Educational Environment is Related to White Matter Development

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Introduction

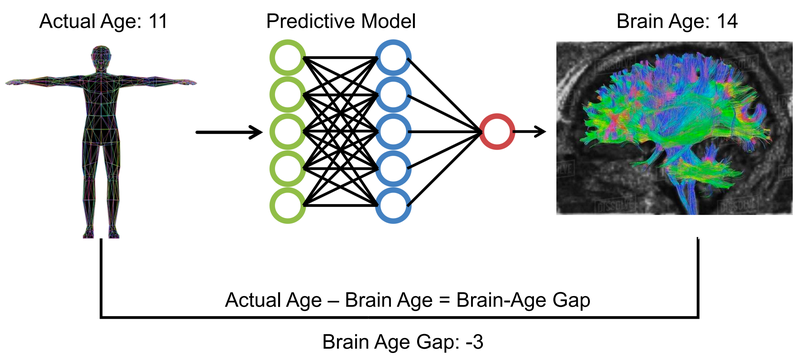
- Measures of socioeconomic status (SES), such as parental income and parental education, have been linked to differences in white matter development[1,2]
- Learning intervention studies have demonstrated that changes in an individual's learning environment can drive changes in white matter tracts that correspond to gain in academic skills , such as reading[3]

Research Question: Does the quality of an individual's educational environment relate to differences in white matter development, even when controlling for other measures of SES?

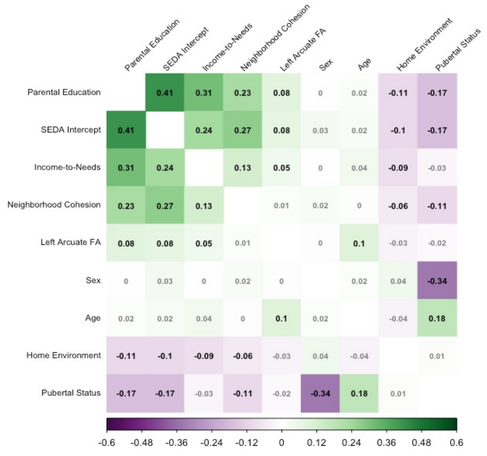
Methods

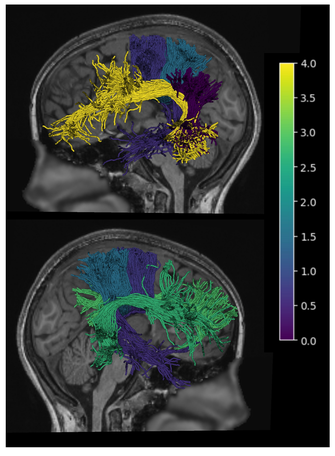
- Analyzed dMRI data from 6,410 participants from the baseline and follow-up observations of the ABCD study[4]
- Calculated tractometry metrics from dMRI using pyAFQ[5]
- Educational environment measured using linked Stanford Education Data Archive[6] (SEDA) data available in ABCD.
- Trained a CNN (resnet) on tractometry data from both timepoints to generate brain-age predictions
- Fit linear growth models to understand developmental relationships in individual white matter tracts.

Overview of Brain-Age Gap Model



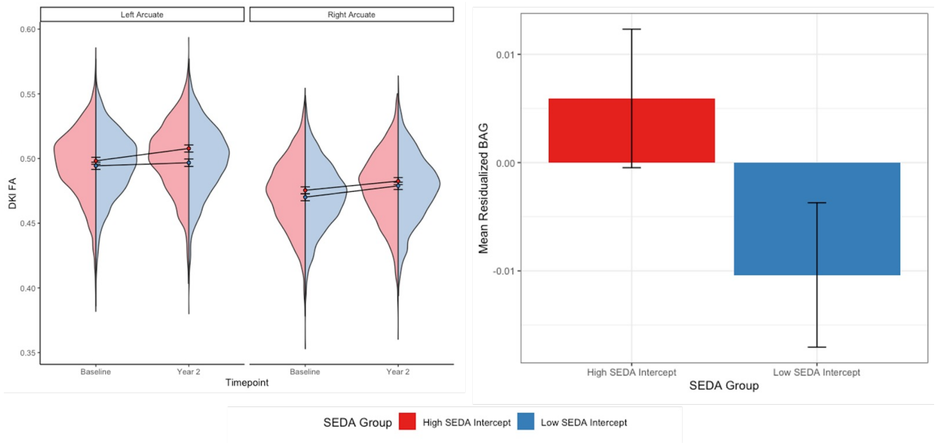
White matter properties are related to measures of SES, including educational opportunity





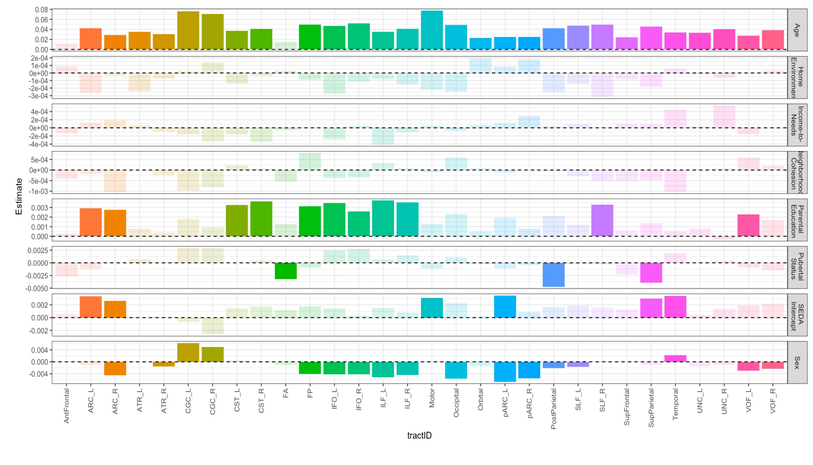
- Univariate correlations suggest that FA in the left arcuate is related to measures of SES, including educational environment
- Educational environment is most strongly related to FA in the left arcuate when controlling for other measures of SES

Educational Opportunity Accelerates White Matter Development, Especially in Tracts Related to Reading



- Students in higher quality educational environments demonstrate increased brain age, suggesting accelerated white matter development
- This accelerated maturation is even more pronounced in the left arcuate, a tract typically associated with reading skill, compared to the right arcuate

The relationship between educational opportunity and tissue properties varies across the white matter



- White matter is related to a range of developmental and socioeconomic factors, however, these relationships vary across the white matter
- School environment is related to FA in tracts linked with reading skill, whereas parental education is related to FA in tracts associated with arithmetic ability

Discussion

- A learner's educational environment relates to their white matter development above and beyond the influence of other socioeconomic factors
- This relationship is strongest in the left arcuate, which has been associated with reading skill
- Future work is needed to better understand the dynamic between brain development, environment, and learning

References

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