

Associations between brain microstructure and age, sex and obesity from childhood to young adulthood determined using diffusion MRI

Richard Watts¹

¹ University of Canterbury

Aim

To use large neuroimaging datasets of adolescents and young adults to determine the influence of age, sex and body mass index (BMI) on microstructural brain development from age 9 to 35.

Materials and Methods

Diffusion MRI data from the Adolescent Brain Cognitive Development (ABCD, n>10,000, age 9-16) and the Human Connectome Project – Young Adult (HCP-YA, n>1000, age 22-35) studies. Tissue microstructure was assessed using multicompartiment modelling of the diffusion MRI signal as a combination of restricted (intracellular), hindered (extracellular), and free water.

Results

Adolescents show widespread developmental effects, especially in subcortical grey matter(1). In young adults there is continued development in the ventral striatum and cortex. Prepubertal sex differences are mainly restricted to white matter, with some evidence of sex differences emerging over puberty in subcortical grey matter and especially the ventral striatum. Young adults show strong sex differences in the hippocampus and amygdala. In childhood, associations with BMI are observed throughout subcortical grey matter, especially in the ventral striatum(2), but reduce with age. In contrast, young adults demonstrate strong effects restricted to the hippocampus, amygdala and the surrounding cortex.

Discussion and Conclusions

Continued development between age 22-35 supports the concept that the brain is not fully developed until the third decade of life. Tissue microstructure shows the largest sex-dependent imaging effect size yet reported(3), and may help to explain sex-specific differences in mental health problems. Children show BMI-related differences in the brain's reward system that diminish with age, while in young adults BMI is strongly associated with areas of the brain associated with emotions and learning. This suggests that obesity in children and adults may have different neurobiological origins, and that treatments may be optimized by tailoring to age.

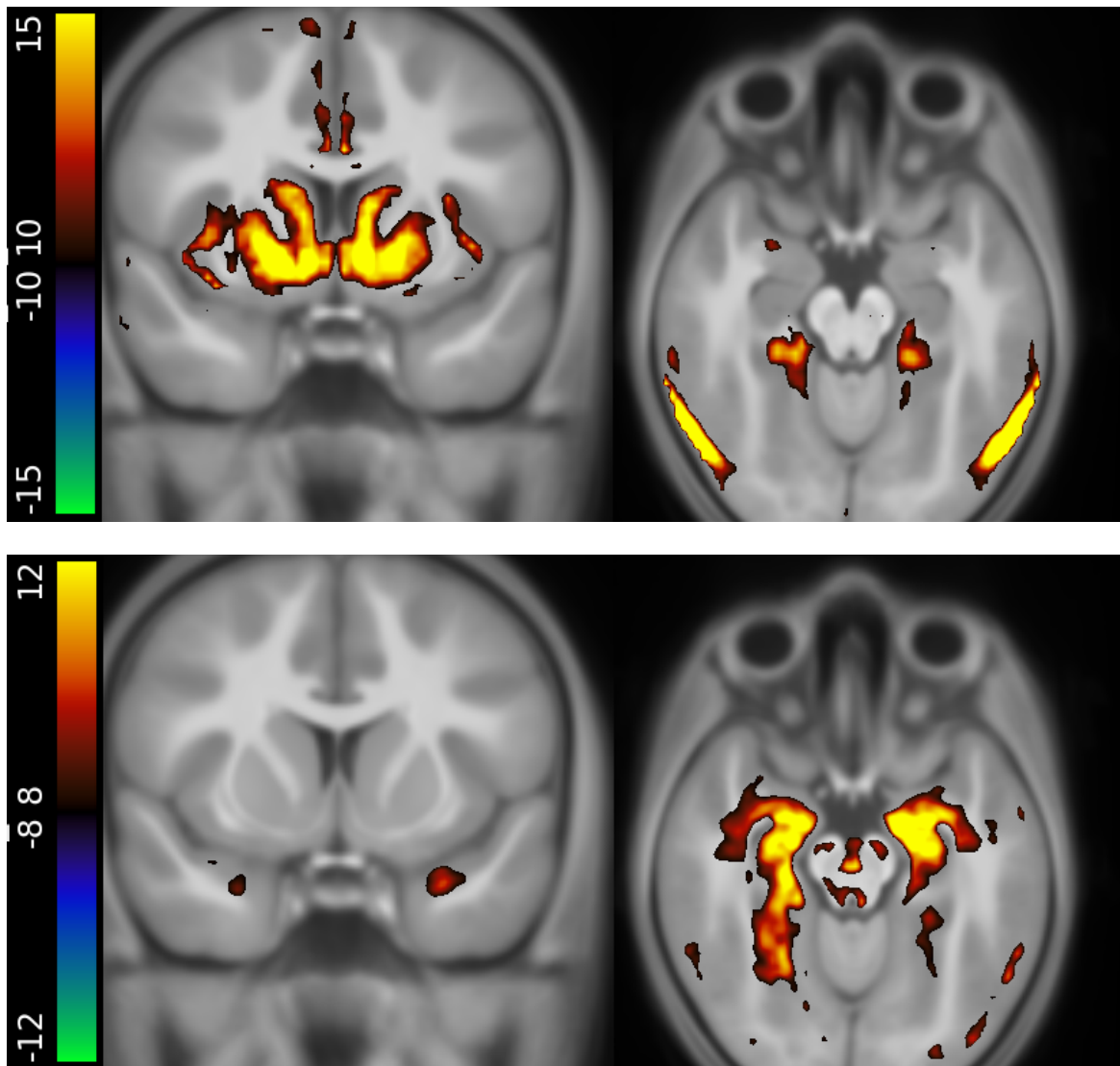


Figure 1. Associations of restricted component of diffusion with BMI in children (top) and young adults (bottom). Colour bars indicate z-statistic.

1. C. E. Palmer *et al.*, Microstructural development from 9 to 14 years: Evidence from the ABCD Study. *Dev Cogn Neurosci* **53**, 101044 (2022).
2. K. M. Rapuano *et al.*, Nucleus accumbens cytoarchitecture predicts weight gain in children. *Proc Natl Acad Sci U S A* **117**, 26977-26984 (2020).
3. D. Pecheva *et al.*, Sex and mental health are related to subcortical brain microstructure. *Proceedings of the National Academy of Sciences of the United States of America* **121**, e2403212121 (2024).