

## Grammatical category-specific deficits in bilingual aphasia

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### Abstract

We report the naming performance of an early and highly proficient Spanish–Catalan bilingual (JPG) suffering from Primary Progressive Aphasia (PPA). JPG's performance revealed a grammatical category-specific deficit, with worse performance in naming verbs than nouns. This dissociation was present in oral and written naming and in his two languages, and it seems to stem from damage to, at least, the lexical level. Despite the fact that JPG's performance was qualitatively very similar across languages, his second language seemed to be more affected than his first language. These results indicate that the cortical organization of the two languages of highly proficient bilinguals follow similar organizational principles, one of this principles being grammatical class.  
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### 1. Introduction

A critical issue for understanding the cognitive processes involved in bilingualism is to advance in our knowledge of the cortical representation of the two languages of a bilingual. Despite the numerous studies that have addressed this issue, several important questions still remain open. Are the two languages subserved by the same neural substrate? Does the cortical representation of a second language (L2) depend on the age (and manner) at which this language has been acquired? Does the linguistic similarity between languages affect the way they are finally mapped into the brain? Such questions remain the topic of debate and current research. In this article we report the performance of an early and highly proficient

bilingual individual (JPG) suffering from primary progressive aphasia (PPA). JPG's performance reveals a grammatical category-specific deficit in both written and oral naming.<sup>1</sup> Importantly, this impairment is present in the bilingual's two languages and across several time periods.

The issue of the cortical organisation of language in bilinguals has been mostly informed from three different sources: (a) studies of the linguistic performance of bilingual aphasic individuals, (b) studies in which the hemodynamic activity of the brain has been recorded in healthy individuals while performing linguistic tasks, and (c) electrocortical stimulation in bilingual patients who undergo surgery. Although these three lines of research have provided interesting insights, the critical question of whether

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<sup>1</sup> Although the existence of grammatical category-specific deficits is very well documented by many case reports in which the dissociation between nouns and verbs has been observed in both directions. However, the potential origin(s) of this deficit in different patients are still an open issue (e.g. Berndt, Mitchum, Haendiges, & Sandson, 1997; Breedin, Saffran, & Schwartz, 1998; Caramazza & Hillis, 1991; De Renzi & di Pellegrino, 1995; Hillis, Heidler-Gary, & Newhart, 2006; Hillis, Tuffiash, & Caramazza, 2002; Hillis, Oh, & Ken, 2004; ; Miceli, Silveri, Villa, & Caramazza, 1985; Miceli et al., 1984; Robinson, Rossor, & Cipolotti, 1997; Robinson et al., 1999; Shapiro & Caramazza, 2003a; Sörös, Cornelissen, Laine, & Salmelin, 1997; Sörös et al., 2003; Zingesser & Berndt, 1988, 1990).

the neural substrate is shared or not between languages is still controversial. Although our goal is not to review the literature on these issues (see for excellent recent reviews [Abutalebi & Green, 2007](#); [Gollan & Kroll, 2001](#); [Indefrey, 2006](#)), in the following we will briefly discuss some relevant observations.

Evidence suggesting that the neural substrates of the two languages may be segregated comes from those studies of aphasic patients who recover selectively one language (e.g., [Albert & Obler, 1978](#); [Gomez-Tortosa, Martin, Gaviña, Charbel, & Ausman, 1995](#); [Moretti et al., 2001](#); [Paradis & Goldblum, 1989](#)). Further evidence comes also from electrocortical stimulation in bilingual patients who undergo surgery ([Ojemann & Whitaker, 1978](#)), which showed that, although L1 and L2 shared some common areas, they also have independent brain regions. For example, [Lucas, McKhann, and Ojemann \(2004\)](#) found that the stimulation of certain brain areas of epileptic patients interfered with L1 and L2 picture naming, while the stimulation of other areas disturbed L1 but not L2 naming and vice versa.

The more exhaustive evidence coming from imaging studies is somewhat less consistent (e.g., [Briellmann et al., 2004](#); [Chee, Hon, Lee, & Soon, 2001](#); [Chee, Tan, & Theil, 1999](#); [De Bleser et al., 2003](#); [Dehaene et al., 1997](#); [Kim, Relkin, Lee, & Hirsch, 1997](#); [Klein, Milner, Zatorre, Evans, & Meyer, 1994](#); [Klein, Milner, Zatorre, Zhao, & Nikelski, 1999](#); [Perani et al., 2003](#); [Pillai et al., 2003](#); [Pu et al., 2001](#); [Rüeschmeyer, Fiebach, Kempe, & Friederici, 2005](#); [Wartenburger et al., 2003](#); [Yetkin, Yetkin, Haughton, & Cox, 1996](#)). Although in some of these studies, a cortical segregation between languages has been observed, as pointed out by [Abutalebi and Green \(2007\)](#), these hemodynamic differences were mainly found in areas such as the anterior prefrontal cortex and the anterior cingulate cortex. According to the authors, given that these areas are not classical language areas, the observed difference may reflect the engagement of more effortful processing when performing linguistic tasks in L2, rather than differences in the actual organisation of L1 and L2 representations. However, a recent metanalysis by [Indefrey \(2006\)](#) leads to a somewhat different conclusion, according to which some subgroups of bilinguals seem to show reliable differences between patterns of L1 and L2 activation (see also [Abutalebi, Cappa, & Perani, 2001](#); and [Perani & Abutalebi, 2005](#), for discussion of this issue).

This debate is also complicated by the fact that several variables may have an impact on the final cortical organisation of the two languages. Among these variables, the ones that appear to have more pervasive effects are: L2 proficiency and L2 age of acquisition (e.g., [Kim et al., 1997](#); [Perani et al., 1998](#)). In fact, according to several researchers ([Paradis, 1994](#); [Ullman, 2001](#)) factors such as age and manner of acquisition may affect the way in which L2 representations are organized in the brain (see also [Weber-Fox & Neville, 2001](#)) making improbable that L1 and L2 representations follow the same organisational principles if L2 has

not been acquired early in life and in a similar context as L1 (see [Abutalebi et al., 2001](#); [Indefrey, 2006](#), for a review of this issue).

The study of the linguistic performance of brain-damaged individuals provides relevant information to assess critical questions regarding bilingual language processing. However, it is often the case that the reports of bilingual aphasics focus mostly on the relative preservation of one language in comparison to the other, and little attention is paid to the specific pattern of linguistic breakdown of the individual in the two languages. This is problematic, because a closer look at the individual's performance could also inform us about whether the two languages of a bilingual follow the same functional governing principles of cortical organization, regardless of whether or not there is cortical overlap between them. Thus, assessing whether brain damage affects the two languages in a qualitatively similar manner, could provide us with information not only about cortical overlapping areas, but also, and perhaps more importantly, about whether the organizational principles that apply to the L1 are also at work for L2. In this context, the study of early and highly proficient bilinguals that present the same pattern of aphasic deficits in both languages is of special interest. For example, [De Diego Balaguer, Costa, Sebastián-Gallés, Juncadella, and Caramazza \(2004\)](#) described two early and highly proficient bilingual aphasic individuals with the same pattern of regular and irregular verbal morphological deficit in their two languages. More recently, ([Hernández, Costa, Sebastián-Gallés, Juncadella, & Reñé, 2007](#)) reported the case of an early and highly proficient bilingual patient with Alzheimer's disease (LPM) who presented the same pattern of grammatical category-specific deficit in the two languages. Specifically, LPM showed a disproportionate deficit in naming nouns in comparison to verbs in her two languages. This observation is of special relevance in the present context, given that in the following we present the performance of a bilingual individual (JPG) that shows the opposite pattern of grammatical category-specific deficit. That is, JPG's naming performance was more impaired for verbs than for nouns. In a way, the performance of these two patients complements each other and suggests that, beyond the specific neural overlapping between the two languages, some of the principles governing the cortical organisation of the L1 are also functional in L2.<sup>2</sup>

## 2. Case report

JPG is a right-handed, Spanish–Catalan bilingual male born in 1948 in Barcelona and working as an

<sup>2</sup> Interestingly, LPM showed a fronto-temporal hypoperfusion more evident in temporal regions, while JPG showed frontal lobe atrophy and hypoperfusion. It has been argued that damage to more posterior areas (temporal areas) tends to correlate with a disproportionate impairment for nouns, while damage to frontal areas of the left hemisphere tends to correlate with a disproportionate impairment for verbs (see [Shapiro & Caramazza, 2003b](#), for a review).

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