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Does the left posterior fusiform gyrus play a critical role in fruit and vegetables categorization? Evidence from 19 semantic dementia patients

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Introduction

In our previous study ^[1], we reported a relative preservation of fruit and vegetables knowledge in a large cohort of 35 semantic dementia (SD) patients. This category effect was observed on a semantic sorting task, compared with three others categories: animals, tools and kitchenware.

⇒ Why fruit and vegetables seem to better resist to the massive semantic disruption that occurs in SD?

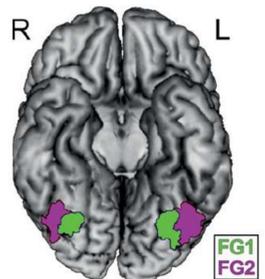
- This relative preservation of fruit and vegetables might be considered with regard to the importance of color knowledge in their discrimination ^[2] ^[3].
- Color knowledge retrieval is known to depend on the left posterior fusiform gyrus ^[4] ^[5], that is relatively spared in SD ^[6] ^[7].

Aim of the study

To test this neuroanatomical hypothesis, we studied the link between sorting performance for fruit and vegetables and the volumes of two recently described areas within the posterior fusiform gyrus in the left side: FG1 and FG2 ^[8] ^[9].

Two cytoarchitectonic visual areas on the human posterior fusiform gyrus:
FG1 & FG2 (Caspers *et al* 2013 ^[8])

(see also ^[9] for the SPM Anatomy Toolbox)



Methods

Population

- 19 SD patients:**
 - performing the semantic sorting task
 - undergoing an MRI scan (anatomical 3D-T1w 1x1x1 mm³) within a period of 3 months
- 12 controls:**
 - performing the semantic sorting task

Semantic sorting task: stimuli and procedure

⇒ 64 stimuli

- Selected from the "Imagier du Père Castor" playing cards
- Divided into 4 categories
- Presented first as words, then as pictures



- Sorted at both superordinate and subordinate levels (see labels in Table)

Superordinate level	Animals	Food	Tools	Kitchenware
Subordinate level / Functional features	Domestic or Wild	Fruit or Vegetables	DIY or Gardening	Used to prepare meals or Used during a meal
Subordinate level / Sensory-Perceptual features	Four legs or more or fewer than four legs	Round or not round	With or without sharp points	With or without handles

Anatomical data (MRI): processing

1/ **Pre-processing** using Matlab/SPM8
Segmentation into grey matter (c1), white matter (c2) and cerebro-spinal fluid (c3)

2/ **Spatial normalisation** into the MNI space, with modulation

4/ **Correction** of the ROIs volumes by the intra cerebral volume {c1+c2+c3}

3/ **ROIs analysis**: computation of c1 volumes in the two sides of temporal lobes, for:
- **FG1 and FG2**
- 5 others areas from the AAL template ^[10]: **Superior, middle and inferior temporal gyri, temporal pole, fusiform gyri minus {FG1 + FG2}**

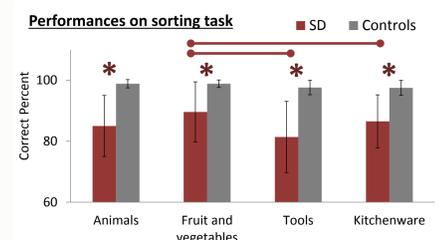
Results

Sorting task performances: a category-specific effect

On all categories, SD patients < controls (p < 0.01 *)

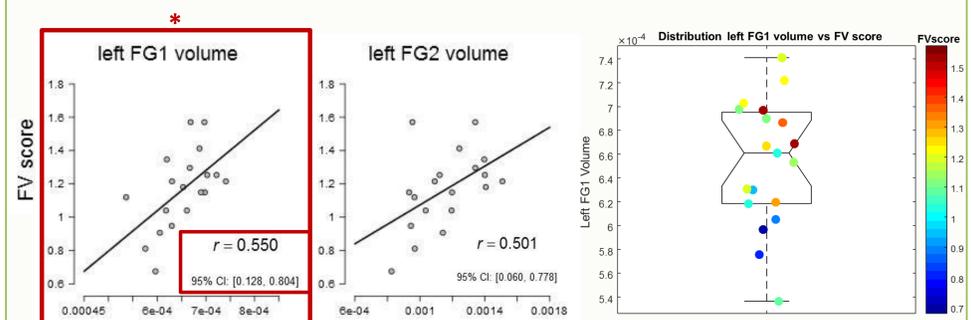
Within the SD group:

- Repeated-measures ANOVA: F(3,54) = 7.712; p < 0.001
- Planned comparisons (t-tests):
 - Fruit and vegetables vs. : - animals; p = 0.012 (NS)
 - tools; p < 0.001
 - kitchenware; p = 0.009



Link between the fruit and vegetables score and the left FG1 volume

Correlations between Fruit & Vegetables (FV) scores and the volumes of two areas in the left posterior fusiform gyrus (left FG1 & left FG2)



Linear regression analysis

For each ROI, the c1 volume was predicted using: (a) sociodemographic features (age, sex, years of education), (b) total c1 volume, (c) MRI models, and (d) sorting scores for: FV, Animals, Tools and Kitchenware categories

- Only FV score predicted the left FG1 volume: R² = 0,302; t = 2,711 p=0,015
- None of the other categories-scores was a predictor of the left FG1 volume
- FV score was not associated with any other ROIs volumes

Discussion

① We reported a specific relationship between the volume of a subregion within the left posterior fusiform gyrus and sorting performance for fruit & vegetables in SD.
This area was proved to be a core region underlying the ability to identify fruit and vegetables.

② Since prior studies emphasized the major role of color knowledge in the identification of fruit and vegetables, the **left FG1 and its strategic position - in the far posterior part of the fusiform gyrus, near the lingual gyrus - could be a privileged candidate for the storage of the color knowledge of objects.**

③ Recent studies ^[7] ^[11] pointed out the major contribution of fusiform gyrus to semantic performances in SD. Our results revealed that the left FG1 is more involved in semantic processing when concepts depend upon color knowledge. We further bring evidence for a functional specialization along the longitudinal axis of the fusiform gyrus that depends on the nature of concepts.

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