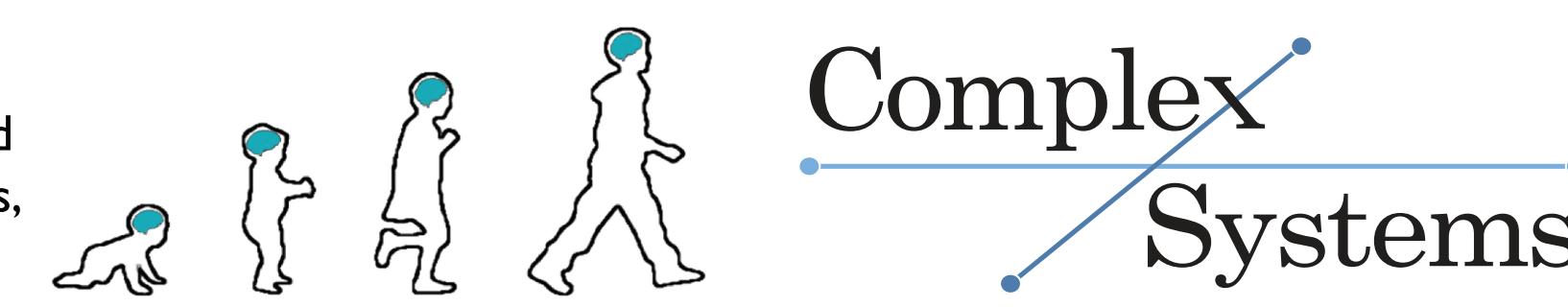


Functional Network Development in Early Childhood

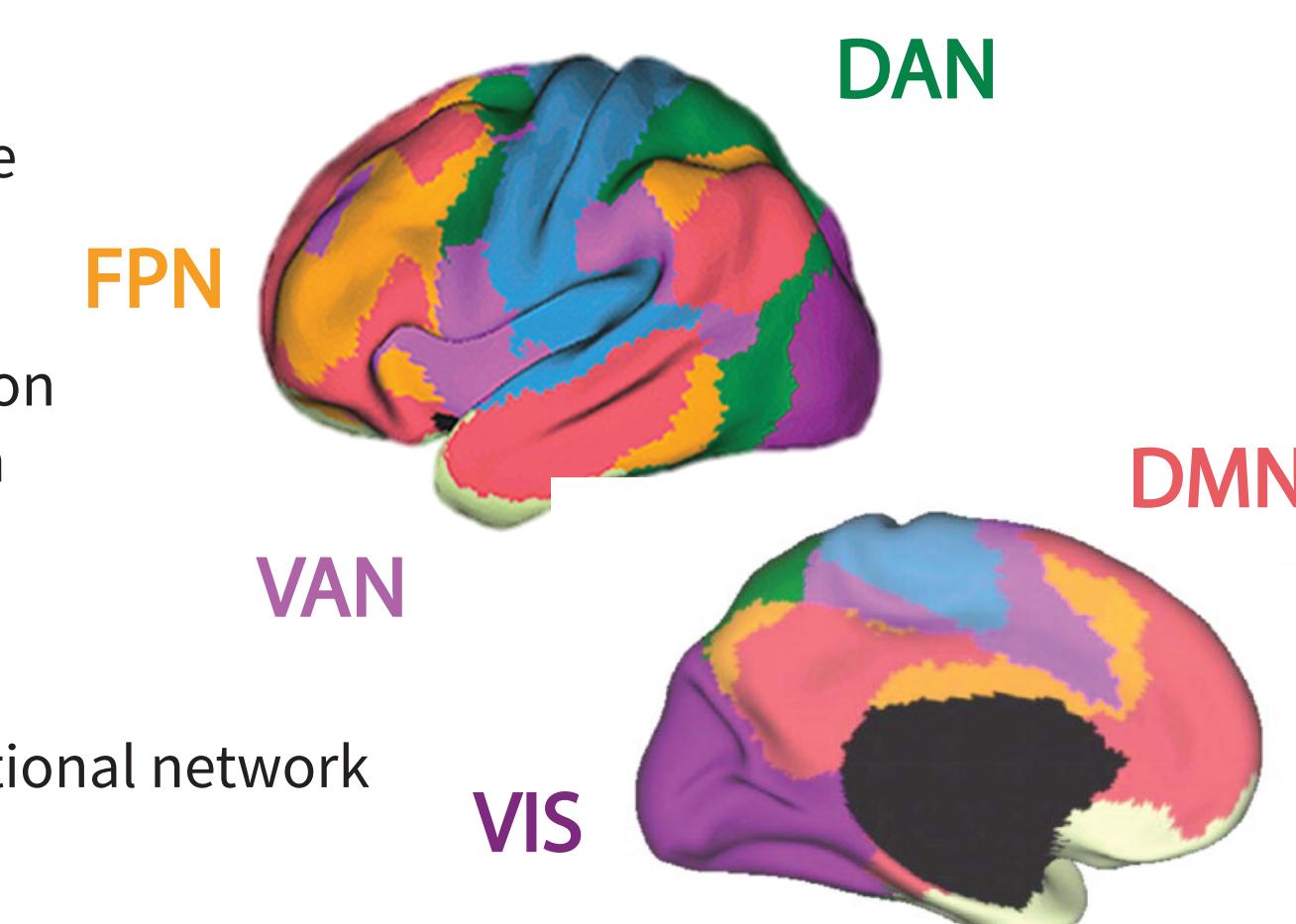
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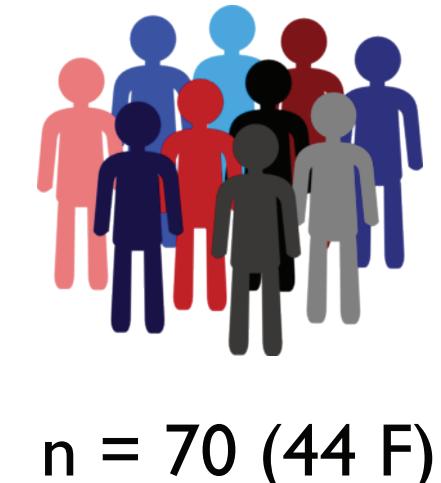


Introduction

- As children grow up, their brains undergo considerable experience-dependent rewiring and reconfiguration.
- Socioeconomic status (SES) has been found to be associated with aspects of both structural and functional brain development [1], but less is known about how functional patterning of the cortex is associated with early life experiences.
- Prevalent theories hold that the strongest effects of early-life SES are in language and executive function areas.
- An alternate hypothesis is that effects of early environment on the brain follow a developmental progression, with effects on early-developing primary sensory areas early, and effects on later-developing association areas late [2].
- Here, we examine associations between age, SES, and functional network development in early childhood.



Dataset



Children ages 4-10 (mean age 6.8 yrs) were recruited from the surrounding Philadelphia community.

QA criteria for inclusion included: full-term (> 34 weeks) and birthweight > 5 lbs, no diagnosed neurological or psychiatric conditions, no learning disabilities, passed visual MRI QA checks, mean FD < 1 mm, < 10% outliers over 2mm FD, max FD < 10 mm, < 50% of volumes over 0.5 mm FD or 1.75 DVARS.

Preprocessing and QA checks performed with MRIQC [3], fMRIprep [4], and xcpEngine [5].

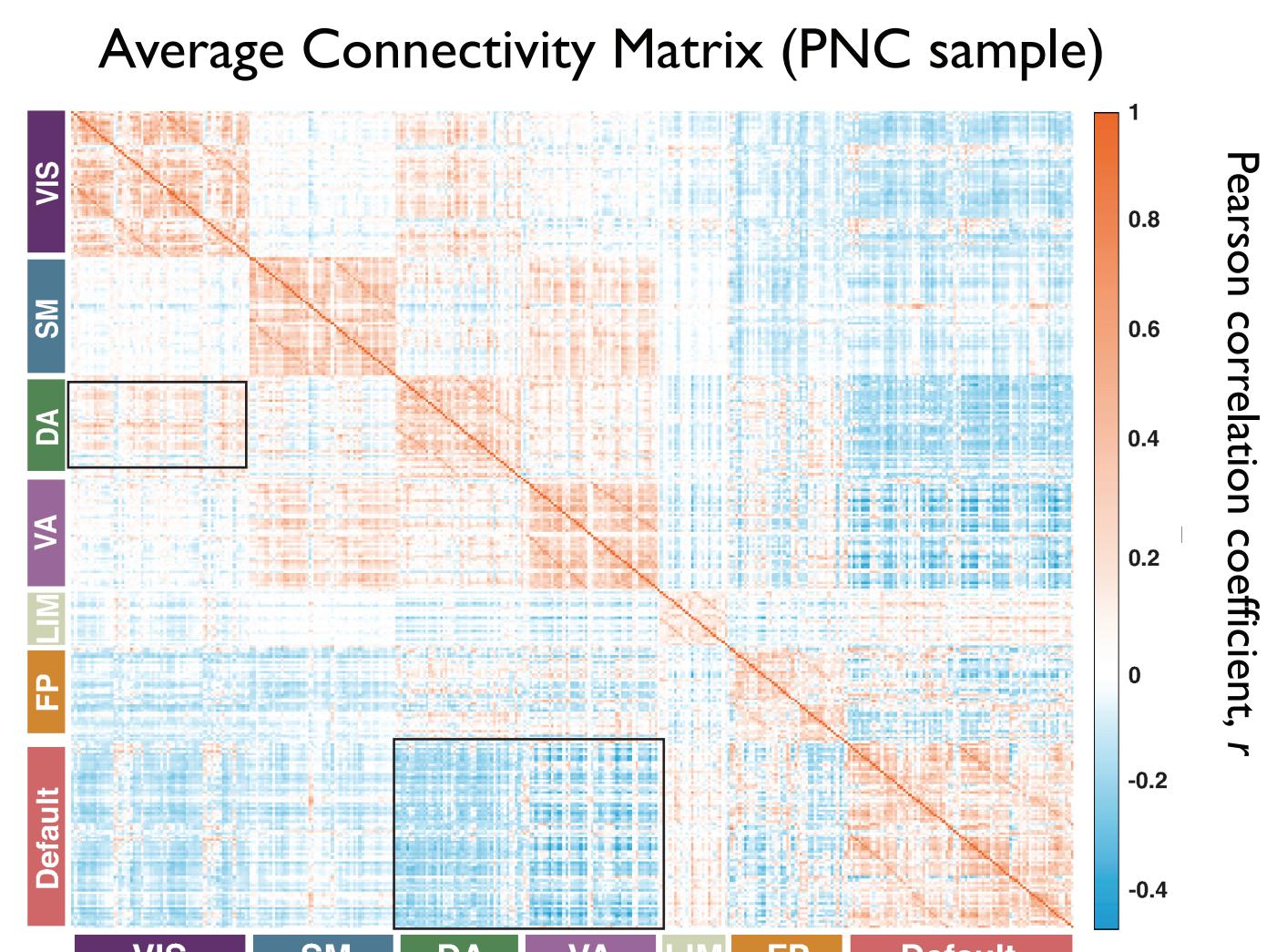
Methods



We extracted BOLD signal from N = 400 regions of interest [6]. We estimated the functional connectivity between any two brain regions (region *i* and region *j*) by calculating the Pearson correlation coefficient between the mean activity time series of region *i* and the mean activity time series of region *j*.

We used the corresponding canonical division of parcels into 7 systems [7] to examine system effects.

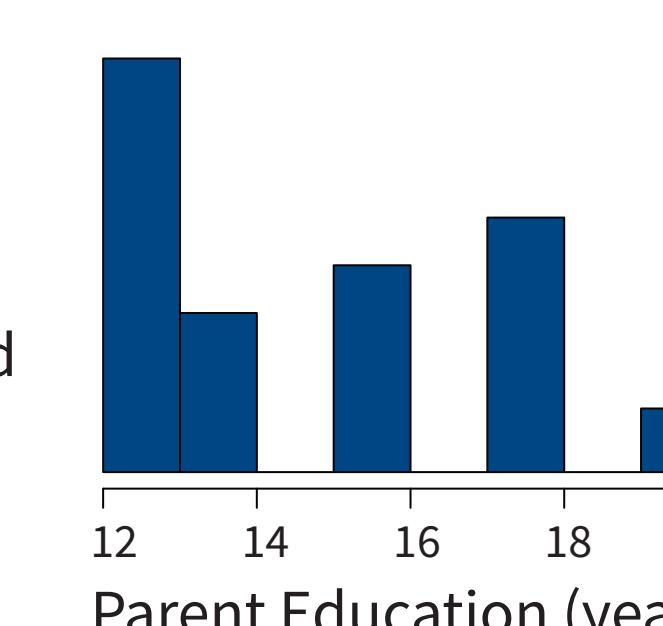
All analyses controlled for sex, total number of volumes, average FD, % outlier volumes, and average network weight.



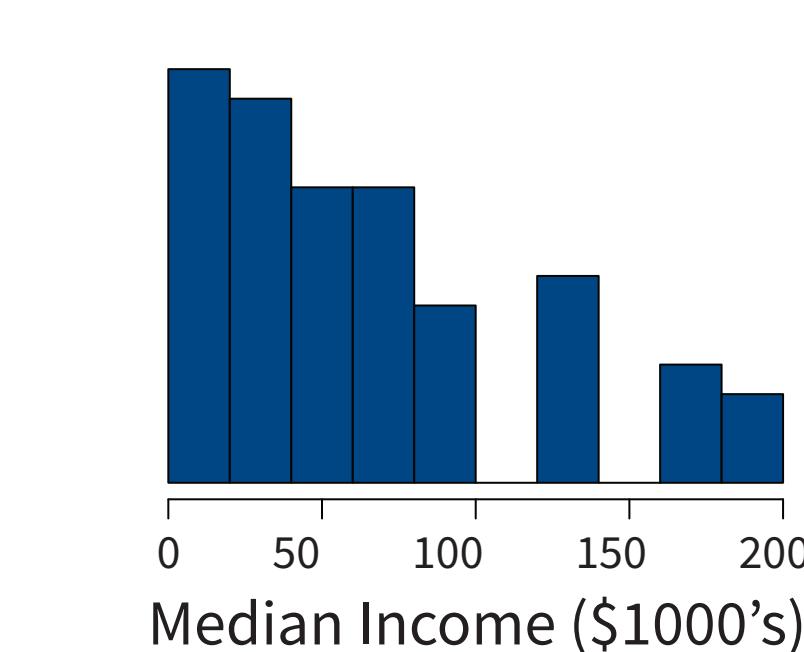
Measures of environment

SES: composite of z-scored income and parent education; income range \$2,500-\$200,00+, median income \$42,500; education range high school-20+ years, median education associate's degree.

Although SES is median-split for visualization here, all analyses examined it as a continuous variable.

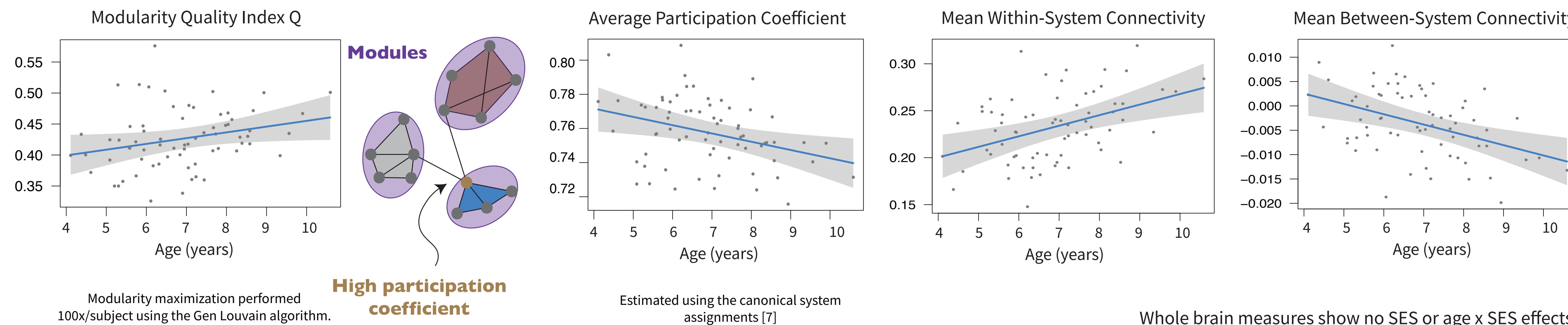


Our sample was 61.2% Black, 25.4% White, and 13.4% Other, 14% of our sample identified as Hispanic or Latino. All analyses examining SES also controlled for race and ethnicity.



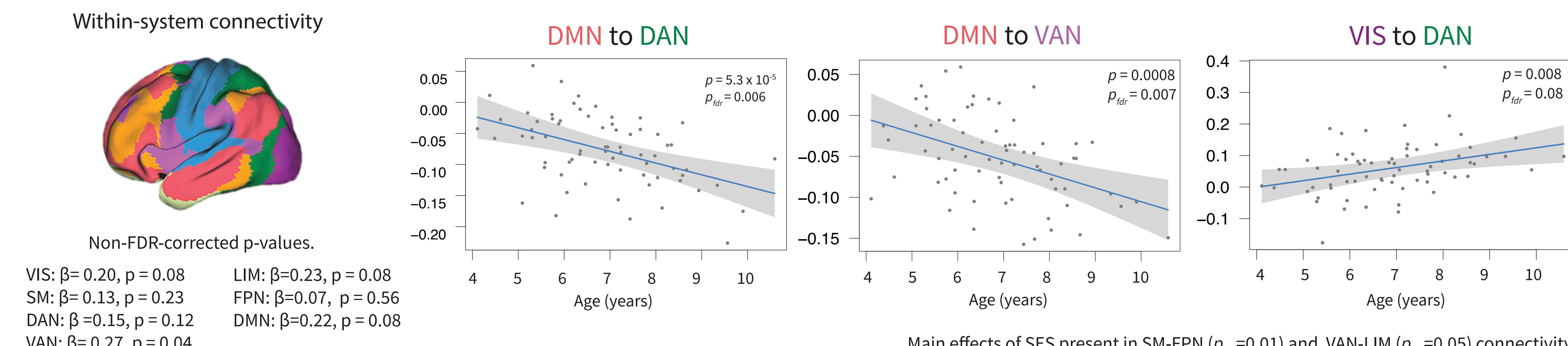
Results

Functional network segregation is positively associated with age



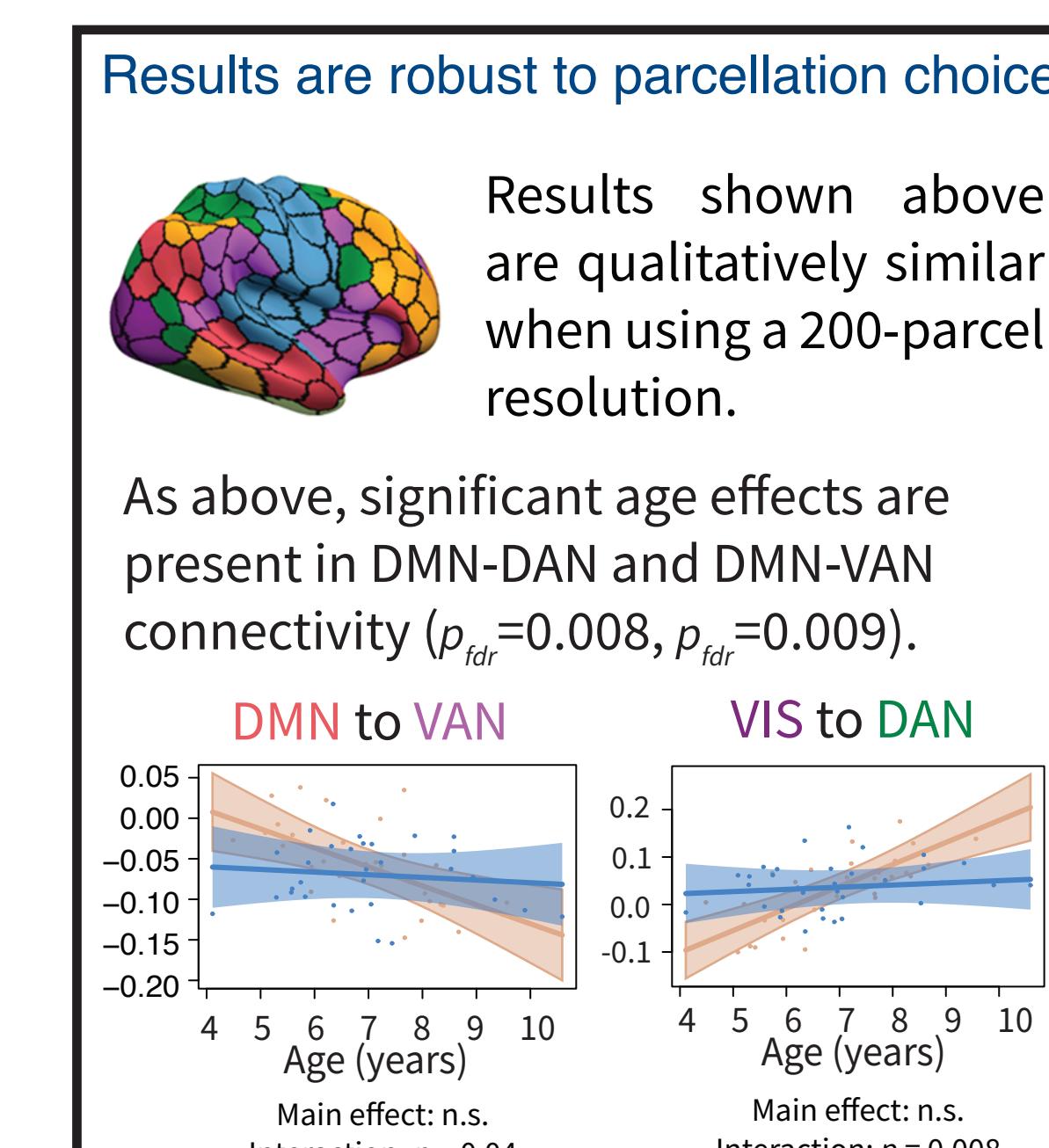
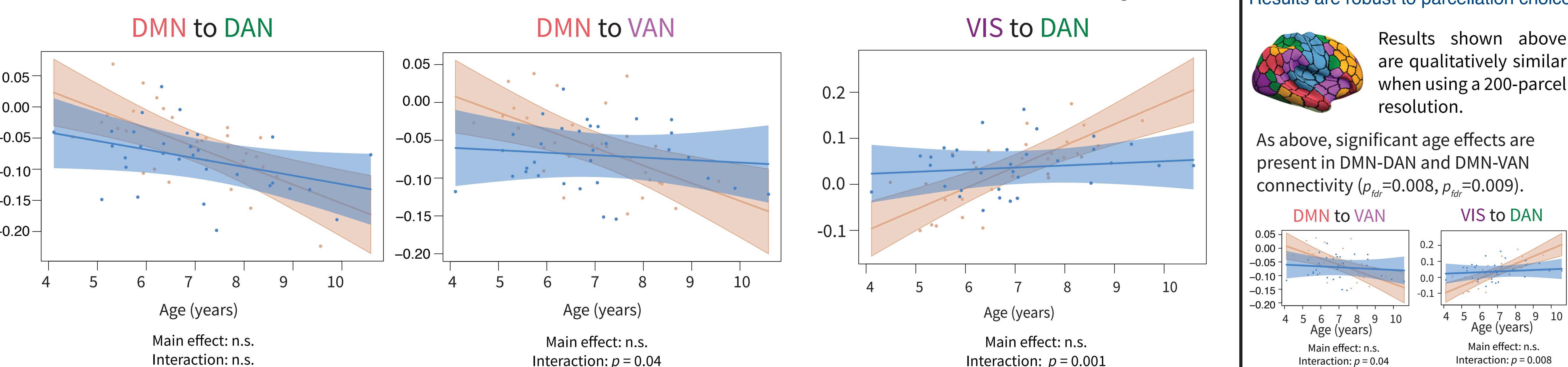
Whole brain measures show no SES or age x SES effects.

System-specificity of network segregation



Main effects of SES present in SM-FPN ($p_{\text{fdr}}=0.01$) and VAN-LIM ($p_{\text{fdr}}=0.05$) connectivity.

Age x SES interactions



Conclusions

- Age is positively associated with measures of functional network segregation, likely reflecting increasing refinement of network architecture as children develop.
- Decreased connectivity between default and attention systems with age suggests increasing segregation between externally-directed attention and internally-oriented cognition, while increased connectivity between visual and dorsal attentional systems suggests continued development of the dorsal stream through childhood.
- SES moderates positive associations between age and visual to dorsal attention system connectivity, such that lower-SES children show a stronger positive association between age and connectivity, and age and default mode to ventral attention system connectivity, such that lower-SES children show a stronger negative association between age and connectivity. This suggests that low SES might accelerate cortical development early in childhood, during periods of rapid developmental change.
- Future work will examine the use of a developmental parcellation, spatial specificity of these effects, and links to cognition.

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Acknowledgments

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