SESSION I: BRAIN FUNCTION & STRUCTURE

Kevin Pelphrey
June 18, 2015  //  3:00 pm EDT
Harris Professor, Yale Child Study Center, Yale University

Course Materials
The purpose of these materials is to help provide an introduction to the Summer Institute session on brain function and structure. The materials were designed to prepare trainees who are unfamiliar with brain research with the general background to get the most educational benefit from Dr. Pelphrey’s presentation. Toward this objective, we have prepared the following: (1) learning objectives for this session; (2) some key terms and concepts to become familiar with different methods of brain research; (3) some broad review articles that are recommended reading. These materials could be considered “prerequisites” in preparing for Dr. Pelphrey’s presentation.

In collaboration with Dr. Pelphrey, these materials were developed by the trainee group for this session: Aarti Nair (postdoc at UCLA; anair@mednet.ucla.edu), Gabriela Rosenblau (postdoc at Yale; gabriela.rosenblau@yale.edu), and Mark Shen (postdoc at UNC; mark_shen@med.unc.edu). Feel free to contact us with questions/comments.

Register for this course and other sessions in this series at http://sfari.org/summer
Learning Objectives
The Summer Institute for Autism Research was established in direct response to requests from early career researchers (graduate students, postdocs, etc), who asked INSAR and SFARI for greater training opportunities in multidisciplinary topics. In designing the Summer Institute, the priorities were: (1) to provide a multidisciplinary training platform for young scientists from various backgrounds; (2) allow international participation; and (3) make it freely available. Thus, the inaugural Summer Institute covers broad topics (which are geared to researchers outside the respective topic areas), is offered over a free web platform, and allows researchers from around the world to connect with the presenter. The overarching goal of the Summer Institute is to expose junior scientists to topics they are not currently engaged in, with the hope that basic scientists and clinical scientists could learn from each other to ultimately advance the understanding of autism spectrum disorders.

The current session, Brain Structure and Function, is lead by Kevin Pelphrey and a team of trainees who worked in tandem to prepare these materials and the web presentation. The learning objectives for attendees of this session include:

- To learn about the different methods that are used to study the brain structure and function of individuals with autism spectrum disorder.
- To obtain a broad overview of the current research on brain imaging studies of autism.
- To gain the requisite background in brain imaging in order to read and interpret the related literature more effectively.
- To receive a deeper understanding of the areas of brain research that are among the expertise of the presenter, Kevin Pelphrey.
- To understand the potential clinical benefit that brain research could have for individuals with autism spectrum disorder.
**Glossary of Terms / Key Concepts**

- **Structural MRI.** Structural magnetic resonance imaging (MRI) is a non-invasive technique for examining the physical structure of the brain such as the shape, size, and structural integrity of grey and white matter structures in the brain. Many structural MRI scan sequences are volumetric, meaning that measurements can be made of specific brain structures to calculate volumes of tissue, but some measurement techniques also look at thickness, or surface area of the cerebral cortex. [See Background Reading: Lainhart, 2015]

- **Functional MRI.** Functional magnetic resonance imaging, or fMRI, is a non-invasive technique for measuring brain activity by detecting changes in cerebral blood flow. Cerebral blood flow and brain activity are coupled. Increased neuronal activity in a certain brain region is associated with increased blood flow to that region. Through a process called the hemodynamic response, blood releases oxygen to neurons of that particular region at a greater rate than to neurons of another inactive region. This causes a change of the relative levels of oxygenated or deoxygenated blood, which results in detectable changes in the magnetic field. fMRI measures the signal resulting from changes in oxygenated or deoxygenated blood, which is called blood-oxygen-level dependent (BOLD) signal. [See Background Reading: Dichter, 2012]

- **Diffusion Tensor Imaging.** DTI is a type of MRI scan that measures the movement (or diffusion) of water molecules in the brain. Water molecules move in a coherent direction (anisotropic diffusion) when physically constrained in brain tissue such as along white matter (WM) tracts. In contrast, water molecules move in a more random way (isotropic diffusion) when unconstrained in tissue (such as in cerebrospinal fluid or in grey matter). The extent of anisotropic diffusion in WM can be quantitatively measured, with values that indicate a more coherent and well-organized WM tract. These diffusion values can then be compared between different WM tracts, ages in development, or groups of individuals (e.g., children with ASD vs. typical development). [See Background Reading: Ameis & Catani, 2015]

- **EEG/ERP.** Electroencephalography (EEG) refers to the recording of intrinsic electrical activity in the brain, based on the propagation of electric impulses along a nerve fiber when the neuron fires. EEG is typically analyzed in frequency bands that correspond to different mental states (e.g., alpha-frequency of 8-13 Hz associated with a relaxed mental state). By recording small potential changes in the EEG signal immediately after the presentation of a sensory stimulus, it is possible to record specific brain responses that are time-locked to cognitive events. This method is called Event-Related Potentials (ERPs), and is one of the widely used methods for the investigation of cognitive processes. [See Background Reading: Jeste & Nelson, 2009]

- **Histological studies of postmortem brain tissue.** The above techniques are used to assess in vivo brain structure and function in humans, but because of the relatively coarse spatial resolution of MRI and EEG (~1 mm or greater), these methods cannot directly elucidate microscopic brain pathology at the cellular and molecular level. Analyses of postmortem brain tissue fills this gap. Brain tissue is obtained through donation, quickly removed after death, and prepared in various ways to maintain its cellular integrity. Histological studies can analyze the microscopic anatomy, such as quantifying the number of neurons, length of dendritic processes, or characterizing synapses and axons. Molecular studies can measure the level of proteins, neurotransmitter receptors, or genes expressed in particular brain regions. Thus, analyses of postmortem brain tissue can evaluate neuropathology on multiple levels (from cellular characteristics to gene expression), within an individual, or compared between groups of people. [See Background Reading: Schumann & Nordahl, 2009]
Recommended Background Reading


Get Engaged

Continue the conversation and connect with peers currently working or interested in autism.

- Join the private autism research Facebook discuss group: http://on.fb.me/1yWVOoO
- Contact the INSAR Student & Trainee Committee: studentcommittee@autism-insar.org