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# Localization of cognitive processes using Stroke patients and fMRI

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Localization of cognitive processes to brain regions have mainly utilized the location of infarcted brain regions in stroke patients or fMRI in normal subjects. The BOLD effect in fMRI studies may be difficult to interpret in stroke patients who have areas of hypoperfusion (with resultant reduction in hemodynamic response) due to arterial stenosis. This study was undertaken to examine the influence of hypoperfused regions, in addition to the area of infarct itself, on cognitive processes and fMRI in stroke patients.

## Methods

Subjects with subcortical strokes in the left MCA or right-MCA territories, along with normal controls, were imaged while performing a verbal fluency task. The experiments were performed on a 1.5 T whole-body scanner (Philips Medical System, Best, The Netherlands). The study population included six normal participants (3M, 3F, ages 24-57) and six stroke patients (3M, 3F, ages 28-58) with MCA distribution subcortical infarcts. Patients were given a verbal fluency task of 1 min. in duration, compared to rest of 30 secs, organized in an alternating block design, while being scanned with a whole brain fMRI/Stroke MRI-Protocol that included perfusion weighted imaging (PWI) that reveals areas of hypoperfusion as well as structural scans (FLAIR, DWI, T2 sequences)

## Results

While normal subjects displayed a left-lateralized fronto-temporal and bilateral cingulo-striatal-thalamic-cerebellar network, the activation pattern of stroke patients was determined both by the hypoperfused regions and/or infarcted areas of the brain. Specifically, the left frontal-temporal network showed diminution of activity in our left MCA patients that had cortical hypoperfusion in the corresponding regions, although their infarcted areas were subcortical.

**Table 1:**

	Left Middle Cerebral Artery Stroke				Right Middle Cerebral Artery Stroke	
<b>Patient</b>	MS	SB	MZ	HS	TG	JH
<b>Gender</b>	Male	Female	Female	Female	Male	Male
<b>Age,Race</b>	58, W	34, AA	50, W	52, W	50, AA	28, W
<b>Infarct</b>	Minimal left posterior temporo-parietal infarct	Minimal left frontoparietal infarct	Left caudate and Centrum semiovale	Left basal ganglia and Centrum semiovale	Right parietal watershed	Right anterior temporal lobe and basal ganglia
<b>Perfusion Defect Occurrence fMRI test</b>	Posterior temporo-parietal hypoperfusion 04/18/02 11/07/02	Frontoparietal hypoperfusion 02/99 10/08/02	Fronto-temporo-parietal Hypoperfusion 08/18/01 12/12/03	Frontal hypoperfusion 07/00 01/07/03	Fronto-temporo-parietal hypoperfusion 1990 02/05/04	Parietal Hypoperfusion 07/19/02 09/30/02
<b>Signs and Symptoms</b>	Impaired word retrieval Impaired sentence comprehension Right upper extremity tingling	Alexia, agraphia Minimal word retrieval difficulty Right-sided weakness	Impaired word retrieval Right upper extremity weakness	Impaired word retrieval Right upper extremity numbness Slurring of speech	<b>Impaired word retrieval</b> Right arm numbness Slurring of speech	Left-sided facial droop Slurring of speech Right temporal headache

## Conclusions

The observation of a diminished BOLD signal in hypoperfused regions of cortex could either reflect reduced activation in these areas due to tissue dysfunction or reflect normal activation accompanied by increased oxygen extraction without a normal hemodynamic response. The results raise the possibility that localization studies should take into account brain regions that are hypoperfused, as well as infarcted brain regions, in trying to map cognitive processes to brain regions.

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