Compromised temporal responsivity in fusiform areas by aging

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Introduction

One of effective ways to compensate age-related memory decline is repetition. Previous studies showed that it eliminated the age-related decline in memory performance [1][2]. Recent study showed that neural mechanism underlying the effect did not differ between young and elderly groups [3]. However, they examined it with relatively small repetition numbers (e.g. [4]), and with line drawings including impossible figures. In order to study the aging effect on neural mechanism of visual repetition, we performed an fMRI study on it with longer time-constant and natural scenes.

Materials and Methods

Participants were 46 healthy adults (23 young, 11 female, age 21.7±1.6 years; 23 elderly with normal performance, 12 female, age 67.2±3.2 years). We adapted a novelty encoding task from Golby et al. [5] but with original stimulus sets. Participants were presented with a same pair of indoor and outdoor photos repeatedly for five blocks (each block contains eight trials of three seconds), and instructed to judge indoor or outdoor by button press. The study was performed with MAGNETOM Trio, A Tim System (Siemens) and VisuaStimDigital for MRI (Resonance Technology Inc.). Functional images were obtained using GRE-EPI sequences (Slices = 39, TR = 2000ms, TE = 24ms, FA = 90, Thickness = 3mm, Gap = 0.75mm, FOV = 192mm, 64x64). All the fMRI data were analyzed using standard SPM5 preprocesses and random effects analysis (The FIL methods group) under Matlab 7.5 (The Mathworks). The first two blocks (eight repetitions for each scene) were compared with the last two blocks for Young and Elderly. Thus, the factorial design was 2x2; Group (Young vs. Elderly) and Sequence (First vs. Last).

Results

Behavioral data showed over 98% of Hit Rates for both groups. Reaction times showed age-related slowing: 597±91 ms for Young and 713±107 ms for Elderly. fMRI data showed the interaction Group x Sequence in regions including fusiform areas, superior, middle, and inferior occipital lobe, cuneus, and calcarine sulcus, all bilaterally (Figure 1, left). Maximum effects were found within bilateral fusiform gyri (33, -57,-11; -36, -75, -8), in which task-related deactivation were modulated by age (Figure 1, right). The interaction showed less deactivation for Elderly group during initial repetition blocks, though it was relatively comparable during last blocks.

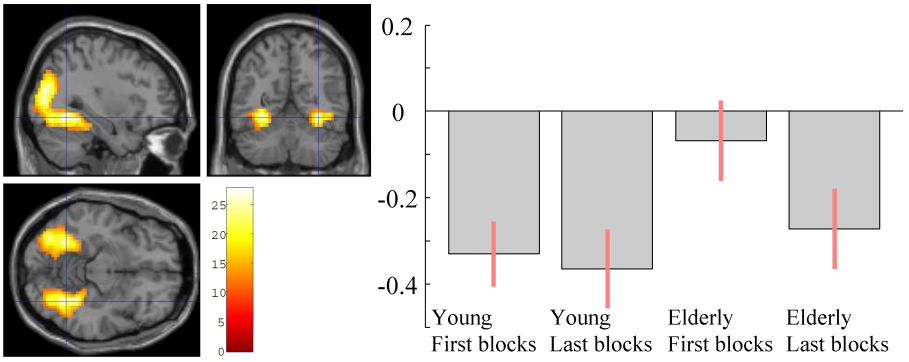

Figure 1. The interaction Group (Young vs. Elderly) x Sequence (Initial vs. Last). Left, the activation maps showing areas involved. Right, bar graphs illustrating task-relevant repetition effect in the right fusiform gyrus. Note diminished repetition effect for Elderly First blocks in contrast with comparable Last blocks for both Groups.

Discussion

The results from the present study revealed neural substrates sensitive to visual repetition. For Young group, these areas showed rapid floor effects, and did not show much difference between initial and last blocks. The effect for the Elderly group, however, showed clear discrepancy. The decrease in the first blocks was much smaller than that for Young group, whereas the decrease in the last blocks was comparable. The results suggest that the Elderly group has longer time-constant for the visual repetition effect in the neural level to take place. Previous studies indicated that activation decrease in fusiform area is related to the progress of familiarity acquisition [4]. The present results seem to support the conclusion that the aging effect on visual repetition is represented by the compromised 'slew rate' i.e., temporal responsivity in the fusiform gyri, and also proposes the view of neural time-constant modulation in the aging process.

References

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