cortex 49 (2013) 1648–1667

Available online at www.sciencedirect.com

SciVerse ScienceDirect

Journal homepage: www.elsevier.com/locate/cortex

Research report

Famous face identification in temporal lobe epilepsy: Support for a multimodal integration model of semantic memory

Daniel L. Drane[a,b,*], Jeffrey G. Ojemann[c,d], Vaishali Phatak[b], David W. Loring[a], Robert E. Gross[e], Adam O. Hebb[c], Daniel L. Silbergeld[c], John W. Miller[b], Natalie L. Voets[f], Amit M. Saindane[g], Lawrence Barsalou[h], Kimford J. Meador[a], George A. Ojemann[c] and Daniel Tranel[i]

[a] Department of Neurology, Emory University School of Medicine, Atlanta, GA, USA
[b] Department of Neurology, University of Washington School of Medicine, Seattle, WA, USA
[c] Department of Neurological Surgery, University of Washington School of Medicine, Seattle, WA, USA
[d] Children's Hospital of Seattle, Seattle, WA, USA
[e] Department of Neurological Surgery, Emory University School of Medicine, Atlanta, GA, USA
[f] Nuffield Department of Clinical Neurosciences, FMRIB Centre, University of Oxford, UK
[g] Department of Radiology, Emory University School of Medicine, Atlanta, GA, USA
[h] Department of Psychology, Emory University School of Medicine, Atlanta, GA, USA
[i] Department of Neurology, University of Iowa College of Medicine, Iowa City, IA, USA

ARTICLE INFO

Article history:
Received 6 January 2012
Reviewed 28 February 2012
Revised 26 April 2012
Accepted 22 August 2012
Action editor Stefan Schweinberger
Published online 5 September 2012

Keywords:
Famous face naming
and recognition
Epilepsy surgery
Models of semantic memory

ABSTRACT

This study aims to demonstrate that the left and right anterior temporal lobes (ATLs) perform critical but unique roles in famous face identification, with damage to either leading to differing deficit patterns reflecting decreased access to lexical or semantic concepts but not their degradation. Famous face identification was studied in 22 presurgical and 14 postsurgical temporal lobe epilepsy (TLE) patients and 20 healthy comparison subjects using free recall and multiple choice (MC) paradigms. Right TLE patients exhibited presurgical deficits in famous face recognition, and postsurgical deficits in both famous face recognition and familiarity judgments. However, they did not exhibit any problems with naming before or after surgery. In contrast, left TLE patients demonstrated both pre- and postsurgical deficits in famous face naming but no significant deficits in recognition or familiarity. Double dissociations in performance between groups were alleviated by altering task demands. Postsurgical right TLE patients provided with MC options correctly identified greater than 70% of famous faces they initially rated as unfamiliar. Left TLE patients accurately chose the name for nearly all famous faces they recognized (based on their verbal description) but initially failed to name, although they tended to rapidly lose access to this name. We believe alterations in task demands activate alternative routes to semantic and lexical networks, demonstrating that unique pathways to such stored information exist, and suggesting a different role for each ATL in identifying visually presented famous faces. The right ATL appears to play a fundamental role in accessing

* *Corresponding author*. Department of Neurology, Emory University School of Medicine, Woodruff Memorial Research Building, 101 Woodruff Circle, Suite 6111, Mailstop 1930-001-1AN, Atlanta, GA 30322, USA.
E-mail address: ddrane@emory.edu (D.L. Drane).

http://dx.doi.org/10.1016/j.cortex.2012.08.009

semantic information from a visual route, with the left ATL serving to link semantic information to the language system to produce a specific name. These findings challenge several assumptions underlying amodal models of semantic memory, and provide support for the integrated multimodal theories of semantic memory and a distributed representation of concepts.

1. Introduction

The anterior temporal lobes (ATLs) have been implicated as important regions for object naming and recognition in a wide range of patients [e.g., focal epilepsy, tumors, semantic dementia, Alzheimer's disease (AD)] (Chan et al., 2004; Drane et al., 2008; Glosser et al., 2003; Warrington and Shallice, 1984), using a variety of neuroimaging paradigms in both patients and healthy controls (Grabowski et al., 2001; Martin and Chao, 2001; Noppeney et al., 2004), and through direct stimulation brain mapping to protect eloquent cortex during neurosurgery (Giussani et al., 2009). These findings have contributed significantly to models of semantic memory, with nearly all of these models placing importance on the ATL regions, and most assuming these regions play a role in activating stored object representations. Nevertheless, controversy exists regarding the specific role of these regions in semantic memory (Kiefer and Pulvermuller, 2012). Some models postulate that the left and right ATL regions form a unitary semantic storage system, which is amodal yet accessible from each input modality (e.g., Semantic Hub account: Lambon Ralph and Patterson, 2008; Patterson et al., 2007). Other models view the ATLs as including multiple processing regions that reactivate stored conceptual information residing in distributed neural networks (i.e., frequently presumed to be the primary sensory and motor areas where object perception occurs), and linking this information to the classic language network. This includes the modality-specific models of semantic memory, such as the convergence zone (CZ) model of Damasio, and Barsalou's "embodied cognition" adaptations of the CZ model (Barsalou et al., 2008, 2003; Damasio, 1989; Damasio et al., 2004). In the current study, we investigate the error patterns of pre- and postsurgical temporal lobe epilepsy (TLE) patients using a famous face identification task along with a novel multiple choice (MC) recognition paradigm to explore the veracity of these models.

1.1. *Support for the amodal models of semantic memory*

Amodal models of semantic memory are typically based on research in semantic dementia demonstrating that degradation or loss of semantic knowledge is observed across all lexical and sensory processing modalities (e.g., no recognition of objects visually or from characteristic sounds, tastes, or smells, or the meaning of words representing these objects) (see Kiefer and Puvermuller for a thorough review, and representative articles such as Bozeat et al., 2000; Lambon Ralph et al., 2007; Luzzi et al., 2007). Semantic dementia is associated with damage to the temporal poles and lateral inferior temporal cortex of both cerebral hemispheres with sparing of the hippocampi. While this disease progresses into posterior TL regions and the frontal lobes, damage to the bilateral temporal poles appears to be sufficient to lead to the core semantic deficits observed (Patterson et al., 2007). The Hub account (Lambon Ralph et al., 2007; Patterson et al., 2007; Rogers et al., 2004) is probably the most well-known amodal model at present.

Hub model advocates suggest the extreme semantic knowledge deficits observed in semantic dementia could not result from a multimodal distributed model, as this would require a widespread disruption of brain regions in their view. This is because different types of knowledge would be widely represented throughout the brain. As semantic dementia primarily involves the bilateral ATL regions, they conclude these regions must act as a unitary, amodal representation or repository for conceptual information. They have noted that semantic memory is "largely subserved by a unitary and relatively homogeneous neural system in the anterior and lateral aspects of the temporal cortices bilaterally [p. 206, (Rogers et al., 2004)]." They also indicate that the amodal nature of the ATL system is underscored by very high correlations observed in semantic dementia patients between scores on different semantic tasks and strong item-specific consistency across modalities (Pobric et al., 2007). Thus, conceptual information would no longer be tied to the original sensory/motor processing regions where the experience of all objects initially occurred. They note that "the system acquires abstract representations whose similarity relations are not tied to any individual modality" (Rogers et al., 2004) (p. 206).

Hub proponents state that processing functions of the bilateral ATLs are partially redundant and non-unique (Lambon Ralph et al., 2012), with damage to either leading to graded deficits in all functions that this amodal region supports. This is based on their research showing that both the processing of words and pictures can be slowed by applying repetitive transcranial magnetic stimulation (rTMS) to either the left or right ATL of healthy adults (Lambon Ralph et al., 2009; Pobric et al., 2007, 2010). Finally, the Hub advocates (Lambon Ralph et al., 2012) point to functional neuroimaging studies that have found bilateral ATL activation during multimodal semantic processing as evidence of their model (Vandenberghe et al., 1996; Visser et al., 2010). They also indicate that the reason why numerous studies failed to find such activations is due to the methodological difficulties associated with obtaining adequate signal activations in this brain region.

1.1.1. *More recent emphasis on Spokes of the hub*

Hub advocates have more recently emphasized a Hub and Spoke account of semantic memory (Lambon Ralph et al., 2012; Pobric et al., 2007, 2010), suggesting there are both