Accelerated maturation of white matter in young children with autism: A high b value DWI study

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Background/ Aims:

The goal of this work was to study white matter connectivity in young children with autism following previous reports of increased cerebral volume during early development, along with arguments for abnormal neural growth patterns[1,4] and regulation at this critical developmental period.

Methods:

Seven individuals diagnosed with autism age 1;8 -3;6 (mean age: 2;6), and forty-one typically developing (TD) subjects (20 males), age 0;4 to 23;2 years (mean age: 9;6 years) were included. DTI (b=1000sec/mm2), high b value DWI (b=6000sec/mm2) were applied at 1.5T GE scanner. Total acquisition time for the diffusion scan was 5.5 min.

FA maps were calculated using images acquired at low b values, up to 1,104 s/mm^2 (ref5). Displacement (Disp) and probability (Prob) maps were obtained, using q-space analysis for the entire diffusion data set[6-7]. Two analyses were done: the percentage of pixel representing mature white matter was calculated for each subject (white matter pixel count- WMPC), showing overall maturation. Additionally, FA, Disp & Prob were measured in 20 selected ROIs in the cerebrum, prescribed on color-coded DTI images. The data obtained from the TD children were fitted to a mono exponential function representing the typical developmental curves. The data from the children with autism were plotted against these curves.

The residuals between the values measured in individuals with autism and the predicted typical values were calculated. One sample one-tail t-test analysis was calculated (significant p=0.05). For the ROI analysis, Keppel multiple comparisons correction was applied (ROIs=20, significant p=0.032).

Results and Discussion:

White matter pixel count (WMPC): In all three indices (FA, Prob & Disp), significant increase in restriction was found ($p<0.05$). This result is compatible with previous reports of total increase in brain volume at the age 2-4 years, and of abnormal pruning.

ROI Analysis: Increased diffusion was found in the anterior limb of the internal capsule and in the fminor but not in the fmajor areas (Figure 1). Changes in the posterior and external limb of the internal capsule and in the cortico spinal tract (at the level above the corpus callosum-slice No 3 were detected only in the left hemisphere. No significant changes were detected in all other ROIs.

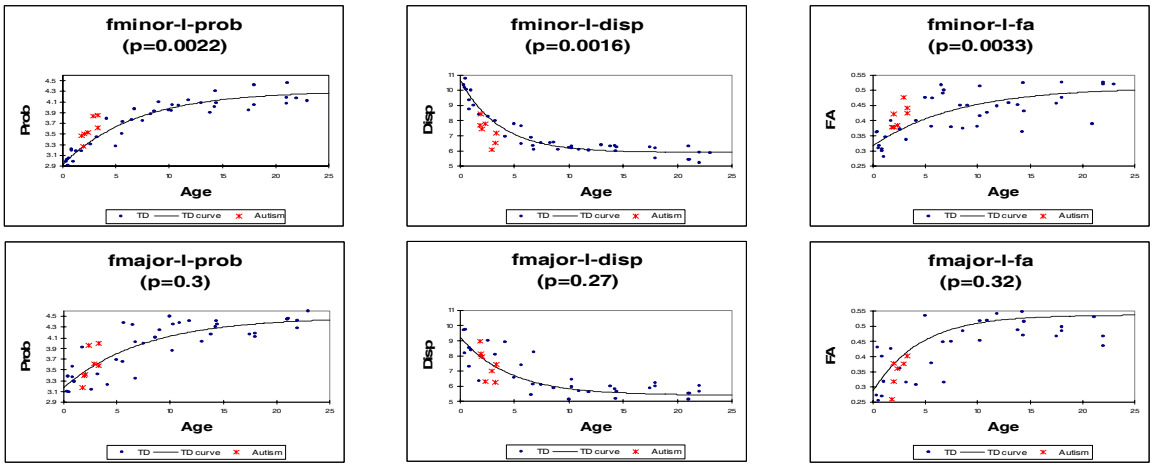

Figure 1.

Note that while our results suggest abnormal accelerated maturation in autism, as detected by increased diffusion, pilot studies of children with CP and PDD-NOS show the reverse trend of decreased diffusion and hence under-maturation. Further research is needed with additional developmental disorders to indicate potential developmental patterns.

Is early maturation unique to autism? Could these patterns distinguish autism from other developmental disorders?

References: [1]Courchesne & Pierce,*Curr Opin Neurobiol*:15, 2005; [2]Herbert *et al*, *Brain*:128, 2005; [3]Barnea-Gorali *et al, Biol Psychiatry*:55, 2004; [4]Mukherjee *et al, Radiology*:221,2001; [5]Basser, *JMRB*:111, 1996; [6]Assaf & Ben-Bashat, *MRM*:47, 2002; [7]Ben-Bashat *JMRI*:21,2005; [8] McCaffery & Deutsch, *Prog Neurobiol*:77, 2005.