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Using the Talairach atlas with the MNI template

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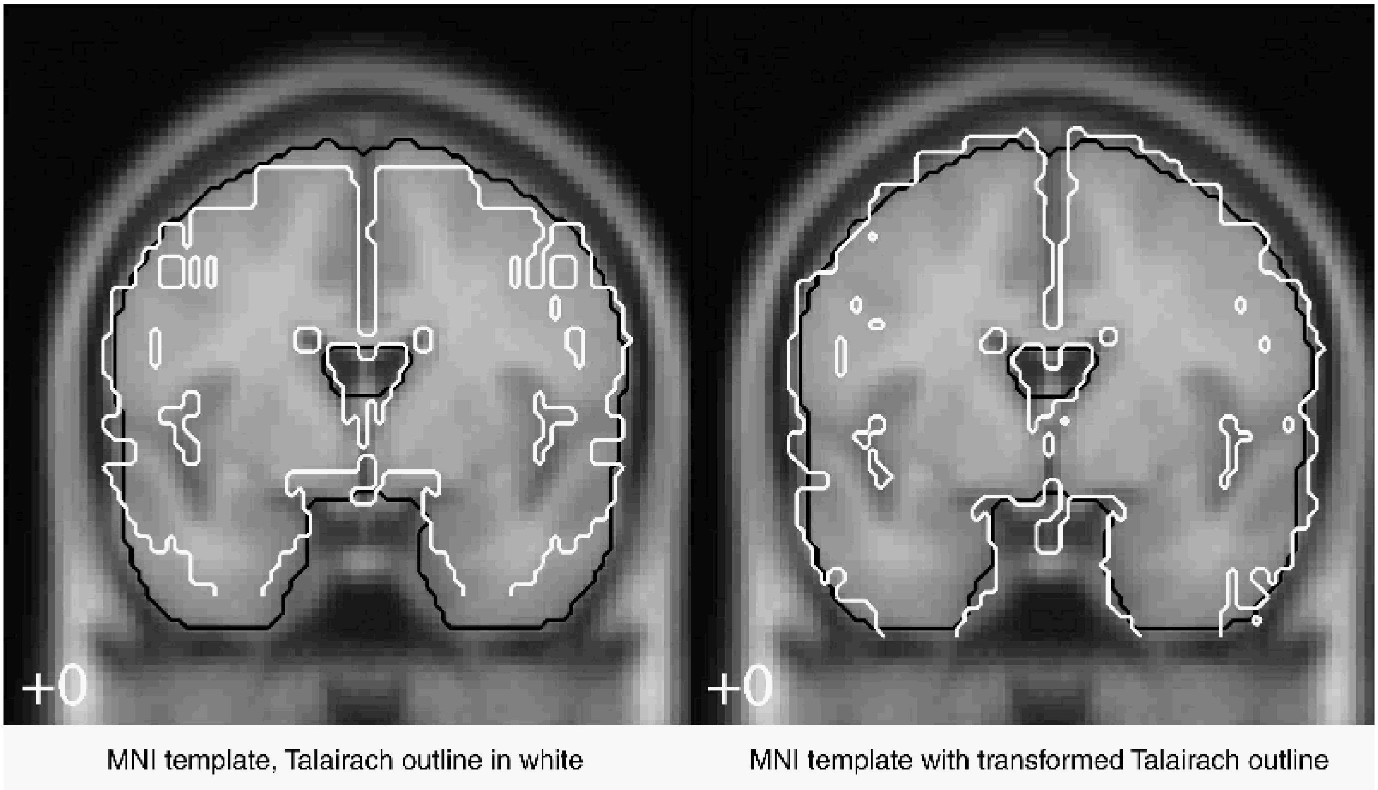
Abstract
Most studies in functional imaging present the position of activations in terms of Brodmann cytoarchitectonic areas (BAs). The allocation of activations to BAs often uses the Talairach 1988 atlas. This allocation is beset by uncertainties; for example, outside primary sensory and motor areas, we have little data on the ability of different normalization techniques to overlay cytoarchitectonic areas across individuals. The atlas itself presents problems; the brain used in the atlas (the "Talairach brain" - TB) did not have cytoarchitectonic analysis, so that the BA labels had to be estimated by eye by comparing the TB surface with Brodmann's published data; despite this caveat, Talairach remains the de facto standard for estimating BAs.

The problems enumerated above require considerable research to address. One problem that could be addressed relatively simply is the difference between the TB and the brain templates created by the Montreal Neurological Institute (MNI). Many studies, including most performed using SPM software, normalize to a template based on those of the MNI. Although these templates differ from the TB, it is common to interpret coordinates from the MNI brain using the Talairach atlas.

The TB was a post mortem specimen, and has been aligned to the Talairach system, with the anterior and posterior commisure on the same axial plane. The MNI template is based on an average of a number of normal MRI scans, which have been linearly aligned to a common orientation, which is similar but not identical to that of Talairach. The MNI template represents an average brain, and is larger than the TB. The difference in size is most marked for the temporal lobes, where the differences are of the order of 1cm (see left panel of figure).



MNI 152 template, with untransformed (left) and transformed (right) Talairach brain outlines in white, MNI outline in black

We wished to create a transformation to apply to the coordinates from the MNI brain, to give matching coordinates in the TB. There is no MRI scan for the TB, but we created a brain outline for the TB, using data from the Talairach daemon (http://ric.uthscsa.edu/projects/talairachdaemon.html). For every voxel in the MNI brain, we queried the daemon for the tissue type and BA for the same voxel in the TB. By using all voxels with tissue type labelled gray or white, or labelled as brain stem / cerebellum, we created a binary brain outline matching the shape of the TB. We then used SPM99 to normalize the binary brain outline of the TB to a binary brain outline of the MNI brain (see right of figure). The brain outline is closer to that of the MNI brain, notably in the inferior temporal lobes. Maximum length in the axial plane for the MNI brain is 180mm, as for the transformed TB; the TB untransformed measures 174mm.

The transformation parameters from this normalization allow us to a) convert between MNI and TB coordinates in an objective and automated way, and b) reslice BA definitions from the TB to create BA regions of interest in the space of the MNI brain.