**Declining Structural Integrity of Speech-Related Temporal Lobe Cortex Predicts Age-Related Declines in Word Recognition**

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**Introduction**

- Speech recognition becomes more difficult and effortful with age, even for normal hearing listeners (see Refs. and others, 1980; Dubno et al., 1996).
- Speech recognition is particularly affected in older adults when listening conditions are demanding (Sommers and Danielson, 1999; Gordon-Salant and Fitzgibbons, 2001, 2004; Dubno et al., 2005, 2006).
- Neural systems that support cognitive control are engaged in demanding listening conditions (Dubno et al., 2005).
- Age-related increases in the engagement of cognitive control systems have been observed, as demonstrated by increased frontal activity during perceptual and memory tasks (Fernandes et al., 2006; Moffat et al., 2006; Cabeza et al., 1997; Grady et al., 2007; Rypma and D’Esposito, 2000).
- We examined the extent to which age-related structural and functional changes within speech and cognitive control systems predicted age-related declines in word recognition.

**Methods**

**Participants**

<table>
<thead>
<tr>
<th>Age</th>
<th>Younger</th>
<th>Older</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>M</td>
<td>F</td>
</tr>
<tr>
<td>Age</td>
<td>28.8 (6.7)</td>
<td>70.5 (5.9)</td>
</tr>
<tr>
<td>Edinburgh Handedness</td>
<td>90.0 (9.7)</td>
<td>94.4 (9.4)</td>
</tr>
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**Functional Imaging**

- Sparse sampling image acquisition: TR = 8 s, TA = 1.64 s, TE = 30 ms, 36 slices, 64 x 64, 3 mm thick.
- Realignment, artifact analysis, normalization, and 8mm kernel smoothing was performed using the Artifact Repair Toolbox and SPM5.

**Structural Imaging**

- Image Acquisition: TR = 8.13 ms, TE = 3.7 ms, 160 slices, 256 x 256, 1 mm thick.
- Unified segmentation and DARTEL normalization (Ashburner and Friston, 2000; Shmueli, 2007) were performed to normalize, segment, and bias field correct the images.

**Results**

- Younger adults exhibit greater gray matter volume than older adults within speech and attention-related regions shown in Figs 3, 4, and 5.
- Age group differences in gray matter volume were significant for left hemispheric auditory cortex, superior temporal gyrus, and anterior cingulate cortex. (ACC) and bilateral anterior insula / frontal operculum activity for incorrect vs. correct responses (peak voxel t = 3.7, cluster p < .01). Similar results were observed for decreasing word intelligibility.

**Discussion**

- The results of this study indicate that the speech recognition difficulty experienced by older adults stems, in part, from declines in speech-related auditory cortex.
- The results of this study also are consistent with evidence that speech recognition is particularly affected in older adults when listening conditions are demanding (Dubno et al., 2005). Indeed, the relation between word recognition and speech-related auditory cortex was most robust when words were recognizable, but difficult to recognize because of filtering.
- The association between speech-related auditory cortex morphology and word recognition was independent of the degree of hearing loss. This indicates that both age-related declines in peripheral and central auditory systems contribute to the communication problems of older adults. The significance of central declines may be most prevalent in challenging listening conditions where top-down modulation may enhance speech recognition.
- The age-related change in ACC activation appears to reflect the engagement of the ACC regardless of whether older adults with neurobiologically based language learning disability may be at particular risk for age-related speech recognition problems.
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