

Reduced inter-hemispheric temporal lobe connectivity in language impairment: a study of adolescents born preterm

GB Northam¹, F Liegeois¹, L Croft¹, JD Tournier², WK Chong¹, JS Wyatt³, T Baldeweg¹

¹ Developmental Cognitive Neuroscience Unit, UCL Institute of Child Health and Great Ormond Street Hospital for Children, London, UK;

² Brain Research Institute, Melbourne, Australia; ³ UCL Institute for Women's Health, London, UK.



BACKGROUND

Recent evidence suggests that **inter-hemispheric pathways** may play an important role in language comprehension, in addition to the well-known **perisylvian connections** in the left-hemisphere¹⁻³.

Abnormalities in both of these brain regions are common in children born prematurely⁴, who are known to be at high risk of language impairment⁵.

AIM

To identify **neural correlates of language impairment** in adolescents born preterm, focusing on two vulnerable white matter structures:

- the **arcuate fasciculus**, a language-associated bundle in the periventricular white matter
- the **corpus callosum**, which includes inter-hemispheric connections between temporal lobe language areas

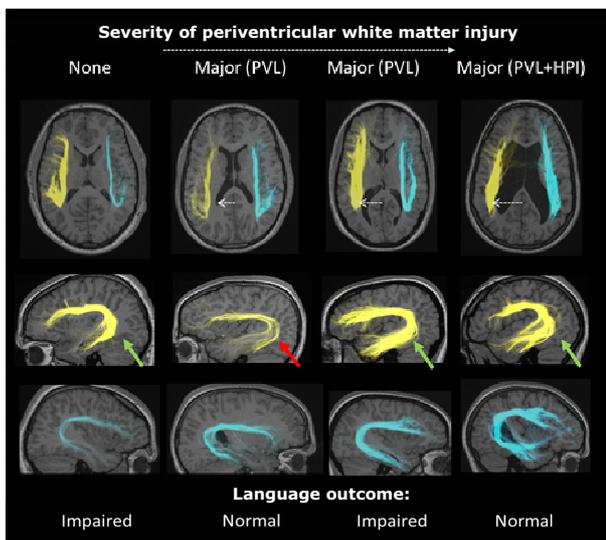


METHOD

Participants: 50 preterm (born <33 weeks) adolescents and 30 controls (mean age: 16 years). 19/50 preterm children scored >1.5 Z scores below controls on the total language score from the CELF-3^{UK} and were classified as **language-impaired**. **Structural MRI:** 3DFLAIR, 3DFLASH, DWI. **DWI-tracking** of the **arcuate fasciculus** was performed using spherical deconvolution with seed ROI placement according to the method⁶. Tracking of the **corpus callosum** was performed from a seed region in the posterior CC to target ROIs in the parietal, occipital and temporal lobes⁷. Tracts were thresholded ($p > 0.001$) and converted into volumes and mean fractional anisotropy (FA) was calculated. **Whole brain analyses** between the preterm groups with and without language-impairment included Voxel-Based Morphometry (VBM) and Tract-Based Spatial Statistics (TBSS).

RESULTS (A)

Arcuate fasciculus integrity:

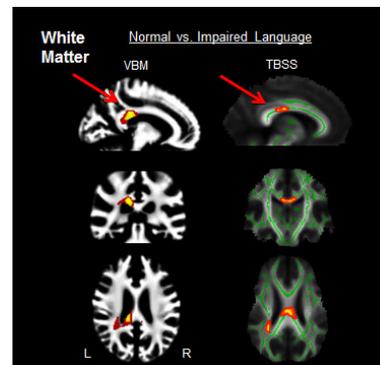


- The size and fractional anisotropy of the arcuate fasciculus was **not different** between those with normal and impaired language.

RESULTS (B)

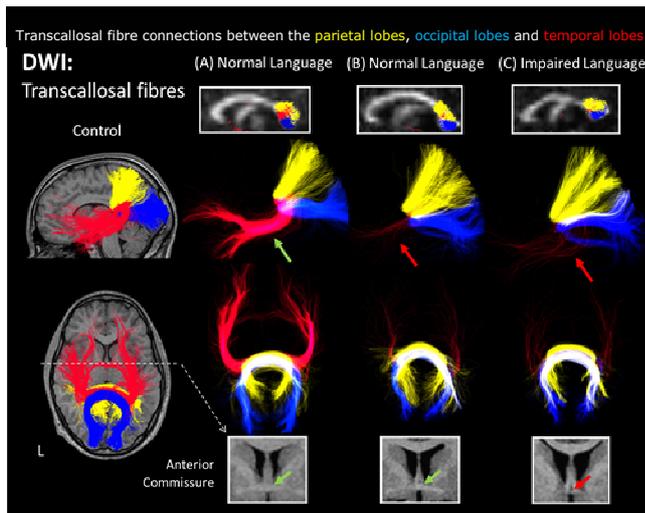
Whole brain analyses:

- Language-impaired children showed white matter reduction in the **posterior corpus callosum** and **left temporal lobe** ($p < 0.001$, uncorrected).
- Reduced fractional anisotropy was also found in similar regions ($p < 0.05$, corrected).



DWI-tractography of posterior corpus callosum:

- Inter-hemispheric connections were **reduced** in language-impaired children: this was specific to **temporal lobe fibres** ($p < 0.001$). The **anterior commissure** was also smaller ($p < 0.001$).



- Importantly, language impairment was only seen in individuals with **both** callosal and anterior commissure reduction (connecting the temporal lobes).

Independent predictors of language impairment

(logistic regression analysis):

- (1) volume of transcallosal temporal lobe fibres,
- (2) area of anterior commissure

($p < 0.0001$, sensitivity=94%, specificity=89%)

CONCLUSION

Language impairment in adolescents born preterm is associated with specific **reduction of inter-hemispheric connections between the temporal lobes** within the corpus callosum and the anterior commissure.

This finding supports recent theories emphasising the importance of inter-hemispheric cooperation in language¹⁻³.

REFERENCES

- (1) Friederici AD, Alter K. Brain Lang 2004 May;89(2):267-76. (2) Jung-Beeman M. Trends Cogn Sci 2005 Nov;9(11):512-8. (3) Bozic M, Tyler LK, Ives DT, Randall B, Marslen-Wilson WD. Proc Natl Acad Sci U S A 2010 Oct 5;107(40):17439-44. (4) Northam GB, Liegeois F, Chong WK, Wyatt JS, Baldeweg T. Ann Neurol 2011 Apr;69(4):702-11. (5) Foster-Cohen SH, Friesen MD, Champion PR, Woodward LJ. J Dev Behav Pediatr 2010 Oct;31(8):658-67. (6) Catani M, Jones DK, Ffytche DH. Ann Neurol 2005 Jan;57(1):8-16. (7) Hofer S, Frahm J. Neuroimage 2006 Sep;32(3):989-94.