



# Naming unique entities in the semantic variant of primary progressive aphasia and Alzheimer's disease: Towards a better understanding of the semantic impairment



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## ABSTRACT

While the semantic variant of primary progressive aphasia (svPPA) is characterized by a predominant semantic memory impairment, episodic memory impairments are the clinical hallmark of Alzheimer's disease (AD). However, AD patients also present with semantic deficits, which are more severe for semantically unique entities (e.g. a famous person) than for common concepts (e.g. a beaver). Previous studies in these patient populations have largely focused on famous-person naming. Therefore, we aimed to evaluate if these impairments also extend to other semantically unique entities such as famous places and famous logos. In this study, 13 AD patients, 9 svPPA patients, and 12 cognitively unimpaired elderly subjects (CTRL) were tested with a picture-naming test of non-unique entities (Boston Naming Test) and three experimental tests of semantically unique entities assessing naming of famous persons, places, and logos. Both clinical groups were overall more impaired at naming semantically unique entities than non-unique entities. Naming impairments in AD and svPPA extended to the other types of semantically unique entities, since a CTRL > AD > svPPA pattern was found on the performance of all naming tests. Naming famous places and famous persons appeared to be most impaired in svPPA, and both specific and general semantic knowledge for these entities were affected in these patients. Although AD patients were most significantly impaired on famous-person naming, only their specific semantic knowledge was impaired, while general knowledge was preserved. Post-hoc neuroimaging analyses also showed that famous-person naming impairments in AD correlated with atrophy in the temporo-parietal junction, a region functionally associated with lexical access. In line with previous studies, svPPA patients' impairment in both naming and semantic knowledge suggest a more profound semantic impairment, while naming impairments in AD may arise to a greater extent from impaired lexical access, even though semantic impairment for specific knowledge is also present. These results highlight the critical importance of developing and using a variety of semantically-unique-entity naming tests in neuropsychological assessments of patients with neurodegenerative diseases, which may unveil different patterns of lexical-semantic deficits.

## 1. Introduction

The semantic variant of primary progressive aphasia (svPPA), also referred to as semantic dementia, is a neurodegenerative disease

characterized by a progressive deterioration of semantic memory (Gorno-Tempini et al., 2011). The core cognitive features of patients with svPPA are impaired confrontation naming and single-word comprehension, most often accompanied with impaired object knowl-

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edge as well as surface dyslexia and dysgraphia. While semantic deficits in svPPA patients are relatively isolated, at least in the early stages, Alzheimer's disease (AD) is characterized by a cognitive decline typically beginning with episodic memory impairments but resulting in general debilitating dementia affecting many other cognitive domains (McKhann et al., 2011). Interestingly, language impairments in AD initially affect confrontation naming and verbal fluency (Adlam et al., 2006; Hodges and Patterson, 1995; Huff et al., 1986; Verma and Howard, 2012).

Therefore, both svPPA and AD patients present with impaired confrontation naming. While it is a core symptom of svPPA (Gorno-Tempini et al., 2011), naming difficulties are much more heterogeneous in AD. Domoto-Reilly and colleagues found that approximately 41% of a large sample of early stages AD patients scored below the normal range when naming common entities (e.g. animals, objects, etc.) on the Boston Naming Test (Domoto-Reilly et al., 2012). However, deficits in naming semantically unique entities (i.e., entities with a unique semantic and lexical association) such as famous persons have been shown to be more severe than for non-unique entities in AD (Delazer et al., 2003; Joubert et al., 2010, 2008; Semenza et al., 2003a; Thompson et al., 2002). Considering that both populations present naming impairments, it appears necessary to compare svPPA and AD patients in terms of their ability to name semantically unique entities. Studies which have investigated semantically unique entities in dementia so far have largely focused on famous persons. However, it is necessary to determine if naming deficits in svPPA and AD patients extend to other categories of semantically unique entities such as famous places (e.g. landmarks and buildings) and famous logos (e.g. brands or everyday life pictograms). It is also critical to investigate if some types of items are selectively impaired within each population. The characterization of naming impairments across item types in each clinical population could be a valuable tool in clinical settings and contribute to identifying specific anomia profiles (e.g. proper name anomia or prosopagnosia). It also has the potential to improve differential diagnosis. To our knowledge, famous places have only been investigated in some patient populations such as Mild cognitive impairment patients (Ahmed et al., 2008), post-stroke aphasics (Vitali et al., 2015), traumatic brain injury patients (Milders, 2000), and epileptic patients (Benke et al., 2013). Famous logos have never been used with patient populations.

Investigating naming for different types of semantically unique entities is critical for several reasons. First, it is still unclear if famous persons and other entities such as famous places are processed the same way and therefore equally difficult to name for AD and svPPA patients. Previous neuroimaging studies have demonstrated that naming both famous persons and places activate the same brain regions related to semantics (i.e. the left anterior temporal cortex), in addition to brain regions subserving category-specific perceptual processing (i.e. fusiform regions for faces and parahippocampal/lingual regions for places/buildings) (Gorno-Tempini and Price, 2001; Grabowski et al., 2001). This could suggest that both types of entities would be relatively equally impaired in AD and svPPA, as is the case in mild cognitive impairment patients (Ahmed et al., 2008) and traumatic brain injury patients (Milders, 2000). In AD, only famous-landmark identification has been investigated and shown to be as impaired as famous-person identification (Sheardova et al., 2014). Secondly, in comparison to famous persons, famous places might be less time-period sensitive, which might be an advantage for the construction of a validated neuropsychological test that is durable. Finally, logos are different from other types of semantically unique items in the sense that they are characterized by a very stable and invariable perceptual representation. They also have the potential to be a valuable tool for clinicians as an indication of patients' abilities to identify everyday life stimuli.

Comparing svPPA and AD patients on tests of naming and semantic knowledge of semantically unique entities may also provide insight into the nature of the impairment underlying anomia in these patients.

Cognitive models of semantic memory suggest that naming impairments may be caused by either (1) a semantic impairment, in which stored information is lost, or (2) impaired lexical access, in which the access to stored information is dysfunctional (Lambon Ralph, 2014). While it is recognized that svPPA naming deficits result from the disease's characteristic progressive degradation of conceptual knowledge (Gorno-Tempini et al., 2011; Reilly et al., 2011; Rogers and Friedman, 2008), the nature of the impairment underlying anomia in AD is still a matter of debate. Previous studies have compared naming abilities and semantic knowledge in AD, i.e. the ability to name entities versus the ability to answer semantic knowledge questions about the same entities (Chertkow and Bub, 1990; Joubert et al., 2010). A correspondence between naming impairments and impaired semantic knowledge in AD patients was observed, suggesting that word finding difficulties were at least in part due to underlying semantic disruption, which could potentially be combined with additional difficulties in the selection, manipulation, and retrieval of knowledge (Joubert et al., 2010). Other studies observed strong associations between naming abilities and executive functioning in AD patients, suggesting that naming impairments may be associated in part with impaired controlled semantic retrieval (Reilly et al., 2011). In terms of neuroanatomy, these two mechanisms are associated with different brain regions. Semantic processing has principally been associated with anterior temporal lobes (ATL) and lexical access mainly with the temporoparietal junction (Gesierich et al., 2011; Vitali et al., 2015). While it is widely acknowledged that naming impairments in svPPA are associated with atrophy in the ATLs (Gorno-Tempini et al., 2004; Mesulam et al., 2009), previous neuroimaging results in AD patients have provided support for the role of both regions in naming abilities (Domoto-Reilly et al., 2012; Grossman et al., 2004; Lars et al., 2011; Nelissen et al., 2007, 2011; Vandenberg et al., 2007).

In this study, we aim to characterize and compare naming abilities in 13 AD patients, 9 svPPA patients, and 12 cognitively unimpaired elderly subjects (CTRL). To do so, we used a non-unique-entity naming test (the Boston Naming Test) and experimental semantically-unique-entity naming tests (famous persons, famous places, famous logos). While previous studies suggest that famous-person naming is more impaired than non-unique-entity naming in svPPA and AD, we aimed to evaluate if these impairments also extend to other semantically unique entities such as famous places and famous logos, which have never been studied in this population. In order to provide insight into the nature of the naming impairments observed (i.e. impaired lexical access vs. semantic impairment), semantic knowledge of semantically unique entities (for famous persons and places) was also assessed.

## 2. Material and methods

### 2.1. Participants

Thirteen patients with a clinical diagnosis of AD (5 women, 8 men), nine patients with svPPA (2 women, 7 men), and twelve CTRL (4 women, 8 men) took part in this study. Demographics of participants are presented in Table 1. The three groups were matched for age, gender, and education. The svPPA and AD patients were recruited through La Clinique interdisciplinaire de Mémoire du Centre hospitalier universitaire (CHU) de Québec and referred by a behavioral neurologist with expertise in neurodegenerative diseases and cognition (R.J.L.). svPPA patients were diagnosed according to currently accepted criteria (Gorno-Tempini et al., 2011). Diagnosis of AD was made based on the criteria of the National Institute on Aging and the Alzheimer's Association workgroup (McKhann et al., 2011). General exclusion criteria were as follows: native tongue other than French, left-handedness, developmental learning disabilities, past psychiatric disorder, history of traumatic brain injury, and uncorrected hearing and vision problems. The study was approved by the research ethics committee of the CHU de Québec (Project #2015-1909) and written

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