THE NEURAL BASIS FOR THE AGE-RELATED POSITIVITY EFFECT IN LANGUAGE PROCESSING

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Title: The neural basis for the age-related positivity effect in language processing.

Target audience: Researchers who are interested in the neural mechanisms of age-related cognitive changes

Purpose: Memorization is fundamental to online human communication. However, many elderly experience memory decline with aging, which often hampers fluent communication. In order to facilitate elderlies' memory performance, positive emotions have been shown to have a beneficial effect [1] (e.g., pictures, episodes). Particularly, elderly are more likely to retrieve positive memories compared to negative ones (i.e., age-related positivity effect). However, the neural correlates of this bias has not yet been clarified within the language domain. The present study aims to assess the age-related neural changes particularly concerning the role memory plays during emotional sentence processing, by employing functional magnetic resonance imaging (fMRI).

Methods: Thirty healthy right-handed young adults (14 males, age 22.6±3.0) and 30 healthy right-handed elderly adults (14 males, age 69.2±4.2) participated in the experiment (3T MR Siemens Trio/Tim) in accordance with the local ethics regulations. *Behavioral data acquisition*: A sentence judgment task and a subsequent surprise sentence recognition task were administered. In the first task, the participants were visually presented with simple emotional sentences, each of which included either a positive, negative, or neutral adjective followed by an object (e.g. "Ken finished the sociable/foul/final meeting."). At this stage, no mention was made about what would follow in the next task. In the subsequent task (after a short break), the participants were asked to judge whether the sentence was newly presented or not. *fMRI data acquisition:* Functional images were obtained by using a T2* weighted GRE-EPI sequences with the following parameters: TE = 30 ms, TR = 2500 ms, flip angle = 90°, matrix 64 × 64, field of view = 192 mm, 39 axial slices, slice thickness = 3mm, and distance factor = 25%. For each EPI run, 170 volumes were acquired. We also obtained a three-dimensional MPRAGE high-resolution T1-weighted image for anatomical detail. *fMRI data analysis*: First-level contrasts for each condition of the task were entered into second-level, random effects analyses of variance (ANOVA) on the basis of the general linear model using SPM 8 (Wellcome Department of Cognitive Neurology, London, UK).

Table 1

Interaction between emotional valence and age group on recognition of previously-presented sentences

	H	Voxels	MNI			*z*-value
Pos. > Neut, Elderly > Young			X	Y	Z	
Putamen	R	49	20	-14	0	5.93
Putamen	L	28	-18	15	-3	5.32
Insula	R	4	51	9	-6	5.16
Neg. > Neut, Elderly > Young						
No regions						
Pos. > Neut, Young > Elderly						
Postcentral Gyrus	L	57	-50	-21	63	5.59
Neg. > Neut, Young > Elderly						
No regions						

Notes: H: hemisphere. $p < 0.05$ (FWE corrected)

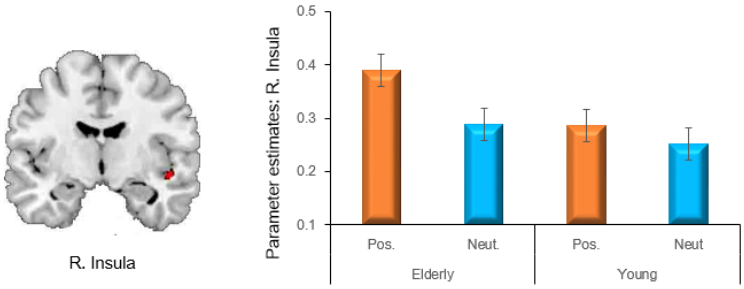

Figure 1. Insula activiy during a surprise recognition task of emotional sentences. Elderly group revealed greater activation when recognizing positive emotional senteces compared with neutral ones. Error bars indicates standard error.

Results: *Behavioral data*: A two-way ANOVA using age group and emotional valance in the sentence recognition task revealed that the young group more accurately recognized previously read sentences compared to the elderly group ($F_{1, 165} = 76.789$, $\eta_p^2 = 0.318$, $p = 0.000$). The accuracy rate did *not* significantly differ depending on the emotional valence ($F_{2, 165} = 0.847$, $\eta_p^2 = 0.010$, $p = 0.435$). Also, the interaction effect between the two factors was not significant ($F_{2, 165} = 0.369$, $\eta_p^2 = 0.004$, $p = 0.692$).

fMRI data: As shown in Table 1, group analyses of the second task (i.e., the surprise recognition task) indicated that, compared to neutral sentences, the elderly group's recognition of positive emotional sentences recruited regions including the bilateral putamen and the right insula, while the left postcentral gyrus was recruited for the younger group. No supra-threshold regions were found for recognition of negative emotional sentences in comparison with that of neutral ones in the both age groups ($p < 0.05$ FWE corrected).

Discussion: Although emotional valence did not explicitly moderate behavior within sentence recognition both in young and elderly groups, neural activity during the task showed particular interaction effects between emotional valence and age group. Among the enhanced regions for recognizing positive emotional sentences, the insula is known to be involved in emotional awareness [2]. Our results suggest that the insula might reflect the elderlies' greater awareness to positive emotional sentences (Figure 1).

Conclusion: The present fMRI study indicates a potential role for the right insula in the age-related positivity bias within the language domain. Future studies are required to examine how the elderlies' individual memory ability moderates the insula activity.

References: [1] Reed et al. 2012, Front. Psychol. 3, 339. [2] Gu et al. 2013, J. Comp. Neurol. 521, 3371-3388.