

# The Dorsomedial Prefrontal Gray Matter Density Enhances Elderly's Positivity Effect in Emotional Sentence Retrieval

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## INTRODUCTION

Memorization is fundamental to human communication. However, elderly experience memory decline with aging thereby hampering fluent communication. In order to facilitate elderly's memory performance, positive emotions have been shown to have a beneficial effect (Reed, et al., 2012): They are more likely to retrieve positive memories compared to negative ones (i.e., the age-related positivity effect, Mather & Carstensen, 2005). However, the neural basis underlying this effect within the language domain remains unclear. Using functional magnetic resonance imaging (fMRI) we assessed in what way age-related changes influence the role positive emotion plays during sentence processing.

## METHOD

**Participants:** Twenty healthy right-handed young adults (10 males, age  $23 \pm 3$ ) and 20 healthy right-handed elderly adults (11 males, age  $69 \pm 4$ ) participated in the experiment on a 3T MR scanner (Siemens Trio/Tim).

**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. 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 =  $90^\circ$ , matrix  $64 \times 64$ , FoV = 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.

**Behavioral data analysis:** We calculated accuracy rate of the sentence retrieval task as ratio of hit plus correct rejection to the total number of trials.

**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).

**VBM analysis:** The structural images were preprocessed using VBM8 toolbox (<http://dbm.neuro.uni-jena.de/vbm>) implemented in SPM8, and then explored regions showing correlation of the gray matter volume (GMV) with the elderly participants' positivity effect of behavioral data within the SPM8 second level analyses.

### Positive

- 勇太は**なごやかな**会談を終えた。  
Yuta finished the **sociable** meeting.

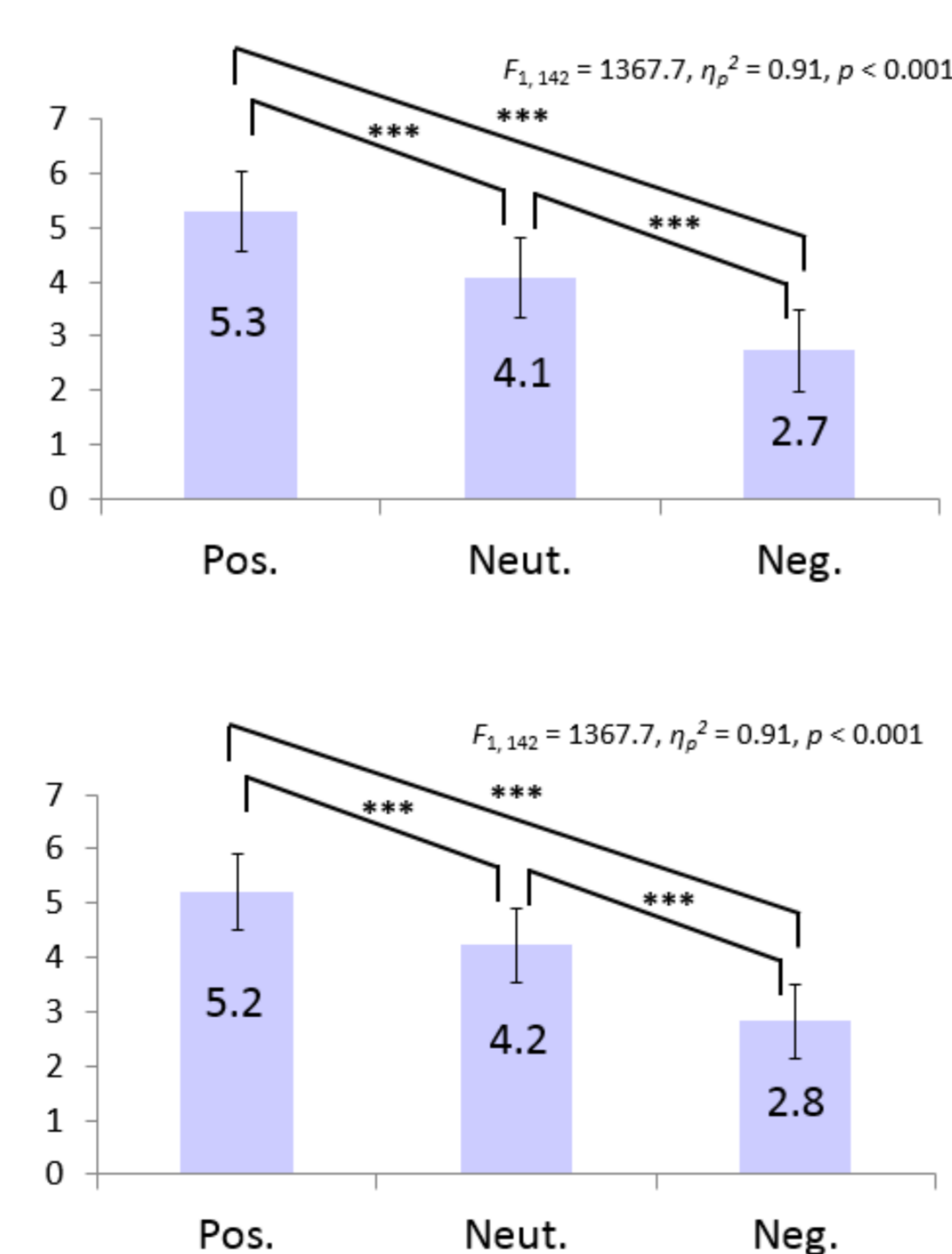
### Neutral

- 勇太は**最終の**会談を終えた。  
Yuta finished the **final** meeting.

### Negative

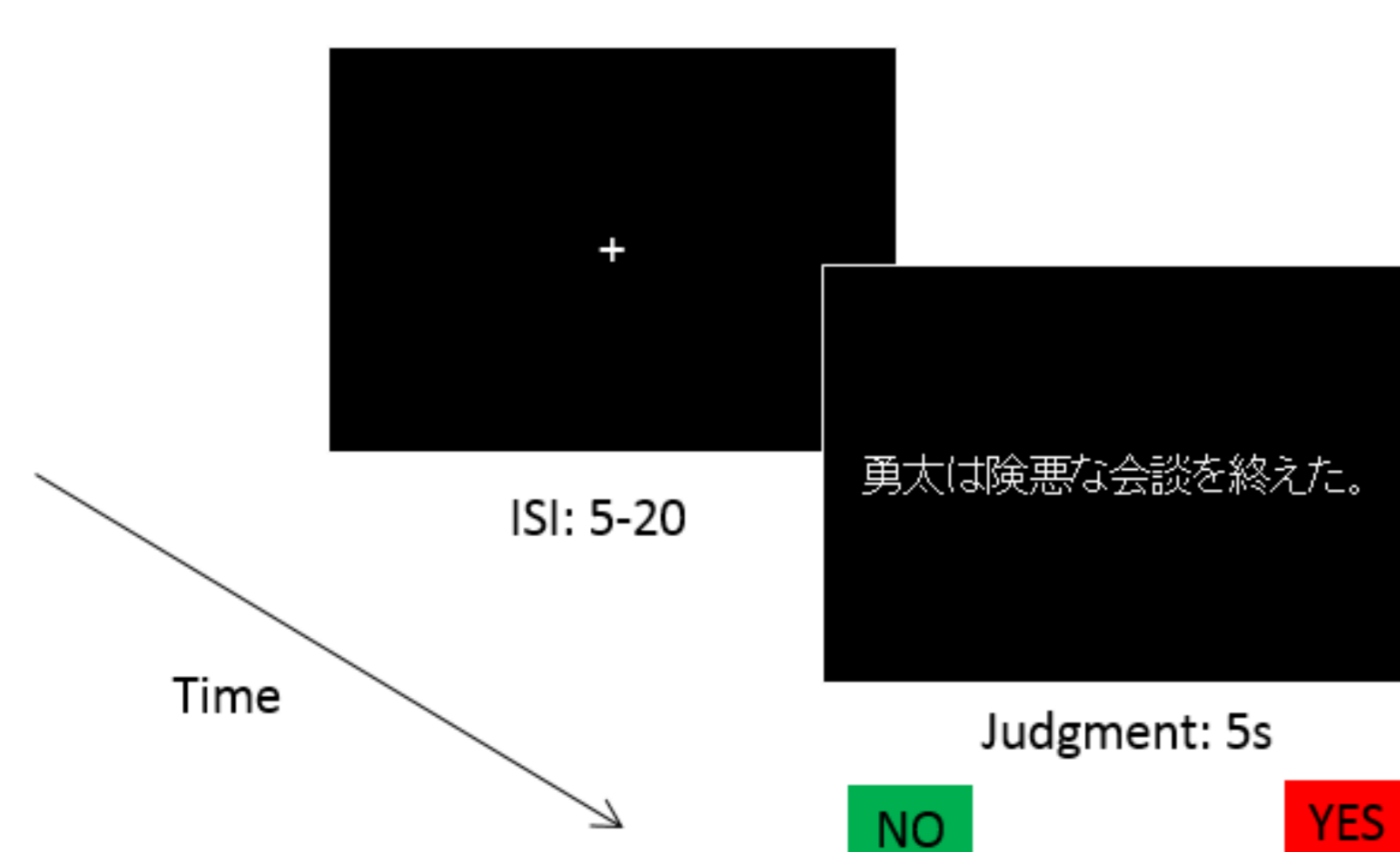
- 勇太は**険悪な**会談を終えた。  
Yuta finished the **foul** meeting.

Manipulation check of emotional valence (7-point scale, N = 221)



Task 1:  
Sentence correctness  
judgment (to memorize)  
Correct or not?

Task 2:  
Sentence retrieval  
Old or new?



## RESULTS

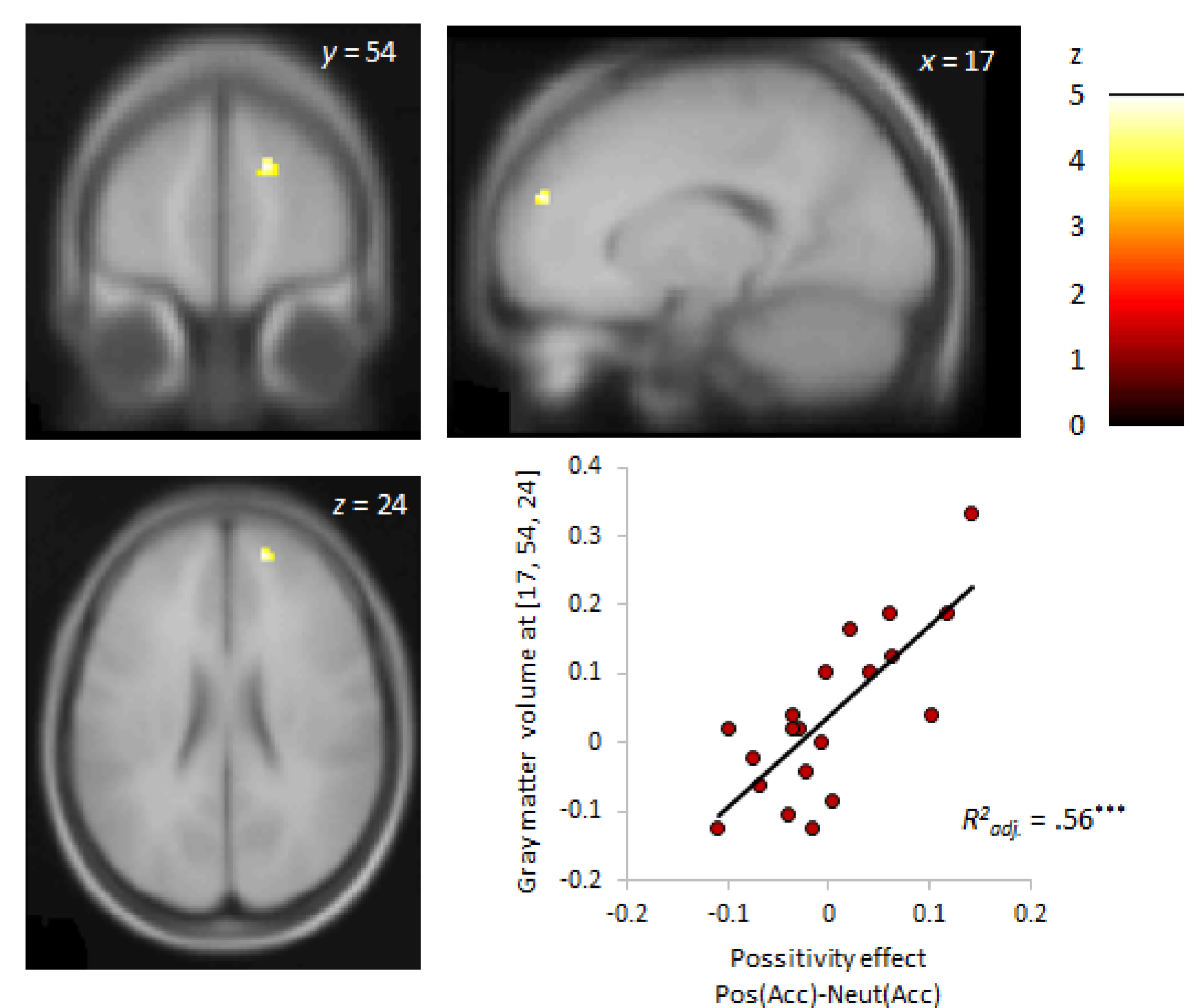
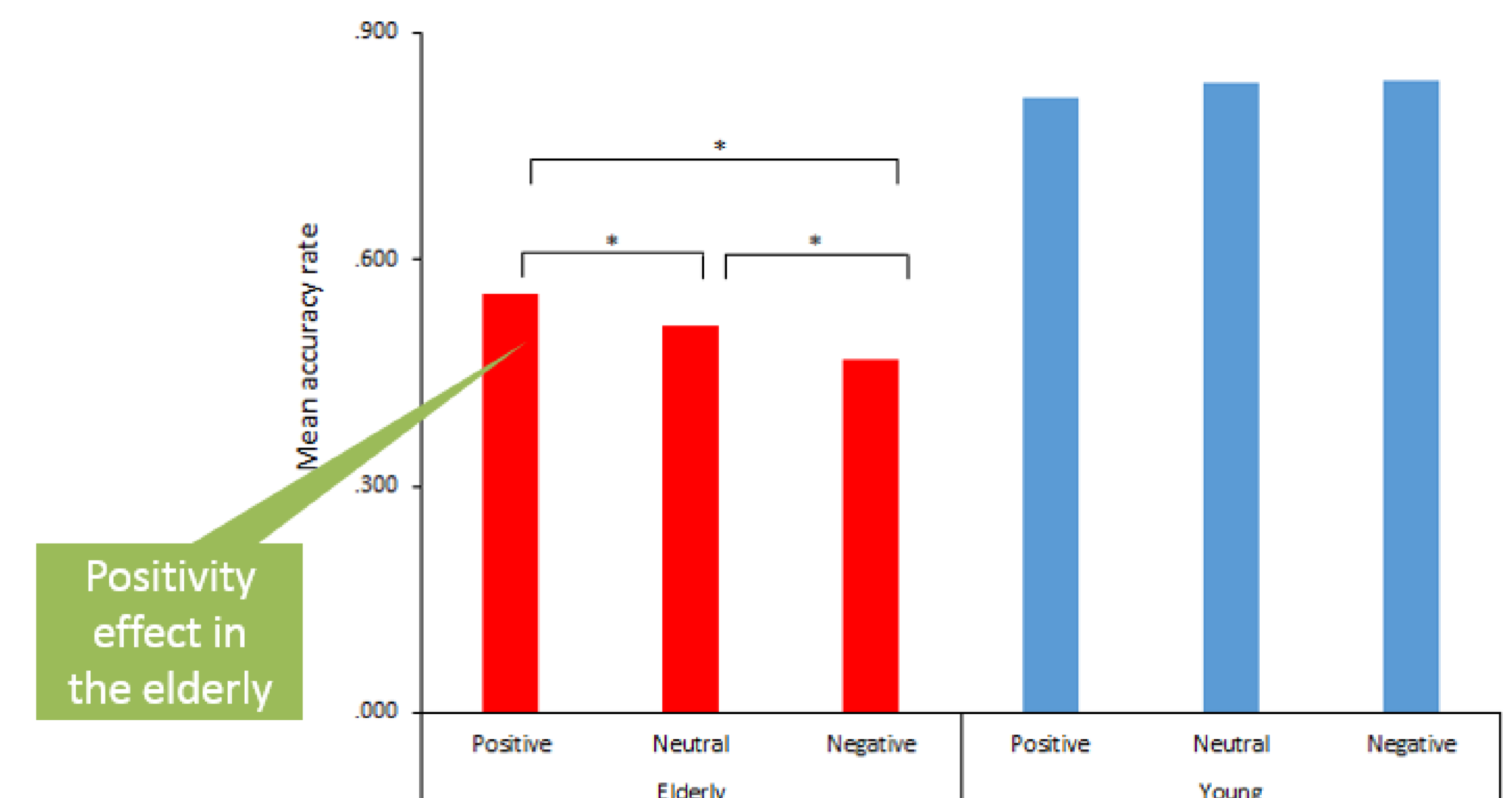
**Behavior:** An ANOVA revealed that the elderly participants' accuracy rate was significantly higher in retrieving positive emotional sentences than neutral and negative ones, although the young participants did not yield the positivity effect.

**fMRI:** Analysis during the sentence retrieval task indicated that, in comparison with the younger counterparts, the elderly participants recruited broader regions including the bilateral putamen, the bilateral hippocampus, the bilateral insula, the bilateral anterior cingulate cortices, the right superior and inferior frontal gyri, the right superior medial gyrus, the bilateral superior temporal gyrus, and the right temporal pole for positive emotional sentences than neutral ones.

**VBM:** It was found that GMV in the right superior frontal gyrus (MNI coordinates:  $x = 17, y = 54, z = 24, k = 38, p < .001$  uncorrected), which is a part of the dorsomedial prefrontal cortex (dmPFC), predicted the elderly's positivity effect during sentence retrieval ( $R^2_{adj} = .56, p < .001$ ).

## DISCUSSION & CONCLUSION

The current study was the first to reveal the elderly's positivity effect in sentence processing. They could retrieve positive emotional sentences compared with neutral and negative ones. Although they generally have difficulty in recognizing sentences, the elderly adults seem to be able to compensate for it with utilizing positive emotion. In addition, we found a structural basis for the elderly's positivity effect on the dmPF GMV, which might play a compensatory role for elderly's decline in memorizing sentences.



## REFERENCES

- Mather, M., & Carstensen, L. L. (2005). Aging and motivated cognition: The positivity effect in attention and memory. *Trends in Cognitive Sciences, 9*, 496-502.
- Reed, A.E., & Carstensen, L. L. (2012). 'The theory behind the age-related positivity effect', *Frontiers in Psychology, 3*, 339.