DTI of Choice Reaction Time Performance

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Abstract – Using diffusion tensor MRI (DTI) we sought to test whether diffusion tensor fractional anisotropy (FA) is correlated with behavioral reaction time (RT) on a visual self-paced choice RT task. In young healthy adults, choice RT performance was found to be highly correlated with FA in specific WM pathways including the right optic radiation (OR), and the WM projecting to right superior parietal gyrus, bilateral superior temporal gyrus, and pre-frontal cortex. The localization of the correlation to the occipital, parietal, and pre-frontal WM, but not to motor cortical WM or the callosum argues that the predominant factors affecting performance on the choice RT task are visuospatial attention and action selection as opposed to motor performance or interhemispheric transmission. The correlation between RT and FA suggests that WM physiology may be a key factor in behavioral performance ability.

Methods, Reaction Time Task – Twelve young healthy participants (4M/8F. Mean age: 22.8±1.6 years) were tested on a self-paced choice reaction time (RT) task. Four empty squares were presented horizontally on a computer monitor. Participants rested the index and middle fingers of both hands on 2 keys of a 4-key response board. In each trial, one of the four squares (the target square) was filled in solid. The participant responded by pressing the corresponding key on the response board. The task was repeated in 6 blocks of 72 trials for a total of 432 trials. The RT for block 1 provided an index of native RT and the ΔRT between blocks 1 and 6 provided a measure of within-session improvement. **Image Acquisition** – Diffusion tensor MRI scans were obtained on all 12 participants. The scans were performed on a Siemens Sonata 1.5T MRI scanner. The imaging parameters were TR/TE=9000/68ms, b=700s/mm^2, 7 directions (6 diffusion-weighted + 1 T2), 8 averages, 2mm isotropic resolution, 60 slices. **Analysis** – Each participant's FA volume was normalized to MNI space using the FSL FLIRT tool (1), and then smoothed (6mm FWHM, 6mm extent). For each voxel in the template space, a linear model $RT=\beta_0+\beta_1\times FA$ was fit to the data, where RT is the participants' behavioral reaction time, FA is the participants' FA values for that voxel, and β_0 and β_1 are the model parameters.

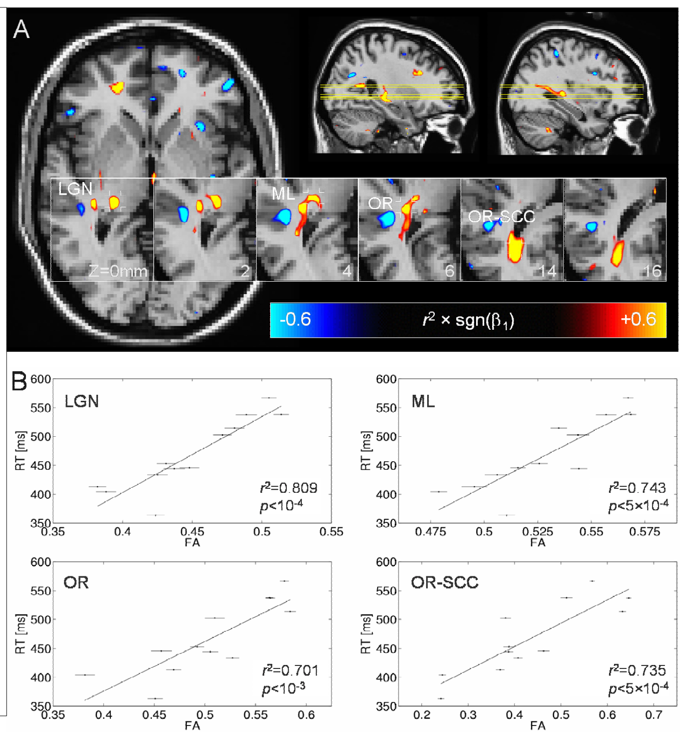

Fig 1. Map of correlation between diffusion anisotropy and reaction time reveals right optic radiation (OR). (**A**) The frames show the r^2 correlation maps from 6 axial slices through the OR. The superior-inferior level of the axial slices is indicated by the yellow lines in the sagittal images at top right and by the MNI Z-coordinate at the bottom-right of each frame. The RT-FA correlation map shows the trajectory of the right visual pathway from LGN through ML to the OR to the junction between the optic radiation and the splenium of the corpus callosum (OR-SCC). (**B**) RT and FA values for the ROIs designated by the crosshairs above. The FA values were taken from 3×3×3 voxel ROIs centered on the peak of the correlation. The FA error bars are SEM over each participant's ROI.

Results – Highly significant correlations (r^2>0.7) between FA and block 1 RT were observed in right OR) right superior parietal gyrus (SPG) WM, cerebellum, and bilateral frontal and superior temporal WM (Fig. 1). The RT-FA correlation map for right OR revealed the optic pathway from lateral geniculate nucleus (LGN) through Meyer's loop (ML) to the OR at the level where the OR meets the posterior-lateral striations of the splenium of the corpus callosum (SCC). Fig. 1B shows the individual participant data for 4 ROIs in the right visual pathway: LGN, ML, OR, and OR-SCC, where OR-SCC denotes the junction of OR and SCC. The correlations in the right visual pathway were predominately positive.

Discussion - DTI in young healthy adults revealed a highly significant correlation between FA and choice RT performance in specific WM pathways. Madden et. al. (2) previously reported a moderate correlation between RT on a visual target detection oddball task and FA in the splenium of the corpus callosum The correlations reported here indicate that visual choice RT and FA are also correlated in specific WM pathways. The lateralization of the RT-FA correlations to specifically the right OR is consistent with the specialization of the right visual cortex for visuospatial attention. The positivity of the correlations in the visual pathway requires further investigation. The observation of a correlation between FA and choice RT performance suggests that individual variations in WM microstructure may play a key role in interindividual behavioral performance variability.

References – 1. Jenkinson, M., Bannister, P., Brady, M. & Smith, S. (2002) *Neuroimage* **17,** 825-41. 2. Madden, D. J., Whiting, W. L., Huettel, S. A., White, L. E., MacFall, J. R. & Provenzale, J. M. (2004) *Neuroimage* **21,** 1174-81.

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