

# Isolated left posterior insular infarction and convergent roles in verbal fluency, language, memory, and executive function

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The posterior insular cortex—a complex structure interconnecting various brain regions for different functions—is a rare location for ischemic stroke. We report a patient with isolated left posterior insular infarction who presented with multiple cognitive impairment, including impairment in semantic and phonemic verbal fluency.

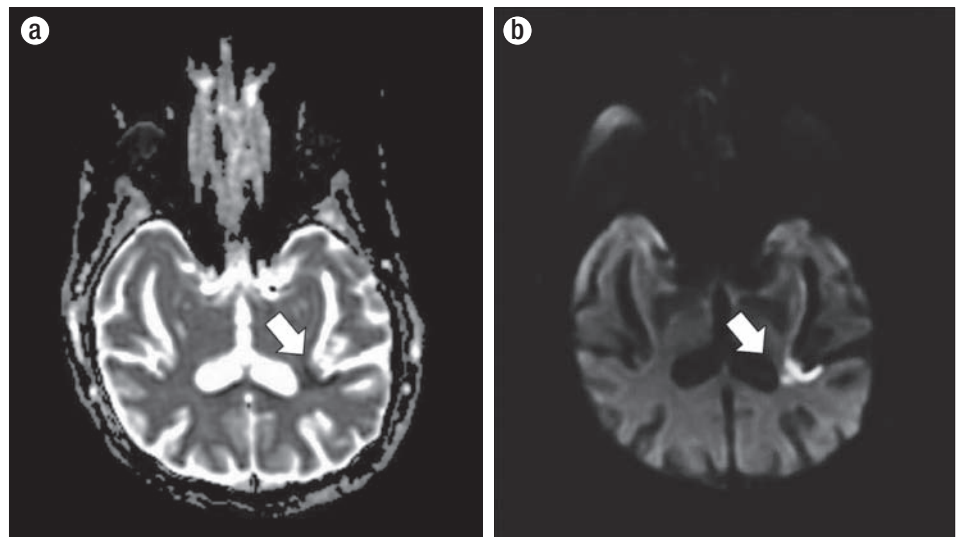
The insular cortex is a hidden structure located in the Sylvian fissure surrounded by the temporal, frontal, and parietal lobes. It is a complex structure interconnecting various brain regions that contribute to autonomic, gustatory, auditory, and speech and language function as well as somatosensory perception and emotional response (1). The arteries supplying the insular area mainly originate from the M2 segment of the middle cerebral artery (2). This article presents a case of isolated left posterior insular infarction (PII) resulting in impairment in multiple cognitive domains.

## CASE REPORT

An 80-year-old right-handed man with 13 years of education woke up with a speech problem. Previously, he had childhood poliomyelitis, diabetes mellitus, coronary artery disease, and hypertension. After waking up, he could not speak fluently, although his comprehension was fully preserved. He also had mild right facial drooping and right-sided weakness.

His vital signs and general exam were normal. The body mass index was 25.4 kg/m<sup>2</sup>. He had right facial weakness, word-finding difficulty, and mild dysarthria. Apart from the lower-extremity weakness from childhood poliomyelitis, he had no other motor or sensory deficits.

Magnetic resonance imaging of the head demonstrated an acute infarction in the left posterior insular cortex (*Figure 1*), and imaging of the neck showed approximately 50% narrowing of the proximal right internal carotid artery. Transthoracic



**Figure 1.** Acute left posterior insular infarction demonstrated by (a) apparent diffusion coefficient imaging and (b) diffusion-weighted imaging.

echocardiogram and telemetry were unremarkable. Aspirin 325 mg/day and atorvastatin 40 mg/day were started.

Two days later, the patient's right facial drooping, dysarthria, and word-finding difficulty completely resolved. He scored 20 out of 30 in the Montreal Cognitive Assessment (*Figure 2*) (3, 4). A retrieval memory deficit was detected with delayed recall of 0/5 and a Memory Index Score of 8/15 (5). He also had impairment in semantic fluency (7 words in 1 minute) and phonemic fluency (4 words in 1 minute). Impairment in repetition of complex sentences was detected. He did not demonstrate any naming problem when evaluated by the shortened Boston Naming Test (6). Based on clinical interview and the Geriatric Depression Scale (7), he did not have any affective disturbance that could impair his cognition. The Modified Rankin Scale score was 1 at discharge.

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**MONTREAL COGNITIVE ASSESSMENT (MOCA)**  
Version 7.1 Original Version

NAME: \_\_\_\_\_ Education: \_\_\_\_\_ Date of birth: \_\_\_\_\_  
Sex: M DATE: \_\_\_\_\_

**VISUOSPATIAL / EXECUTIVE**

Copy cube  [X]

Draw CLOCK (Ten past eleven) (3 points)

Contour  Numbers  Hands  4/5

**NAMING**

3/3

**MEMORY**

Read list of words, subject must repeat them. Do 2 trials, even if 1st trial is successful. Do a recall after 5 minutes.

	FACE	VELVET	CHURCH	DAISY	RED	No points
1st trial	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
2nd trial	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	

**ATTENTION**

Read list of digits (1 digit/ sec.). Subject has to repeat them in the forward order  2 1 8 5 4  
Subject has to repeat them in the backward order  7 4 2 2/2

Read list of letters. The subject must tap with his hand at each letter A. No points if ≥ 2 errors  
[ ] FBACMNAAJKLBFAKDEAAAJAMOF AAB 1/1

Serial 7 subtraction starting at 100  93  86 [ ] 79 [ ] 72 [ ] 65 2/3  
4 or 5 correct subtractions: 3 pts, 2 or 3 correct: 2 pts, 1 correct: 1 pt, 0 correct: 0 pt

**LANGUAGE**

Repeat: I only know that John is the one to help today.   
The cat always hid under the couch when dogs were in the room.  1/2

Fluency / Name maximum number of words in one minute that begin with the letter F  4 (N ≥ 11 words) 0/1

**ABSTRACTION**

Similarity between e.g. banana - orange = fruit  train - bicycle  watch - ruler *time* 1/2

**DELAYED RECALL**

Has to recall words WITH NO CUE	FACE	VELVET	CHURCH	DAISY	RED	Points for UNCUED recall only
Category cue	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
Multiple choice cue	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	

0/5

**Optional**

**ORIENTATION**

Date  Month  Year  Day  Place  City 6/6

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Figure 2. The performance of this patient on the Montreal Cognitive Assessment.

## DISCUSSION

Isolated PII is a rare condition. In one study, among 4800 patients with their first episode of ischemic stroke, only 4 patients (0.08%) had isolated insular infarction (8). The findings of multidomain cognitive impairment in this patient suggest that the posterior insular cortex is a convergent structure; thus, the deficits caused by PII are more likely to be the consequence of diaschisis rather than damage of a specialized or isolated center itself (Figure 3).

Due to the complexity of the cognitive process, it is challenging to draw conclusions about the role of the insular cortex in speech production. In one study, the anterior insular cortex was a common area of infarction in all 25 stroke cases with disorder of motor planning in articulation (9). Left PII was previously reported to cause both dysarthria and aphasia in a single case (8). The insular cortex is activated in the phonological process dur-

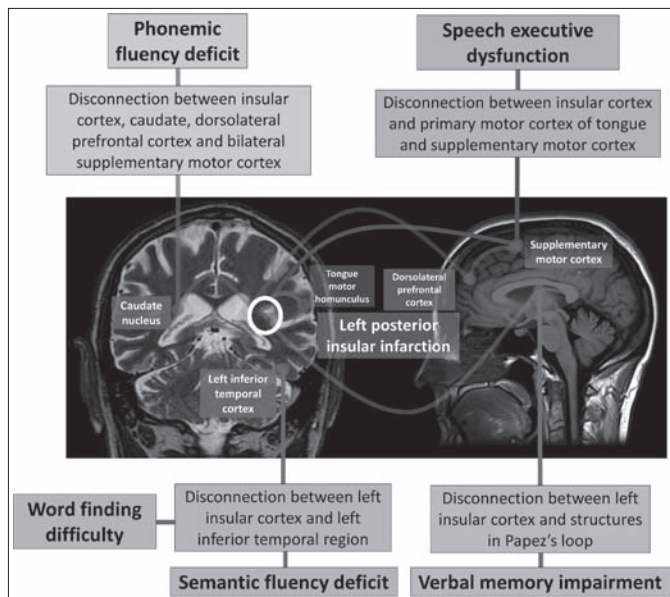
ing reading in functional magnetic resonance imaging (10). Executive function is also required in planning of articulation. Therefore, PII may cause a disconnection between the primary and supplementary motor cortex, leading to executive dysfunction of motor speech (8, 11).

The insular cortex is associated with gustatory, visual, and verbal memory (12–14). Patients with a left insular stroke have more impairment in verbal memory and logical memory than patients with a right insular stroke (13). The disruption of the connection between the left temporal lobe and the left insular cortex may play a role in this deficit. Positron emission tomography in healthy volunteers showed a correlation between cerebral blood flow in the insular cortex and the verbal memory task (15). Improvement with cue may imply that the memory impairment was primarily from deficits in retrieval of the previously registered information, not the encoding process.

Phonemic fluency is primarily mediated by the frontal lobe, while semantic fluency requires lexicosemantic memory, which is functioned mainly by the temporal cortex. In 48 patients with a left-hemisphere stroke, voxel-based lesion symptom mapping showed the association between the phonemic fluency task and the insular cortex lesion (16). The left anterior insular infarction was reported to cause executive dys-

function, including impairment of semantic and phonemic fluency, which may be a result of neuronal network disruption between the anterior insula and frontal lobe and/or cingulate regions (17). To the best of our knowledge, this is the first report of a verbal fluency deficit in a patient with an isolated left PII. Since the posterior insular cortex is adjacent to the semantic storage areas, this infarction may cause network disconnection between these areas, resulting in difficulty retrieving previously learned knowledge.

Even though various types of aphasia were reported in strokes involving the insular cortex (8, 18, 19), pure insular infarction with aphasia is very uncommon. Anatomically, the insular lobe is in the central part of the structures that are important in language functions, including the frontal operculum and Wernicke's area. The disconnection of these structures and insular area may contribute to language dysfunction after insular damage.



**Figure 3.** The role of the posterior insular cortex and its connecting areas in multiple cognitive domains including phonemic and semantic verbal fluency, speech executive function, language function, and verbal memory. The posterior insular cortex is a convergent structure connecting with multiple brain regions; thus, the deficits caused by posterior insular infarction are more likely to be the consequence of diaschisis than damage to a specialized or isolated center.

The prognosis of the isolated insular infarction is favorable. In a case series, more than half of patients with isolated insular infarction or minimal extension to adjacent areas completely recovered or had minimal deficits within 48 hours, and all had a Modified Rankin Scale score of 0 to 2 at 6 months (18).

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