Large scale voxel-based lesion-symptom mapping on subacute stroke patients reveals the critical involvement of the left basal ganglia in phonological and semantic verbal fluency

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Introduction

Verbal fluency (or word generation) tests consist in generating as many words as possible in a given time interval without repetition and according to either a phonological (each word begins with a given letter) or a semantic rule (each word belongs to a given semantic category). They allow neuropsychological assessment of language and executive functions in brain-damaged populations and are considered to rely on left temporal and frontal structures. However, their supporting brain mechanisms still remain unclear, and notably whether shared or distinct anatomo-functional pathways support phonological and semantic fluency.

Method

To address these questions, we conducted a large-scale voxel-based lesion symptom mapping (VLSM) study on 83 unselected, subacute patients with a first left- or right- hemispheric stroke and their continuous, age-corrected scores in phonological and semantic fluency. The patients had to generate respectively as many words as possible in 1 minute, starting with an M or S (phonological condition), or belonging to the animal category (semantic condition). Naming ability was also assessed by the French version of the Boston Naming test.

Results

Among the 83 patients, 70\% had normal naming performances. Behaviorally, results in verbal fluency performances reveal a significant positive correlation between the scores to the two types of fluency, suggesting that common mechanisms subserve the generation of word independently of the production rule. The VLSM result supported this finding by showing that both phonologic and semantic fluency are impaired following lesions to the left basal ganglia. There was no evidence for brain areas in which lesions selectively impact on phonological or semantic fluency.

Discussion

Our results indicate that both type of verbal fluency require a common subcortical network centered around the left basal ganglia, a structures implicated in the motivational domain. They also suggest that a phonological-semantic dissociation is generally not to be expected in unselected focal
brain lesions. We discuss our results in terms of current models of the executive control of word retrieval and production, as well as with regards to the role of cortico-subcortical interactions in fluency.