YOUR BRAIN

NEUROSCIENCE AND SOCIETY

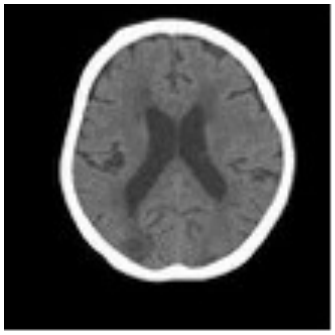
NON-INVASIVE IMAGING METHODS

Student Guide for 'Choosing the Right Methods'

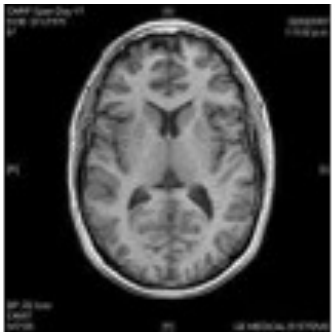
Introduction:

This guide provides a quick overview of the main non-invasive methods that neuroscientists use to image or collect data from the active human brain. Each method has its strengths and weaknesses; no single method is ideal for all situations or for all research questions.

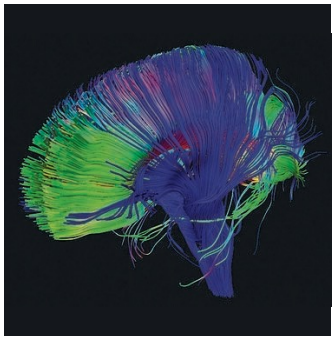
Methods for Imaging Brain Structure



CT Imaging - Computed tomography is much like a fancy X-ray. Digital X-ray detectors gather the waves that bounce off body tissue to form an image of whatever is being scanned. This method is very good at detecting areas of damage, such as a tumor, broken bone, or an area of dead tissue, but does not distinguish between different brain structures or gray and white matter within the brain.



MRI - Magnetic resonance imaging uses a strong magnetic field and radio waves to generate detailed images of the body's internal structure based on how much energy is given off by whatever is being scanned. Since white matter, gray matter, bone, fluid, and skin are all different densities, they each give off a slightly different amount and pattern of energy. Therefore, MRI is a very good method for seeing details of specific brain structure and telling white matter from gray matter, producing sharp and precise images.



DTI - Diffusion tensor imaging is a special form of MRI that is specifically useful to take pictures of long extended tracts of white matter. DTI tracks the movement of water molecules within brain tissue and uses this to figure out the orientation, direction (meaning which way action potentials will move down these axons), and overall organization of bundles of white matter.

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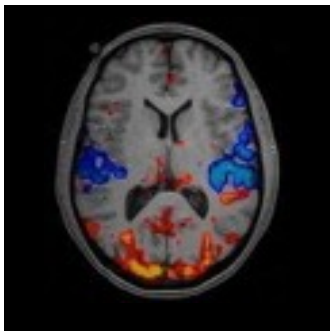
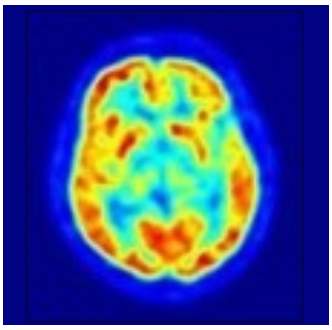
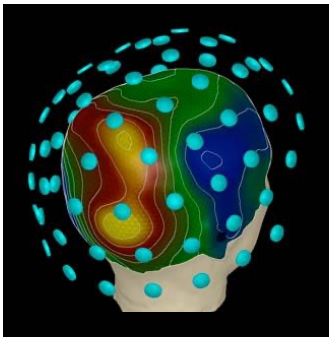
Methods for Imaging Brain Function



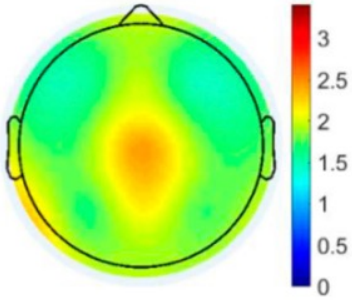
Functional Magnetic Resonance Imaging (fMRI) - fMRI is similar to regular MRI. It relies on the fact that when a particular region of the brain becomes more active, there is an increase in blood flow and oxygen to that specific area. By comparing the images taken during different tasks or conditions, we can identify which regions of the brain are activated or deactivated at a specific time. This technique takes fairly crisp and precise images of the brain but is somewhat slow, as it is only able to take a new picture of the brain's activity every 2 seconds, during which the brain could do many different things.



Positron Emission Tomography (PET) - After a person is injected with a radioactively labeled tracer molecule similar to glucose, oxygen, or a neurotransmitter, a PET scan can follow the uptake and use of the tracer by different brain regions, showing which brain regions are the most active in a similar way to fMRI. PET scans are very useful as they can track many types of radioactive molecules, but the pictures are not as crisp as an MRI or fMRI. PET imaging is also very slow, only taking a new picture every 30 seconds or more.



Magnetoencephalography (MEG) - MEG measures the magnetic fields generated by the electrical activity of the brain. This newer technique is a more direct way to see where activity is occurring in the brain, instead of fMRI or PET which must look indirectly at blood flow. MEG can take new pictures of brain activity very quickly, every few milliseconds, but it can only sense neural activity just underneath the scalp, so is only useful for looking at certain regions of the brain, like the cerebral cortex.



Electroencephalography (EEG) - EEG is a method that directly measures and records the electrical activity of the brain. This method measures brain activity very rapidly, in less than a millisecond, giving high quality information about when that activity occurs. However, this method is not very accurate about where neural activity is occurring in the brain. Much like MEG, it is only useful for the surface regions of the brain.

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