

What semantic dementia teaches us about the functional organization of the left posterior fusiform gyrus



Catherine Merck^{a,b,*}, Isabelle Corouge^{c,d,e,f}, Pierre-Yves Jonin^a, Béatrice Desgranges^b,
Jean-Yves Gauvrit^{c,d,e,f,g,h}, Serge Belliard^{a,b}

^a Service de neurologie, CMRR, CHU Pontchaillou, Rennes, France

^b Normandie Univ, UNICAEN, PSL Research University, EPHE, INSERM, U1077, CHU de Caen, Neuropsychologie et Imagerie de la Mémoire Humaine, 14000 Caen, France

^c University of Rennes 1, Faculté de Médecine, Rennes F-35065, France

^d Inria, Rennes Research Center, Rennes F-35042, France

^e Inserm, U1228, ERL VISAGES, Rennes F-35042, France

^f CNRS, UMR 6074, IRISA, Rennes F-35042, France

^g CHU Rennes, Neuroradiology Dept, Rennes F-35033, France

^h Service de Radiologie, CHU Pontchaillou, Rennes, France

ARTICLE INFO

Keywords:

Semantic dementia
Category specificity
Fruits and vegetables
Left posterior fusiform gyrus
Functional specialization

ABSTRACT

After demonstrating the relative preservation of fruit and vegetable knowledge in patients with semantic dementia (SD), we sought to identify the neural substrate of this unusual category effect. Nineteen patients with SD performed a semantic sorting task and underwent a morphometric 3T MRI scan. The grey-matter volumes of five regions within the temporal lobe were bilaterally computed, as well as those of two recently described areas (FG1 and FG2) within the posterior fusiform gyrus. In contrast to the other semantic categories we tested, fruit and vegetable scores were only predicted by left FG1 volume. We therefore found a specific relationship between the volume of a subregion within the left posterior fusiform gyrus and performance on fruits and vegetables in SD. We argue that the left FG1 is a convergence zone for the features that might be critical to successfully sort fruits and vegetables. We also discuss evidence for a functional specialization of the fusiform gyrus along two axes (lateral medial and longitudinal), depending on the nature of the concepts and on the level of processing complexity required by the ongoing task.

1. Introduction

Semantic dementia (SD) is a rare neurodegenerative disease (Belliard et al., 2013; Gorno-Tempini et al., 2011; Landin-Romero et al., 2016; Neary et al., 1998; Snowden et al., 1989) characterized by a selective loss of conceptual knowledge responsible for deficits in naming, word meaning comprehension, and in the identification of objects and persons in different input modalities (Bozeat et al., 2000; Luzzi et al., 2007; Snowden et al., 2012). This disruption of semantic memory occurs without any impairment of general intellectual ability, day-to-day memory or visuo-perceptual abilities. Language remains fluent and well-structured, without any phonological or grammatical errors, and only subtle abnormalities in the syntactic structure of speech have been reported (Meteyard and Patterson, 2009).

SD is associated with predominant anterior temporal lobe atrophy, often bilateral but predominantly on the left side and affecting the

temporal pole (Collins et al., 2017) as well as the lateral and ventral temporal surfaces (Agosta et al., 2012; Kumfor et al., 2016). These regions have been identified as making a critical contribution to semantic representations (Jackson et al., 2016; Jefferies, 2013; Rice et al., 2015; Wong and Gallate, 2012). Several imaging studies have highlighted a rostrocaudal gradient of dysfunction in the temporal lobes as the disease progresses, with the anterior parts more affected than the posterior ones (Brambati et al., 2015; Bright et al., 2008; Chan et al., 2001; Desgranges et al., 2007; La Joie et al., 2014; Leyton et al., 2016). There are similar findings for the fusiform gyrus, with neuroimaging studies of SD highlighting abnormalities in the rostral parts of this structure (Desgranges et al., 2007; Mion et al., 2010) rather than the caudal ones. Like the anterior parts, the caudal parts of the fusiform gyrus have long been associated with semantic knowledge (Chao et al., 1999; Chao and Martin, 1999).

Semantic disturbances in SD are frequently presented as a general

* Correspondence to: Service de Neurologie, CMRR du CHU Pontchaillou, 2 rue Henri Le Guilloux, 35033 Rennes Cedex, France.
E-mail address: catherine.merck@chu-rennes.fr (C. Merck).

and pervasive breakdown in conceptual knowledge. Patterson et al. (2007) defined this disorder as “a selective impairment to semantic abilities that affects all modalities of reception and expression, for all kinds of concepts, more or less equally, and it is the consequence of relatively focal brain lesions” (p. 978). However, several case reports have described patients with domain-specific deficits, reflected in poorer performance for living things than for nonliving entities (*Patient MF*: Barbarotto et al., 1995; *Patient IW*: Lambon Ralph et al., 1998; *Patient KH*: Ralph et al., 2003; *Patient LI*: Zannino et al., 2006). More recently, our team highlighted an unusual category-specific effect in a large cohort of 35 patients with SD, consisting in the relative preservation of the fruit and vegetable category compared with three others (animals, tools, and kitchenware) in a sorting task (Merck et al., 2013). To explain this result, we collated studies that had focused on the neuroanatomical basis of fruit and vegetable semantic processing. In their lesion-mapping study, Capitani et al. (2009) investigated the relationship between stroke in posterior cerebral artery territory and a category-specific deficit for plant life entities. They provided evidence that strokes damaging the caudal portions of the left fusiform gyrus are associated with poor performance on fruits and vegetables. Based on this finding, the authors raised the possibility that a specific type of processing is driven by the caudal portions of the left fusiform gyrus, given that fMRI studies in healthy adults have demonstrated a critical role of the posterior part of the left fusiform gyrus in colour knowledge retrieval (Simmons et al., 2007; Chao and Martin, 1999; Price et al., 2003). Moreover, some studies have underlined the major role of colour knowledge in the correct identification of fruits and vegetables compared with other object categories, including living ones (Connolly et al., 2007; Crutch and Warrington, 2003; Warrington and McCarthy, 1987). We therefore argued that our finding of better fruit and vegetable sorting performance by patients with SD could be explained by the relative preservation of the posterior part of the left fusiform gyrus, which plays a specific role in colour knowledge retrieval.

Recently, Caspers et al. (2013, 2014) isolated two cytoarchitectonic areas in the posterior fusiform gyrus: FG1 and FG2 (see Fig. 1, taken from Caspers et al., 2014), and examined their functional characterization and specialization. In their meta-analysis of studies in healthy subjects, Caspers et al. (2014) found that both these areas were involved in several aspects of visuo-perceptual processing, as well as language components and goal-oriented attentional processing for visual stimuli. However, differences between these two areas also emerged, with FG1 being more involved in an earlier and lower level of visual processing, and FG2 in a later and higher-level one. Furthermore, only FG2 was found to have a lateralized domain specificity, with the left side being related to language abilities, and the right side to emotion and faces.

These two regions in the ventral stream were identified in 10 postmortem brains using quantitative microscopic and stereotactic location approaches (Caspers et al., 2013). The authors also provided

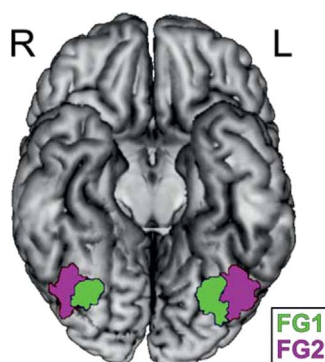


Fig. 1. Maximum probability map of cytoarchitectonic areas FG1 and FG2; basal view of the MNI single-subject brain without cerebellum, taken from Caspers et al. (2014).

probabilistic maps for each area within the reference space. FG1 was found in the medial half of the posterior part of the fusiform gyrus, whereas FG2 was located laterally to FG1. FG2's histological volume was larger than that of FG1. No difference in volume between the hemispheres was found for either area.

In the present study, we aimed to test our main neuroanatomical hypothesis by measuring the link between sorting performance on fruits and vegetables and the volume of the posterior part of the left fusiform gyrus in patients with SD. To this end, we closely examined the two cytoarchitectonic areas isolated by Caspers et al. (2013, 2014) in the posterior fusiform gyrus (i.e., FG1 and FG2). To determine the specificity of any link between these areas and performance on fruits and vegetables, we adopted an ROI approach, to check whether any other region in the temporal lobes could be associated with this performance. We also checked whether any other semantic category could be related to that specific ROI. Furthermore, we looked for differential contributions of the left FG1 and FG2 to performance on fruits and vegetables that would indicate the cognitive level (lower or higher) of processing engaged for that particular semantic category.

2. Materials and methods

2.1. Participants

2.1.1. Patients with SD

A total of 19 patients fulfilling the diagnostic criteria for SD (Gorno-Tempini et al., 2011; Neary et al., 1998) were included in our study between 2004 and 2015 (see Table 1 for sociodemographic and clinical features). Roughly half these patients (10/19) had been included in our previous study (Merck et al., 2013).

All 19 patients were recruited at the memory clinic of Rennes University Hospital (Belliard et al., 2011). All of them were right-handed native French speakers with no history of neurological or psychiatric disorders, or drug or alcohol abuse. Their neurological physical examination was unremarkable. They all presented with the typical clinical features of SD: a history of complaints about worsening comprehension deficits, anomia, and difficulty identifying objects and/or persons, reflecting a predominant and distressing loss of conceptual knowledge, contrasting with the relative preservation of day-to-day memory and perceptual abilities. Speech was still fluent, without any phonological or syntactic errors.

All 19 patients with SD underwent an MRI scan and a comprehensive neuropsychological battery, in addition to the task of interest (64-item semantic sorting task). The neuropsychological battery consisted of assessments of their *general cognitive functioning* (Raven's Coloured Progressive Matrices; Raven et al., 1998; Mini Mental State Examination, MMSE; Folstein et al., 1975), *nonverbal episodic memory* (“La Ruche” visuospatial learning task; Violon and Wijns, 1984; Delayed recall of the Rey–Osterrieth Complex Figure Test – Form A; Osterrieth, 1944), and *working memory* (Digit Span Forward and Backward, Wechsler Adult Intelligence Scale-Revised, WAIS-R; Wechsler, 1981). We also administered *attentional and executive tasks*, namely the Digit Symbol subtest of the WAIS-R (Wechsler, 1981) and the Trail Making Test (Reitan, 1958). *Language skills and semantic knowledge* were

Table 1
Demographic and clinical features of healthy controls and patients with semantic dementia.

	Healthy controls		Patients with semantic dementia	
	Mean (SD)	Range	Mean (SD)	Range
Sex (Male; Female)	5; 7		12; 7	
Age (years)	62.8 (4.5)	55–70	64.26 (7.22)	53–80
Education (years)	11 (4.7)	7–17	10.26 (3.11)	7–17
Disease duration (years)	–	–	0.63 (0.58)	0.05–2.12

Download English Version:

<https://daneshyari.com/en/article/5045041>

Download Persian Version:

<https://daneshyari.com/article/5045041>

[Daneshyari.com](https://daneshyari.com)