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Addendum to “Waxholm Space atlas of the Sprague Dawley rat brain” [NeuroImage 97 (2014) 374–386] (10.1016/j.neuroimage.2014.04.001)

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Abstract

The main focus of our original article was to describe the anatomical delineations constituting the first version of the WHS Sprague Dawley atlas, apply the Waxholm Space coordinate system, and publish the associated MRI/DTI template and segmentation volume in their original format. To increase usability of the dataset, we have recently shared an updated version of the volumetric image material (v1.01). The aims of this addendum are to inform about the improvements in the updated dataset, in particular related to navigation in the WHS coordinate system, and provide guidance for transforming coordinates acquired in the first version of the atlas.

Dataset improvements

The volumetric datasets of our atlas template are published in NIfTI-1 data format (<http://nifti.nimh.nih.gov/nifti-1/>). The expected orientation of the image coordinate system in standard NIfTI volumes is right, anterior, superior (RAS), while our original high resolution (39 μ m) T₂*-weighted MRI and lower resolution (78 μ m) diffusion weighted images were acquired in anterior, left, superior (ALS) orientation (Fig. 1). In the updated v1.01 dataset we have transformed all volumes, including the anatomical segmentation, to RAS orientation to fully comply with the NIfTI-1 standard. Anatomical boundaries in the segmentation, and the corresponding label files (.label, .ilf) are identical to those in version 1.

As a result of the ALS to RAS transformation, the order and the orientation of the x and y axes have changed. This implies that the voxel coordinates describing the position of the WHS origin in the transformed v1.01 dataset are different from the WHS origin coordinates published in our paper for the initial version of the dataset (see Spatial reference system under Results). We provide the new voxel coordinates for the origin, and the transformation from v1 to v1.01 coordinates in Table 1. The same transformation applies to the voxel

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coordinates of stereotaxic landmarks bregma and lambda, as well as any arbitrarily selected point of interest, acquired in the first version of the atlas.

To further improve navigation in the Waxholm Space coordinate system, we have incorporated the metric coordinates of the WHS origin, and full precision voxel dimensions into the appropriate fields of the NIfTI file header for all volumes. These updates allow metric WHS coordinates of any point of interest to be read off real-time using neuroimaging and atlasing software such as ITK-SNAP and MBAT.

Finally, we have standardized the RGB color coding used in the DTI images (color FA maps) in both resolutions, so that R (red) is assigned to left-right (LR) diffusion orientation, G (green) is assigned to anteroposterior (AP) diffusion orientation, and B (blue) is assigned to inferosuperior (IS) diffusion orientation.

The updated atlasing template and related documentation is available for download on the INCF Software Center (<http://software.incf.org/software/waxholm-space-atlas-of-the-sprague-dawley-rat-brain/download/?version=v1.01>).

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Fig. 1. Coordinate system orientation in the original (v1) and reoriented (v1.01) atlas volumes. The same orientation applies to all NIfTI files bearing the same version. Note that from v1 to v1.01 the left-right axis has been inverted, and the x and y axes has been transposed. A: anterior, I: inferior, L: left, P: posterior, R: right, S: superior; x, y, z: WHS coordinate system axes (arrows point in positive direction)

Voxel coordinates of the WHS origin, and an arbitrarily selected point of interest (POI), in the original (v1) and updated (v1.01) datasets. hi: high resolution (39 μm) volumes, lo: low resolution datasets (78 μm)

Table 1

		Voxel coordinates				WHS coordinates in voxels			
		v1	v1.01 hi	v1.01 lo	v1	v1.01 hi	v1.01 lo	v1	v1.01 lo
WHS origin	x	623	244	122	0	0	0	0	0
	y	268	623	311.5	0	0	0	0	0
	z	248	248	124	0	0	0	0	0
POI	x	a	512 - b	(512 - b)/2	a - 623	(512 - b) - 244	(512 - b)/2 - 122		
	y	b	a	a/2	b - 268	a - 623	a/2 - 311.5		
	z	c	c	c/2	c - 248	c - 248	c/2 - 124		