Anatomy the fronto parietal pathways correlates with the symmetrical processing of visual scenes

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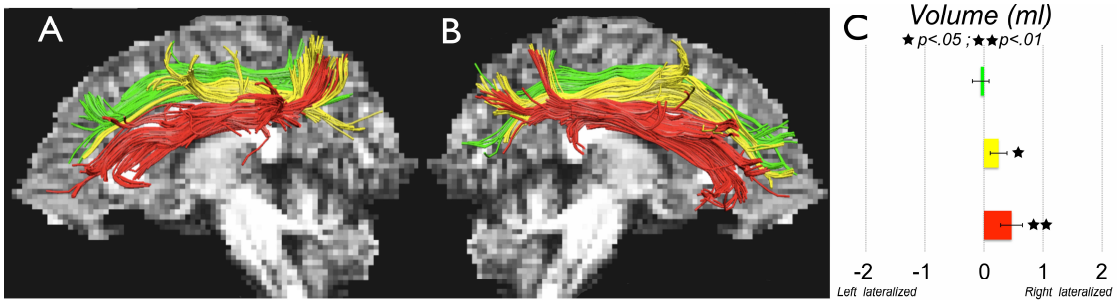
Introduction. The fronto-parietal network has been reported as involved in a large panel of function including spatial processing (1). In the monkey brain, Petrides & Pandya (2) used the term superior longitudinal fasciculus (SLF) to indicate the fronto-parietal connections and identified three separate branches. In this study we have used advanced diffusion imaging to dissect the three branches of the SLF in 14 human living brains, measure the pattern of lateralization of its components and correlate these patterns with the spatial processing performance assessed with the line bisection test.

Material and methods. Diffusion weighted datasets from 14 healthy volunteers aged 23-37 (M:F 6:8) were acquired on a a 3T GE Signa HDx TwinSpeed system (General Electric, Milwaukee, WI, USA) with the following parameters: voxel size 2.4x2.4x2.4 mm, matrix 128x128, slices 60, NEX 1, TE 90 ms, b-value 3000 s/mm2, 60 diffusion-weighted directions and 7 non-diffusion-weighted volumes, using a spin-echo EPI sequence. Cardiac Gating was applied with effective TR of 20/30 R-R intervals. Diffusion datasets were corrected for motion and eddy current distortions (3) and then process with a Spherical Deconvolution algorithm based on a damped version of the Richardson-Lucy algorithm (4). Tractography was performed following the method described in (5). Virtual in vivo dissections of the three branches of the superior longitudinal fasciculus (SLF I, SLF II, and SLF III) were performed on both hemispheres and a lateralization pattern calculated for the volume of each tract. Lateralization indexes were correlated with neuropsychological assessments.

Figure 1. Human in vivo spherical deconvolution tractography in the left (A) and the right (B) hemisphere of the SLF I in green, the SLF II in yellow and the SLF III in red. (C) Lateralization index of the volume of the tract



Results. Using two region of interest approach (6), we were able to reconstruct the three branches of the SLF in all subjects (Figure 1). SLF I (in green) is the most dorsal component, connecting the superior parietal lobule and the superior frontal gyrus. SLF II (in yellow) is the largest component, connecting the posterior region of the inferior parietal lobule with the superior and the middle frontal gyrus. SLF III (in red) is the most ventral branch, connecting the temporo-parietal junction with the inferior frontal gyrus. The SLF I has a bilateral and symmetrical distribution and no correlation with any neuropsychological test. The SLF II shows a slight right asymmetry ($t(13)= p<0.05$ not significant at $p<0.05$ after Bonferroni correction) and was positively correlated with the degree of left deviation on the line bisection test (Pearson's correlation $r=0.668$ $p<0.01$; correlations are significant at $p<0.05$ after Bonferroni correction). Finally the SLF III showed a significant right lateralization asymmetry ($t(13)= p<0.001$ significant at $p<0.001$ after Bonferroni correction) with no correlation with pseudo neglect effect.

Discussion and Conclusion. These findings show for the first time that in the human brain the most ventral branches of the fronto-parietal connections are right anatomically lateralized. The correlation with behaviour performances suggests that of the three branches, SLF II is most likely specialized in visuo-spatial processing.

(1) Husain and Rorden. Nature Reviews Neuroscience (2003) (2) Petrides and Pandya. Projections to the frontal cortex from the posterior parietal region in the rhesus monkey. The Journal of Comparative Neurology (1984) (3) S.M. Smith et al NeuroImage (2004) (4) Dell'acqua et al. NeuroImage (2009) (5) Schmahmann et al. Brain (2007) (6) Conturo et al. PNAS (1999)