

Behavioural and neural correlates of age-related speech perception deficits



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Aujourd'hui Québec, demain le monde



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Introduction

Amongst the difficulties experienced by elderly adults, a highly prevalent and disabling problem is a decline in the ability to comprehend speech, particularly in challenging situations. These difficulties reduce the effectiveness of communication as a whole, and can lead to decreased social participation. Despite the importance of communication on quality of life, the extent of these difficulties is not well understood. The objectives of the present study were (1) to characterize age-related changes in the ability to discriminate speech sounds in challenging situations (presence of more than one speaker and degraded stimuli quality), (2) clarify the role of auditory sustained attention in the aetiology of speech perception deficits, and (3) evaluate the neurofunctional changes associated with age-related speech perception decline.

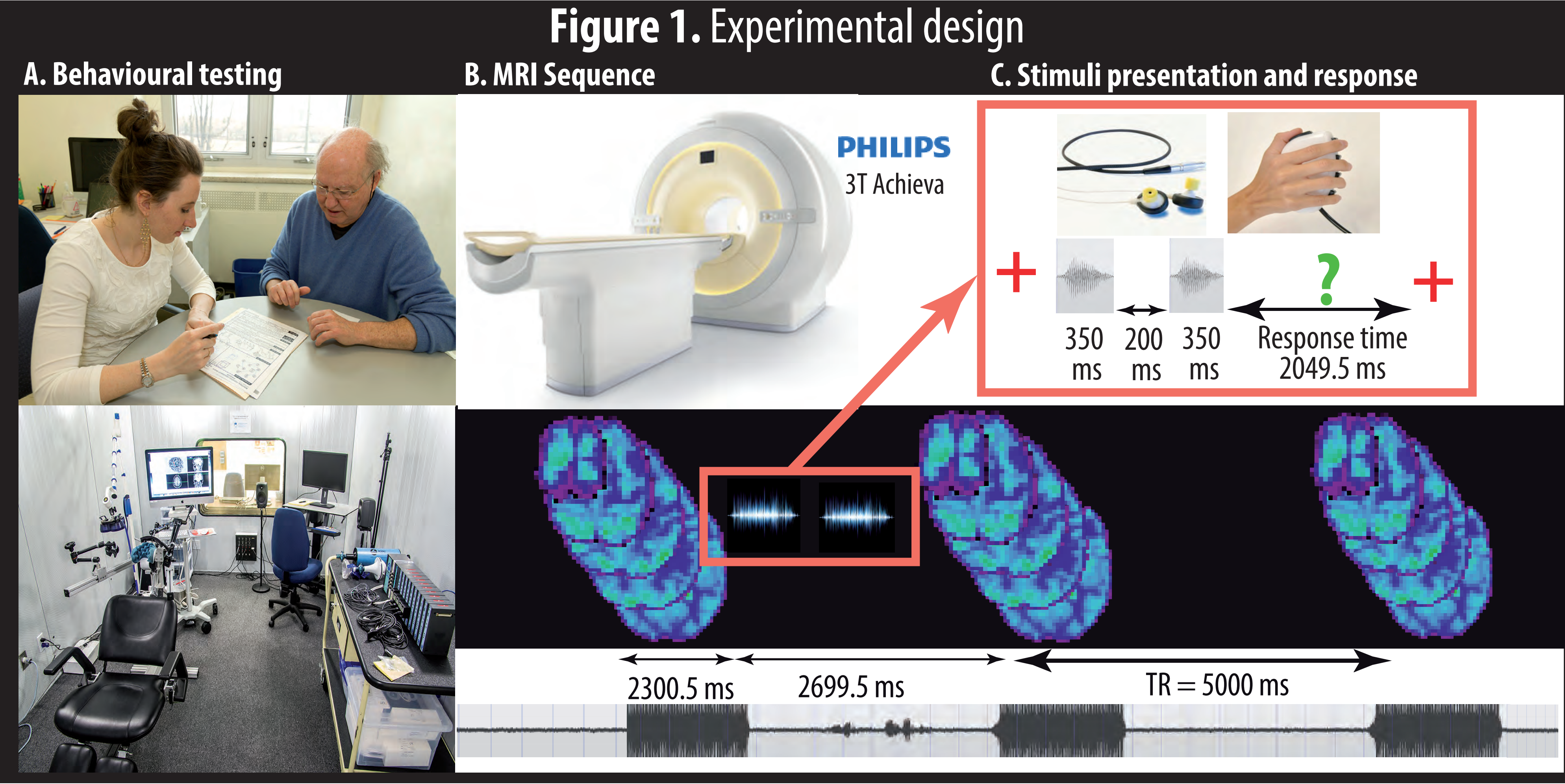
Methods

Behavioural study:

- 69 healthy adults (30 males, 19-87 years, mean 52.4±20 years).
 - Cognitive assessment (MOCA), test of sustained auditory and visual attention (IVA)
 - Comprehensive hearing assessment.
 - Two-alternative forced choice task: 360 identical syllables (/fe/ vs. /fe/) and 360 different pairs (e.g. /fe/ vs. /se/).
 - 3 intelligibility levels: **low** (-5dB SNR), **mid** (15 dB SNR) and **high** (no pink noise).
 - The same token was never repeated. On each trial, there was **1 or 2 speakers**.
- 3x2x3 ANCOVAs on syllable discrimination accuracy and speed, with Intelligibility and Speakers as within subject factors, and Age (young, middle-aged and older) as between-subject factor, and hearing and vigilance as covariates.

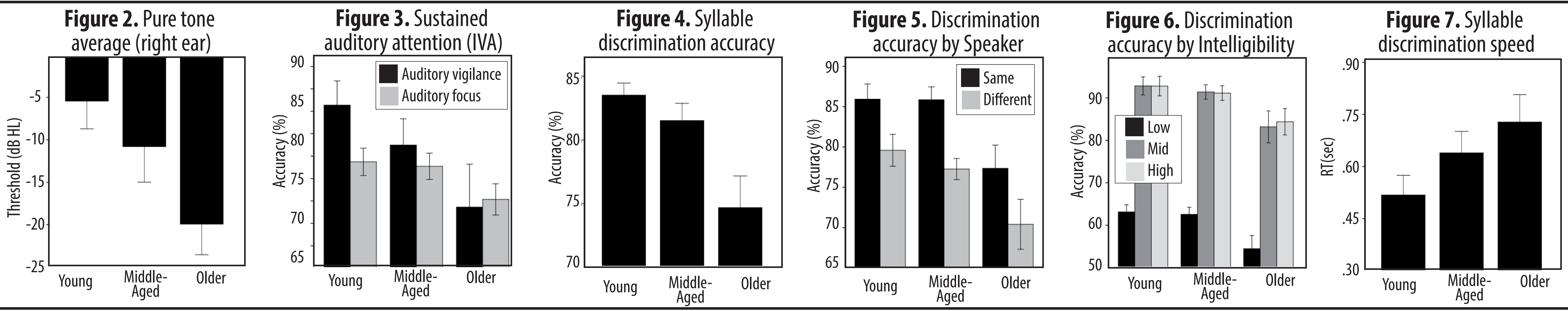
MRI Study:

- 16 adults (8 young: mean 25y/o; 8 older: mean 58 y/o) underwent a short version of the speech task using a sparse sampling paradigm with parallel imaging (43 axial slices 3mm³, TR = 5s, delay in TR = 2.7s; SENSE = 2) (**Fig. 1**).
- fMRI data were pre-processed using AFNI, and convolved with a 2 parameter SPM response model and entered in a 3x2x3 ANCOVA (3dLME) (same as for the behavioral data (with the exception that Group has only 2 levels: young, older).



Results

With age, hearing declines (**Fig. 2**) and so does sustained auditory attention in terms of vigilance ($F_{(2,66)} = 11.17, p \leq .00007$), focus ($F_{(2,66)} = 8.95, p \leq .00037$) and speed ($F_{(2,66)} = 3.49, p \leq .036$) (**Fig. 3**). Overall accuracy in the syllable discrimination task declines with age ($F_{(2,64)} = 31.89, p \leq .00001$), while speed (RT) increases ($F_{(2,64)} = 11.027, p = .00008$) (**Fig. 4**). The ANCOVA on discrimination accuracy revealed a main effect of Age ($F_{(2,62)} = 9.48, p \leq .00001$), Vigilance ($F_{(1,62)} = 4.91, p = .03$), Speakers ($F_{(1,62)} = 11.36, p = .001$) and Intelligibility ($F_{(2,64)} = 11.027, p = .00008$) but not hearing. There was a significant interaction between Age and Speakers ($F_{(2,62)} = 5.38, p = .007$) (**Fig 5-6**). The ANCOVA on discrimination speed revealed a main effect of Age ($F_{(2,62)} = 4.73, p = .012$), Vigilance ($F_{(1,62)} = 15.43, p = .00008$), and Intelligibility ($F_{(2,124)} = 3.99, p = .021$) but not Speakers or hearing and no interaction (**Fig. 7**).



A conjunction analysis revealed that the robustness of the core speech processing network is less stable in older compared to younger adults [less participants showing significant activation] (Fig.8). Controlling for hearing and attention, we found, for the two Speaker conditions, a decline in the BOLD signal in the right AI and a bilateral increase in the parieto-occipital sulcus and precuneus for the older adults (Fig. 9).

Figure 8. Core speech processing network (Conjunction of all conditions)

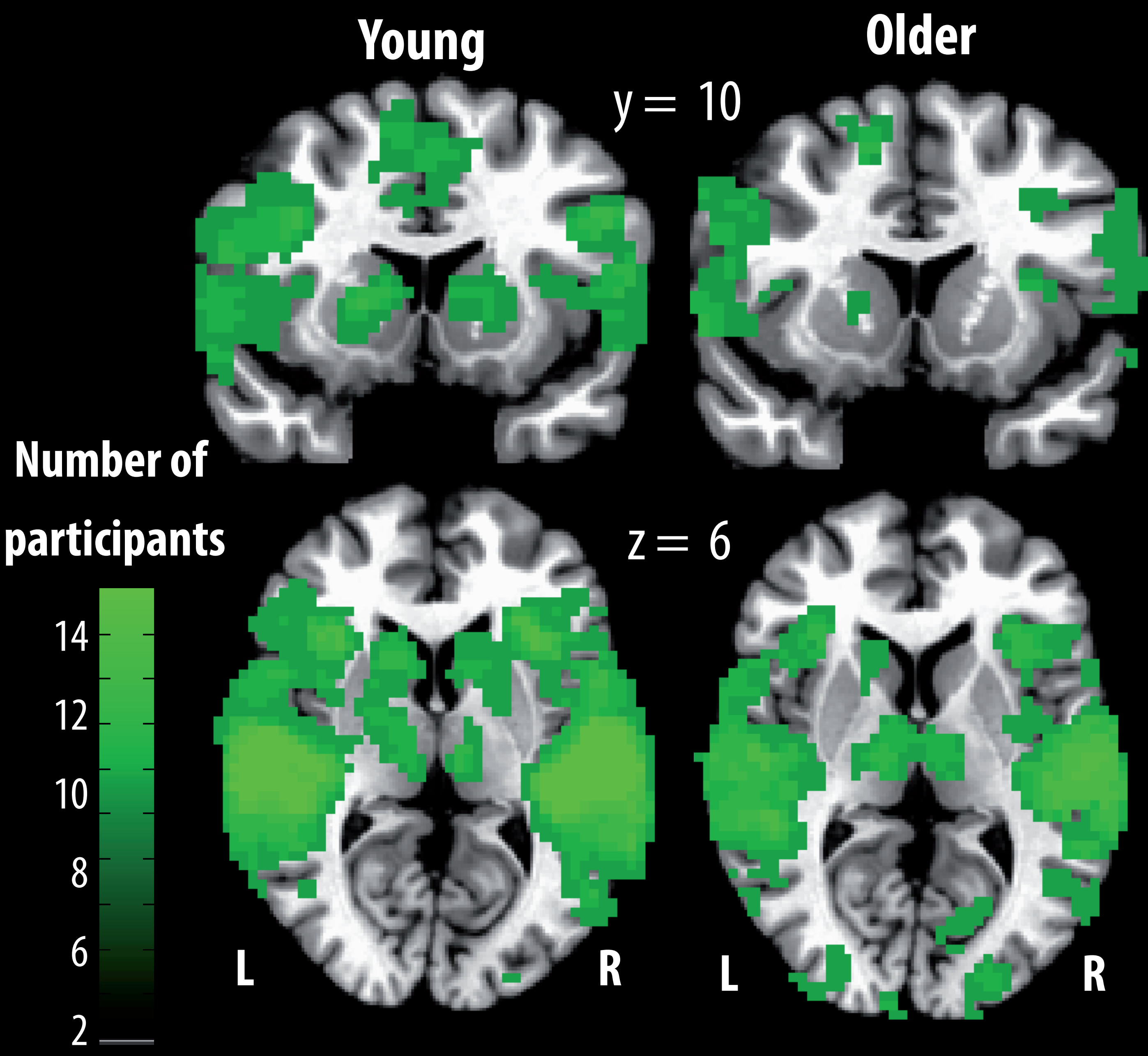
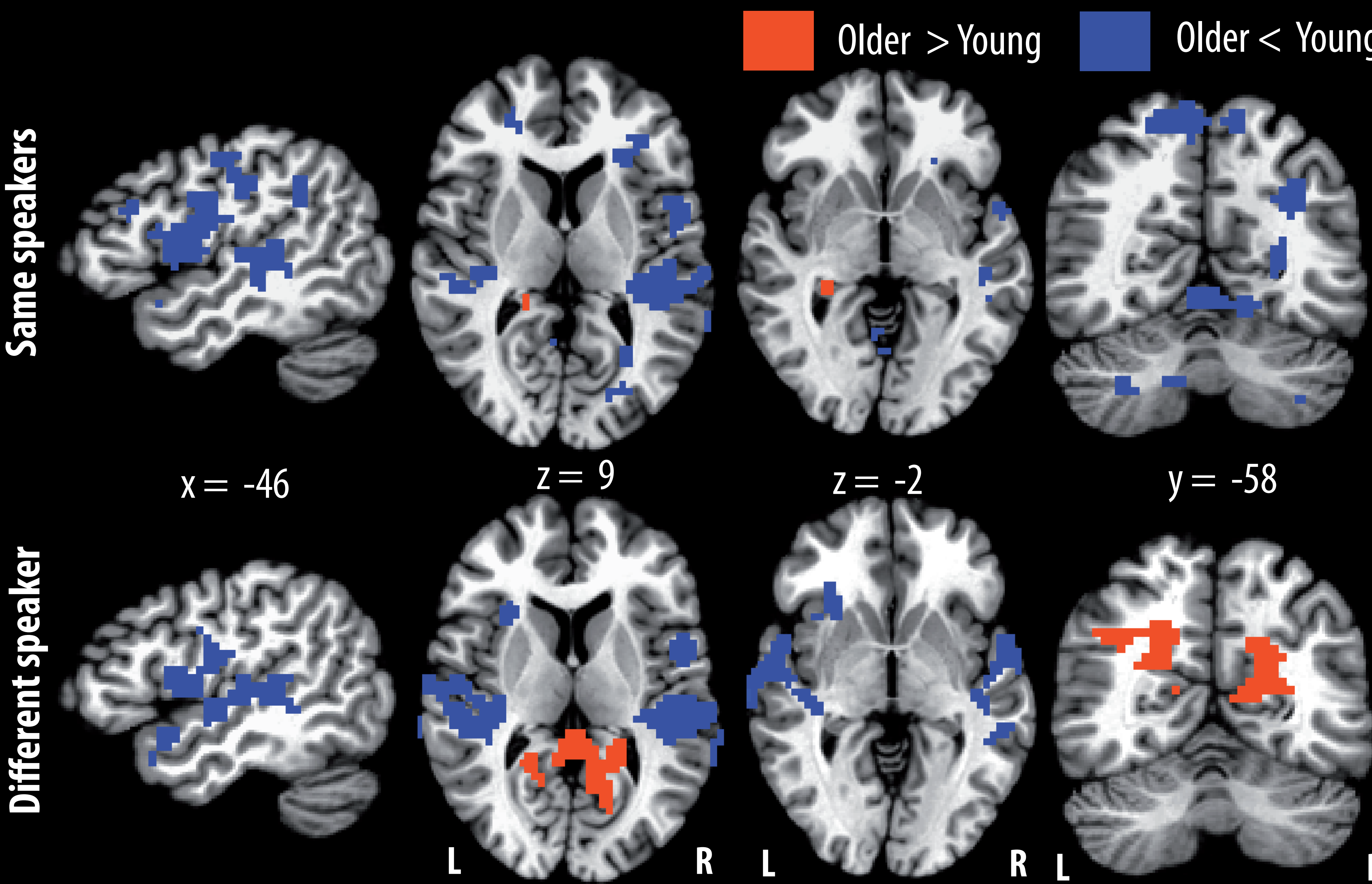


Figure 9. FWE corrected Age x Speaker interaction



Discussion and conclusions

The present study provides evidence that auditory sustained attention declines with age, and that this decline contributes to difficulty discriminating speech sounds. However, controlling for attention and hearing, our results reveal that the presence of more than one speaker is also an important factor contributing to age related speech perception decline. Moreover, our results also demonstrate evidence of neural reorganization within cortical and subcortical structures that may be associated with performance. Further analyses are underway to explore the interaction between Intelligibility and Speakers on the brain's response during speech perception in young and older adults.

Acknowledgments

