Dexterity and age relate differently to white matter organization in cervical spinal cord in healthy subjects

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Background- Diffusion tensor imaging (DTI) can be used to elucidate relations between CNS structure and function.
Objectives- We hypothesized that the degree of spinal white matter organization relates to the level of dexterity.
Methods- Healthy subjects of different age were studied using DTI and visuomotor tracking of precision grip force. The latter is a prime component of manual dexterity. A regional analysis of spinal white matter (fractional anisotropy, FA) across multiple cervical levels (C2-C3, C4-C5, C6-C7) and in different regions of interest (ROI, left and right lateral or medial spinal cord) was performed.
Results- FA was highest at the C2-C3 level, higher on the right than the left side, and higher in the lateral than in the medial spinal cord ($p<0.001$). FA of whole cervical spinal cord (C2-C7) was lower in subjects with high tracking error ($r=-0.56$, $p=0.004$) and decreased with age ($r=-0.63$, $p=0.001$). A multiple regression analysis revealed an independent contribution of each predictor (semi-partial correlations: age, $r=-0.55$, $p<0.001$; tracking error, $r=-0.49$, $p=0.003$). The closest relation between FA and tracking error was found at the C6-C7 level in the lateral spinal cord, where the corticospinal tract innervates spinal circuitry controlling hand and digit muscles. FA of the medial spinal cord correlated consistently with age across all cervical levels, whereas FA of the lateral spinal cord did not.

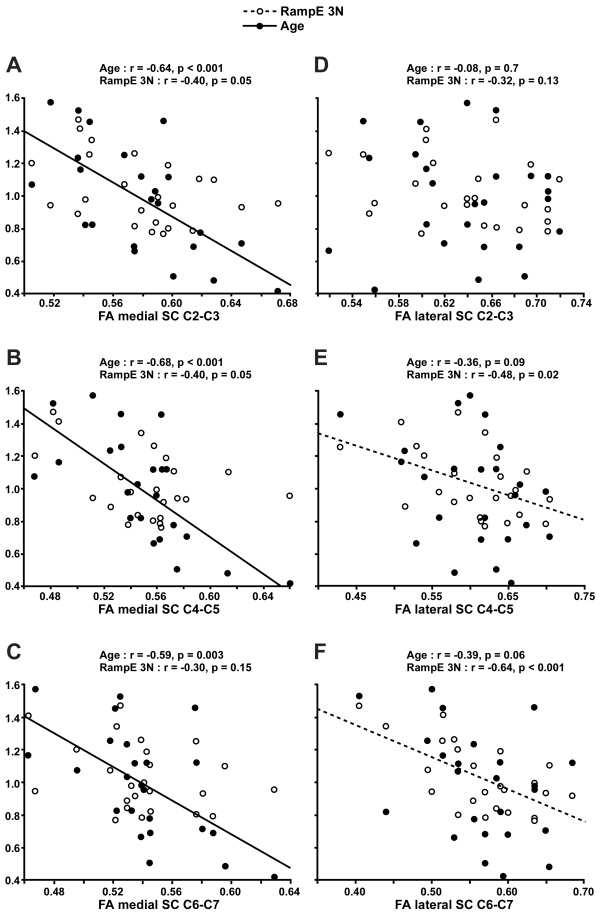

Fig. FA as a function of age, tracking error and spinal cervical level.
A-C) FA of the medial spinal cord. Significant Pearson correlations for age but not for tracking error at each cervical level. D-F) FA of the lateral spinal cord. The Pearson correlations between the lateral spinal cord FA and the tracking error increased successively from the C2-C3 (non significant), to C3-C4 (weakly significant) to C6-C7 (highly significant).

Conclusions- The results suggest (i) a functionally relevant and dexterity-related specialization of lateral spinal cord white matter and (ii) an increased sensitivity to age-related decline in medial spinal cord white matter in healthy subjects.