A 3T event-related fMRI study of natural taste perception.

M. Smits[1], R. R. Peeters[2], P. Van Hecke[2], S. Sunaert[2]
[1]Radiology, Erasmus MC Rotterdam, Rotterdam, Netherlands, [2]Radiology, U.Z. Gasthuisberg, Leuven, Belgium

Introduction

From PET experiments it is known that taste is represented in the insula, frontal and parietal operculum, as well as in the orbitofrontal cortex (secondary gustatory cortex) (Small et al. Neuroreport 1999;10:7-14). In fMRI experiments activation in the insula has been confirmed (Faurion et al. Ann N Y Acad Sci 1998;855:535-545), but no activation in the orbitofrontal cortex (secondary gustatory region) has been described as yet. Due to large susceptibility artefacts, the orbitofrontal cortex is a very difficult region to examine with fMRI. We performed an experiment in healthy volunteers in which we used lemon juice and chocolate as tastants. Our aim was to localize these tastes in the human cortex, both in the orbitofrontal cortex (gyrus rectus) and other areas.

Materials and Methods

Image acquisition: All scans were performed on a 3T MR scanner (Intera, Philips Medical Systems, Best, the Netherlands). A 3D high resolution T1w image covering the whole brain (matrix 256x256; TE/TR 4.6/9.7 ms; SENSE reduction factor 3) was acquired for anatomical reference. Two different sequences were then used to image the whole brain and the gyrus rectus respectively during the stimulation paradigm. For the whole brain a T2*w-EPI sequence was used with slice thickness 3.75 mm, matrix 128x128, TE/TR 30/2000 ms and SENSE reduction factor 2. Per run 185 images were acquired with a total scan time of 6:18 mins. To minimize susceptibility artefacts for imaging the gyrus rectus we used a multishot 3D EPI sequence with SENSE reduction factor 3*2 = 6, TE/TR 28/3200, slice thickness 1.5 mm and matrix of 128x128. In this run 125 images were acquired in 6:52 mins.
Stimulation paradigm: Two different tastants, chocolate and lemon juice, were used as stimuli; water was used as a control. These liquid tastants were administered by pump via silicon tubes into the mouth of the subject to the middle of the tongue at a rate of 2 ml/s. The stimulation paradigm consisted of a random alternation of the two tastants that were administered for brief periods at the time (8.0 and 9.6 s for the whole brain and gyrus rectus respectively), i.e event-related. Water was always administered in between the two tastants for neutralisation. Per run each tastant was administered ten times in the whole brain experiment, and nine times in the gyrus rectus experiment. Subjects were instructed to use the buttons provided to register their perception of lemon juice, chocolate, a mixture of tastes or no taste.
Subjects: Seven healthy volunteers participated. A total of twelve runs was performed for the whole brain and of thirteen runs for the gyrus rectus.
Data analysis: Data were analysed using SPM2 (Statistical Parametric Mapping, Wellcome Department, London, UK). Data were preprocessed with realignment, coregistration and normalisation and smoothed with a FWHM Gaussian filter of 6 mm and 4 mm for the whole brain and gyrus rectus respectively. For both the single subject and group analyses statistical parametric maps were calculated using the general linear model. As covariates were modeled: the actual taste administration times, the subjects' taste perception and subjects' button responses.

Results & Discussion

Event-related delivery of natural taste stimuli is feasible on a 3T scanner. Subjects rated taste perception of 'lemon', 'chocolate' or 'mixed-taste' perception > 90 % correctly.
A 3D EPI sequence using a SENSE reduction factor of 6 significantly reduces susceptibility artefacts in orbitofrontal cortex, making the detectability of fMRI signal in this part of the brain feasible.
Both orbitofrontal and insular cortices were significantly activated during taste perception. In contrast to earlier studies using 'unnatural' stimuli such as quinine, we observe these activations with 'natural' taste stumuli such as lemon and chocolate. Furthermore the brain activity is mostly correlated with taste perception, more than with stimulus delivery.