

# New Anatomical Characterizations of the Posterior Sylvian Fissure using the Human Connectome Project Database

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## Introduction

Cortical folding has been studied by neuroanatomists. Some attempts have been made to describe cortical folding variability [1], and linking cortical folding pattern to behaviour or pathology [2]. Human vision remains limited in analyzing these complex forms, especially when analyzing the three-dimensional forms of the sulci instead of the two-dimensional surface-based shapes. With the aid of BrainVISA [3,4], an automatic cortical folding recognition and analysis platform, studies have been carried out revealing the link between sulci shape and traits such as handedness and the activation pattern during silent reading [5,6]. Thanks to the joint effort of the community, large public databases such as Human Connectome Project (HCP) became available for systematic study of the cortical folding patterns [7]. The Sylvian Fissure (or Lateral Fissure) is the longest sulcus of the brain with well-known hemispheric asymmetry (Yakovlevian torque and asymmetry observed using surface-based techniques) [8,9]. The current study is focused on the posterior portion of the Lateral Fissure (PLF).

## Material and methods

The public HCP database was used, 882 subjects were processed (release of 2015), PLF extracted and labelled automatically by the “Morphologist 2012” toolbox of BrainVISA [<http://brainvisa.info>] [4,10]. All brains were normalized by affine transformation to the Talairach space, the right hemisphere PLF were flipped to the left hemisphere space. The pairwise shape similarities of the fissure were computed using rigid alignment. The Isomap-based manifold learning method was used to restrict the study to the six dimensions that captured the most variability, in decreasing order. For each of the six Isomap dimensions, local average shapes were computed at regular-spaced intervals for visualization. The hemispheric asymmetry was studied using two-sided Wilcoxon tests. The correlation of grey matter volume to shape characterization were studied, to clarify the relationship between folding characteristic and brain volume. Since there is a well-known correlation between gender and brain volume, gender effect on PLF shape was only studied for the Isomap dimensions that were not correlated to brain volume.

## Results

The shape change characteristics of the six dimensions are shown to the right in Fig 1. The amount of variability respectively explained by these dimensions is 21.2, 9.7, 7.1, 6.5, 5.3, 4.6%. Referring to the first dimension, a gradual change in the angle of the bending of the fissure is observed, which is in agreement with the literature [10, 11]. The other dimensions correspond to: gradual elongation of the terminal ascending portion; gradual upward rotation of the terminal portion; gradual increasing in upward curvature of the terminal portion; gradual inward rotation of the terminal portion; and gradual increase in size of the terminal “spoon” shape.

Out of the six dimensions, only dimensions 1 and 4 were not correlated to brain volume. Refer to Fig 2, a gender effect was observed on the right hemisphere of dimension 1 ( $p=2e-5$ ). The hemispheric asymmetry was studied, dimensions 1, 2, 3, and 4 ( $p=2e-15$ ,  $2e-15$ ,  $2e-9$  and  $1e-9$  respectively) were found to be asymmetric. The direction of correlation of brain volume to shape is illustrated in Fig 2 for dimensions 2 (Left  $p=0.01$ , right  $p=0.02$ ) and 3 (Right,  $p=0.01$ ).

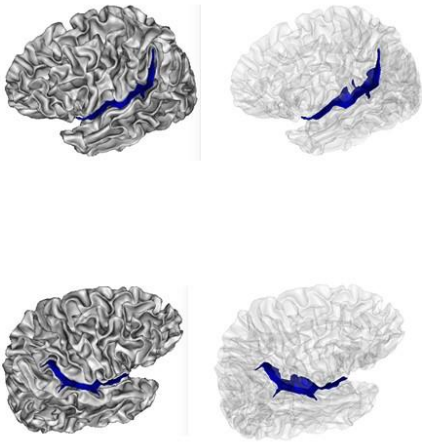
## Conclusions

The results confirm the main variability trait of the region observed in previous studies. New variability traits were identified and characterized. Valuable insights were gained regarding the relationship between cortical folding shapes and volume. Shape asymmetry was found in four out of six dimensions, possibly due to the strong asymmetry of this region already observed in literature. In future studies the branches of PLF and the surrounding sulci will be added to clarify the local configuration and its possible relationships to functional areas.

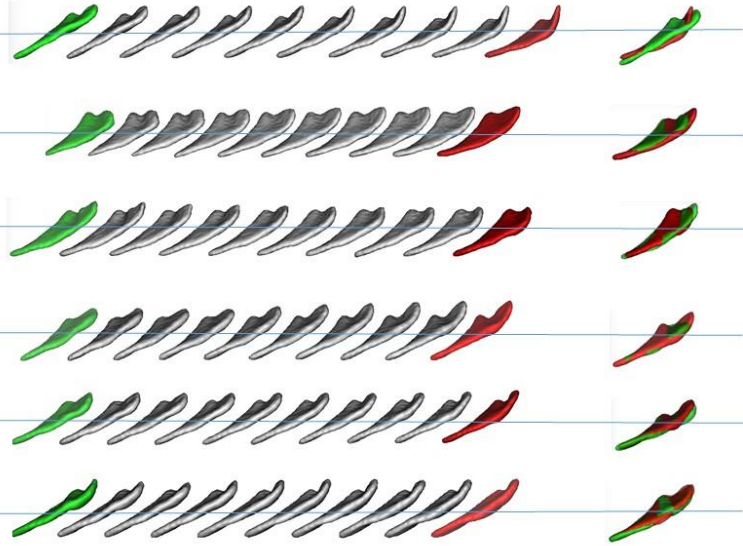
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Examples of the Posterior Lateral Fissure (PLF) without the branches



The shape changes of PLF along the six Isomap axes



Hemisphere, volume and gender asymmetry of the Posterior Lateral Fissure (PLF)

