

Specialty Area: Multidisciplinary Neuroradiology, Part 2B (Sunday 11 May 2014)

Speaker Name: Dr. Christine Ecker

Title: WHAT IS AUTISM AND HOW IS THE BRAIN INVOLVED?

Target Audience. This talk is aimed at individuals coming from various backgrounds with an interest in autism spectrum disorders and neuroimaging. The target audience may include mental health professionals, radiologists, psychologists/psychiatrists, and neuroimaging scientists.

Objectives. Autism Spectrum Disorder (ASD) encompasses a group of life-long neurodevelopmental conditions characterized by a triad of symptoms in (1) impaired social communication, (2) social reciprocity, and (3) repetitive and stereotypic behavior ¹. The aetiology and neurobiology of ASD are complex, and there is significant clinical heterogeneity among individuals with ASD ^{2,3}. Developing biomarkers and pharmacotherapies for ASD is therefore a challenge. However, there is consensus that ASD is associated with neurodevelopmental differences in brain anatomy ⁴, connectivity ⁵ and neurochemistry (e.g. ⁶), and that these differences mediate specific autistic symptoms and traits. The purpose of this talk is therefore to introduce current concepts and insights into the neurobiological underpinnings of ASD, with particular reference to the neuroimaging literature.

Methods. The talk will review findings coming from structural Magnetic Resonance Imaging (MRI) studies including regions-of-interest approaches as well as spatially unbiased techniques (e.g. voxel-based morphometry or surface-based approaches). Moreover, we will discuss findings from Diffusion Tensor Imaging (DTI) studies that allow the investigation of differences in structural white-matter connectivity, and findings from Magnetic Resonance Spectroscopy (MRS) studies to assess differences in brain chemistry.

Results. Taken together, neuroimaging studies demonstrate that ASD is accompanied by an atypical neurodevelopmental trajectory of brain maturation. For example, structural neuroimaging studies suggest that the brain of toddlers with ASD (2–4 years of age) is, on average, larger than that of children without ASD ⁷. The overall increase in total brain volume seems to disappear by the age of 5–6 years after which no significant between-group differences in total brain volume are typically observed. Moreover, deviations from the normal trajectory of brain maturation (in terms of total brain volume) might arise even before first symptoms manifest (typically at the age of 2 years) ⁸, and may be driven by a significant increase in cortical thickness ⁹, rather than an increase expansion of the cortical surface. The atypical neurodevelopmental trajectory of brain maturation in ASD also seems to be idiosyncratic for different lobes of the brain with frontal and temporal lobes being more affected than parietal and occipital lobes ¹⁰. Thus, the normal temporal sequence of brain development (i.e. from ‘back to front’ ¹¹) seems to be disturbed in ASD, which will not only affect the development of isolated brain regions but also the way the brain is

connected. ASD has therefore also been described as a 'neural systems' condition, which is characterized by subtle and spatially distributed neuroanatomical differences in several large-scale neurocognitive networks¹². The neural systems most affected by adulthood primarily include regions that form part of the (1) fronto-thalamic-striatal system, (2) fronto-temporal circuitry, and (3) fronto-cerebellar network (see⁴ for review). There is also evidence that the brain in ASD is atypically connected in terms of its white-matter connectivity, particularly between regions mediating autistic symptoms (e.g. limbic and language pathways, fronto-striatal circuitry, and corpus callosum). Last, there is evidence coming from MRS studies suggesting that ASD is also accompanied by differences in brain chemistry and neurotransmission, particularly involving the GABA-ergic system¹³, glutamate¹⁴ and serotonin (5-HT)¹⁵.

Conclusion. Neuroimaging studies demonstrate that neurobiology of ASD is complex, implicating several neural systems and their structural and functional connections. However, neuroimaging studies have significantly contributed our understanding of the neuroanatomy and neurochemistry of the brain in ASD. These studies are therefore important first steps that could guide future investigations into establishing biomarkers and developing novel pharmacotherapies for the condition.

References

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