Automatic midsagittal plane selection

The midsagittal plane was selected in four steps. First, brain extraction (aka "skullstriping") or "*bet*" was applied to the images to remove the skull and non-brain areas of the MRI to improve the registration process. Second, skull-free images were registered to an atlas image (MNI152_T1_brain.nii.gz, from FSL) using a linear image registration tool or "FLIRT" command [1, 2]. Third, the FSL transformation matrix was applied to the original image. Finally, the midsagittal plane image was selected the same as that of the manually identified midsagittal plane number from the reference atlas.

A custom Python program was written to identify the basion and opisthion, and thus the McRae line on the midsagittal images, using established Python image processing packages [3]. To establish an anchor point on each image, the fastigium was located using a cross-correlation algorithm (*match_template function*, *scikit_image*) based on a single template image from the ABCD data set for which the fastigium was manually located. For the matching process, the cross-correlation was applied twice, once to the template image and a second time to a smaller sub-area of the template image. This algorithm was then tested on 230 images for which the fastigium was previously located manually. The results demonstrated that the automated identification was accurate within 1 pixel 87% of the time and within 2 pixels 99% of the time. The same manually measured sample set was used to establish a range of possible basion and opisthion locations, described as offsets from the fastigium, to establish the smallest possible regions of interest (20x20 pixel) containing the clivus and occipital bones. To enhance bone identification, each sub-area was converted from grayscale pixel intensity to black and white. Starting pixels within the bones were identified and followed to the bone end based on neighboring pixel characteristics to determine the most likely endpoints. The final basion and opisthion endpoints were identified as the most

posterior/inferior and anterior/inferior pixels, respectively. Once the McRae line was established, the original image intensity was sampled at a location 3mm inferior to the McRae line to determine the likelihood of cerebellar tissue being present (ICTE) using a manually established cutoff grayscale value.

References

1. Jenkinson, M., et al., *FSL.* Neuroimage, 2012. **62**(2): p. 782-90.
2. Smith, S.M., et al., *Advances in functional and structural MR image analysis and implementation as FSL.* Neuroimage, 2004. **23 Suppl 1**: p. S208-19.
3. *Python packages used: Numpy, Scipy, Matplotlib, Scikit_image* 2020 [cited 2020; Available from: https://www.scipy.org/citing.html