Gustatory stimuli activation of human brain disclosed by fMRI study

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Introduction

Taste strictly subdivides into sweet, salt, bitter and sour. Taste is perhaps the most important primary reinforcer in all animals given that the necessary energy needed to sustain life comes from the nutrition obtained by eating foods, yet relatively little is known about taste processing in the human brain. The biggest problem of gustatory stimuli is flowing backward phenomenon while tastants delivery to subjects and we solved this problem using auto-syringe pump. In this study, we sought to use gustatory fMRI to investigate the effect of taste on gustatory function in the human brain.

Method

Twelve healthy, non-smoking, right-handed male subjects (mean age: 25.6, range: 23-28 years) participated in this functional magnetic resonance (fMRI) study. In this study, NaCl solution (3%) was used as a salty stimulus. The task paradigm consisted of alternating rest-stimulus cycles (30-second rest, 15-second stimulus) for 210 seconds. During the stimulus period, stimuli were dissolved in distilled water and were presented to the subject's mouth through plastic tubes, as boluses of 40□ delivered every 5 s through the microprocessor-controlled auto-syringe pump [Fig. 1]. The subject put a soft plastic tube containing the ends of the tubes delivering water and stimuli in his mouth and was instructed to place it on the tip of the tongue, symmetrically, so that the liquid would flow on the whole tongue before being swallowed by the subject [1-3].

MRI scans were performed with 1.5T GE Signa, using a multi-slice GE-EPI sequence according to a blood-oxygen-level dependent (BOLD) experiment paradigm. Scan parameters included matrix size 128x128, FOV 240 x 240mm^2, TR 5000 msec, TE 60 msec, TH/GAP 5/2 mm. Sequential data acquisitions were carried out for 42 measurements with a repetition time of 5 sec for 210 sec for each taste stimuli experiments. Analysis of fMRI data was carried out using SPM99 (welcome Institute of Cognitive Neurology, London, UK) implemented in Matlab (Mathworks, Inc., Sherbon, MA)

Result

As shown in Figure 2 and 3, we found that the activation areas in response to NaCl stimulation were in the insula/frontal opercular taste cortex and amygdala, orbitofrontal cortex. And finding in this study was highly significant response to taste in the dorsolateral prefrontal cortex. Activation areas of the right side hemisphere are more superior to the left side hemisphere.

Conclusion

Anatomical and functional studies highlight the close functional interaction between the orbitofrontal cortex and amygdala. The results of this study show that significant correlation between the activation regions of the human orbitofrontal cortex. A problem of stimuli flowing backward in the tubes was solved using an apparatus of auto-syringe pump and this showed that this device was suitable for gustatory fMRI. Further research in this field will accelerate to define the mechanism of higher order gustatory process

Reference

1) C. Murphy et al, "fMRI Activation in Response to Odorants Orally Delivered in Aqueous" Chem. Senses 26:625-637, 2001
2) Gudio K. Frank et al, "The evaluation of brain activity in response to taste stimuli", J. Nuroscience Methods 131:99-105, 2003
3) Morten L. Kringelbach et al, "Taste-related activity in the human dorsolateral prefrontal cortex", NeuroImage 21:781-788, 2004

Fig. 1 Auto-Syringe pump

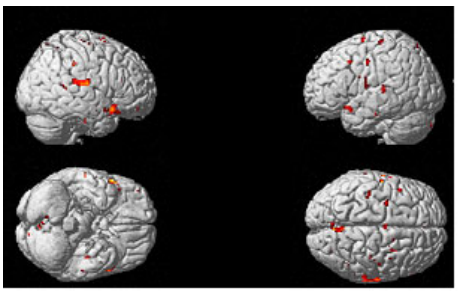

Fig. 2. Brain areas activated by stimuli

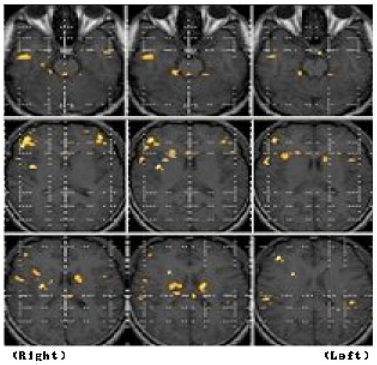

Fig. 3. Taste-related responses in the human brain