

Fusiform Gyrus

Manual Tracing Protocol

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Introduction:

The fusiform gyrus (FG) is highly variable and asymmetrical among most brains. While its medial and lateral borders (the collateral sulcus and occipital-temporal sulcus, respectively) are quite constant, the anterior and posterior borders are more difficult to define. We have chosen the anterior tip of the parietal-occipital sulcus, as visible in the mid-sagittal plane, as the posterior border. The anterior border can be defined as one slice posterior to the appearance of the mamillary bodies. In cases where the FG seems to initiate posterior to this point, the anterior end of the occipital-temporal sulcus, as visible in the axial plane, may be used.

Images and Tool:

- The manual tracing features of ITK-SNAP are used to label the fusiform gyrus. The majority of the tracing is done in the coronal view.
- The images used in the following methods are T1 gray level images, aligned to standard ACPC space and resliced to isotropic voxels using the BRAINS2 software package (University of Iowa). For coronal images from BRAINS2, the SNAP file orientation is **RIP**. Images aligned using other tools may have different orientations.
- Use the existing **fusiform.labels** label description file, which ensures that saved volumes are always properly labeled. A new label file may be generated if the user is working on a data set other than the pediatric Autism or Fragile X Longitudinal data sets.

Steps for Segmentation of the Fusiform Gyrus

Getting Started

- 1) Start ITK-SNAP (InsightSNAP).
- 2) Load the T1 gray level image.
- 3) Load the fusiform gyrus label descriptions file.

Anterior Border Definition

- 1) Begin in the axial plane. Place the crosshairs exactly between the right and left hemispheres to define the mid-sagittal plane. The sagittal view can then be used to find the mamillary bodies. Place the crosshairs on the tip of the mamillary bodies in this plane. They should also appear in the coronal and axial planes.
- 2) Zoom in on the mamillary bodies in the coronal plane and navigate in the posterior and anterior directions to determine at which point they first appear. Position can be verified in the sagittal plane.
- 3) When the appearance of the mamillary bodies is determined, advance one slice in the posterior direction (in the coronal plane) and note this as the anterior border of the FG.
- 4) In some cases, the FG begins posterior to the mamillary bodies. In these cases, continue to navigate posteriorly from the mamillary bodies, noting when the tip of the FG is first visible, essentially at the intersection of the occipital-temporal sulcus and collateral sulcus. The tip of the FG should be clearly visible in the axial and sagittal planes in these cases. Thus, when the FG begins posterior to the mamillary bodies, its tip (as visible in the axial and sagittal views) defines its anterior border.

Posterior Border Definition

- 1) Re-position the crosshairs between the right and left hemispheres in the axial plane, this time attending to the posterior part of the image. The sagittal view should clearly display the parietal-occipital sulcus. Zoom in on the area and position the crosshairs on the most anterior tip of the sulcus in this plane.
- 2) With the crosshairs in this position, check the coronal plane. Without moving the crosshairs, advance anteriorly and then posteriorly until the parietal-occipital sulcus is first visible in the coronal plane (essentially as a dark "spot"). Note this slice as the posterior border of the fusiform gyrus.
 - a. In some images, quality and contrast are not detailed enough to be able to distinguish the parietal-occipital sulcus in the coronal view, thus placing the crosshairs in the sagittal plane and noting their position in the coronal plane is acceptable

Medial and Lateral Borders

- 1) The collateral sulcus defines the medial border, and the occipital-temporal sulcus defines the lateral border of the FG.
- 2) The occipital-temporal and collateral sulci are often interrupted along the length of the FG. In cases where either sulcus is not clear, the more definite sulcus (visible in the coronal and axial planes) can form the lateral or medial boundary. In cases where the occipital-temporal sulcus is unclear or interrupted, the more lateral sulcus is typically clearer.

Tracing the FG in the Coronal Plane

- 1) Before beginning the segmentation steps, the general progression of the FG should be noted from start to finish to identify any regions where the medial and lateral borders are interrupted.
 - a. After marking the anterior and posterior borders, navigate through the region of interest in the coronal plane, particularly attending to the progression of temporal sulci, as these will aid in defining the FG during segmentation.
 - b. From the Sylvian fissure moving medially, the next definite sulcus will be the superior temporal sulcus, then the inferior temporal sulcus, then the occipital-temporal sulcus and the collateral sulcus.
 - c. It is also helpful to note the progression of these more medial sulci in the axial plane, again to formulate a clear idea of the location of the FG.
- 2) Re-position the crosshairs between the two hemispheres in the axial plane, and advance to the slice noted as the anterior border. Outline the FG in the coronal plane.
 - a. In this most anterior view, the FG will be the most medial of the temporal gyri. It is lateral to the entorhinal area, which appears as a blurry structure, eventually becoming the parahippocampal gyrus.
 - b. Moving medially from the Sylvian fissure and the superior temporal gyrus, the fusiform should be the fourth gyrus (its lateral border should be the fourth sulcus, as well).
 - c. Begin outlining the FG at the tip of the occipital-temporal sulcus medially and trace around the gyrus until the tip of the collateral sulcus is reached. Complete the area by drawing a straight line connecting the depths of the two sulci

Note: The general rule for establishing the dorsal boundary of the FG is to draw a straight line across the gyrus, from the tip of the occipital-temporal sulcus to the tip of the collateral sulcus.

- 3) Advance one slice posteriorly. The FG is still counted as the fourth gyrus from the superior temporal gyrus, medial to the inferior temporal gyrus. Begin outlining again at the tip of the occipital-temporal sulcus.

- a. If the sulcus is difficult to define, bisect the grey matter between the FG and its neighboring gyrus (inferior temporal gyrus or parahippocampal gyrus).

Note: The “Paste” function can be used to paste the previous trace onto the current slice, serving as a guideline that can be moved or modified.

- 4) Continue posteriorly, tracing the FG on every slice.
 - a. When the hippocampus is visible, the parahippocampal gyrus should also be defined.
 - b. In cases where it seems that the FG is divided into medial and lateral sections, the area between the parahippocampal gyrus and inferior temporal gyrus (bordered by the inferior temporal sulcus and the occipital-temporal sulcus) defines the FG in the coronal plane.
- 5) Tracing should again proceed using the occipital-temporal and collateral sulci as lateral and medial borders. The FG can also be viewed in the axial and sagittal planes. In the coronal view, the FG will broaden, variably dividing into medial and lateral sections.
- 6) In more posterior slices, the parahippocampal gyrus will become the lingual gyrus. However, the collateral and occipital-temporal sulci still define the FG.
- 7) When the Sylvian fissure is no longer visible, the FG should be the third gyrus medial to the parallel sulcus and the middle temporal gyrus.
 - a. It is most helpful to follow the progression of the temporal sulci as boundaries at this point, as well.
 - b. In these posterior slices, the FG will likely have medial and lateral sections.
- 8) Note progress toward the parietal-occipital sulcus (posterior boundary) in the sagittal plane. When the posterior boundary slice is reached, check again that the tip of the parietal-occipital sulcus is visible in the coronal plane.
- 9) Review FG trace in all views.

Saving FG data

- 1) Save segmentation data. Name the file <ID>_fusiform.gipl
- 2) Save voxel counts (volumes). Name the file <ID>_fusiform.vxct

References

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- Lee CU, Shenton ME, Salisbury DF, Kasai K, Onitsuka, T, Dickey CC, Yurgelun-Todd, D, Kikinis, R, Jolesz, FA, McCarley, RW. (2002). Fusiform gyrus volume reduction in first-episode schizophrenia: A magnetic resonance imaging study. *Archives of General Psychiatry*, 59, 775-781.
- Yushkevich, PA, Piven, J, Hazlett, HC, Smith, RG, Ho, S, Gee, JC, & Gerig, G. (2006). User-guided 3D active contour segmentation of anatomical structures: Significantly improved efficiency and reliability. *Neuroimage*, 31 (3), 1116-1128.
[ITK-SNAP software: <http://www.itksnap.org>]

Summary Information

Tool used: ITK-SNAP segmentation tool.

Reliability has not yet been established.