available at www.sciencedirect.com

ScienceDirect

www.elsevier.com/locate/brainres

BRAIN RESEARCH

Research Report

Conceptual knowledge in the brain: fMRI evidence for a featural organization

J. Frederico Marques[a,*], Nicola Canessa[b,c], Simona Siri[b], Eleonora Catricalà[b], Stefano Cappa[b,c]

[a]Faculty of Psychology and Education Sciences, University of Lisbon, Alameda da Universidade, 1649-013 Lisboa, Portugal
[b]Department of Neuroscience and CERMAC, Vita-Salute University and San Raffaele Scientific Institute, Milan, Italy
[c]CRESA, Vita-Salute University, Milan, Italy

ARTICLE INFO

Article history:
Accepted 20 November 2007
Available online 14 December 2007

Keywords:
Conceptual knowledge
Semantic memory
fMRI
Features
Domain

ABSTRACT

The organization and representation of conceptual knowledge in the brain remains a controversial issue in terms of both neuropsychological and imaging evidence. We report the results of a functional magnetic resonance study in which the role of the most debated dimensions (domain and feature type) was evaluated through a concept–feature verification task. The scope of the task was to eliminate serious methodological concerns that weighed down previous imaging research in this area, and to allow more definitive conclusions regarding the specific contribution of these dimensions. The results show differential patterns of brain activity according to feature type (both motion and visual form/surface features) but not according to concept domain (living vs. nonliving things). These findings are in accord with a modality-specific account of conceptual knowledge organization in the brain, in which specific kinds of features (e.g. form, color, motion, etc) have differential importance for representing different concepts.

1. Introduction

The question of how conceptual knowledge is organized and represented in the brain continues to be widely and controversially debated within the neuroscience research on semantic memory (Barsalou et al., 2003; Caramazza and Mahon, 2003, 2006; Martin and Chao, 2001; Tyler and Moss, 2001). The topic has received considerable attention since patients with category-specific semantic deficits were systematically reported some two decades ago (Warrington and McCarthy, 1983; Warrington and Shallice, 1984). Patients exhibiting impaired knowledge of living things (especially animals), in contrast to preserved artifact knowledge, have been particularly discussed as to their meaning in terms of underlying representation in the brain. For some, the neuropsychological evidence are more in accord with a *domain-specific account* (Caramazza and Shelton, 1998; Shelton et al., 1998). This account proposes that evolutionary pressure has resulted in neuroanatomically and functionally specialized networks for distinguishing evolutionary important categories such as, animals, plant life and artifacts, or, in a more detailed version, animals, plant life, conspecifics and possibly tools (Caramazza and Mahon, 2003, 2006). Others have proposed that the diversity of cases of impairment are best explained by a *modality-specific account* (e.g. Barsalou et al., 2003; Farah and McClelland, 1991; Martin and Chao, 2001; McCarthy and Warrington, 1988; Warrington and McCarthy, 1983; Warrington

* *Corresponding author*. Fax: +351 217933408.
E-mail address: jfredmarq@fpce.ul.pt (J.F. Marques).

0006-8993/$ – see front matter © 2007 Elsevier B.V. All rights reserved.
doi:10.1016/j.brainres.2007.11.070

and Shallice, 1984). This account proposes that different kinds of semantic features (e.g. visual, tactile, function, motion, etc) have a varying importance for representing different concepts and domains, resulting in behaviors that are only apparently constrained by categories. A third perspective, the *conceptual structure account*, proposes a unitary amodal system, in which the correlations between features (in particular the correlation between perceptual and functional features) and their degree of distinctiveness are different between domains. Nonliving things possess more distinctive features that are correlated in comparison with living things (Tyler and Moss, 2001; Tyler et al., 2000). This difference, associated with the assumption that

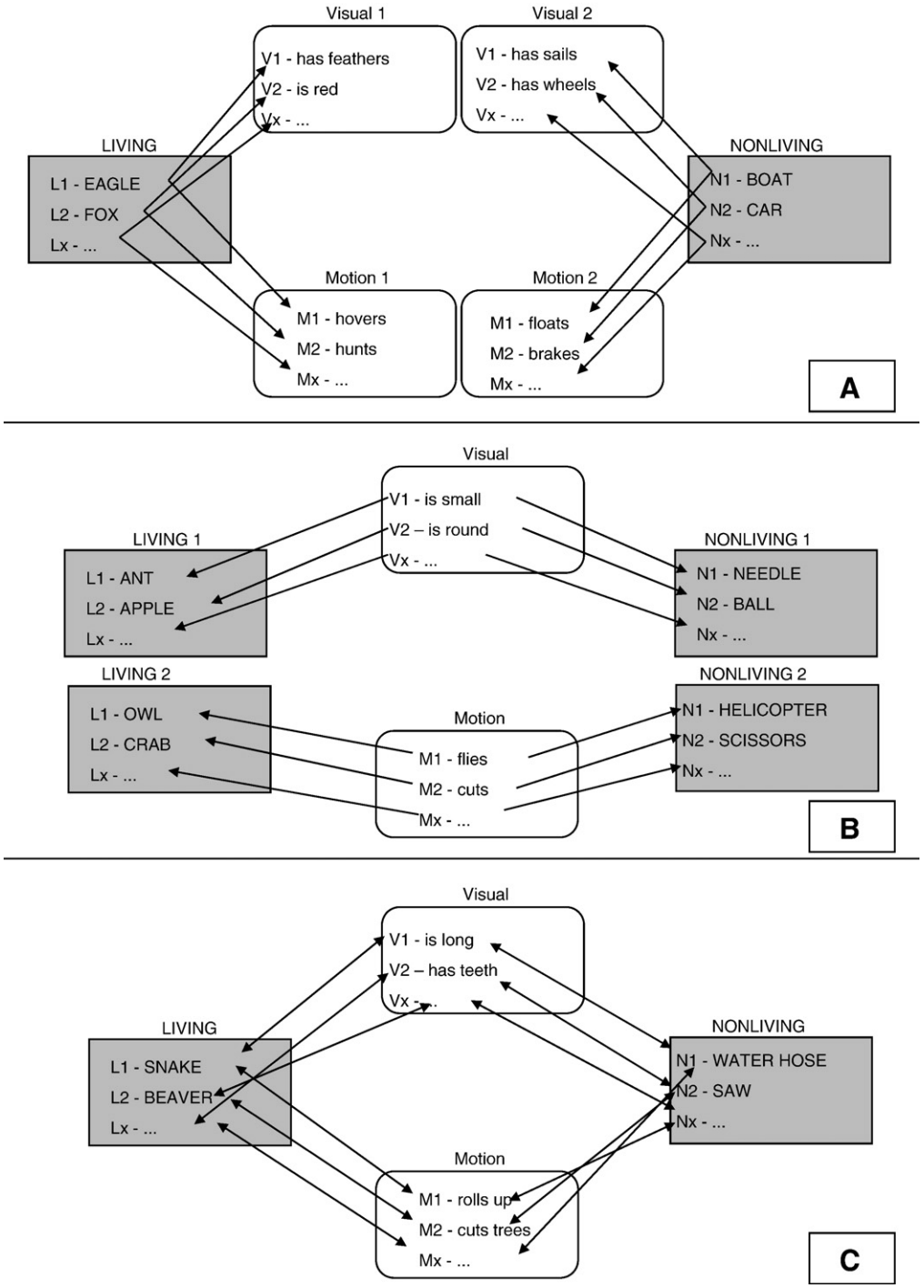

Fig. 1 – Experimental designs and stimuli. Design in top panel (A) is biased by the fact that concepts are compared using different feature sets. Design in middle panel (B) is biased by the fact that features are compared using different concept sets. Design in bottom panel (C) corresponds to the present study. Each feature type (visual/motion) was contrasted on exactly the same exemplars and each category (living/nonliving) was contrasted on exactly the same features. Participants verified simple concept–feature sentences resulting from the combination of feature type, category and status (true vs. false; only true pairs are represented in the figure).