

## Gender differences in the effect of satiation on gustatory brain activity

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### Introduction

Knowledge of the complex processes that control food intake is essential in understanding the etiology of obesity. The brain plays a crucial role in the decision to eat, integrating multiple hormonal and neural signals. A key factor controlling nutrient intake is sensory-specific satiety i.e. the phenomenon that the tastiness of a food eaten to satiety decreases more than that of other foods.<sup>1</sup> Although gender differences in eating behavior have often been described,<sup>2-4</sup> differences between the sexes in the brain activity associated with food stimuli are undocumented. The aim of our study was to investigate gender differences in the effect of chocolate satiation on the brain activity associated with tasting chocolate.

### Subjects and Methods

Twenty-four healthy normal-weight volunteers (12 men, mean age  $21.3 \pm 2.8$  years, mean BMI  $21.45 \pm 1.6$  kg/m<sup>2</sup>, and 12 women, mean age  $20.5 \pm 1.4$  years, mean BMI  $22.0 \pm 1.4$  kg/m<sup>2</sup>) fasted overnight and were scanned the next morning before eating bitter sweet chocolate until satiety (fasted) and after that (satiated). During both scans, subjects tasted chocolate milk followed by water (wash-out) and rest (three alternating blocks of 30 s each with a total scan duration of 13.5 min). Scans were performed on an 1.5-T Philips Gyroscan ACS-NT system using a multi-slice 2D single-shot EPI sequence (TR/TE = 2500/45 ms, flip angle = 90°, 24 interleaved slices, 4x4x4 mm<sup>3</sup> voxels). An anatomical T<sub>1</sub>-weighted volume was also acquired. Before the first functional scan and after the second, subjects filled in a set Visual Analog Scales to assess their degree of hunger. Functional MRI data were preprocessed and analyzed using SPM2. In the first level analyses, the contrast “taste satiated minus taste hungry” was computed for all subjects i.e. the difference in taste activity between the satiated and the hungry state. In the second level analysis, these contrast images were fed into an ANOVA to compare the effect of satiation on taste activity between men and women. In addition to this whole brain analysis we performed a region of interest (ROI) analysis on three a priori regions of interest: the hypothalamus, the amygdala and the insula.

### Results

The effect of satiation was greater in women than in men in the right dorso-lateral and in the medial prefrontal cortex (Figure 1A,  $z = 20$ , peak voxel  $P < 0.001$  and  $z = 46$ , peak voxel  $P < 0.005$ , uncorrected for multiple comparisons), whereas it was greater in men than in women in the hypothalamus and adjacent rostral anterior cingulate (Figure 1B,  $z = -8 / x = 1$ , peak voxel  $P < 0.001$ , uncorrected for multiple comparisons). In the hypothalamus and amygdala ROI's we found that in women, but not in men, satiation was associated with decreased activation. In the insula there were no effects of gender and satiation (not shown).

### Conclusion and discussion

We are the first to report gender differences in the effect of taste-specific satiation on gustatory brain activity. Most notably, we found differences between the sexes in the hypothalamus and amygdala. Previous studies in a group of men<sup>5</sup> and a group of men and women<sup>6</sup> reported decreased brain activity in the orbito-frontal cortex after taste-specific satiation. Our results indicate that it is important to take gender differences into account in studies of gustatory brain responses, the regulation of food intake and the etiology of obesity. Further research into the effects of gender on brain responses is needed.

### References

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**Figure 1.** Comparison of the effect of taste-specific satiation i.e. the difference in taste activity between the satiated and the hungry state between the sexes. Activity maps are thresholded at  $P = 0.01$  ( $t = 2.51$ ), uncorrected for multiple comparisons.