Post-oral nutritive substances elicit brain activation in rats

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Introduction

Postingestive consequences (nutrition, satiety), as well as oronasal sensory stimuli (taste, smell, and texture), are important factors on determining preference and appetite for foods. Recent studies have demonstrated taste receptors and transduction elements in gastrointestinal epithelium (1-3), however, there has been little direct evidence concerning the brain regions perceiving and integrating food-derived chemosensory signals in the gastrointestinal tract. Our purpose is to show brain activation induced by post-oral nutritive substances in rats using functional magnetic resonance imaging (fMRI).

Methods

Male Sprague-Dawley rats (350-450g), were used. Cranioplastic surgery and intragastric cannulation were made. MRI measurements were conducted with α-chloralose anesthesia during dark period after 12-15 h fasting. The BOLD fMRI was obtained by using a T2*-weighted multi-slice gradient-echo pulse sequence. Three coronal images were collected every 15 s for 90 min. Thirty min after the start of scanning, a nutritive solution (60 mM glucose, monosodium L-glutamate (MSG), or NaCl) was delivered into the stomach via implanted tube for 10 min. Pixel-by-pixel T-map data analysis was made using Student's *t*-test. T-map images were obtained by comparing each image to the pre-administration controls.

Results & Discussion

We demonstrated spatio-temporal activation of rat forebrain regions, including the cortex, hypothalamus, basal ganglia, and limbic system after delivery of three nutritive taste substances in the stomach. The anterior cingulate cortex, caudate-putamen, insular cortex and hippocampus were activated by 3 nutritive substances. For another region of the brain, glucose activated the nucleus accumbens and amygdala. MSG activated the hypothalamus (medial preoptic area and dorthomedial nucleus) and amygdala. Second, we assessed the contribution of the vagus nerve on brain activation. Subdiaphragmatic total vagotomy (TVX) essentially decreased activations by MSG (Fig. 1) and NaCl. Glucose-induced activations were little affected by TVX. These data indicate that the vagus nerve is the major pathway transmitting visceral signals arose by post-oral MSG and NaCl, while non-vagal pathway is the major pathway of post-oral glucose.

Conclusion

We provided the first evidence that post-oral nutritive taste substances induced activation in the forebrain regions via vagus or non-vagus signaling pathway, which may link to various post-oral physiological responses.

References

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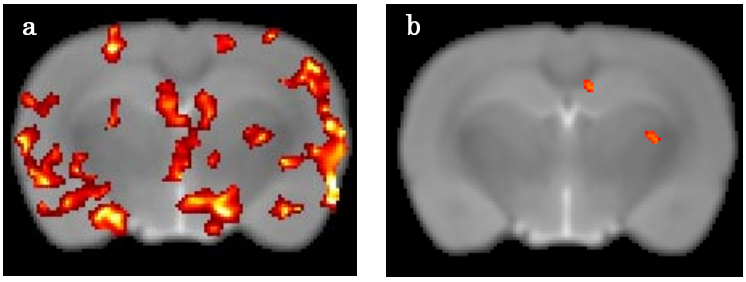

Fig 1. The brain activation caused by intragastric administration of MSG in intact rats (a) and TVX rats (b).