Brain Perfusion Differences in Autism Spectrum Disorders

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Target audience: Researchers interested in arterial spin labeling (ASL) methods, and applications of ASL to psychiatric populations.

Introduction and purpose: Functional imaging studies of autism spectrum disorders (ASD) have associated deficits in social perception with abnormalities in multiple portions of the temporal lobes – particularly the amygdala, fusiform gyrus, and superior temporal sulcus. Almost all imaging studies to date have relied on differences in blood-oxygenation level-dependent (BOLD) effects derived from experimental task manipulations – i.e., differences in the relative magnitude of BOLD signal changes between two conditions (usually social versus non-social information processing). However, temporal lobe deficit models of ASD suggest that alterations in brain function are a phenotypic trait that should also be present at rest. Arterial Spin Labeling (ASL) allows noninvasive quantification of cerebral blood flow (CBF), which is coupled to regional neural activity, and can be used as a measure of regional brain function at rest [1]. We used ASL to measure regional CBF within temporal lobe structures in ASD during a resting state passive viewing task.

Methods: Participants: 26 typically developing controls (TDC) and 33 children with ASD (mean ages = 14.9 years for both groups) viewed a six-minute video (The Discovery Channel’s “Planet Earth”) while pseudo-continuous ASL (pCASL) data were collected. Our goal in presenting the video was to provide some between-group consistency in the deployment of basic attentional orienting. The ASD group was diagnosed following CPEA (Collaborative Programs of Excellence in Autism) guidelines [2], which included diagnostic gold standards: Autism Diagnostic Observation Schedule – Generic (ADOS-G) and Autism Diagnostic Interview-Revised (ADI-R), by research reliable clinicians. The assessment battery included a variety of additional measures including the Behavior Rating Inventory of Executive Function (BRIEF), which includes eight subscales (Inhibit, Shift, Emotional Control, Initiate, Working Memory, Plan/Organize, Organization of Materials, and Monitor).

Procedure and analysis: Scanning was carried out using a Siemens Verio 3T scanner with a 32-channel head coil. High-resolution structural MRI data (MPRAGE sequence, 9 x 8 x 8 mm, TR/TE=2000/3.3 ms) were collected for each participant in order to generate brain regions of interest (ROIs) and register ASL data into standard space. CBF was measured using pCASL with a 2D gradient-echo echo-planar sequence. The labeling and control RF duration was 1.5 sec with post-labeling delay of 1.2 sec. Multi-slice perfusion maps with 40 label/control pairs were acquired (TR/TE=4000/17 ms, flip angle=90°, bandwidth=3005 Hz/pixel, slice thickness=5mm, matrix size=64x64, FOV=220x220 mm² and slice number=20).

Results: The ASD group showed decreased CBF in large portions of the temporal lobes within or adjacent to multiple brain areas involved in social perception, including fusiform gyrus and amygdala (see Fig. 1) as compared to the TDC group. The only area where the ASD group showed increased rCBF was in precuneus. Post-hoc analyses indicated that CBF in amygdala was significantly correlated with the Emotional Control scale of the BRIEF (see Fig. 2).

Conclusion: This study is among the first to establish absolute CBF deficits within critical social intelligence regions in a sample of children with ASD. These data add to the growing literature associating the social deficits of ASD with abnormalities in temporal lobe structures. Correlations between amygdala CBF and emotional control are consistent with emerging findings regarding amygdala hyperactivation and abnormal emotion regulation processes in ASD. The unexpected finding of increased precuneus rCBF is consistent with prior reports of reduced deactivation in default mode network regions during fMRI tasks for individuals with ASD [7,8] as well as siblings [8]. This study supports the growing use of ASL as a measure of functional brain phenotype in the study of region-specific deficits associated with psychiatric conditions.


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Fig. 1

Fig. 2

Bilateral Amygdala CBF (mL/100g/min)