# HARDI Tractography of Thalamic Connectivity of Broca's Area

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## Introduction

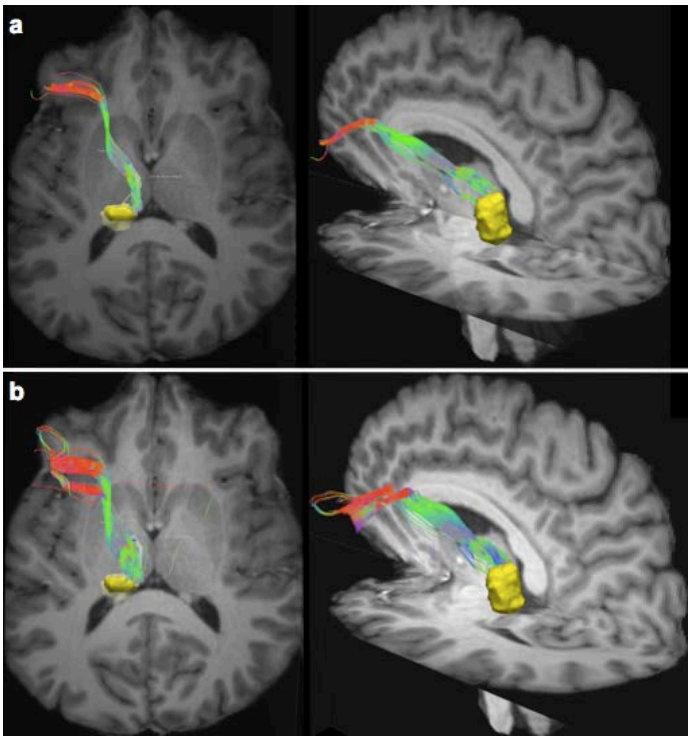
A small stroke affecting human thalamus may cause the debilitating language disruptions of thalamic aphasia; fluent but paraphasic speech and inability to name objects, for example. Broca's area is a roughly golf ball sized region in left frontal cortex which, when damaged, leads to non-fluent aphasia. Structural connections between this language-eloquent cortex and thalamus cannot be readily inferred from studies of non-human primates, because this region of cortex has connectivity that has evolved rapidly from monkeys to apes to humans.

## Experimental

High angular resolution diffusion-weighted imaging (HARDI) was carried out in 64 isotropically distributed directions at b=1000 s/mm$^2$ with 2 mm isotropic voxels on ten neurologically normal right-handed native English speaking young adults in the UF AMRIS 3T human scanner. A further six directions were collected with b=100 s/mm2, and two images collected with b=0. High resolution anatomic MPRAGE was collected with 1.0 X 0.94 X 0.94 mm voxels. These results were analyzed at 0.5 mm "superresolution" using probabilistic tractography. Cortical and subcortical masks were drawn by hand for pars triangularis and pars opercularis of Broca's area, and for ventral anterior nucleus and pulvinar complex of the thalamus, on each anatomic scan, which was in turn registered to the participant's diffusion space.

## Results

The figure shows for a representative participant inferred pathways connecting Broca's area pars triangularis (a) and Broca's area pars opercularis (b) with the pulvinar complex of thalamus (depicted in yellow). Color gradient of the pathways indicates local orientation of the fibers (red: left—right, green: anterior—posterior, blue: superior—inferior). The pathway shown passes through the thalamus from ventral anterior nucleus to pulvinar.




## Discussion

Language deficits resulting from lesions to the anterior or posterior regions of the thalamus show a substantial amount of overlap in clinical manifestations regardless of the lesion's anterior or posterior location (Raymer *et al*., 1997; Crosson, *et al.*, 1997). The present findings show that a lesion in either location could indeed disrupt a network of communication involving Broca's area and both the anterior and the posterior portions of thalamus. Thus, these findings help to understand clinical observations.

## References

[1] Raymer, S. *et al*., Brain and Language, **58**, 137-156 (1997).
[2] Crosson, B, *et al*., Brain and Language, **60**, 407-442 (1997).