A MEG Study of Functional Connectivity During Preparation for Saccades in ASD

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Background: A significant body of evidence has accumulated in support of the cortical hypo-connectivity hypothesis of autism; the hypothesis states that individuals with autism spectrum disorders (ASD) have weaker than normal long-range cortical functional connectivity that may contribute to their cognitive abnormalities. Our own studies show that individuals with ASD (1) make more errors than controls on an antisaccade task, and (2) when preparing for a saccade, show widespread reduced connectivity in the alpha band relative to controls.

Objectives: To investigate whether the reduced functional connectivity in ASD that we observed in the alpha band is task and region specific. In particular, given the higher error rate in the ASD group for antisaccades, we investigated whether group differences in coherence were more pronounced during preparation for a more cognitively demanding task (an antisaccade) than for a simple task (fixation or a prepotent prosaccade), and if so, which cortical regions were most affected.

Methods: We studied 10 high functioning adults with ASD and 10 age and gender matched healthy controls using whole head Magnetoencephalography (MEG). We looked at three conditions – 1) fixation with no immediate associated task ('fixation'), and fixation in preparation for 2) a saccade towards a suddenly appearing visual stimulus ('prosaccade') or 3) a saccade away from the stimulus ('antisaccade'). For each subject and condition, we analyzed the MEG amplitude and coherence in source space (i.e., cortical space), in the peak alpha frequency, during the preparatory interval in between the instructional cue and stimulus appearance. We focused on coherence between ocular motor regions that have been found to show preparatory activity for saccades: the inferior and superior portions of the frontal eye field (FEF), the supplementary eye field (SEF), and intraparietal sulcus (IPS).

Results: Multiple regions showed evidence of task-dependent group differences in functional connectivity in the alpha frequency band: (1) It has been shown that top-down connections suppress activity in visual cortex in preparation for an antisaccade relative to prosaccades. We observed significantly greater suppression in the control group. (2) Relative to fixation, task-related increases in coherence were observed in the control group between the FEF and the SEF and a parietal region overlapping with the IPS, areas critically involved in saccades. No reliable task-related increases in coherence were observed in the ASD subjects. Finally, (3 in the control group, there was a trend for slightly increased coherence between the right and left FEFs during preparation for antisaccades relative to prosaccades, but no such trend was observed in the ASD group.

Conclusions: Our data indicates that when preparing for a saccade, participants in the control group modulate (both increase and suppress) alpha activity and coherence across the saccadic network according to task difficulty. There appears to be no or little such modulation in the ASD group, potentially due to reduced functional connectivity. Such lack of modulation of the coherence may reduce top-down control over volitional saccades and could contribute to the observed increased antisaccade errors and faster correctresponses (i.e., a disruption of the speed-accuracy trade-off).