Cortical and subcortical aging and speech motor control

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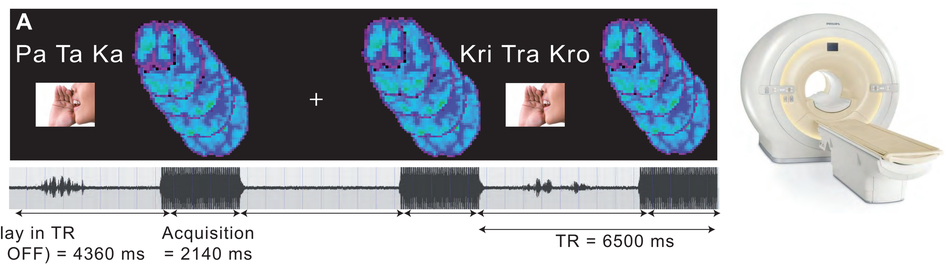
Introduction

The speech production system undergoes several changes in aging (decrease in loudness, changes in fundamental frequency, reduced speech rate, etc.). Preliminary results from our lab suggest an age-related decline in the ability to produce sequences of syllables and non-speech oro-facial movements. The objective of this study was to examine the neurobiological underpinning of speech sequencing in young and older healthy adults.

Figure 1



Material and Methods

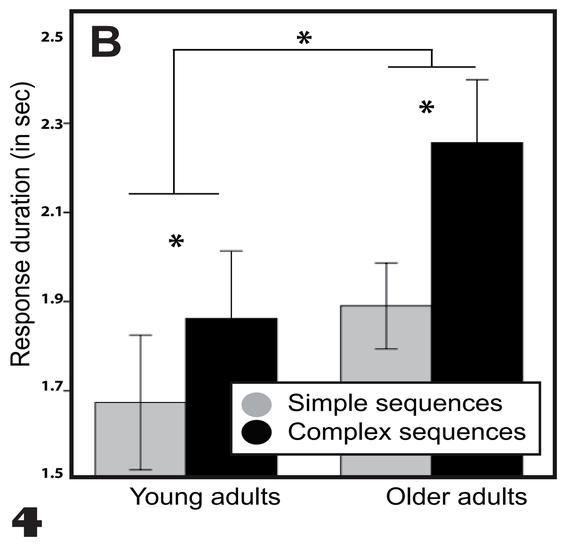
• Participants: 15 young (26.8±4.8 years; 9 women) and 15 older adults (68±3.9 years; 10 women). Participants were asked to repeat visually presented meaningless sequences of syllables. The sequences were either simple, consisting of one syllable repeated 6 times (pa-pa-pa-pa-pa-pa) or complex, with 3 different syllables each repeated twice (pa-ta-ka-pa-ta-ka). All responses were produced while the MRI gradients were turned off (**Fig. 1**), and recorded. Structural and functional MRI images were acquired on a Philips Achieva TX 3 T. EPI sequences: 40 axial slices, 3 mm3; TR = 6.5 sec, delay in TR = 4.36 sec.

• Model-free first-level regression; group-level linear mixed effect (LME) analysis (AFNI 3dLME program) with sequence complexity as within-subject factor, group and sex as between-subject factors and response duration as a within-subject continuous covariate.

Main results

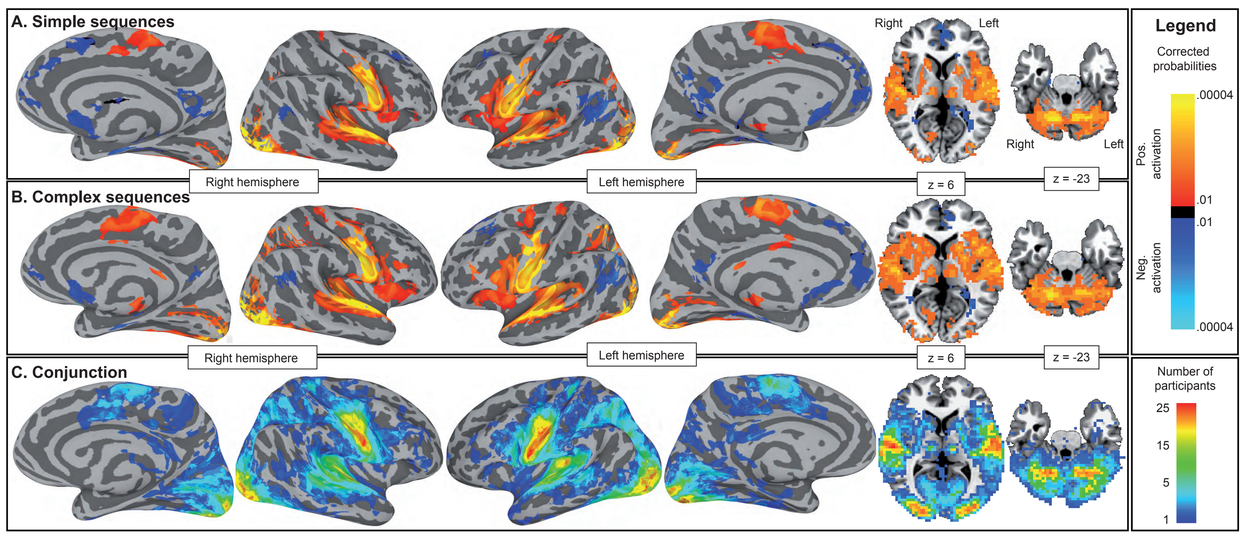
1. BEHAVIOUR. The main age-related difference (**Fig. 2**) was an age-related increase in response duration, particularly for the complex sequences.

Figure 2



2. SEQUENCING. The global speech network is illustrated in **Fig. 3.** Sequence complexity effects were found in several areas including the left dorsal anterior insula (daIns), left thalamus and left putamen (**Fig. 4a**). Age x Sequence complexity interactions were found in a more distributed network (**Fig. 4b**) including the left M1v, daIns, STS, superior parietal cortex (sPar), intraparietal sulcus (IPS), and anterior cingulate (aCing).

Figure 3



3. COMPENSATION. Evidence of neural compensation was found in the daIns (**Fig. 5ab**), in the form of an increase in activation for the complex sequences for the older adults. Older adults who exhibited stronger activation also showed faster responses (**Fig. 5b**)

Figure 4

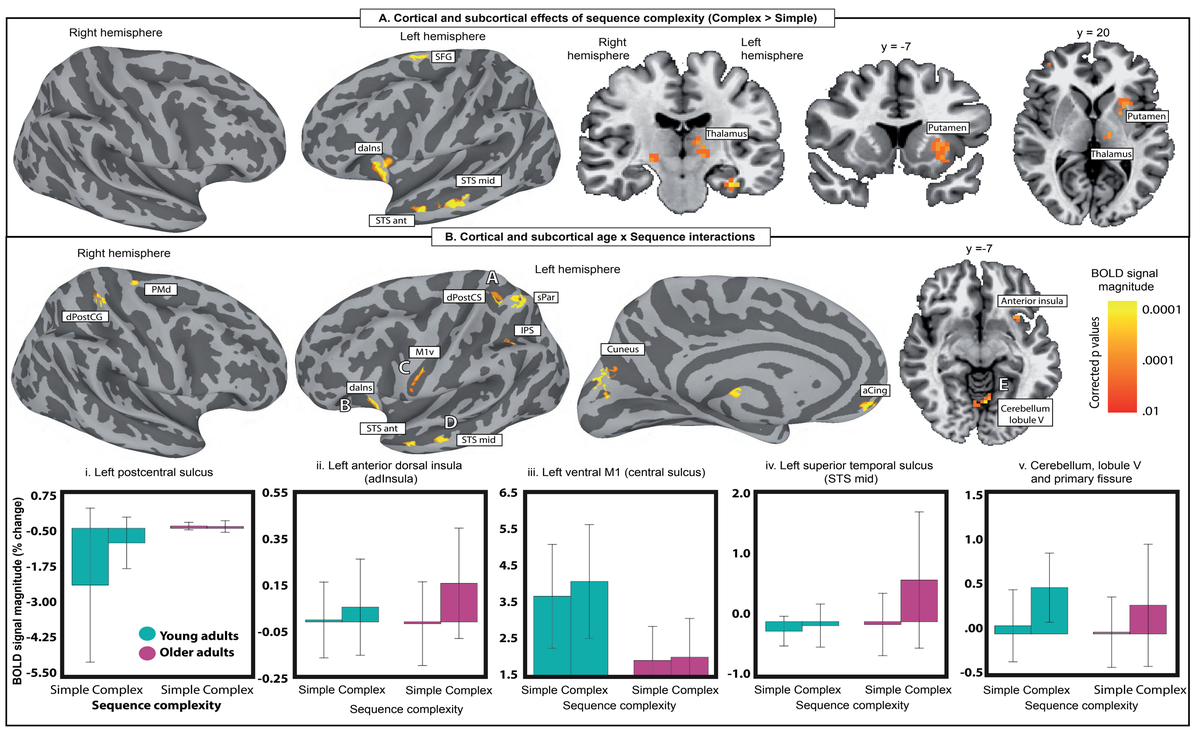
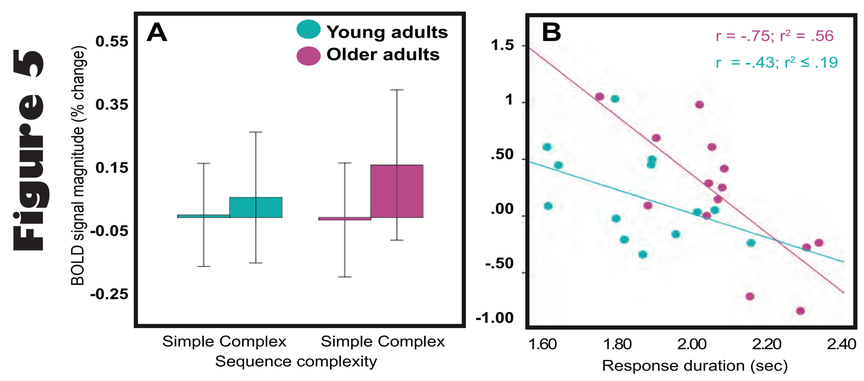


Figure 5



4. RESPONSE DURATION. In the caudate, putamen/thalamus and cerebellum, an increase in BOLD signal magnitude associated with worse performance was found in older compared to young adults (dedifferentiation) (**Fig. 6**). The most common cortical pattern was an age-related loss of BOLD/behaviour relationship, that is, in young adults, stronger BOLD signal in several cortical areas was associated with faster responses; this relationship faded in older adults (**Fig. 7**).

Figure 7

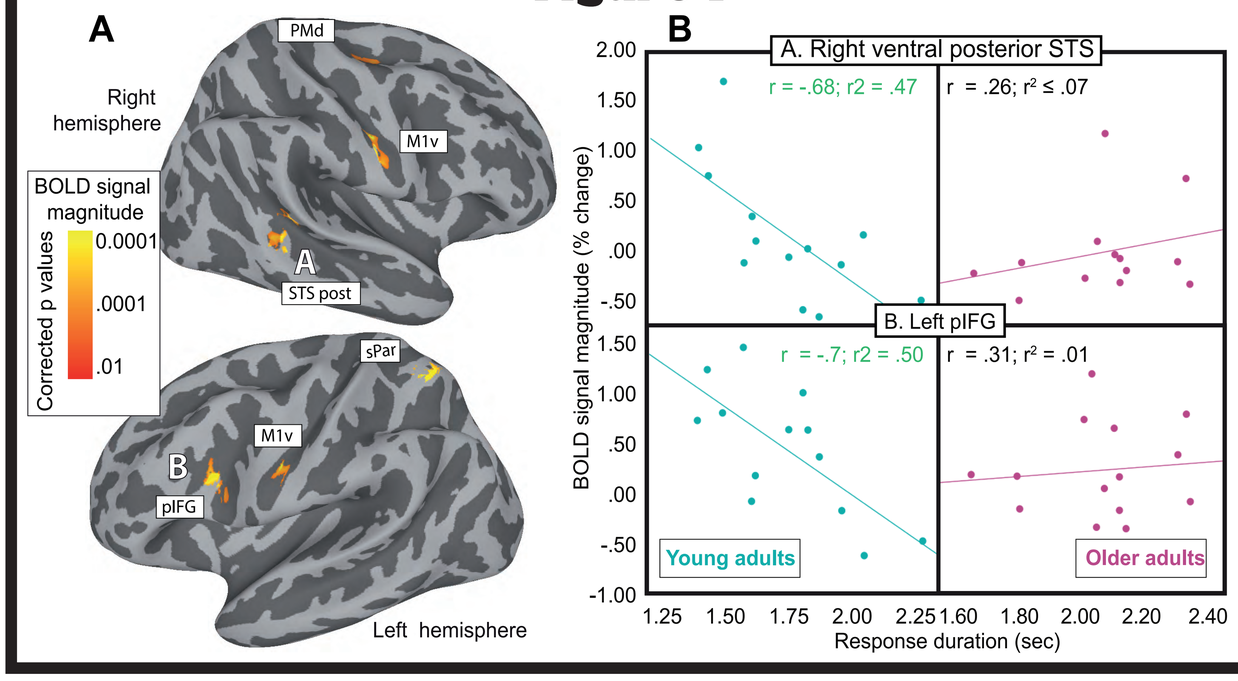


Figure 6

Discussion and conclusions

The present cross-sectional findings offer an important snapshot into the multi-faceted neurobiology of aging, highlighting the various neural mechanisms involved (de-differentiation, decline in neural processing and compensation) and their effects on speech production. The present results also emphasize the important role of the insula in maintaining speech skills throughout aging.

Acknowledgments

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