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Cortical localization by surface parameterization : a gyrus-based approach

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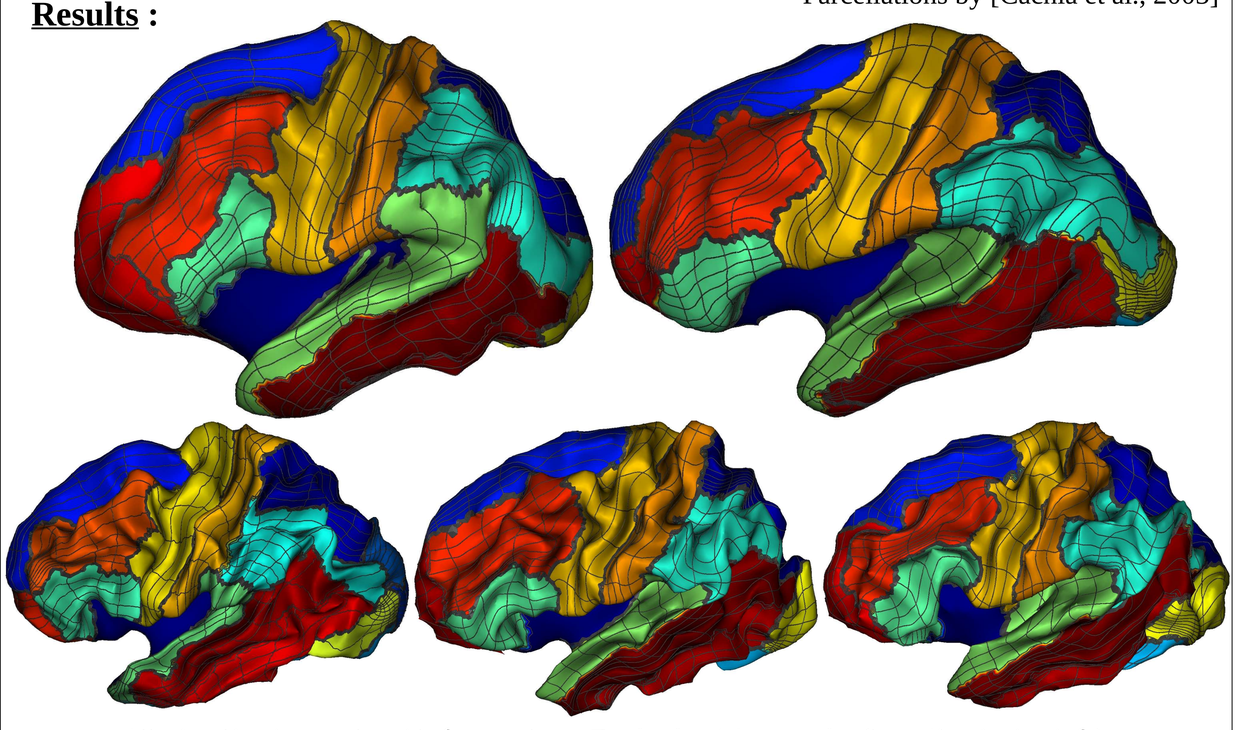
Goals :

Automatic and **reproducible surface-based coordinates system** associated to any parcel of a gyral parcellation.

Application : cortical localization for surface based functional data analysis, morphometry on gyri or generally on cortical ROI, visualization purposes (e.g. surface-flattening, spherizing)...

Results :

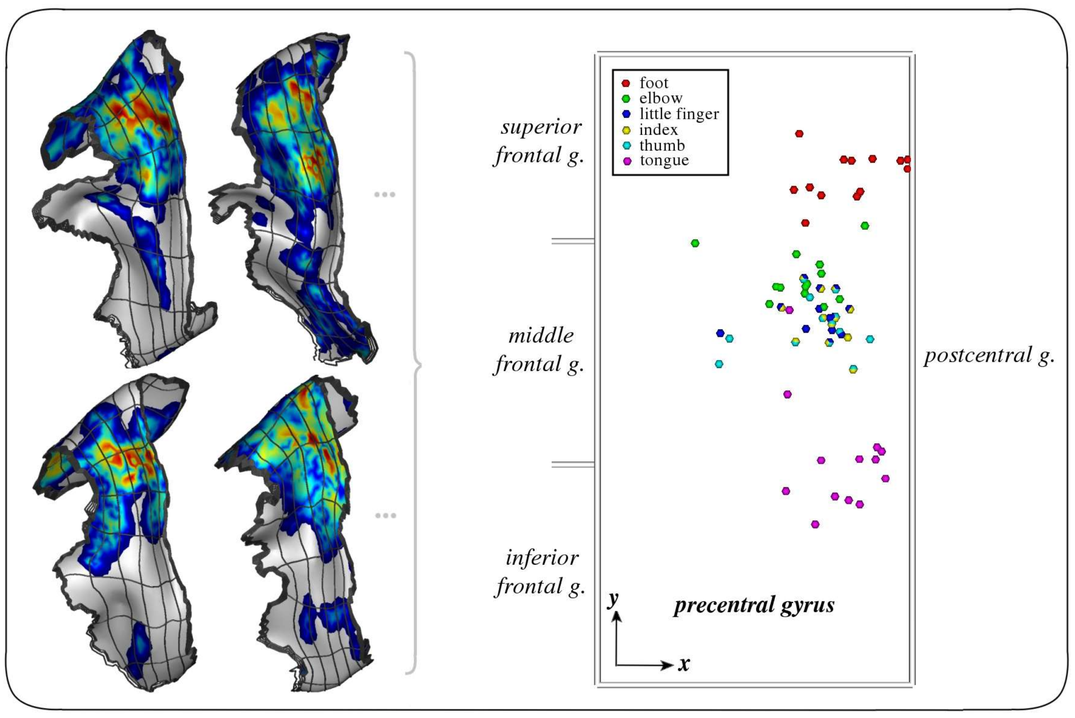
Parcellations by [Cachia et al., 2003]



All visualization made with free package **Brainvisa / Anatomist** (*http://brainvisa.info*)

Somatotopy protocol experiment (J.-L. Anton et al.) :

13 subjects, 6 right motor tasks : foot, elbow, auricular, index, thumb, tongue
Individual SPMt maps are projected onto individual cortical surfaces. Maximum activation foci are localized on each individual gyrus-based coordinate system, and plotted onto a generic atlas.

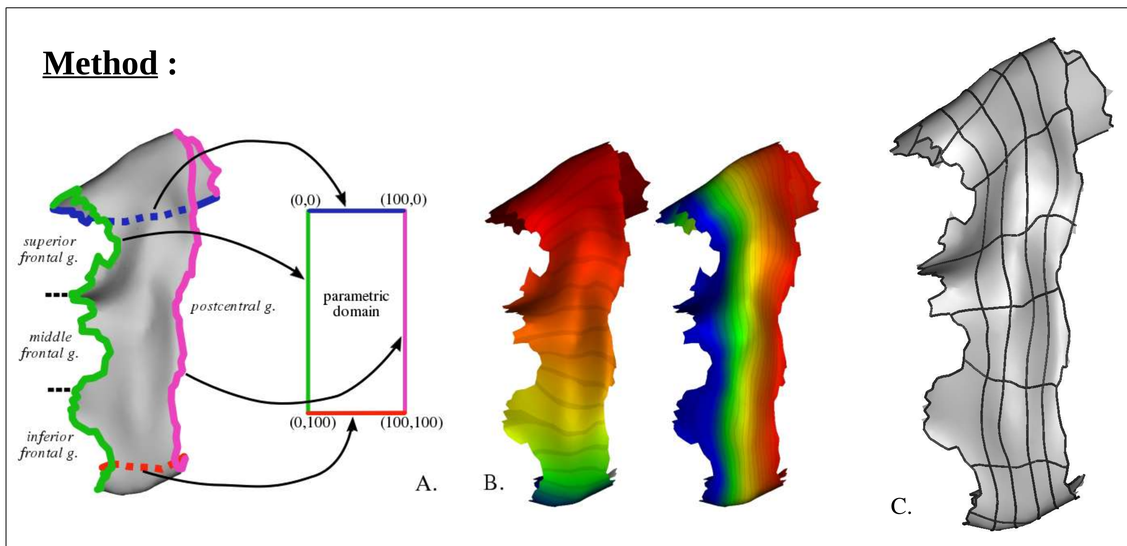


Motor activations displayed on inflated precentral gyri meshes – Maximum activation foci are plotted onto a generic gyrus-based atlas

– Application of the method to intersubject comparisons

– Despite influences of the projection of 3D functional data onto the surface and some functional intersubject variability, some coordinate stability is observed for given activation focus across subjects.

Method :



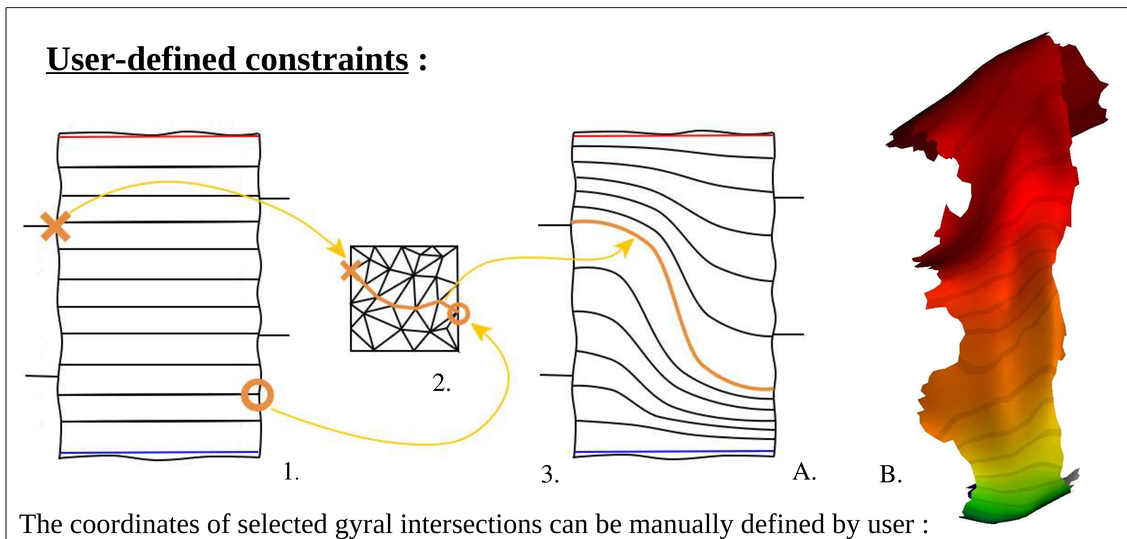
On a given parcellation [Cachia et al., 2003], the method processes each gyrus after another,

– **Association** of four border segments to the edges of the coordinate domain (fig. A). A flexible description model of neighborhood relationships between gyri makes these associations invariant.

– Integration of **user-defined constraints** imposing the values of certain gyral intersections.

– **Propagation** of the coordinates system over the whole gyrus surface (fig. B) using the Heat equation. Latitude and longitude are propagated from the constraints using a heat diffusion process [Clouchoux et al., 2004]. Constraints are used as **heat sources** with constant temperature.

User-defined constraints :



The coordinates of selected gyral intersections can be manually defined by user : after a first constraint-less propagation (fig. A1), the method finds a path connecting the marker from one border (cross-marked) to the point (circle-marked) which carries the user-specified value on the opposite border (fig. A2). This value is then imposed along the path (fig. A3) and the propagation is run once again with this constraint on (fig. B).

– **Additional anatomical information** is integrated to the system

– Interest of constraining coordinates of **functional foci** as well

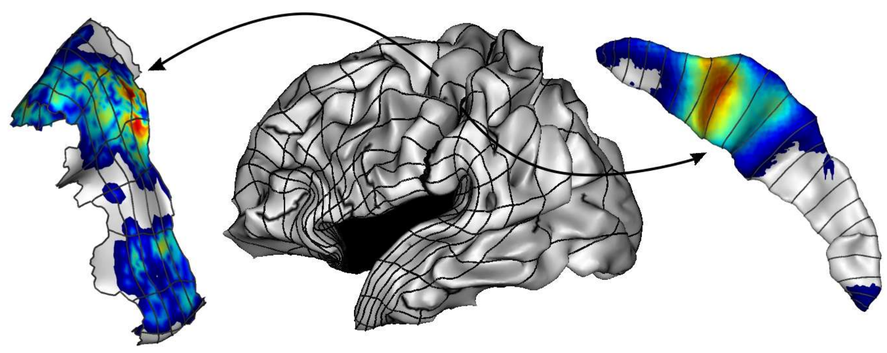
Discussion - conclusions :

– **Automatic** construction of **surface-based system** based on **stable anatomical landmarks**

– Reproducibility and anatomical sense depends strongly on the quality of the parcellation

– The method herein is applied to gyri but can be adapted to other ROI, such as sulci [Coulon et al., 2006] or any other user-defined areas

– A 2D coordinate system opens the way to cortical-based activation detection



References :

B. Fischl, M.I. Sereno, A.M. Dale. Cortical surface-based analysis II: Inflation, flattening, and a surface-based coordinate system. NeuroImage 9:195--207, 1999.

O. Coulon, C. Clouchoux, G. Operto, K. Dauchot, A. Sirigu, J-L. Anton. Cortical localization by surface parameterization : a sulcus-based approach. 12th Human Brain Mapping Conference, 2006.

C. Clouchoux, O. Coulon, G. Operto, D. Riviere, K. Dauchot, A. Sirigu, J-L. Anton, J. Regis. Cortical localization via hemisphere surface parameterization. 12th Human Brain Mapping Conference, 2006

A. Cachia, J.-F. Mangin, D. Rivière, D. Papadopoulos-Orfanos, F. Kherif, I. Bloch, J. Régis. A generic framework for parcellation of the cortical surface into gyri using geodesic Voronoï diagrams. Medical Image Analysis, 7(4):403--416, 2003

Cédric Clouchoux, O. Coulon, D. Rivière, A. Cachia, J.-F. Mangin, J. Régis. Anatomically constrained surface parameterization for cortical localization. MICCAI'05, pp. 344--351, 2005.