White Matter Pathways Related to Reading

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PURPOSE

To analyze white matter structures related to reading ability in children

BACKGROUND

- Diffusion Tensor Imaging (DTI) allows in vivo examination of white matter structure using MRI

- Fractional anisotropy (FA- an estimate of diffusion anisotropy within a voxel) correlates with reading ability in adults (Klingberg, 2000) and children (Deutsch, in press)

- Here we identify the major pathways involved in the FA results from Deutsch et al. and explore alternative explanations for the FA difference
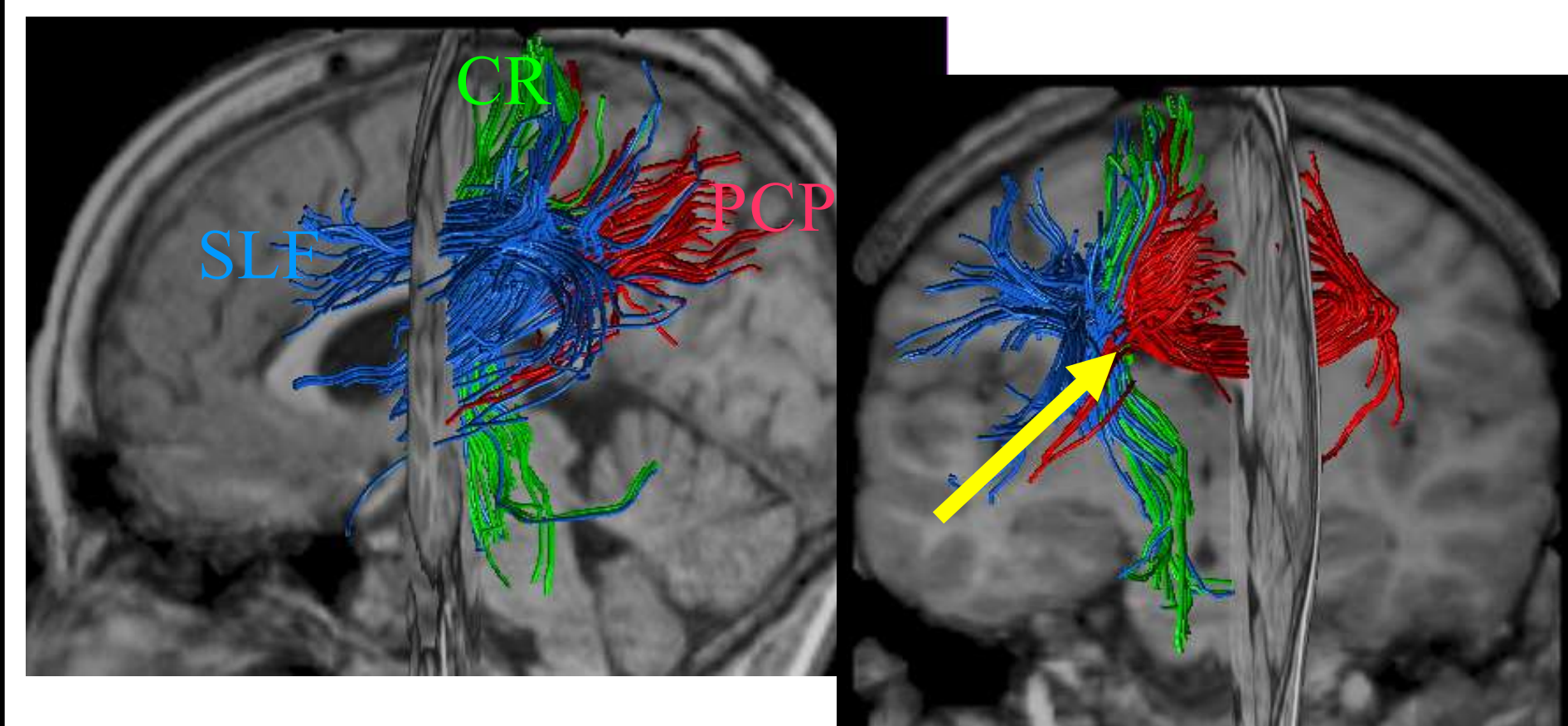
METHODS

- Diffusion-weighted single-shot SE EPI sequence; b = 0 and ~800 s/mm^2 (Bammer 2002); 4 repeats averaged; 2x2x3mm voxels

- Diffusion maps spatially normalized to the MNI EPI template by applying parameters computed from T2-weighted b=0 images (SPM99), using spline-based tensor interpolation (Pajevic, 2002)

- 14 children- 7 normal readers and 7 dyslexic (data from Deutsch et. al.)

Reduced FA has been observed in children and adults. Here, we ask:

Which Pathways?

Virtual fibers in an individual brain

CR
SLF
PCP

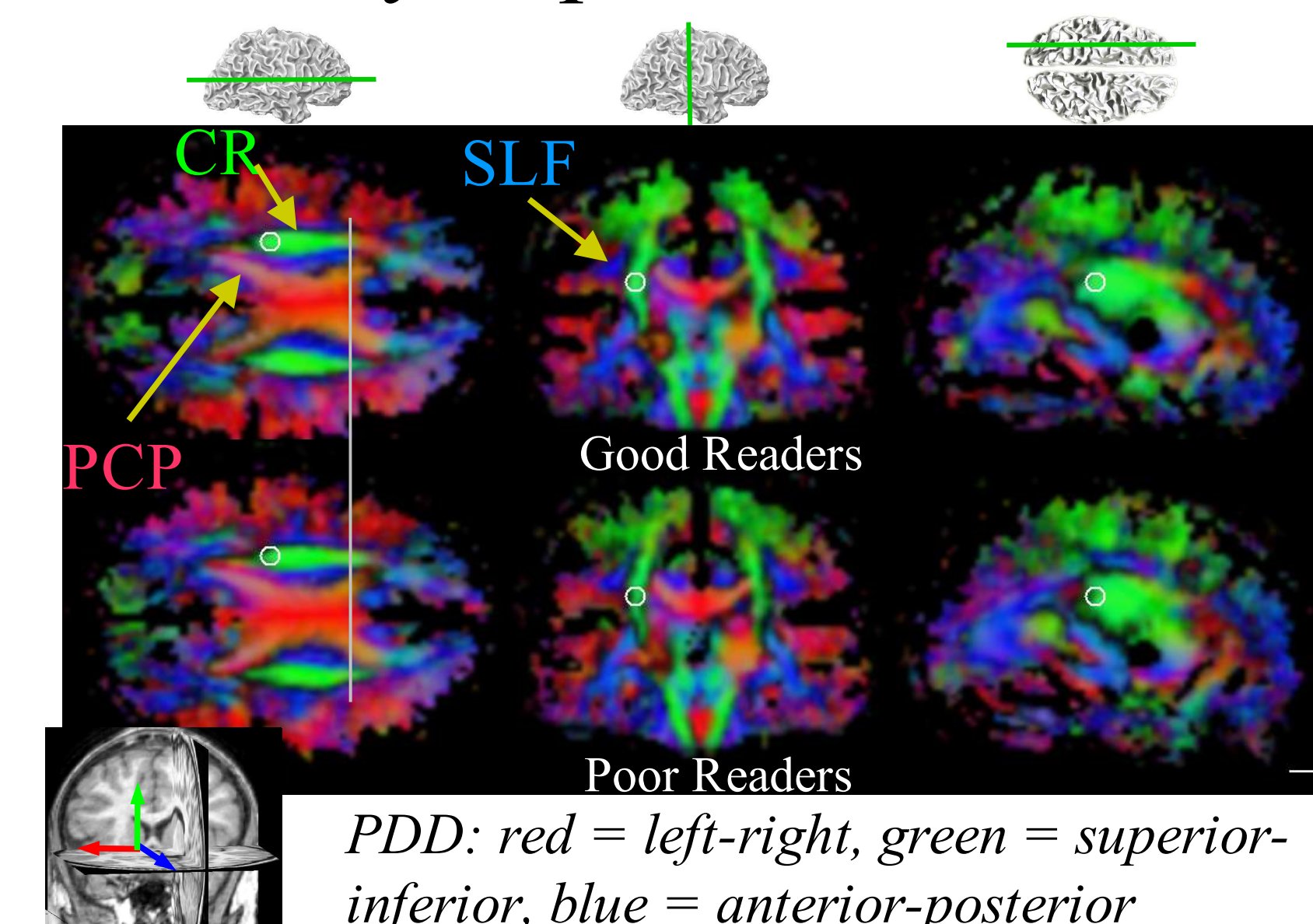FA is reduced in poor readers at the confluence of three major pathways (arrow):
- posterior callosal projections (PCP)
- posterior corona radiata (CR)
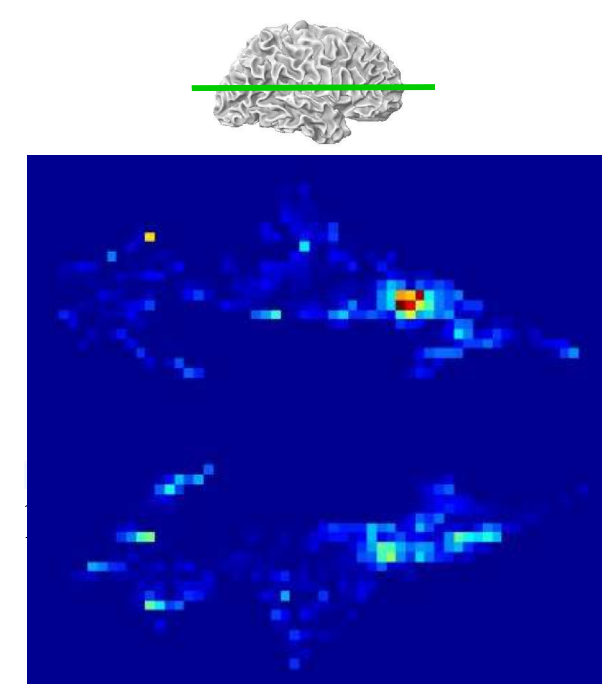- superior longitudinal fasiculus (SLF)

Reduced FA could be due to:
- microstructural differences (e.g. reduced myelination)
- macrostructural differences (e.g. displaced pathways)

Micro or Macro?

Analysis of principal diffusion direction suggests that the corona radiata (CR) is displaced anteriorly in poor readers

CR
SLF
PCP
Good Readers
Poor Readers

PDD: red = left-right, green = superior-inferior, blue = anterior-posterior

Region posterior to CR has lower FA in *all* subjects; thus, displaced CR can explain reduced FA

Also, group differences in principal diffusion direction at anterior end of corona radiata (Schwartzman 2004) suggest the entire structure is displaced anteriorly.

CONCLUSIONS

- White matter pathways differ between normal and poor reading children

- FA difference in poor readers is due to an anterior displacement of the corona radiata

- Displaced CR may be due to callosal differences

  - In our sample, poor readers have:
    - Smaller callosal bending angle, replicating previous reports (Robichon & Habib 1998)
    - Tendency toward larger splenium, also replicating previous reports (Rumsey 1996)

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