Title: Interhemispheric Alpha-Band Hypoconnectivity in Children with Autism Spectrum Disorder (ASD)

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Introduction: Aberrant neural connectivity is widely supported to be an underlying neurobiological mechanism of autism spectrum disorder (ASD; Geschwind & Levitt, 2007). Connectivity patterns in ASD are generally described as short range hyperconnectivity and long range hypoconnectivity (Wass, 2011). The dynamics of neural oscillations in the alpha range (6-12 Hz) are exquisitely sensitive to the healthy development of (Smit et al., 2012), and disruptions to, functional and structural connectivity (Hinkley et al., 2011). It is important to determine how neural connectivity differences manifest across the autism spectrum, and whether these differences are defined by consistent cortical regions. Studying all possible atypical connectivity patterns requires a data driven approach which examines all short and long-range connections across cortex.

Here we used electroencephalography (EEG) to quantify alpha-band functional connectivity in children with ASD across a range of cognitive abilities in order to determine: (1) whether alpha band coherence in both long and short-range networks distinguishes children with ASD from typically developing (TD) children, and (2) whether alpha band coherence relates to developmental level and cognitive function within the autism spectrum.

Method: We studied 59 children with ASD (mean age 69 months; range: 25-126) with nonverbal IQ ranging from 10-145 (mean NVIQ: 75) and 39 age matched TD children (mean age: 72 months; range: 29-146; mean NVIQ: 113). Spontaneous EEG was recorded using a high density 128 channel hydrocel geodesic sensor net (EGI inc.), and extensively cleaned through both manual inspection, and independent component analysis (ICA). To mitigate the effects of volume conduction, EEG data were transformed into current source density (CSD) using a spherical spline Laplacian transform. CSD estimates were then decomposed into the time-frequency domain using fast Fourier transform. Phase coherence within the alpha range was calculated between every possible electrode pair. A permutation test with a false discovery rate (FDR) adjustment for multiple testing was used to identify electrode pairs which demonstrated significantly different phase coherence between ASD and TD participants.

Results: (1) Using a conservative FDR correction of 0.05, one interhemispheric electrode pair between left and right temporal regions showed significantly decreased phase coherence in ASD compared to TD children (t(96)=4.20, P=.000). (2) Alpha phase coherence for this electrode pair was not associated with either age or IQ in the ASD group (age: P=.193; non-verbal IQ: P=.267, verbal IQ: P=.215).

Discussion: Long range alpha band coherence between left and right temporal regions distinguishes TD children from a heterogeneous group of ASD children. No association was found between long range connectivity and cognitive ability. Our results are consistent with previous research, and further support that interhemispheric temporal hypoconnectivity represents a fundamental brain difference in children with ASD across a wide cognitive range. These results may reflect the presence of structural factors underlying decreased neural communication (such as white mater disturbances), or increased signal variability at temporal sites in ASD. Future research will address the earliest developmental origins of aberrant spontaneous functional connectivity in infants at risk for ASD.

References/Citations: