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Cornell Dog Atlas and Template in AFNI
The CornDog Atlas v3.0

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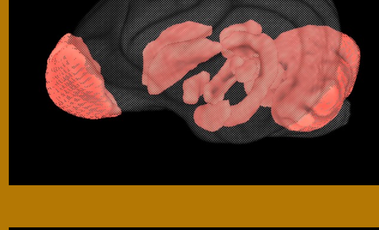


Introduction

Dogs (canis familiaris) are becoming an increasingly important model in MRI and FMRI studies because they are highly trainable, social animals. They also share psychosocial and some clinical diseases with humans and consequently represent a useful animal model for many human disorders. Previously, we introduced a population-based template for the dog composed by iteratively averaging 30 dog brain MRI scans [1]. We also provided an atlas for this template with manual delineation of 234 cortical and subcortical regions found in the canine brain and related lobular labels and masks.

In the present release, we create an improved version (v3.0) of the Cornell Dog Template and Atlas. Here, the atlases have been updated to have more consistent region contiguity, corrections of the NIFTI headers and a number of other additional improvements using AFNI software [2]. We provide a template space name ("CornDog") and consistency across the datasets, for greater sharing and clarity within the field.

Methods

We have updated the datasets in voxel dimension (to 0.5 mm isotropic, to be more representative of the average of datasets used in creating the template), orientation, space information and header fields. Obliquity was removed, and the coordinate system origin was centered around a more convenient location (anterior commissure). Labels were attached to the dataset for identifying each region (e.g., when viewed in the AFNI GUI or for command line region selection). All datasets were converted to have datum=short or byte, for efficiency of disk space and memory usage during processing.

Results

The application of a variety of corrections to the NIFTI header help to make the atlas easier to use in a variety of software packages. Each dataset is assigned the template space name of "CornDog3". The application of modal smoothing at the relatively small voxel neighborhood provided for smoother regions in 3D as shown in Figure 1. Several improvements to ROIs across the brain are apparent.

Region names are stored as both short abbreviations and longer descriptive names. These are visible in the Overlay menu and in AFNI's whereami interface.

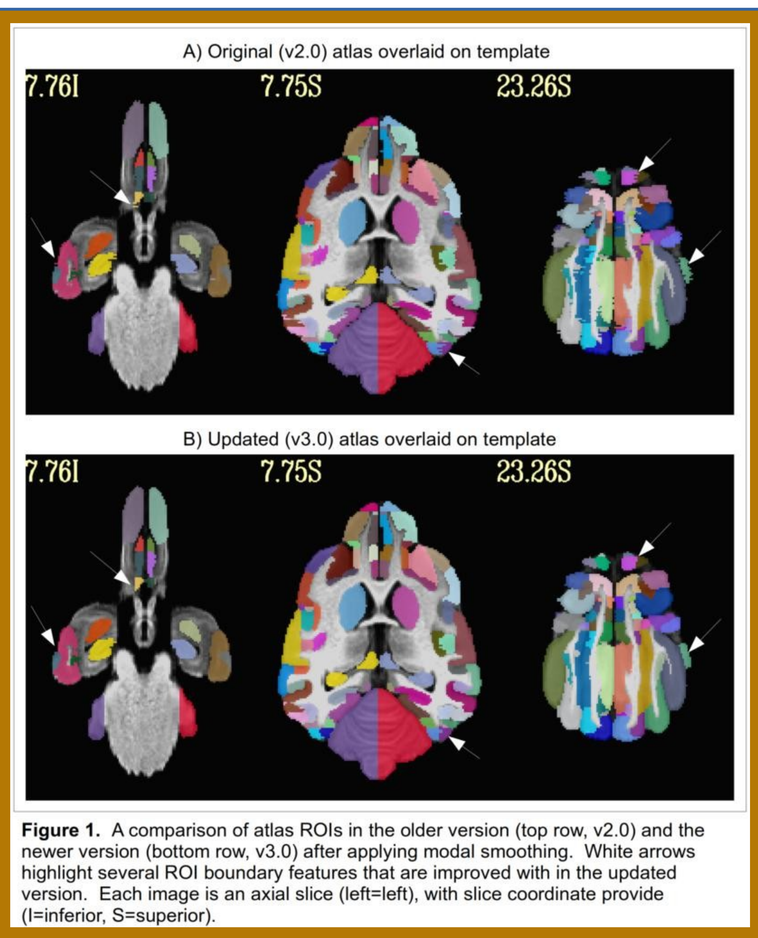


Figure 1. A comparison of atlas ROIs in the older version (top row, v2.0) and the newer version (bottom row, v3.0) after applying modal smoothing. White arrows highlight several ROI boundary features that are improved with in the updated version. Each image is an axial slice (left=left), with slice coordinate provide (I=inferior, S=superior).

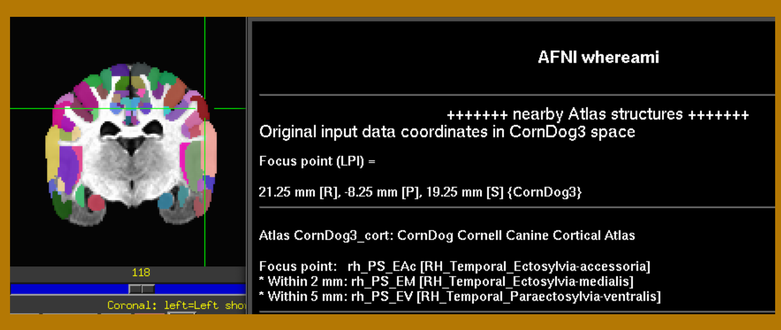
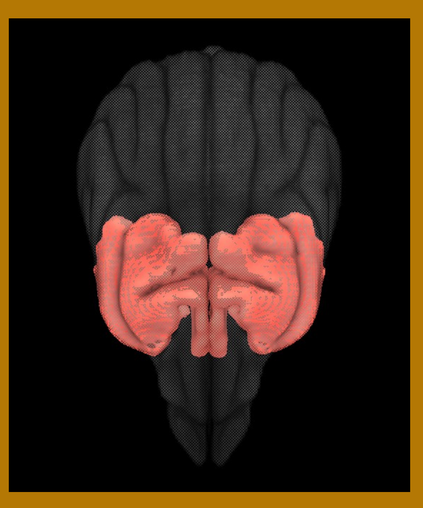


Figure 2. The lobes (surfaces)



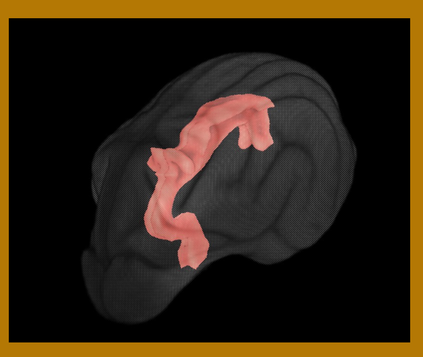
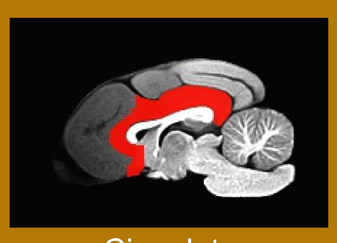
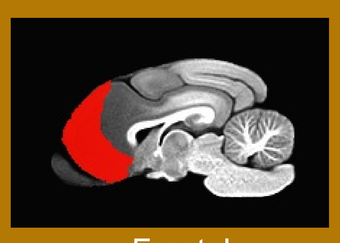


Figure 3. The lobes (sagittal slices)

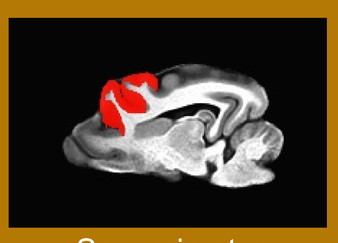

Cingulate

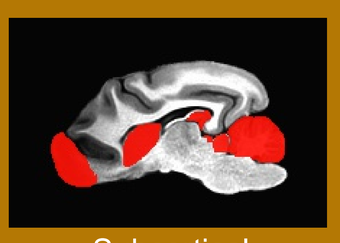

Frontal


Occipital


Parietal


Perisylvian


Sensorimotor


Subcortical

Methods (continued)

One common issue in manually drawn ROIs is inconsistency between each 2D plane of drawing and the full 3D volume. In animal research, drawing is often done in the coronal plane, and therefore the sagittal and axial planes then show rough "zig-zag" irregularities. In the updated atlases, we apply a "modal smoothing" method to regularize each region, producing smoother (and more physiological) boundaries; this also improves surface-based viewing. Modal smoothing uses the simple idea of replacing a voxel with the most common (the mode) voxel label in a small neighborhood. The neighborhood here was a voxel's 26 nearest neighbors (i.e., voxels sharing faces, edges and/or corners). The dataset is examined further to find if the region is not contiguous, and to replace any "lost clusters". Differences from the original atlas were examined for sensibility, and a comparison of each region's relative volume was computed to check for similarity.

Conclusions

A new and improved version 3.0 of the CornDog template and atlas is made available with a simple installation script inside the AFNI software package (@Install_CornDog). The updated template provides for a convenient common target for canine studies involving MRI and FMRI data. The integration within the AFNI software package allows for AFNI's whereami functionality to identify regions within the GUI and on the command line.

The atlases allow for ROI analysis and simplified reference to regions by name, rather than by index. It can be used efficiently with AFNI's @animal_warper program to map atlas information into the native space of the individual canine subjects, as shown within a demo script, currently under development. We expect this atlas will be a useful contribution to the growing canine neuroscience research community.

References
[1] Johnson, P.J., Luh, WM., Rivard, B.C., Graham, K.L., White A., FitzMaurice, M., Loftus, J.P. Stereotactic Cortical Atlas of the Domestic Canine Brain. Sci Rep 10, 4781 (2020). https://doi.org/10.1038 /s41598-020-61665-0
[2] Cox RW. AFNI: Software for analysis and visualization of functional magnetic resonance neuroimages. Computers and Biomedical Research, 29:162-173, 1996. https://doi.org/10.1006/cbmr.1996.0014
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AFNI download/installation
@Install_CornDog

AFNI atlas documentation:
https://afni.nimh.nih.gov/pub/dist/doc/htmldoc/nonhuman/main_toc.html