On-Line Table 1: Structural MR imaging findings in autism

Author (yr)	Patients/Controls (No.)	Patient Age (yr)	Methods	Main Findings
Toal et al 2010[1]	65 (39 ASP, 26 autism)/33 HC	31 ± 10	VBM GM and WM	↓ GM volume of medial temporal, fusiform, and cerebellar regions in ASD, ↓ WM volume of brain stem and cerebellar regions in ASD, ↑ GM volume in frontal and temporal lobe regions in autism, but not in ASP
Kwon et al 2004[2]	20 ASD (9 HFA, 11 ASP)/13 HC	HFA 14 ± 3 ASP 14 ± 2	VBM GM	↓ GM density in ventromedial regions of temporal cortex in ASP and HFA in comparison with HC, ↓ GM density in ASP or combined HFA and ASP groups in right inferior temporal gyrus, entorhinal cortex, and rostral fusiform gyrus, ↓ GM density in ASP in body of cingulate gyrus in comparison with either the HC or HFA group
McAlonan et al 2008[3]	33 ASD (16 ASP, 17 HFA)/55 HC	HFA 11 ± 2 ASP 12 ± 3	VBM GM	↓ GM volumes in subcortical, posterior cingulate, and precuneus regions in HFA compared with ASP, ↓ GM volumes in predominantly frontopallidal regions in HFA compared with HC, ↓ GM volume in mainly bilateral caudate and left thalamus in ASP compared with HC
McAlonan et al 2009[4]	36 (18 HFA, 18 ASP)/54 HC	HFA 139 ± 35 ASP 134 ± 30 months	VBM WM	↑ WM volumes around basal ganglia (HFA>ASP) ↑ WM volume in left cerebellum in HFA, ↓ WM volume in left frontal lobe and corpus callosum in HFA, ↓ WM volume in right frontal lobe and corpus callosum in ASP, ↑ WM in left parietal lobe in ASP
Barnea-Goraly et al 2004[5]	7 HFA/9 HC	15 ± 3	DTI-whole brain	↓ FA in many regions including anterior cingulate cortex, ventromedial prefrontal cortex, bilateral temporoparietal junction, bilateral superior temporal sulcus, bilateral temporal lobes approaching amygdala, orbitotemporal tracts, and corpus callosum
Keller et al 2007[6]	34 HFA/31 HC	19 ± 7	DTI-whole brain	↓ FA within and near corpus callosum and right retrolenticular portion of internal capsule
Brito et al 2009[7]	8 ASD/8 HC	10 ± 1	DTI	↓ FA in anterior corpus callosum, right corticospinal tract, posterior limb of internal capsule, left superior cerebellar peduncle, bilateral middle cerebellar peduncle, left putamen
Lee et al 2007[8]	43 (38 autism, 5 PDD-NOS)/34 HC	16 ± 7	DTI	↓ FA in temporal lobe
Cheng et al 2010[9]	25 ASD (11 autism, 12 ASP, 2 PDD)/ 25 HC	14 ± 3	DTI-whole brain TBSS	↓ FA in right posterior limb of internal capsule, ↑ FA in frontal lobe, right cingulate gyrus, bilateral insula, right superior temporal gyrus, and bilateral middle cerebellar peduncle; age-related FA gain in HC compared with age-related FA loss in ASD in right paracentral lobule and bilateral superior temporal gyrus
Thakkar et al 2008[10]	12 ASD (8 autism, 2 ASP, 2 PDD)/ 14 HC	30 ± 11	DTI TIA fMRI of ACC	↓ FA in ACC ↓ activation in ACC, both correlating with low scores on cognitive test
Sundaram et al 2008[11]	50 ASD (autism, ASP, PDD)/16 HC	58 ± 29 months	DTI	↓ FA and ↑ ADC (only short fibers, not significant for long fibers) in frontal lobe
Alexander et al 2007[12]	43 ASD/34 HC	16 ± 7	DTI-tract	↓ Volume and FA in corpus callosum
Pugliese et al 2009[13]	24 ASP	23 ± 12	DTI-tract	No difference in FA and MD in extended limbic pathways, higher number of streamlines (tract volume) in bilateral cingulum and inferior longitudinal fasciculus, lower number of streamlines in right uncinate
Bloemen et al 2010[14]	13 ASP/13 HC	39 ± 10	DTI-whole-brain TBSS	↓ FA in internal capsule, frontal, parietal, temporal, and occipital lobes; cingulum; and corpus callosum
Ben Bashat et al 2007[15]	17 ASD/41 HC	1.8–3.3	DTI DWI (high b-value)	↑ FA in frontal lobe, mainly in left hemisphere, no changes in occipital lobe
Fletcher et al 2010[16]	10 HFA/10 HC	13 ± 1	DTI-tract	Loss of left>right asymmetry of FA in arcuate fascicle
Pardini et al 2009[17]	10 LFA/10 HC	20 ± 3	DTI–whole-brain and tract	↓ FA and tract volumes in orbitofrontal cortex
Catani et al 2008[18]	15 ASP/16 HC	31 ± 9	DTI-tract	↓ FA in short intracerebellar fibers and right superior cerebellar peduncle, no difference in output tracts

Note:—ACC indicates anterior cingulate cortex; ADC, apparent diffusion coefficient; ASD, autism spectrum disorders; ASP, Aperger syndrome; DTI-tract, DTI tractography; FA, fractional anisotropy; GM, gray matter; HC, healthy control; LFA, low-functioning autism; MD, mean diffusivity; PDD-NOS, pervasive developmental disorder, not otherwise specified; TIA, task-induced activation; TBSS, tract-based spatial statistics; VBM, voxel-based morphometry.

„ On-Line Table 2: fMRI findings in autism

Author (yr)	Patients/Controls (No.)	Patient Age (yr)	Methods	Main Findings
Noonan et al 2009[19]	10 HFA/10 HC	23 ± 9	TIA/conn. from 3 seed regions during source-recognition task	↑ Conn. in HFA
Kennedy et al 2006[20]	15 ASD (10 HFA, 3 ASP, 2 NOS), 14 HC	25 ± 10	Deactivation during stroop task	Failure of deactivation within DMN
Welchew et al 2005[21]	13 ASP/13 HC	31 ± 9	TIA conn. during fearful face processing	↑ Conn. of amygdala and parahippocampal gyrus
Belmonte and Yurgelun-Todd 2003[22]	6 ASD	32 ± 20	TIA during visual attention task	Altered modulation of spatial attention
Deeley et al 2007[23]	9 ASP/9 HC	34 ± 10	TIA during processing of different facial expressions	↓ Activation of fusiform and extrastriate cortex in ASP
Thakkar et al 2008[10]	12 ASD (8 autism, 2 ASP, 2 PDD)/14 HC	30 ± 11	TIA fMRI of ACC DTI	↑ Activation in ACC, ↓ FA in ACC, both correlating with low scores in cognitive test
Solomon et al 2009[24]	22 ASD (10 HFA, 12 ASP)/23 HC	15 ± 2	TIA during executive function task	↓ Activation of frontal, parietal, and occipital regions during high-control trials, ↓ conn. between left anterior prefrontal cortex and visual areas
Kennedy and Courchesne 2008[25]	13 ASD (6 HFA, 6 ASP, 1 PDD)/12 HC	27	TIA of DMN components during social and introspective tasks	↓ Activation of ACC/ventral medial prefrontal cortex
Lee et al 2009[26]	12 ASD/12 HC	10 ± 2	TIA, conn. of IFC during motor-response-inhibition task	No difference in conn. in either IFC region, just trends
Lombardo et al 2010[27]	33 ASD/33 HC	27 ± 7	TIA during self and other representation tasks	↓ VMPFC discrimination, equal activation to self, and other mentalizing (HC SM>OM) = lack of neural self-reference effect in VMPFC
Cherkassky et al 2006[28]	57 HFA/57 HC	24 ± 11	rsfMRI (between different task conditions) seed-based conn. among 12 ROIs	↓ Conn. between most of described ROI (despite similar levels of activation)
Kennedy and Courchesne 2008[29]	13 ASD (6 HFA, 6 ASP, 1 PDD)/12 HC	27	rsfMRI seed-based conn., 3 task-positive seeds, 3 task-negative seeds (MPFC, PCC, left angular gyrus)	↓ Conn. of TNN components, intact conn. of TP seeds
Weng et al 2009[30]	16 ASD (6 HFA, 2 ASP, 8 PDD-NOS)/17 HC	15 ± 1	rsfMRI seed-based conn. between PCC and other regions of DMN	↓ Conn. in 9/11 regions of DMN, correlated with poorer social skills and repetitive behavior ↑ Conn. in other DMN-regions correlated with poorer verbal or nonverbal communication
Monk et al 2009[31]	12 ASD (7 A, 2 ASP, 3 PDD)	26 ± 6	rsfMRI seed-based conn. origination from PCC	↓ Conn. between PCC superior frontal gyrus (correlated with poorer social functioning) ↑ Conn. between PCC and right temporal lobe and right parahippocampal gyrus (latter correlated with more restricted and repetitive behavior)
Paakki et al 2010[32]	28 ASD/27 HC	8	rsfMRI	Right dominant alterations of regional homogeneity in rs brain activity in ASD

Note:—ACC indicates anterior cingulate cortex; ASD, autism spectrum disorder; ASP, Asperger syndrome; Conn., connectivity; DMN, default mode network; HC, healthy control; HFA, high functioning autism; IFC, inferior frontal cortex; MPFC, medial prefrontal cortex; OM, other mentalizing; NOS, not otherwise specified; PCC, posterior cingulate cortex; PDD-NOS, pervasive developmental disorder not otherwise specified; rs, resting state; rsfMRI, resting state functional MR imaging; SM, self mentalizing; TIA, task-induced activation; TNN, task-negative network; TP, task-positive; VMPFC, ventromedial prefrontal cortex.

On-Line References

1. Toal F, Daly EM, Page L, et al. **Clinical and anatomic heterogeneity in autistic spectrum disorder: a structural MRI study.** *Psychol Med* 2010;40:1171–81. Epub 2009 Nov 6
2. Kwon H, Ow AW, Pedatella KE, et al. **Voxel-based morphometry elucidates structural neuroanatomy of high-functioning autism and Asperger syndrome.** *Dev Med Child Neurol* 2004;46:760–64
3. McAlonan GM, Suckling J, Wong N, et al. **Distinct patterns of grey matter abnormality in high-functioning autism and Asperger's syndrome.** *J Child Psychol Psychiatry* 2008;49:1287–95
4. McAlonan GM, Cheung C, Cheung V, et al. **Differential effects on white-matter systems in high-functioning autism and Asperger's syndrome.** *Psychol Med* 2009;39:1885–93
5. Barnea-Goraly N, Kwon H, Menon V, et al. **White matter structure in autism: preliminary evidence from diffusion tensor imaging.** *Biol Psychiatry* 2004;55:323–26
6. Keller TA, Kana RK, Just MA. **A developmental study of the structural integrity of white matter in autism.** *Neuroreport* 2007;18:23–27
7. Brito AR, Vasconcelos MM, Domingues RC, et al. **Diffusion tensor imaging findings in school-aged autistic children**. *J Neuroimaging* 2009;19:337–43
8. Lee JE, Bigler ED, Alexander AL, et al. **Diffusion tensor imaging of white matter in the superior temporal gyrus and temporal stem in autism.** *Neurosci Lett* 2007;424:127–32
9. Cheng Y, Chou K-H, Chen IY, et al. **Atypical development of white matter microstructure in adolescents with autism spectrum disorders.** *Neuroimage* 2010;50:873–82
10. Thakkar KN, Polli FE, Joseph RM, et al. **Response monitoring, repetitive behaviour and anterior cingulate abnormalities in autism spectrum disorders (ASD).** *Brain* 2008;131(pt 9)464–78. Epub 2008 Jun 11
11. Sundaram SK, Kumar A, Makki MI, et al. **Diffusion tensor imaging of frontal lobe in autism spectrum disorder.** *Cereb Cortex* 2008;18:2659–65
12. Alexander AL, Lee JE, Lazar M, et al. **Diffusion tensor imaging of the corpus callosum in autism.** *Neuroimage* 2007;34:61–73
13. Pugliese L, Catani M, Arneis S, et al. **The anatomy of extended limbic pathways in Asperger syndrome: a preliminary diffusion tensor imaging tractography study.** *Neuroimage* 2009;47:427–34
14. Bloemen OJ, Deeley Q, Sundram F, et al. **White matter integrity in Asperger syndrome: a preliminary diffusion tensor magnetic resonance imaging study in adults.** *Autism Res* 2010;3:203–13
15. Ben Bashat D, Kronfeld-Duenias V, Zachor DA, et al. **Accelerated maturation of white matter in young children with autism: a high b value DWI study.** *Neuroimage* 2007;37:40–47
16. Fletcher PT, Whitaker RT, Tao R, et al. **Microstructural connectivity of the arcuate fasciculus in adolescents with high-functioning autism.** *Neuroimage* 2010;51:1117–1125
17. Pardini M, Garaci FG, Bonzano L, et al. **White matter reduced streamline coherence in young men with autism and mental retardation.** *Eur J Neurol* 2009;16:1185–90
18. Catani M, Jones DK, Daly E, et al. **Altered cerebellar feedback projections in Asperger syndrome.** *Neuroimage* 2008;41:1184–91
19. Noonan SK, Haist F, Müller R-A. **Aberrant functional connectivity in autism: evidence from low-frequency BOLD signal fluctuations.** *Brain Res* 2009;1262:48–63
20. Kennedy DP, Redcay E, Courchesne E. **Failing to deactivate: resting functional abnormalities in autism.** *Proc Natl Academy Sci U S A* 2006;103:8275–80. Epub 2006 May 15
21. Welchew DE, Ashwin C, Berkouk K, et al. **Functional disconnectivity of the medial temporal lobe in Asperger's syndrome.** *Biol Psychiatry* 2005;57:991–98
22. Belmonte MK, Yurgelun-Todd DA. **Functional anatomy of impaired selective attention and compensatory processing in autism.** *Brain Res Cogn Brain Res* 2003;17:651–64
23. Deeley Q, Daly EM, Surguladze S, et al. **An event related functional magnetic resonance imaging study of facial emotion processing in Asperger syndrome.** *Biol Psychiatry* 2007;62:207–17
24. Solomon M, Ozonoff SJ, Ursu S, et al. **The neural substrates of cognitive control deficits in autism spectrum disorders.** *Neuropsychologia* 2009;47:2515–26
25. Kennedy DP, Courchesne E. **Functional abnormalities of the default network during self- and other-reflection in autism.** *Soc Cogn Affect Neurosci* 2008;3:177–90
26. Lee PS, Yerys BE, Della Rosa A, et al. **Functional connectivity of the inferior frontal cortex changes with age in children with autism spectrum disorders: a fcMRI study of response inhibition.** *Cereb Cortex* 2009;19:1787–94. Epub 2008 Dec 9
27. Lombardo MV, Chakrabarti B, Bullmore ET, et al. **Atypical neural self-representation in autism.** *Brain* 2010;133:611–24
28. Cherkassky VL, Kana RK, Keller TA, et al. **Functional connectivity in a baseline resting-state network in autism.** *Neuroreport* 2006;17:1687–90
29. Kennedy DP, Courchesne E. **The intrinsic functional organization of the brain is altered in autism.** *Neuroimage* 2008;39:1877–85
30. Weng SJ, Wiggins JL, Peltier SJ, et al. **Alterations of resting state functional connectivity in the default network in adolescents with autism spectrum disorders.** *Brain Res* 2009;1313:202–14
31. Monk CS, Peltier SJ, Wiggins JL, et al. **Abnormalities of intrinsic functional connectivity in autism spectrum disorders.** *Neuroimage* 2009;47:764–72
32. Paakki JJ, Rahko J, Long XY, et al. **Alterations in regional homogeneity of resting-state brain activity in autism spectrum disorders.** *Brain Res* 2010;1321:169–179