**[15O]Water PET study of speech in noise processing in cochlear implant patients**

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### 1 Introduction

- Functional imaging of subjects with cochlear implants (CI) is difficult: MRI impossible with most current devices
- Here we show activation due to SIN can be achieved at a single-subject level

### 2 Methods

- We measured [15O]Water positron emission tomography (PET) blood flow in a group of seven CI patients and one normal hearing participant.
- All CI subjects use a (hybrid) implant device which preserves low frequency acoustic hearing and involves insertion of a short electrode in the basal turn of the cochlea to provide electrical high frequency hearing
- Subjects listened to 2-min blocks of continuous sentences in noise [1] or noise alone (matched on RMS sound level); On a given run for speech in noise (+7 dB), 30 unique sentence tokens (~2.5 sec length) were presented (1.5 sec inter stimulus interval); We acquired 12 scans (6 each condition, random order) to allow for single subject inference; PET data were analyzed in SPM12 using a flexible factorial model

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<th>Subject demographics</th>
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<td>Age</td>
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<td>CI-01</td>
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<td>CI-02</td>
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<td>CI-08</td>
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<td>Group</td>
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All subjects were hybrid CI users with residual low frequency acoustic hearing bilaterally, and an implant on one side.

Image sum

- Two subjects (CI-02 and CI-03) were scanned one month before activation and within one month of activation, both were performing well. The remaining five subjects were established, successful CI users.

Subject audiogram

- Residual acoustic hearing is typically within the mild to moderate hearing loss range up to 1kHz.

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### 3 Results

**CI single subject PET results: Speech-in-noise vs. Noise**

CI-02 (Left implant)  
CI-01 (Right implant)  
CI-03 (Left implant)  
CI-04 (Left implant)  
CI-05 (Right implant)  
CI-07 (Left implant)  
CI-08 (Right implant)  

In every subject bilateral activity is seen in auditory and inferior frontal cortex. Images are oriented to show inferior frontal activity bilaterally, and are displayed at p<0.05 whole brain threshold. Peak activity in each subject was observed in planum temporale.

**CI group PET results: Speech-in-noise vs. Noise**

Activation was observed in the group results in additional areas to bilateral auditory and inferior frontal cortex, which included: supplementary motor cortex, premotor cortex, intraparietal sulcus, dorsolateral prefrontal cortex, hippocampus, insula, supramarginal gyrus, and angular gyrus. Images are displayed at p<0.05 whole brain threshold.

**Normal hearing control subject PET results: Speech-in-noise vs. Noise**

NC-02

Single subject normal control with same stimulus. Hearing screen results were below 25dB HL at 0.5, 1, 2, and 4 kHz. No activation was observed in inferior frontal cortex at p<0.05, however at the more relaxed threshold of p<0.1 bilateral inferior frontal activity was observed. Lines denote orthogonal section locations.

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### 4 Conclusions

- Successful demonstration of network for SIN at single subject and group level
- The two subjects scanned immediately before and after implantation do not show striking changes in the fronto-temporal network, but we propose further experiments to look at this sequentially over a period of two years
- The further analyses will specifically test the hypothesis that auditory cortex activation changes over a period of months after implantation and that the inferior frontal activation reflects listening effort that will decrease during hearing rehabilitation

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**References**


**Contact information**

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