

• These findings may have clinical implications regarding aural (re)habilitation after cochlear implantation.

For example, there may be a benefit of including training of specific components of executive function (i.e. working memory) in everyday modalities (both with visual and auditory cues) in therapy, in order to enhance both auditory and neurocognitive mechanisms. This may be particularly helpful for certain groups of CI users.