METHODS OF INVESTIGATING BRAIN:NEURO IMAGING TECHNIQUES

Course: Neuropsychology CC-6 (M.A PSYCHOLOGY SEM II); Unit I

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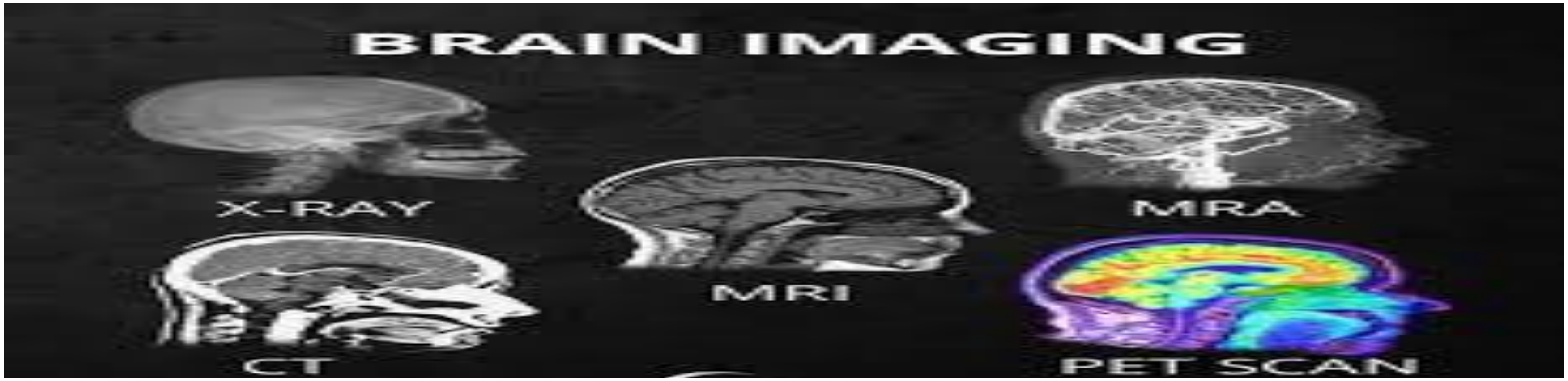
NEURO IMAGING TECHNIQUES

Neuroimaging methodology allow measurement of the structure, function, and chemistry of the living human brain. Over the past decade, studies using these methods have provided new information about the pathophysiology of psychiatric disorders that may prove to be useful for diagnosing illness and for developing new treatment.

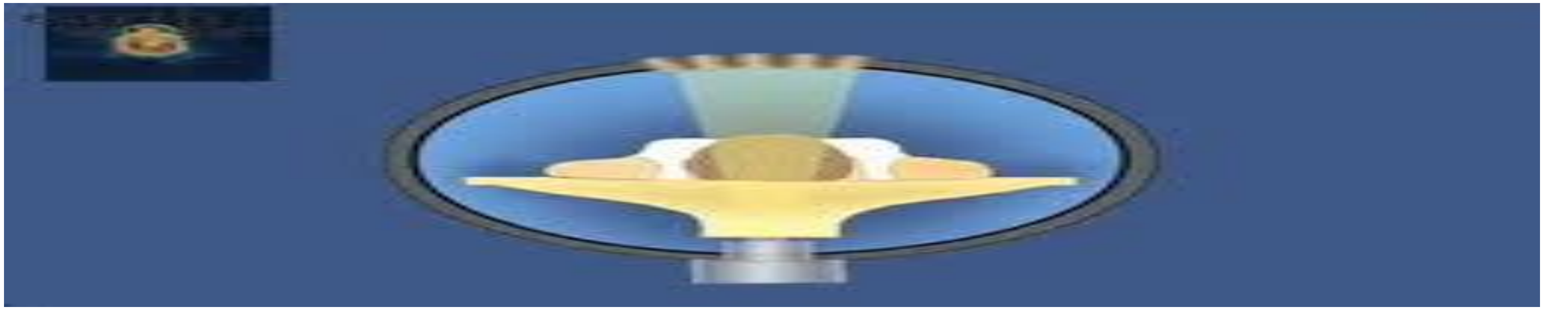
Several new techniques have been devised with which the brain can be imaged by the use of sophisticated computer technology. These include

- **Computerized transaxial tomography,**
- **Position emission tomography,**
- **Single-photon emission computed tomography,**
- **Magnetic Resonance Imaging**
- **Functional Magnetic Resonance Imaging**

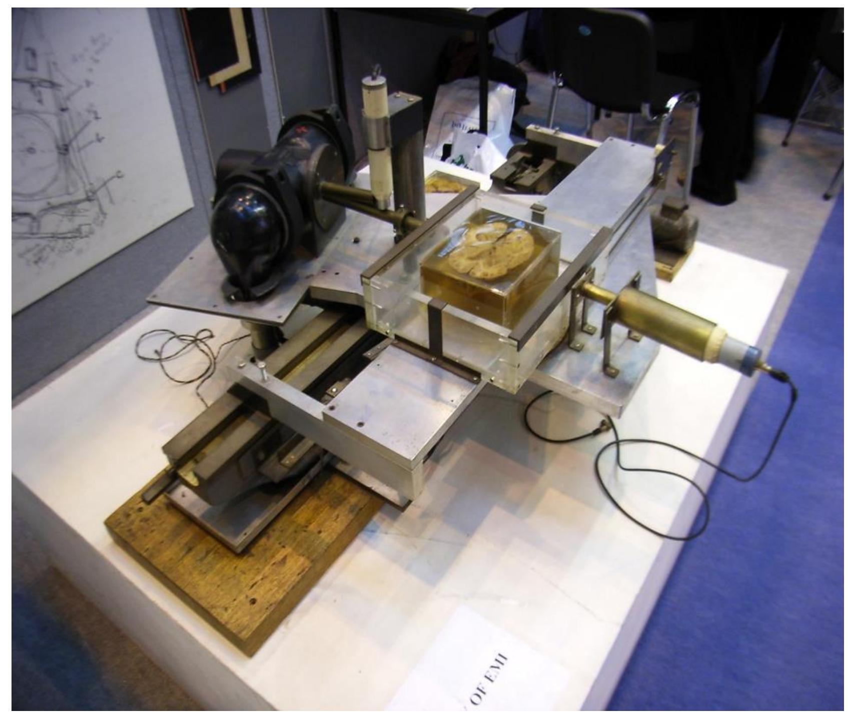


Computerized Transaxial Tomography (CT Scan).

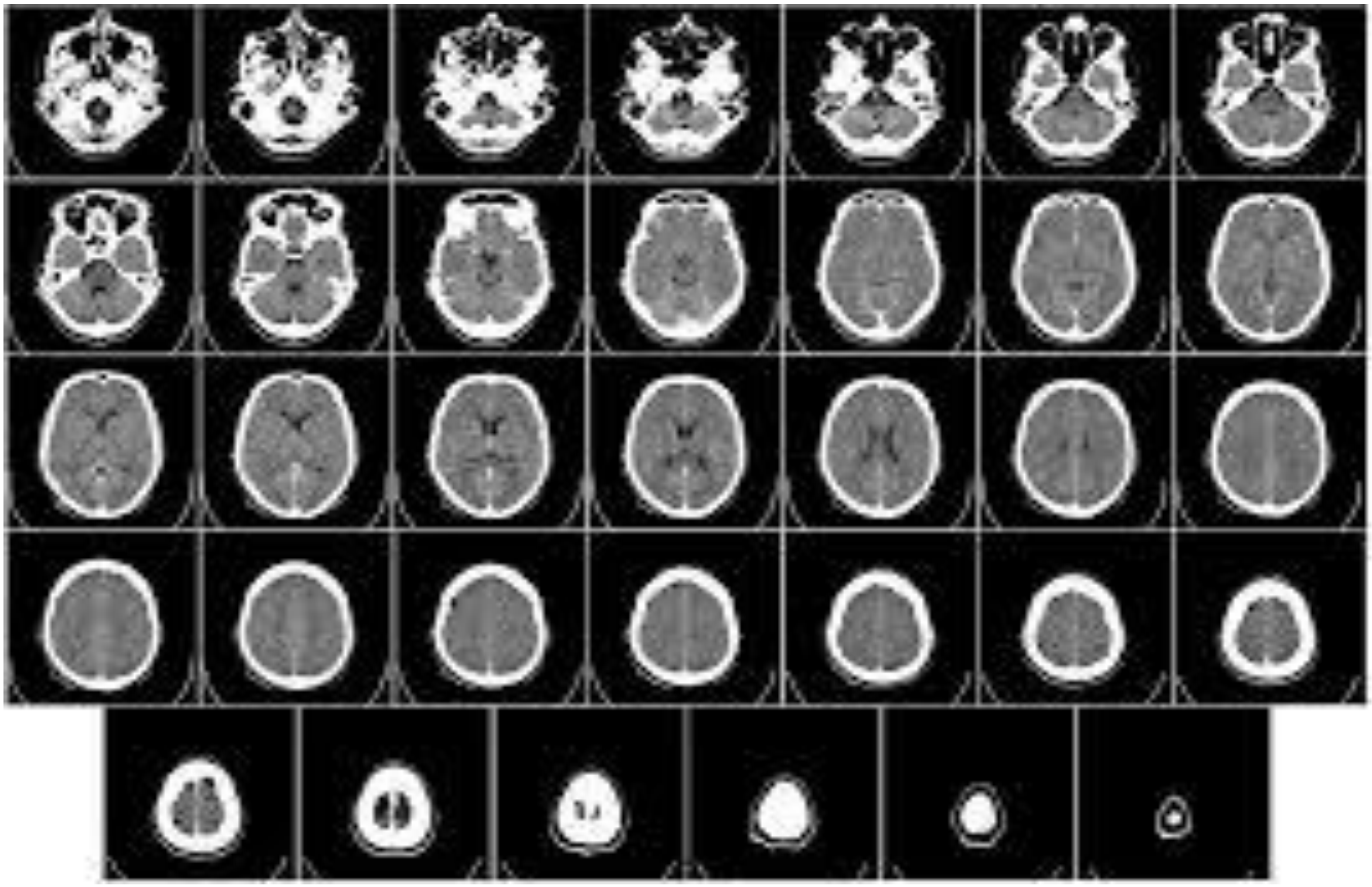
With conventional X rays the two-dimentional projections of a three-dimentional body appear on the X ray films as overlapping structures that are difficult to distinguish from one another, the computerized transaxial tomograph, or CT, scan, on the other hand, provides a three-dimensional representation of the brain. Briefly, the technique is as follows. A narrow beam of X rays is passed from one side of the head and the amount of radiation not absorbed by the intervening tissue is absorbed by radiation detectors. The X ray tube is moved laterally across the patient's head and the amount of radiation detected is recorded at 160 equally spaced positions. These data are stored in computer. The X ray beam is then rotated 1 degree and the procedure is repeated. In all, the beam is rotated through 180 degree. When all the projections are completed, the resulting X ray sums (160*180) are processed by the computer. A reconstruction of the patient's head in cross section is then printed out by the computer. Ordinarily, eight or so cross sections are printed out, each corresponding to a different plane through the head. The CT scan thus allows a simple, noninvasive examination of the patient's brain in about 25 min.



The CT scanner is an expensive apparatus, but it has become an indispensable tool in neurology because of its greater safety, speed, and accuracy compared with other X-ray techniques. Its greater potential lies in locating tumors, assessing vascular accidents and head injuries, and in locating a variety of intracranial lesions or brain atrophy. In fact, neurologists have become so dependent on the CT scan that it is nearly impossible to attract neurologists to communities that do not have a CT scanner. As valuable as this machine is, however, it is not perfect, and cannot identify many neurological abnormalities, such as epilepsy.



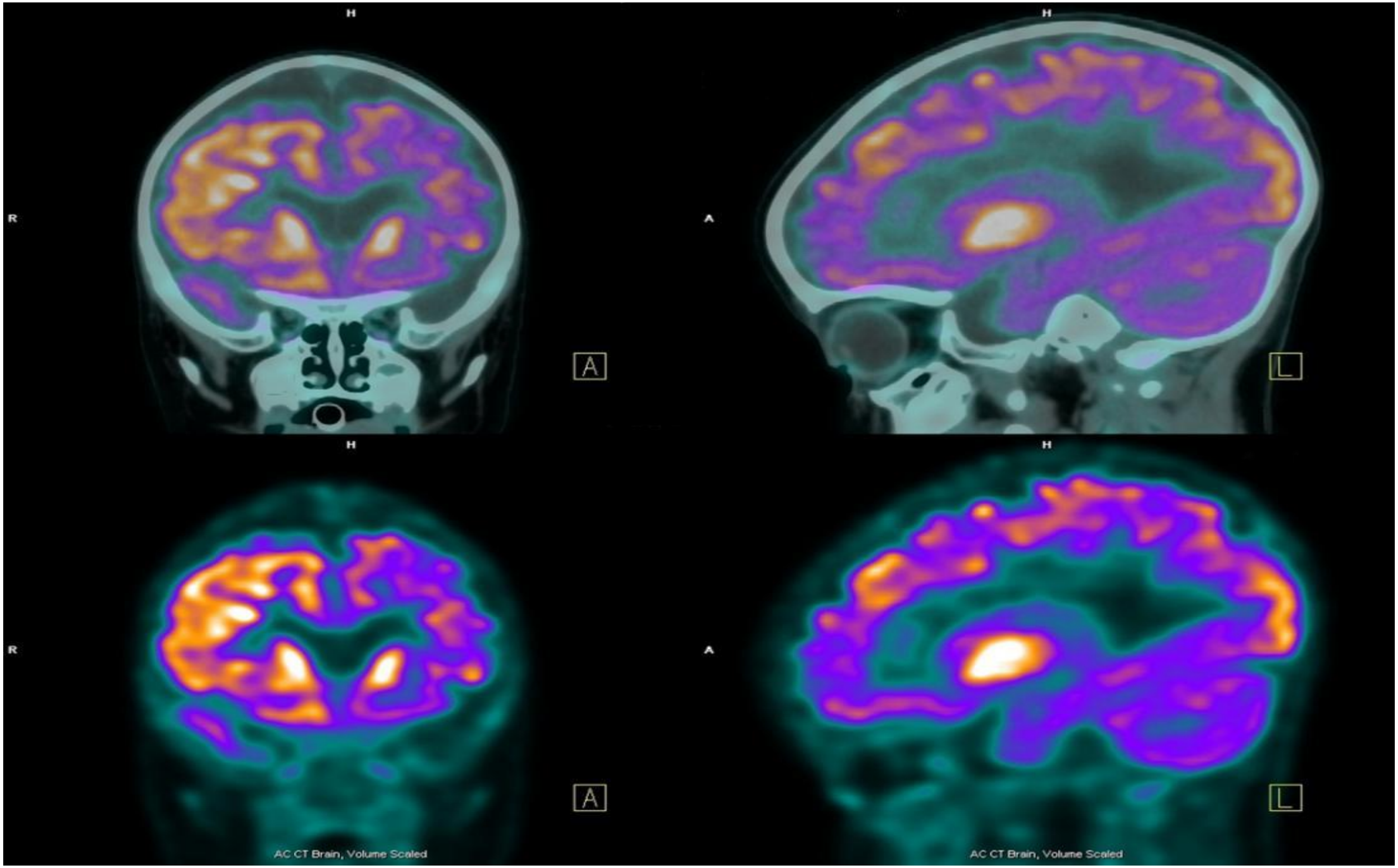
Computerized Transaxial Tomography (CT Scan)



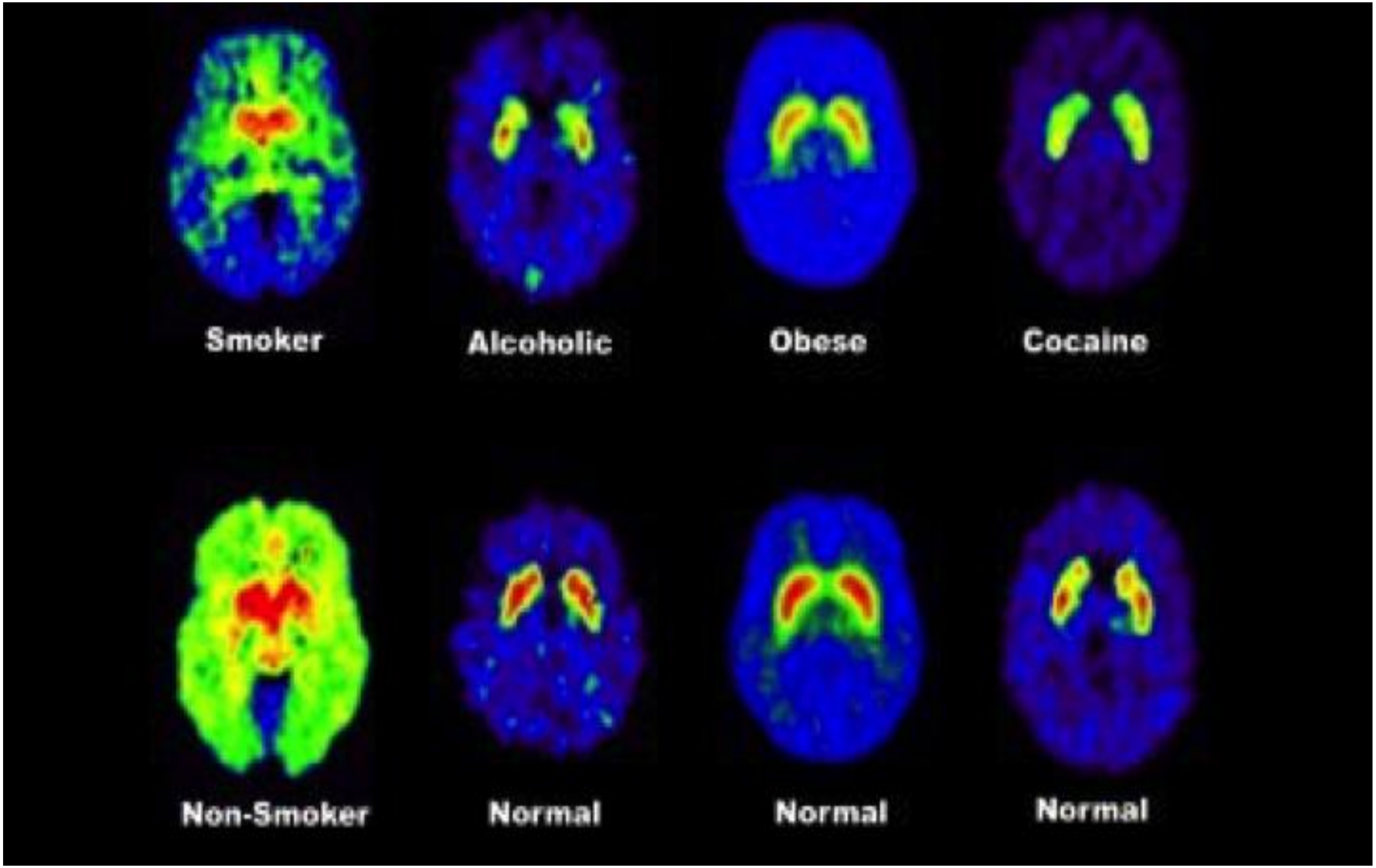
POSITION EMISSION TOMOGRAPHY (PET)

Position emission tomography (PET) is a visual technique in which the subject is given glucose, which is radioactively labeled form of glucose, which is metabolized by the brain, and the radioactivity is later recorded by a special detector. Unlike the CT scan, a PET scan measures the metabolic activity of different brain regions, the idea being that the most active areas at any given time will use more glucose and hence the radioactivity will be more concentrated there.

POSITION EMISSION TOMOGRAPHY (PET)



POSITION EMISSION TOMOGRAPHY (PET)



POSITION EMISSION TOMOGRAPHY (PET)

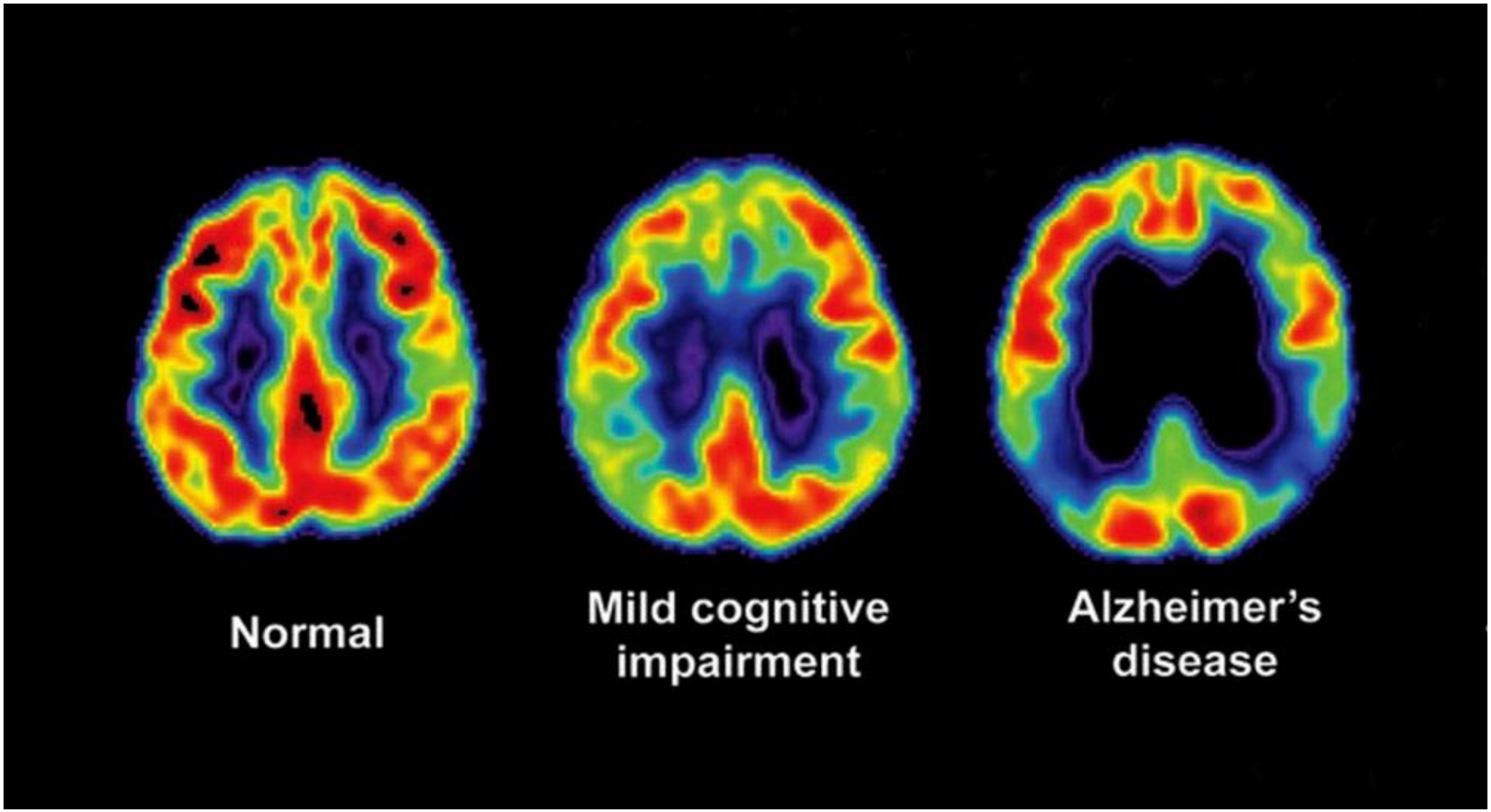
A positron emission tomography (PET) scan is an imaging test that helps reveal how tissues and organs are functioning. A PET scan uses a radioactive drug (tracer) to show this activity. This scan can sometimes detect disease before it shows up on other imaging tests.

The tracer may be injected, swallowed or inhaled, depending on which organ or tissue is being studied. The tracer collects in areas of your body that have higher levels of chemical activity, which often correspond to areas of disease. On a PET scan, these areas show up as bright spots.

A PET scan is useful in revealing or evaluating several conditions, including many cancers, heart disease and brain disorders. Often, PET images are combined with CT or MRI scans to create special views.

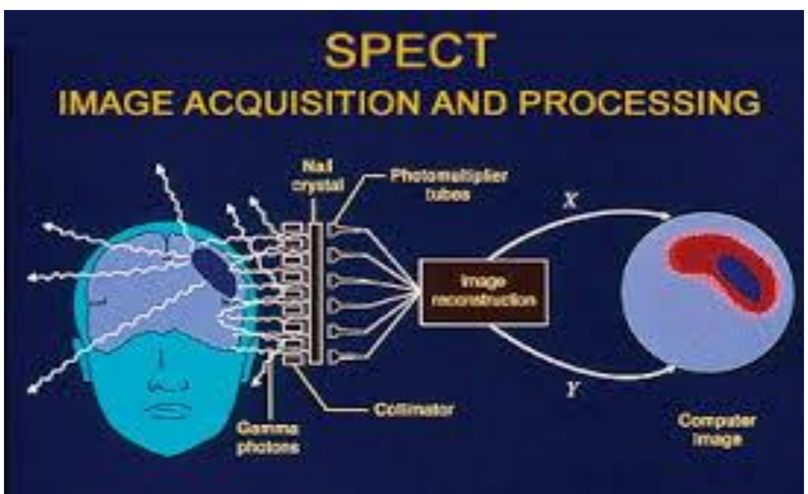
PET scans can be used to evaluate certain brain disorders, such as tumours, Alzheimer's disease and seizures.

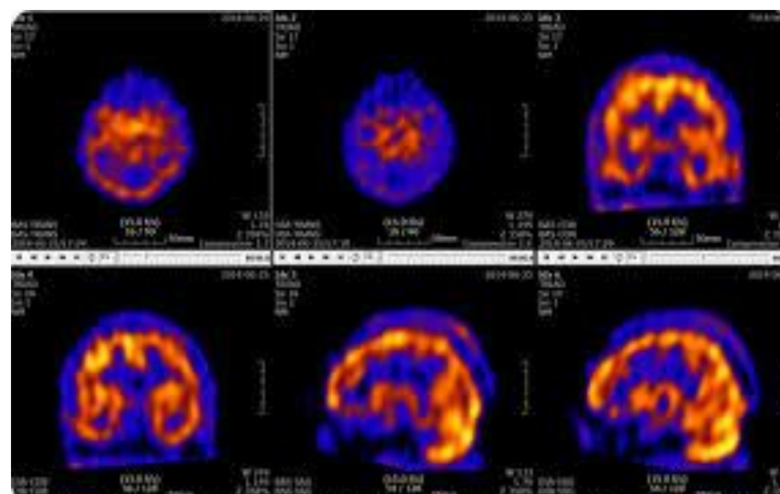
How long does a PET scan take? After the radiotracer is injected into a vein, it usually takes up to one hour to travel throughout the body and be absorbed into the organs or tissues that are being examined. The **PET scan** itself may **take** another 30 to 60 minutes. Heart and brain studies **take** less time for imaging.



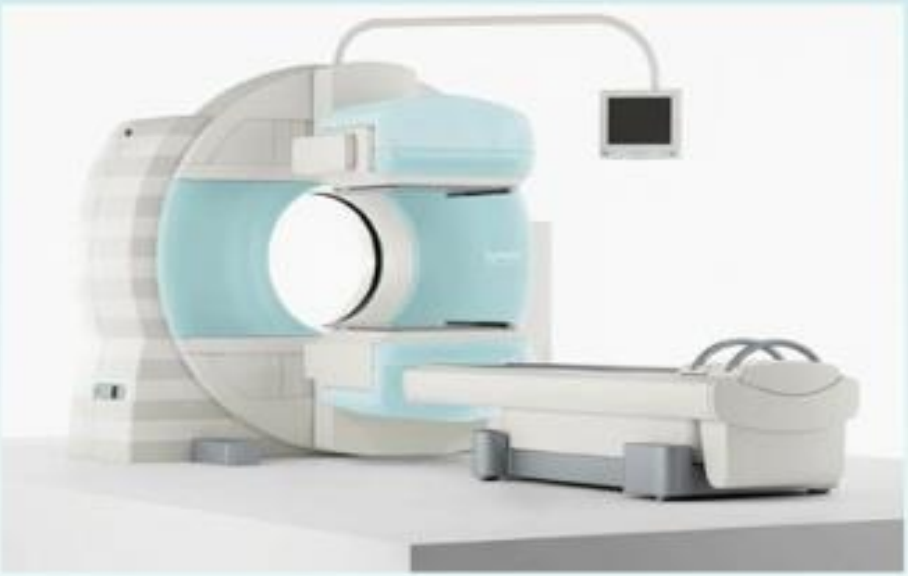
SINGLE –PHOTON EMISSION COMPUTED TOMOGRAPHY (SPECT)

Single photon emission tomography (SPECT) is a scanning technique that uses the technology of CT scan reconstruction, but instead of detecting X rays the machine detects single photons that are emitted from some externally administered tracer. It differs from PET in that the tracer emits a single photon, which is then detected by the machine. The PET scan takes advantage of coincident positrons to localize the source. However, if there was only one photon then the machine could not localize by coincidence. Localization can only occur with the detection of numerous particle collisions. This makes the resolution of SPECT much less than PET, but there are several advantages to SPECT. IN particular, it is possible to use commercially available tracers so a cyclotron (atomic accelerator) is not required. This makes SPECT much less expensive allowing smaller hospitals to obtain a SPECT machine where the cost of PET would be prohibitive.





Picture of SPECT system

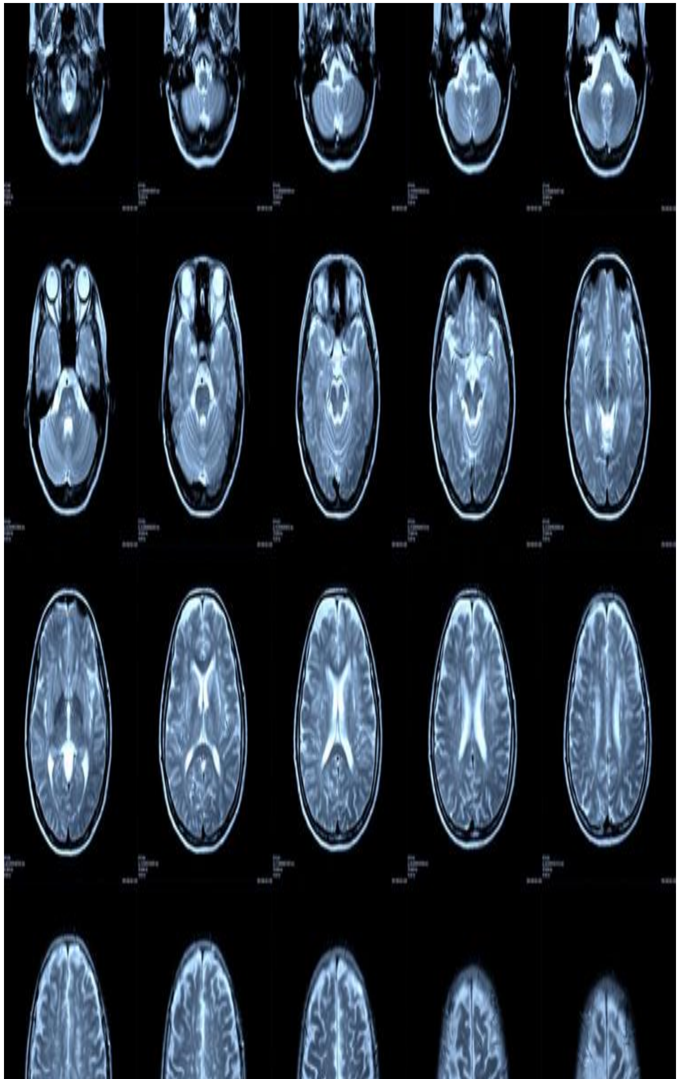


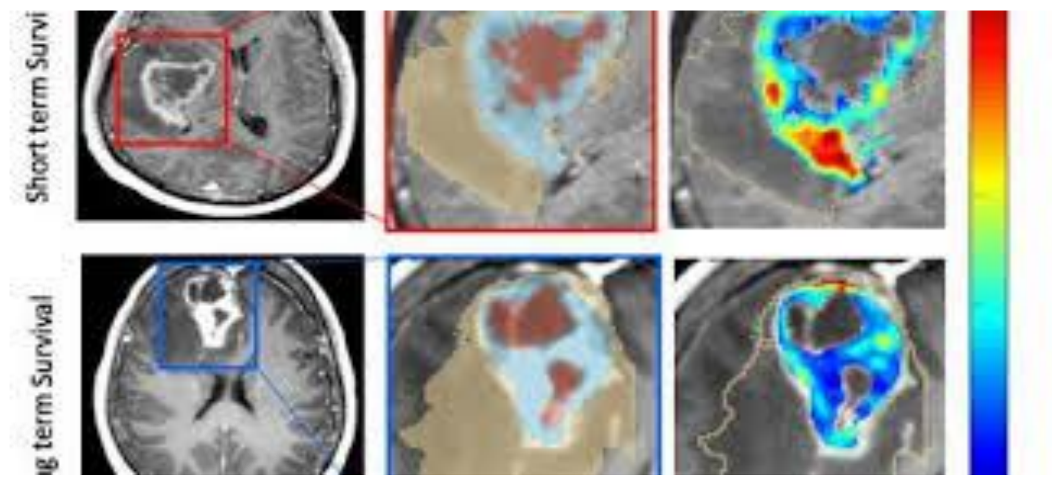
It looks like a CT or MRI system but hardware is different.

MAGNETIC RESONANCE IMAGING (MRI)

Magnetic resonance imaging (MRI), which is also known as nuclear (NMR), is based on the principle that certain atoms such as hydrogen, behave like tiny spinning magnets. Normally, atoms are pointed randomly in different directions, but when they are placed in a magnetic field, they line up in parallel as they placed a magnetic field, they line up in parallel as they orient themselves with respect to the field's lines up force.

MAGNETIC RESONANCE IMAGING (MRI)

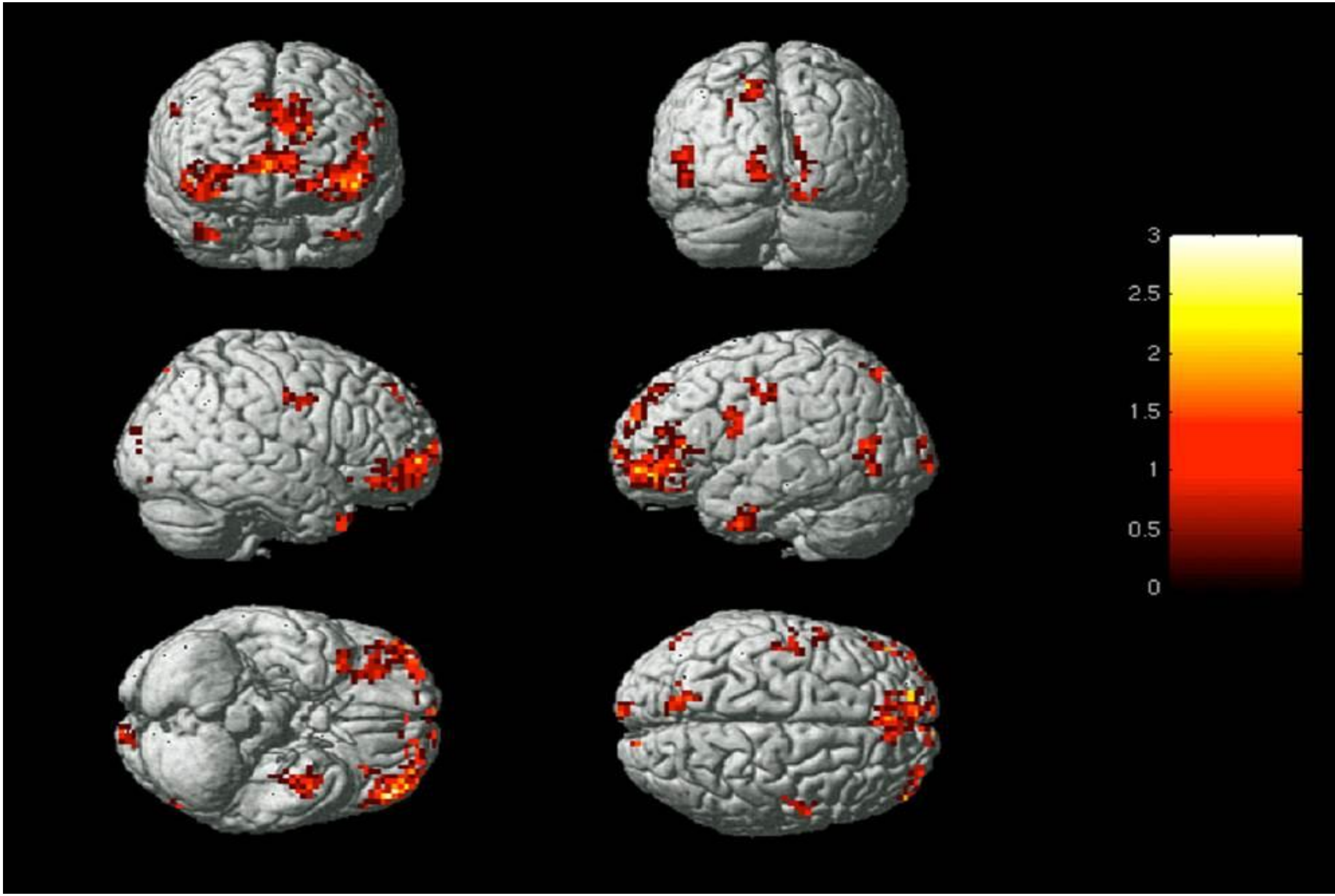




Functional Magnetic Resonance Imaging (fMRI)

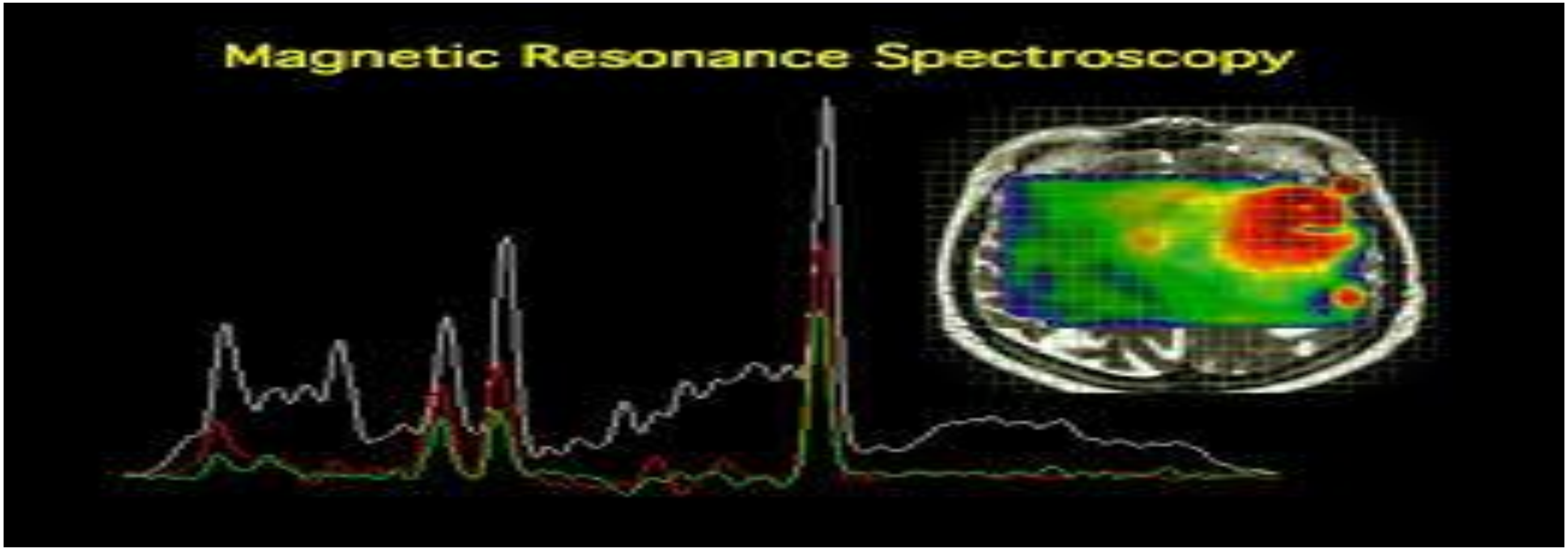
Functional magnetic resonance imaging or **functional MRI** (**fMRI**) measures brain activity by detecting changes associated with blood flow. This technique relies on the fact that cerebral blood flow and neuronal activation are coupled. When an area of the brain is in use, blood flow to that region also increases.

Functional Magnetic Resonance Imaging (fMRI)



Magnetic Resonance Spectroscopy (MRS)

Whereas routine MRI detects hydrogen nuclei to determine brain structure, MRS can detect several odd-numbered nuclei. The ability of MRS to detect a wide range of biologically important nuclei permits the use of the technique to study many metabolic processes. Although the resolution and sensitivity of MRS machines are poor compared with those of currently available PET and SPECT devices, the use of stronger magnetic fields will improve this feature to some extent in the future.



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