

Detecting Cortical Facets of Developmental Disorders using Multivariate Random Forest Classification: The Case of Dyslexia



Ulrike Kuhl, Angela D. Friederici & Michael A. Skeide

Department of Neuropsychology, Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany

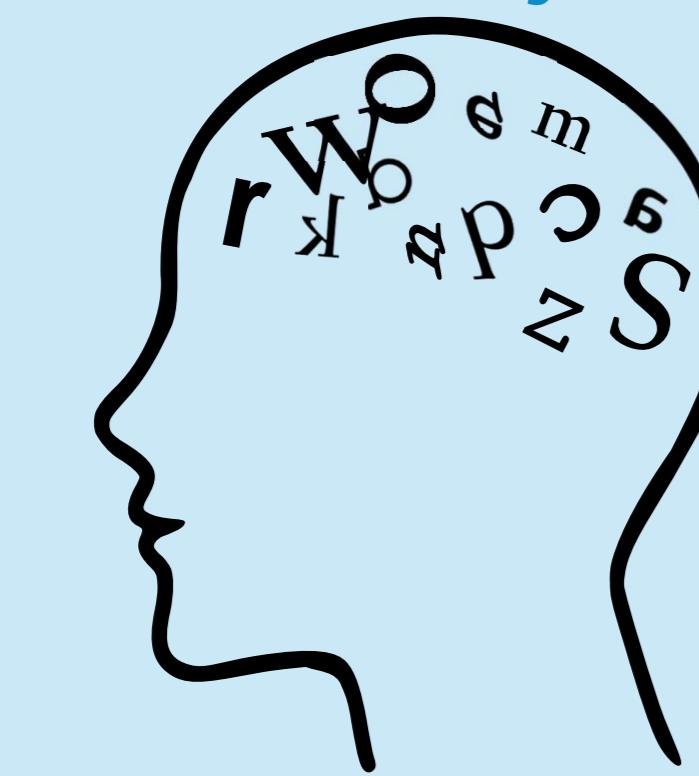
kuhl@cbs.mpg.de

MAX PLANCK INSTITUTE FOR HUMAN COGNITIVE AND BRAIN SCIENCES LEIPZIG

Introduction

Disentangling **neurobiological predisposition** from the **effect of literacy instruction**:

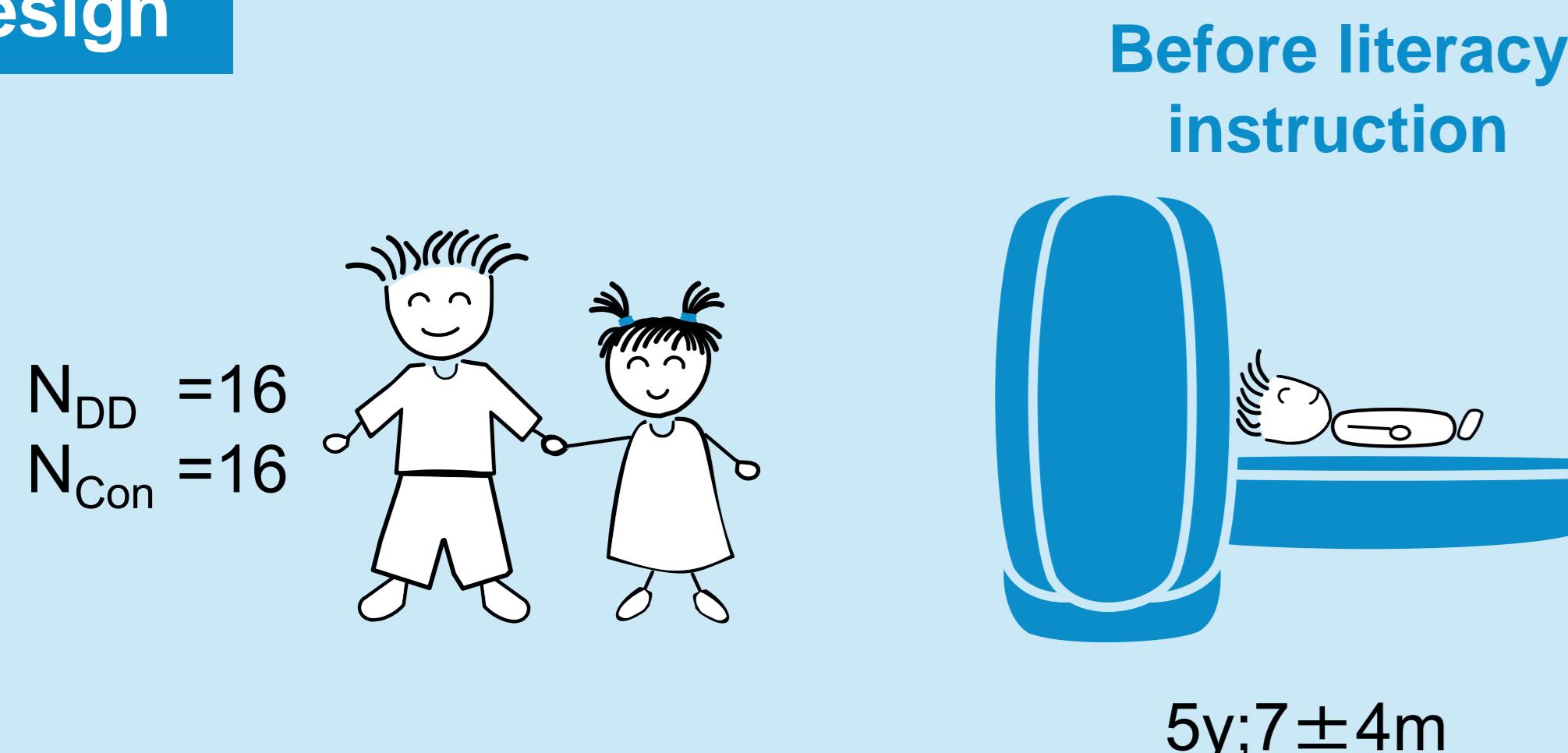
Which cortical features classify as **cause for developmental dyslexia**?



Changes in which cortical measures are a **consequence of being dyslexic**?

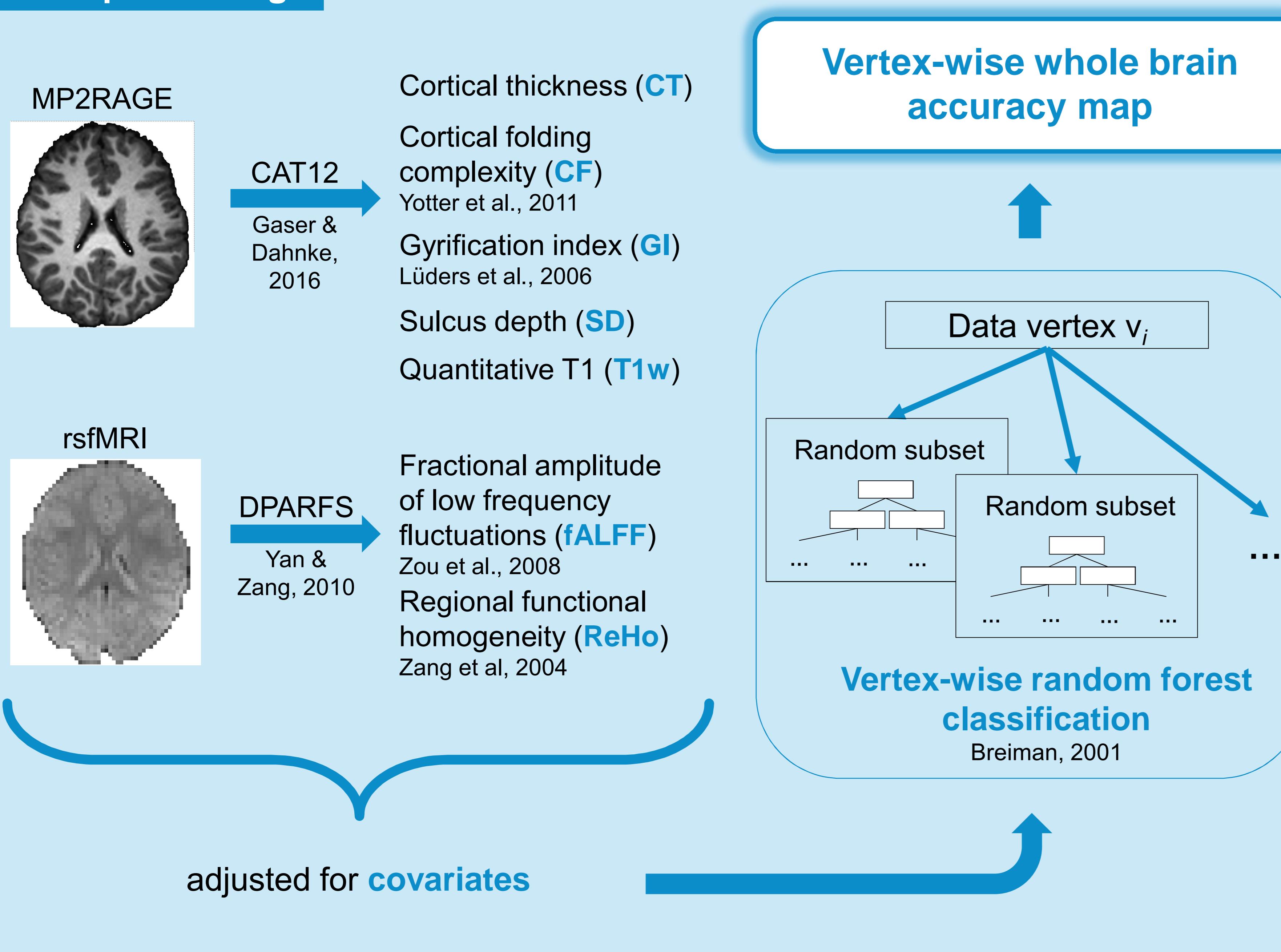
Goswami, 2015

Design



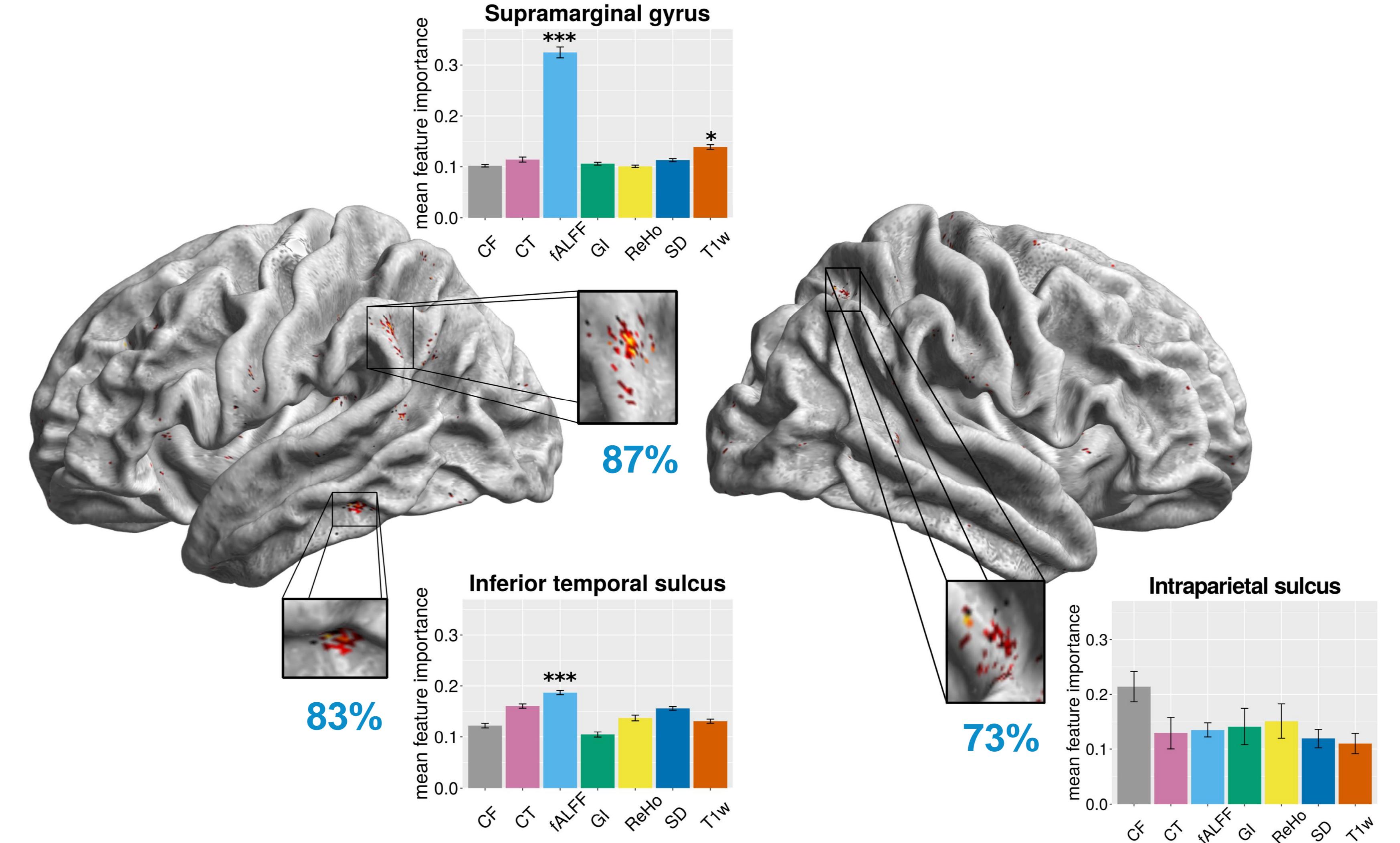
Covariates: Sex, Age, IQ, handedness, parental education, arithmetic ability

Data processing

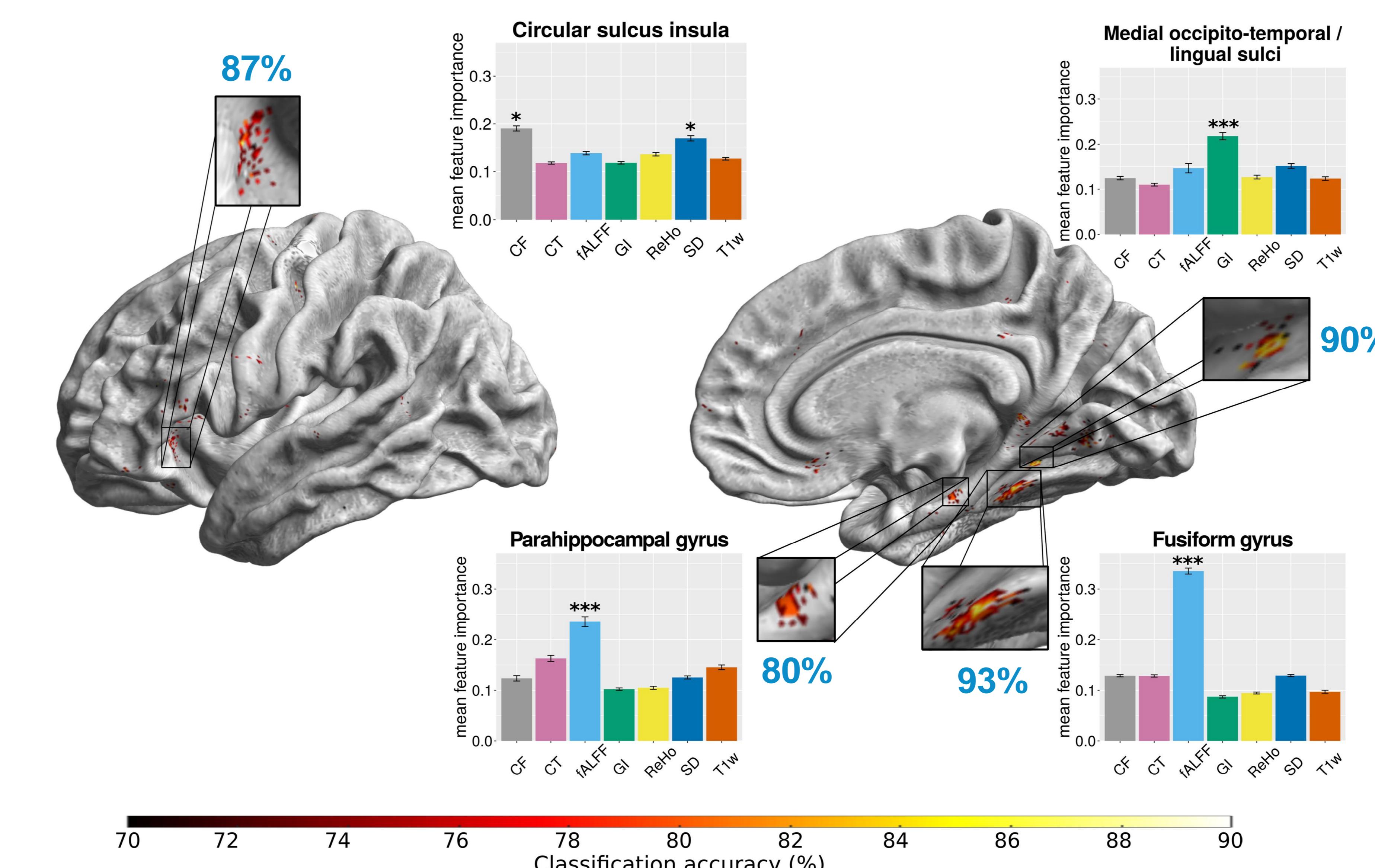


Results

Before literacy instruction (5 years)



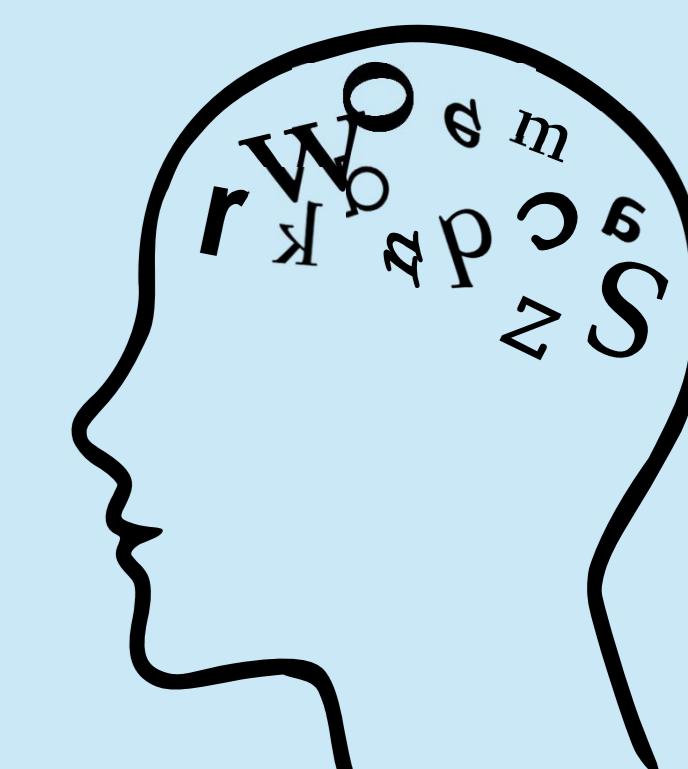
After literacy instruction (8 years)



Discussion & Conclusion

Before literacy instruction

- Left **ventrolateral-temporal cortex**
 - close to the 'visual word form area'
 - Skeide et al., 2016
- Left **supramarginal gyrus**
 - grey matter increase with literacy
 - Carreiras et al., 2009



After literacy instruction

- Left **insula**
 - deficient temporal processing of speech and non-speech sounds
 - Steinbrink et al., 2009
- Right **ventral temporal cortex**
 - reduced grey matter volume in dyslexic adolescents
 - Kronbichler et al., 2008

Classification performance is **differentially driven by various cortical features**.

Discriminative of dyslexia outcome prior to reading: **Regions later forming the reading network**

References

- Breiman, L. (2001). Random forests. *Machine Learning*, 45(1), 5-32.
- Carreiras, M., Seghers, M. L., Baquero, S., Estévez, A., Lozano, A., Devlin, J. T., & Price, C. J. (2009). An anatomical signature for literacy. *Nature*, 461(7266), 983.
- Gaser, C., & Dahnke, R. (2016). CATA: Computational Anatomy Toolbox for the Analysis of Structural MRI Data. *HBM* 2016, 336-348.
- Goswami, U. (2015). Sensory theories of developmental dyslexia: three challenges for research. *Nature Reviews Neuroscience*, 16(1), 43-54.
- Kronbichler, M., Wimmer, H., Staffen, W., Hutzler, F., Mair, A., & Ladurner, G. (2008). Developmental dyslexia: gray matter abnormalities in the occipitotemporal cortex. *Human Brain Mapping*, 29(6), 613-625.
- Lüders, E., Thompson, P. M., Narr, K. L., Toga, A. W., Jancke, L., & Gaser, C. (2006). A curvature-based approach to estimate local gyration on the cortical surface. *Neuroimage*, 29(4), 1224-1230.
- Skeide, M. A., Kraft, I., Müller, B., Schaadt, G., Neef, N. E., Brauer, J., & Friederici, A. D. (2016). NRSN1 associated grey matter volume of the visual word form area reveals dyslexia before school. *Brain*, 139(10), 2792-2803.
- Steinbrink, C., Ackermann, H., Lachmann, T., & Riecker, A. (2009). Contribution of the anterior insula to temporal auditory processing deficits in developmental dyslexia. *Human Brain Mapping*, 30(8), 2401-2411.
- Yan, C. G., & Zang, Y. F. (2010). DPARSF: a MATLAB toolbox for "pipeline" data analysis of resting-state fMRI. *Frontiers in Systems Neuroscience*, 4.
- Yotter, R. A., Nenadic, I., Ziegler, G., Thompson, P. M., & Gaser, C. (2011). Local cortical surface complexity maps from spherical harmonic reconstructions. *Neuroimage*, 56(3), 961-973.
- Zang, Y., Jiang, T., Lu, Y., He, Y., & Tian, L. (2004). Regional homogeneity approach to fMRI data analysis. *Neuroimage*, 22(1), 394-400.
- Zou, Q. H., Zhu, C. Z., Yang, Y., Zuo, X. N., Long, X. Y., Cao, Q. J., ... & Zang, Y. F. (2008). An improved approach to detection of amplitude of low-frequency fluctuation (ALFF) for resting-state fMRI: fractional ALFF. *Journal of Neuroscience Methods*, 172(1), 137-141.