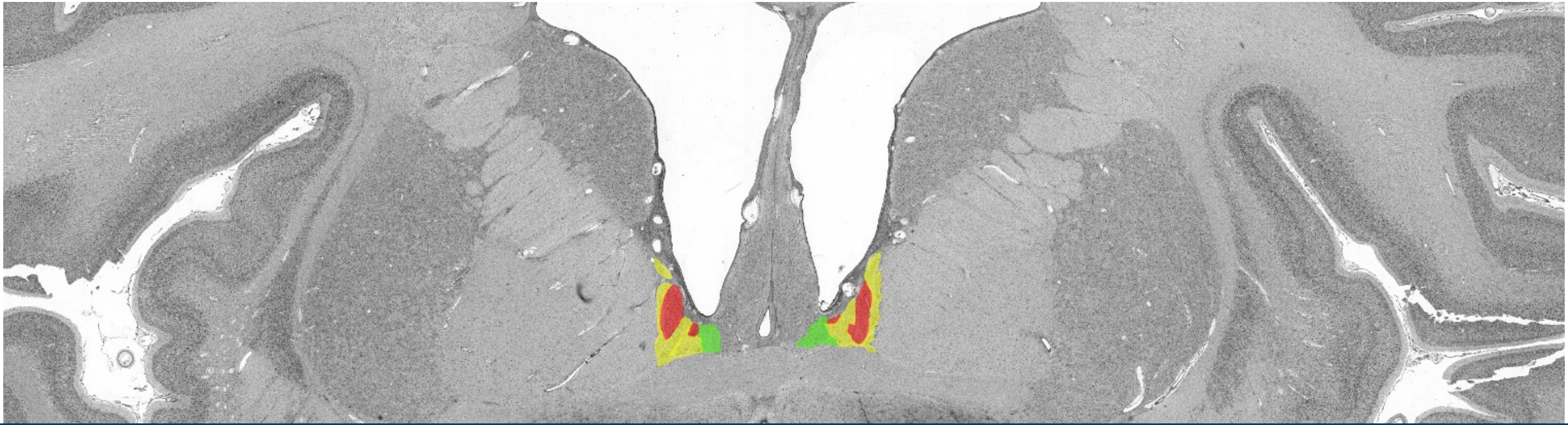

Cytoarchitectonic Mapping, 3D-reconstruction and Texture Analysis of the human Bed nucleus of the stria terminalis

SEPTEMBER 21ST 2022 I ANDREA BRANDSTETTER

Co-funded by the European Union

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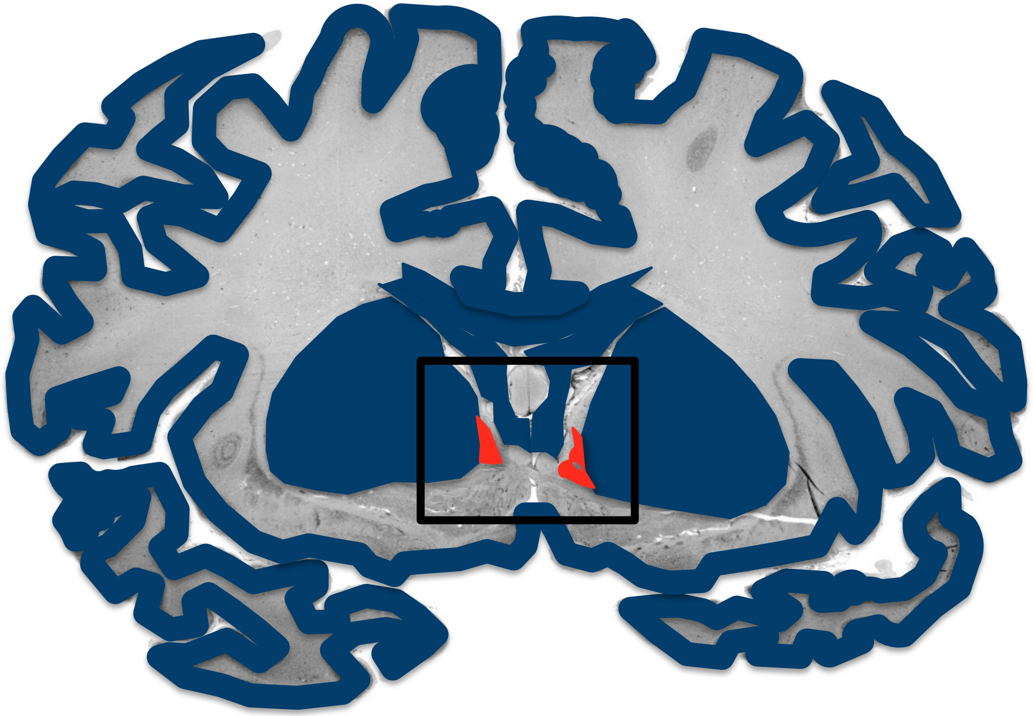
BED NUCLEUS OF THE STRIA TERMINALIS

Location

Left hemisphere of a human brain (B13)

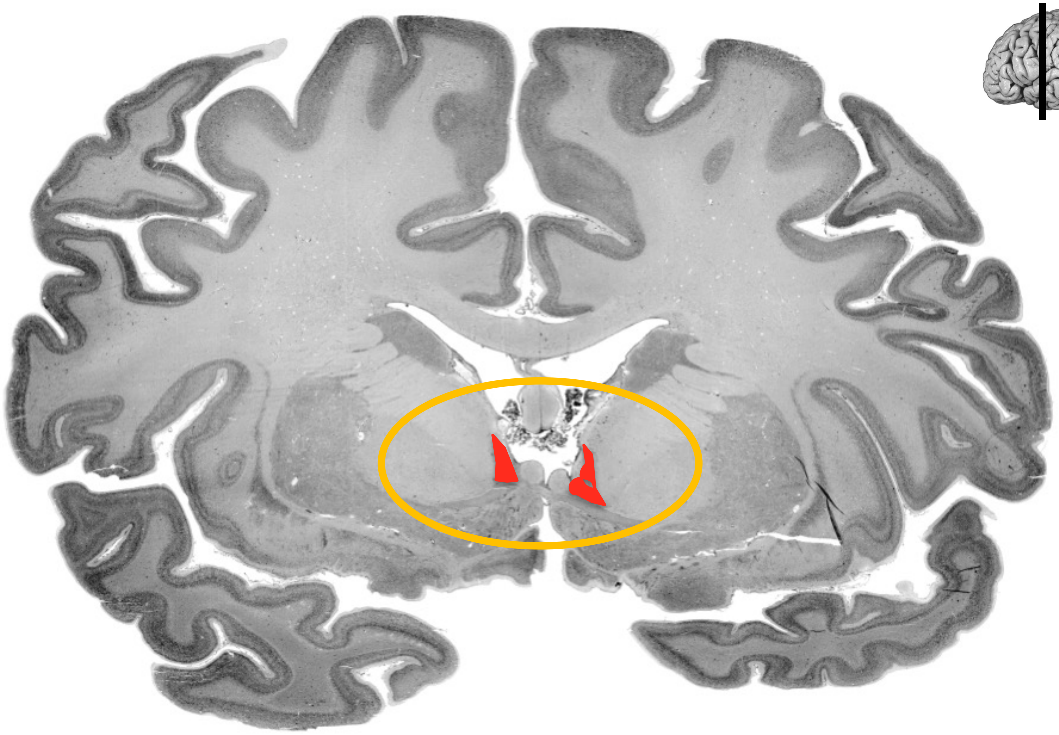


Cell body-stained, coronal section (B13, section 4004)

BED NUCLEUS OF THE STRIA TERMINALIS

Connectivity and Function

- **Inputs** from amygdala: central and medial amygdaloid nuclei
- **Outputs** to hypothalamus, brainstem, amygdala
- **Sustained Fear** ≠ immediate threats
- **Stress response**

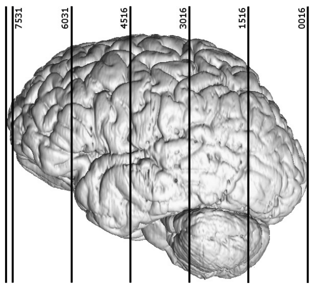


Cell body-stained, coronal section (B13, section 4004)

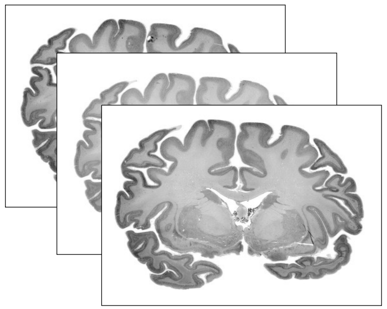
CYTOARCHITECTONIC MAPPING

Method

Ten postmortem brains
Fixed in formalin, embedded in paraffin

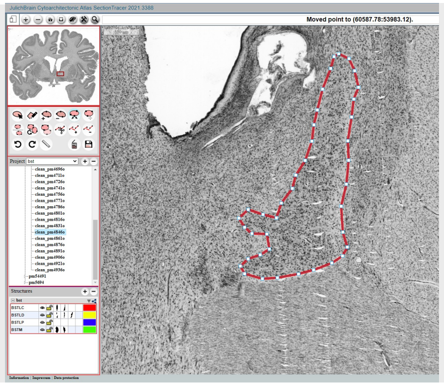


Serial sectioning:
in coronal plane



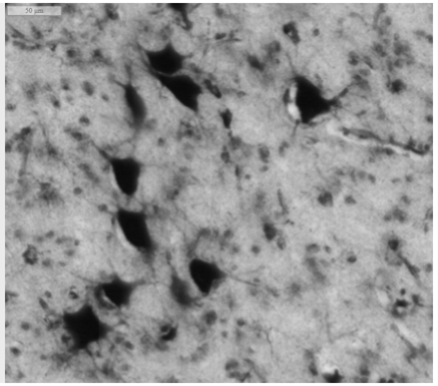
Sections: 20 μm thick,
stained for cell bodies

Cytoarchitectonic Mapping
in digitized sections

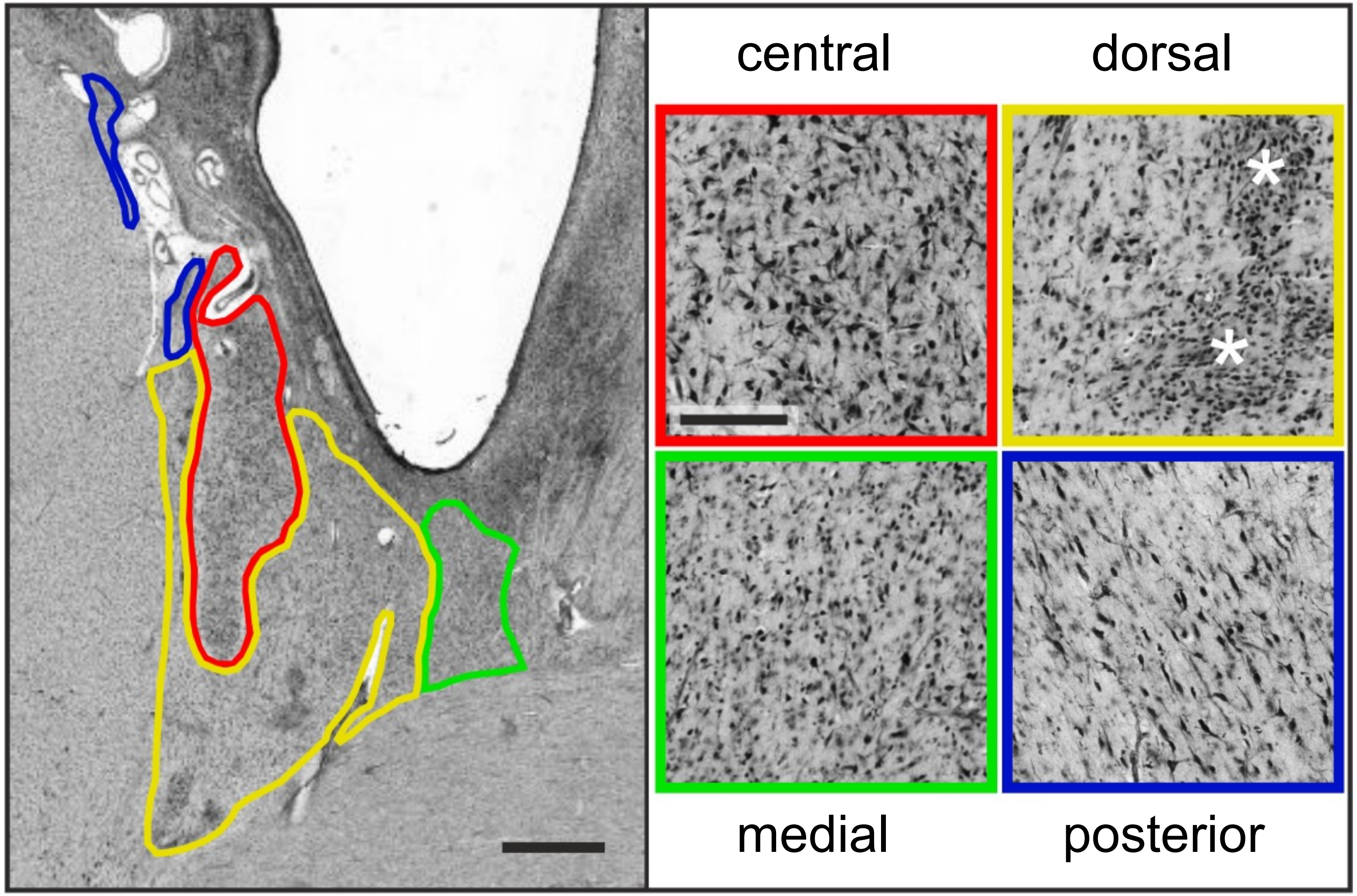


Criteria:

- Shape
- Size
- Distribution of neurons



BED NUCLEUS: FOUR SUBDIVISIONS



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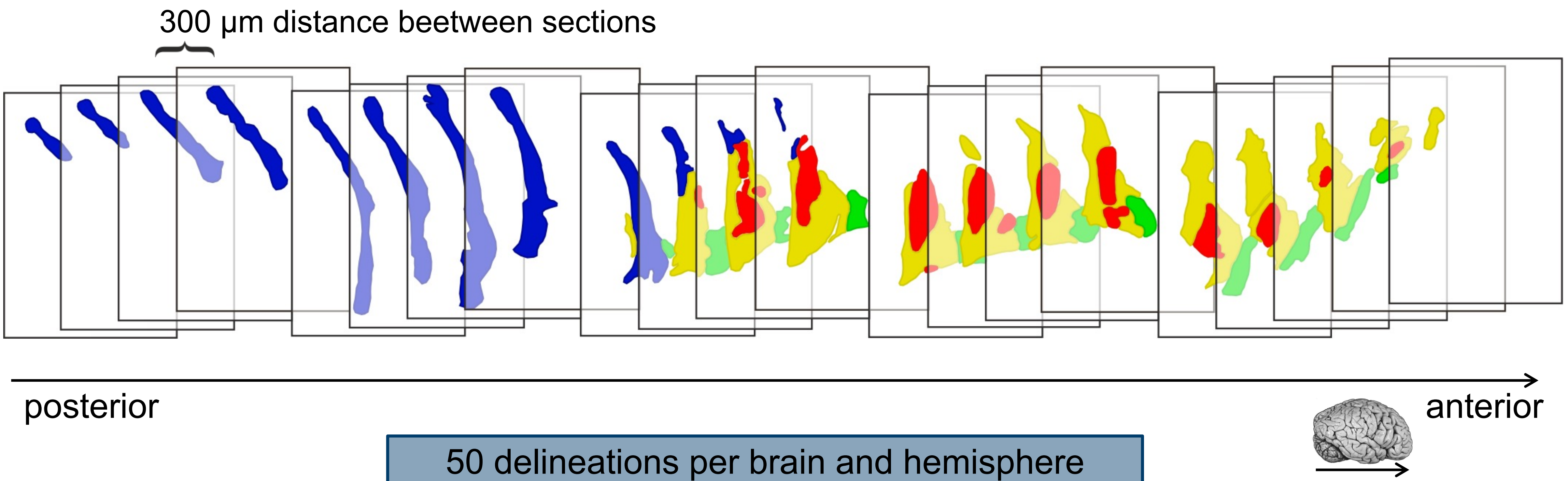
SERIAL MAPPING IN TEN BRAINS

Covers full extent of the BST

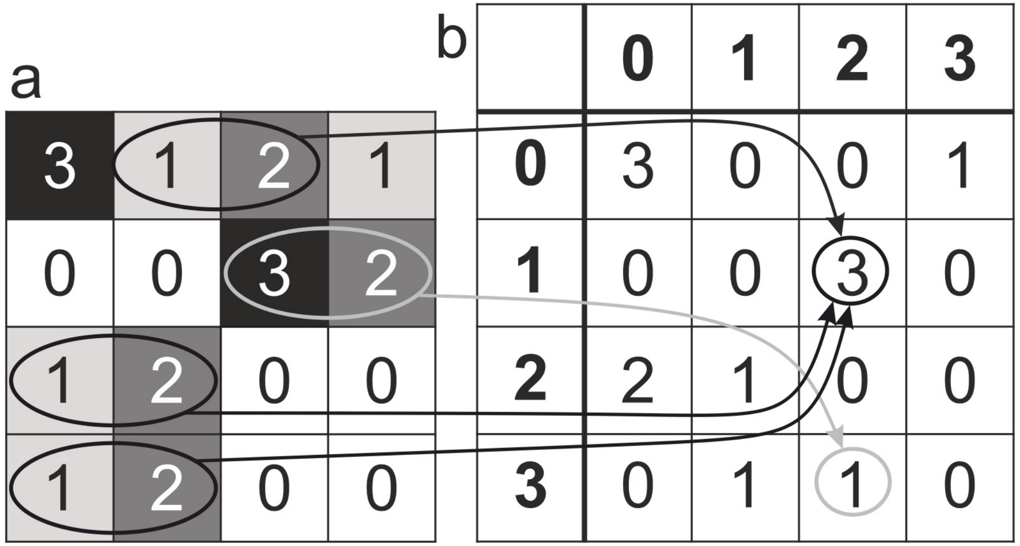


50 delineations per brain and hemisphere
~ 1000 annotations in total

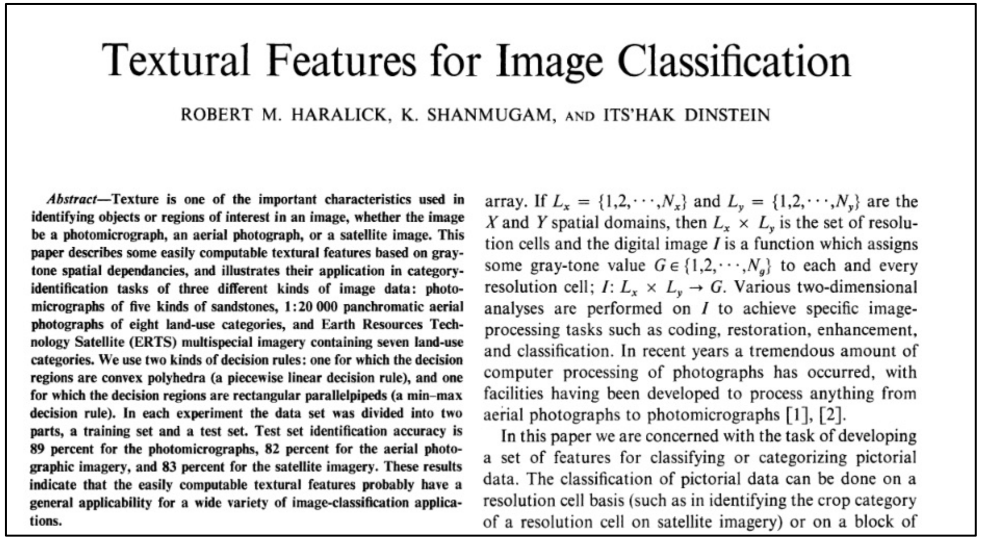
TEXTURE ANALYSIS

Methods

Gray-level co-occurrence matrix: gray-level frequency of neighborhood pixels



Example of a gray-level co-occurrence matrix



Textural Features for Image Classification

ROBERT M. HARALICK, K. SHANMUGAM, AND ITS'HAK DINSTEIN

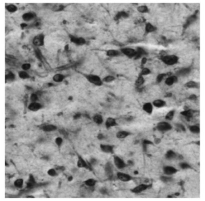
Abstract—Texture is one of the important characteristics used in identifying objects or regions of interest in an image, whether the image be a photomicrograph, an aerial photograph, or a satellite image. This paper describes some easily computable textural features based on gray-tone spatial dependancies, and illustrates their application in category-identification tasks of three different kinds of image data: photomicrographs of five kinds of sandstones, 1:20 000 panchromatic aerial photographs of eight land-use categories, and Earth Resources Technology Satellite (ERTS) multispecial imagery containing seven land-use categories. We use two kinds of decision rules: one for which the decision regions are convex polyhedra (a piecewise linear decision rule), and one for which the decision regions are rectangular parallelpipeds (a min–max decision rule). In each experiment the data set was divided into two parts, a training set and a test set. Test set identification accuracy is 89 percent for the photomicrographs, 82 percent for the aerial photographic imagery, and 83 percent for the satellite imagery. These results indicate that the easily computable textural features probably have a general applicability for a wide variety of image-classification applications.

array. If $L_x = \{1,2,\cdots,N_x\}$ and $L_y = \{1,2,\cdots,N_y\}$ are the X and Y spatial domains, then $L_x \times L_y$ is the set of resolution cells and the digital image I is a function which assigns some gray-tone value $G \in \{1,2,\cdots,N_g\}$ to each and every resolution cell; $I: L_x \times L_y \rightarrow G$. Various two-dimensional analyses are performed on I to achieve specific image-processing tasks such as coding, restoration, enhancement, and classification. In recent years a tremendous amount of computer processing of photographs has occurred, with facilities having been developed to process anything from aerial photographs to photomicrographs [1], [2].

In this paper we are concerned with the task of developing a set of features for classifying or categorizing pictorial data. The classification of pictorial data can be done on a resolution cell basis (such as in identifying the crop category of a resolution cell on satellite imagery) or on a block of

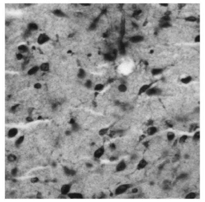
Sebastian Bludau

BSTC



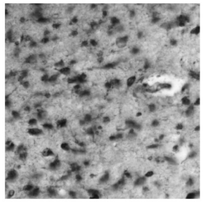
contrast	184.08559
correlation	0.94956
energy	0.00025
homogeneity	0.19732

BSTM



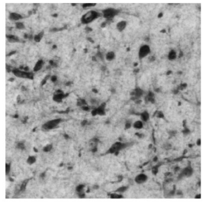
contrast	182.87454
correlation	0.94215
energy	0.00027
homogeneity	0.19691

BSTD



contrast	162.28924
correlation	0.94865
energy	0.00023
homogeneity	0.19650

BSTP



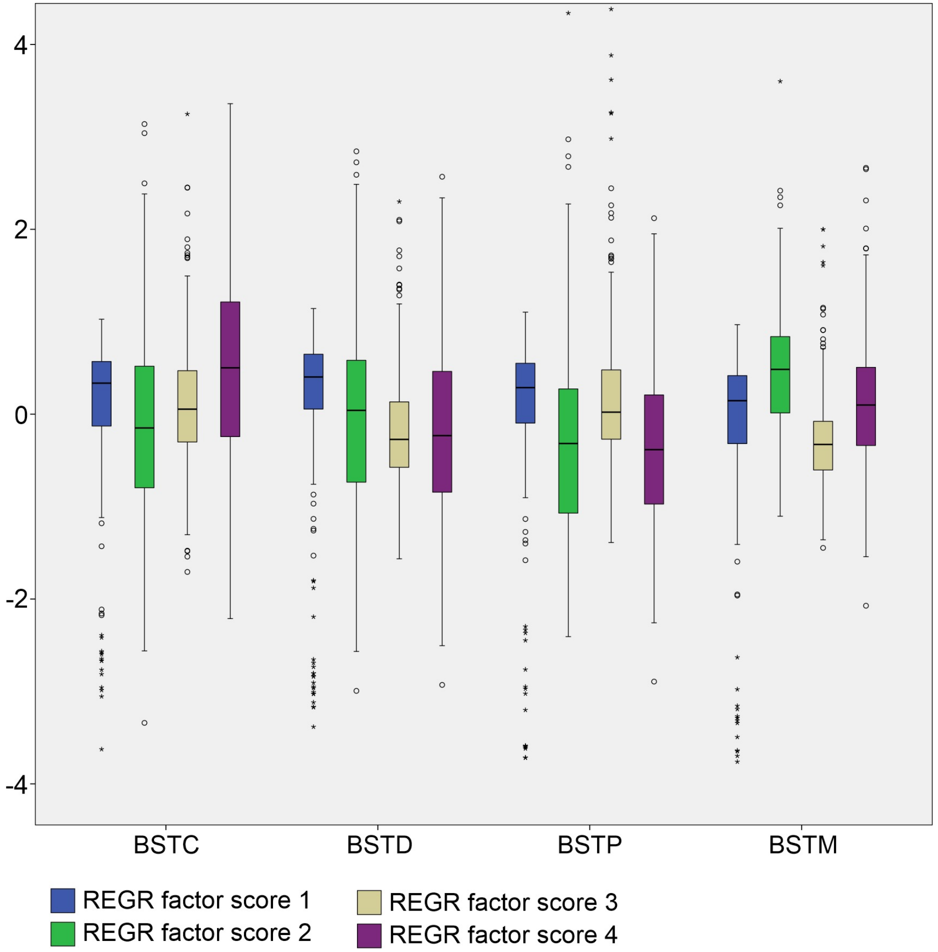
contrast	164.27814
correlation	0.94201
energy	0.00034
homogeneity	0.19714

Example patches and correspondent values of four example features

Haralick, R. M., Shanmugam, K., & Dinstein, I. H. (1973). Textural features for image classification. *IEEE Transactions on systems, man, and cybernetics*, (6), 610-621.

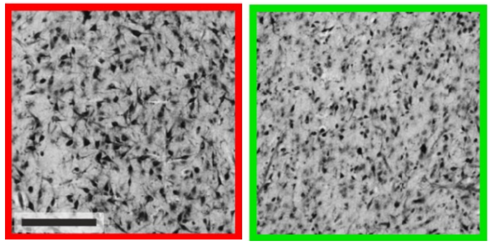
TEXTURE ANALYSIS

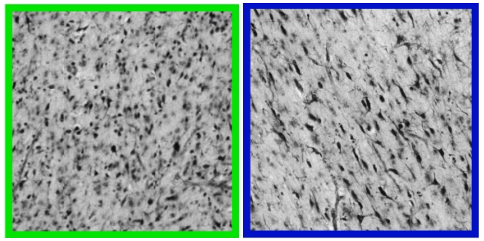
Results after Principal Component Analysis



Box plot for each subdivision and each of the principal components

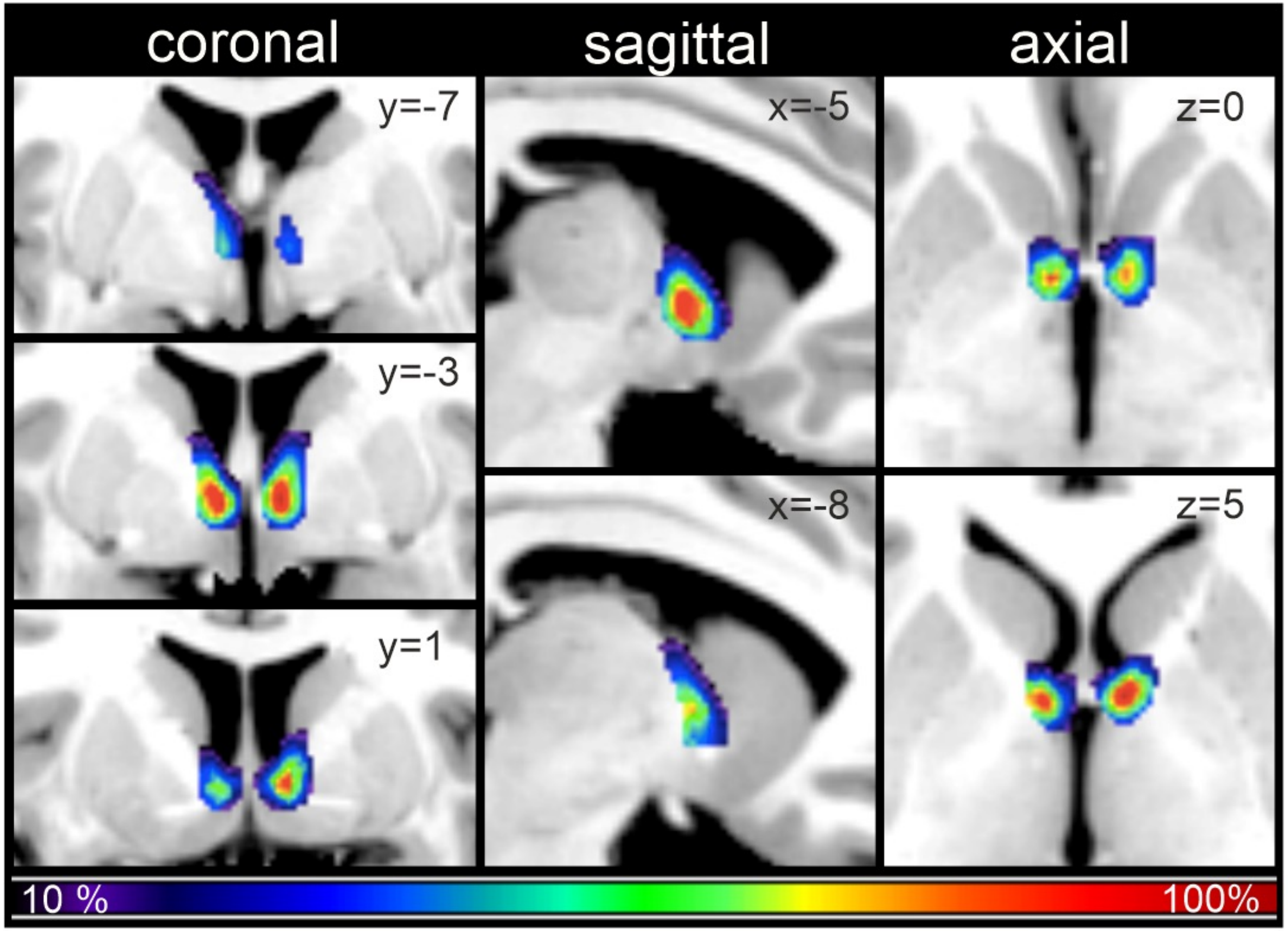
	BSTD	BSTM	BSTP
BSTC	<0,001 <0,001	0,008 <0,001 <0,001 0,047	<0,001
BSTD		<0,001 <0,001 0,004	0,002 <0,001
BSTM			0,013 <0,001 <0,001 <0,001





P-values of Bonferroni-corrected pairwise comparison post hoc tests.

PROBABILISTIC MAPS



- Reconstructed, normalized and warped to MNI space
- Colors indicate probability of the BST in each voxel
- Combination of the four subdivisions

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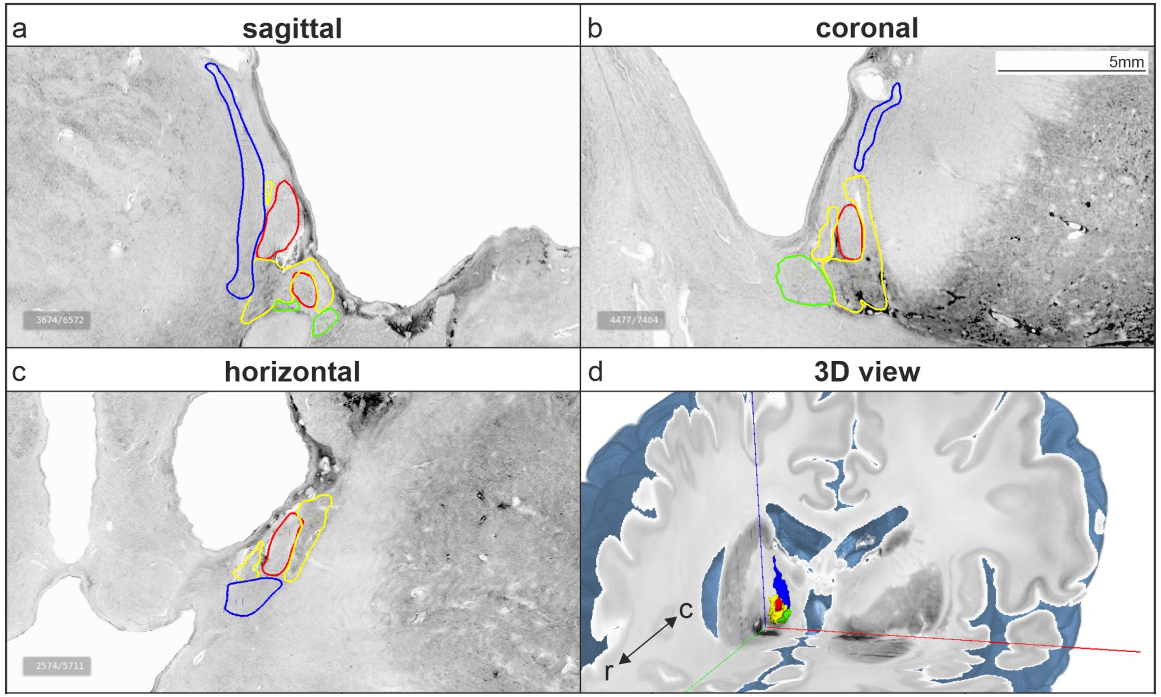
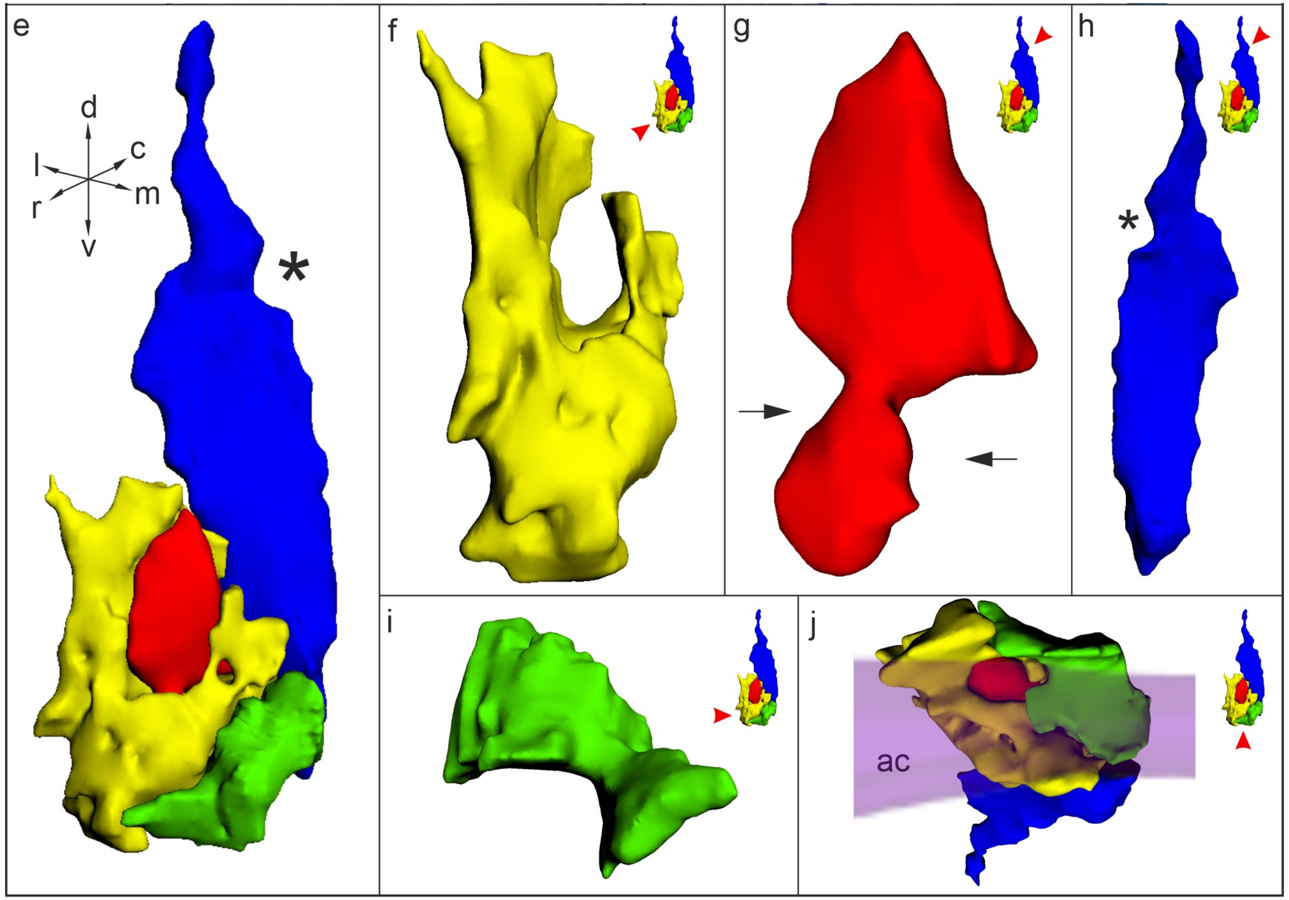
3D-RECONSTRUCTION IN THE BIGBRAIN



Microstructural parcellation in three different planes and on every 5th section using Atelier 3D

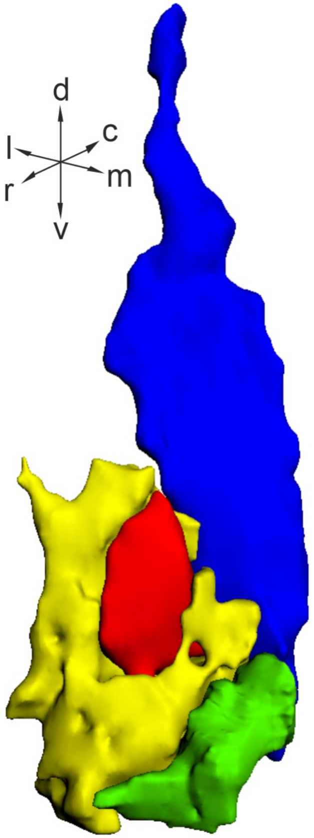


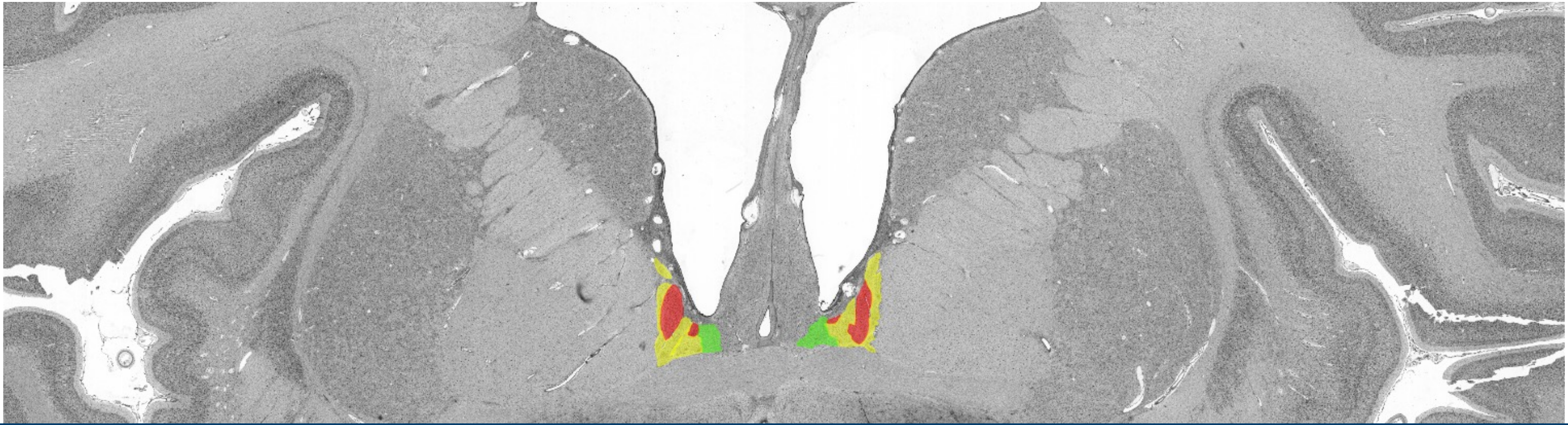
3D surface of the four subdivisions of the BST

Borgeat, L., Godin, G., Massicotte, P., Poirier, G., Blais, F., & Beraldin, J. A. (2007). Visualizing and analyzing the Mona Lisa. *IEEE Computer Graphics and Applications*, *27*(6), 60-68.

SUMMARY AND CONCLUSION

- Borders not entirely recognizable in standard imaging techniques due to structural similarity between BST and neighboring nuclei
- Texture analysis confirmed differences of the four distinct subdivisions at quantitative level
- Surface based 3D-reconstruction provides spatial reference in BigBrain template
- Maps may be a valuable base for clinical or functional studies
  Will be publicly accessible via EBRAINS





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