Peak alpha frequency and brain structure associations: differences in children with typical development and autism spectrum disorder

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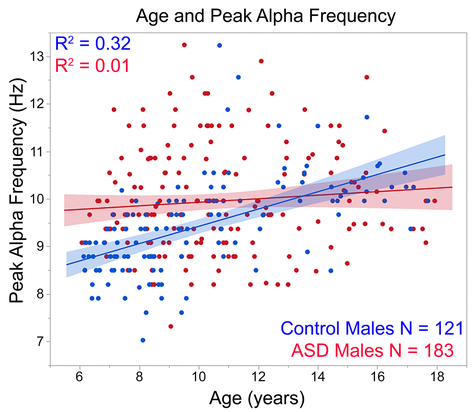
BACKGROUND

- In Edgar et al. (2019) we showed **age-related increases in eyes-closed peak alpha frequency (PAF) activity (8-12 Hz)** in typically developing children (TDC) but not in children with autism spectrum disorder (ASD).
- Lack of change in the ASD sample was attributable to **early maturation of PAF**, such that **younger (6 to 9-year-old) children with ASD had significantly higher PAF values** than TDC.



OBJECTIVE

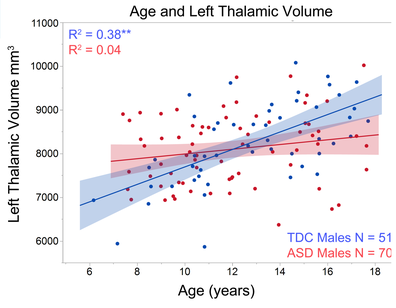
Explore the structural underpinnings of PAF, focusing on brain structure known to be associated with resting-state alpha activity.

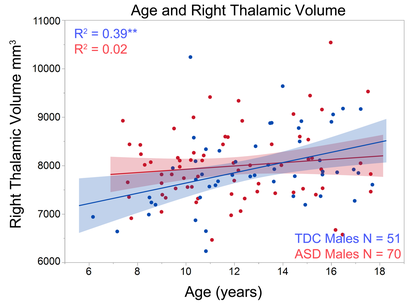
METHODS

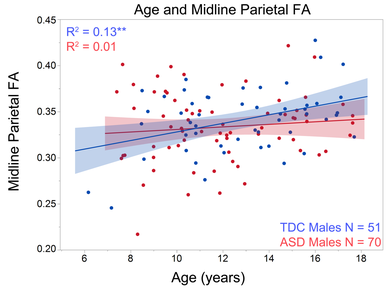
- MEG resting-state eyes-closed data and MRI T1 and 30 directional diffusion tensor imaging data were obtained from **51 TDC males** (mean age = 12.7 years, range 6.2-17.7 years) **and 70 males with ASD males** (mean age = 11.9 years, range 7.4-17.7 years)**.**
- Using BESA Research 6.1, a source model with 15 regional sources projected the raw MEG surface data into brain source space and a Fast Fourier Transform was applied to artifact-free 3.41 second epochs of continuous data at each regional source.
- From the 15 average power spectrum, PAF was identified in each participant from the source (most often the midline parietal source) showing the largest amplitude alpha activity (8-12Hz).
- Using Freesurfer (Harvard-Oxford Atlas), the following measures were obtained:
  - Left and Right Thalamic volume
  - Left and Right Gray matter surface area for superior occipital, superior parietal, precuneus and cuneus
- Fractional anisotropy (FA) characterized the microstructure of local white matter (white-matter ROI near MEG PM source).

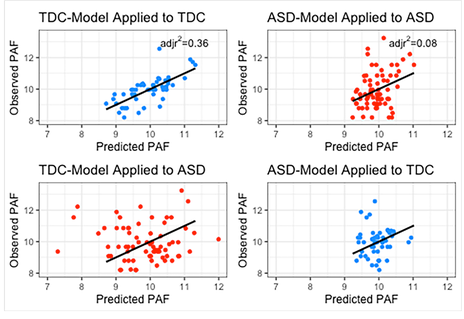
RESULTS

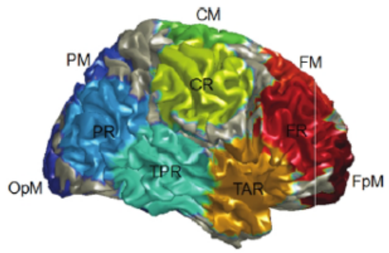
- To identify brain structure associations 'unique' to PAF, **the lasso technique was used.**
- In **TDC,** the final model included age and all structure variables. **The adjusted R² for this model was 0.36.** Variables with a particularly strong association with PAF included age, and left and right thalamic volume.
- In **ASD**, the final model included only midline parietal FA, left cuneus, and left occipital surface area. **The adjusted R² for the final ASD model was 0.08.** Of the three selected ASD variables, midline parietal FA had the strongest association with PAF.
- Finally, each of the selected models was refit to the alternate group.
  - When the TDC model was applied to the ASD group, the adjusted R² was .03.
  - When the ASD model was applied to the TDC group, the adjusted R2 was .11.
  - Results suggest that in a multivariable model, structure variables can be combined to explain a substantial portion of the variability in function in the TDC but not ASD group.



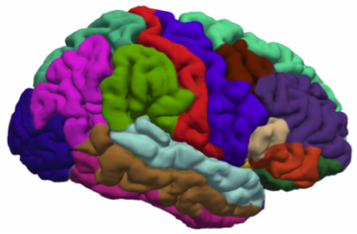








Functional Locations



Structural Locations

DISCUSSION

- Different brain structures were associated with PAF in TDC and ASD.
  - **TDC showed expected associations for thalamic volume, white matter and cortical gray matter.**
  - **In ASD, only midline parietal FA, left cuneus, and left occipital surface area .**
- Findings suggest abnormal brain maturation in ASD, with less organized brain development perhaps accounting for the paucity of RS structure-function associations in ASD.
- Present findings contribute to the literature indicating thalamo-cortical dysfunction in ASD.

REFERENCES

Edgar, J. Christopher, et al. "Abnormal Maturation of the Resting-State Peak Alpha Frequency in Children with Autism Spectrum Disorder." *Human Brain Mapping*, John Wiley & Sons, Ltd, 11 Apr. 2019, onlinelibrary.wiley.com/doi/abs/10.1002/hbm.24598.

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