IMAGES OF THE MIND

Images of the brain, created by powerful magnetic resonance scanners, are at face value both spectacular and intriguing. These images allow us to study two very different aspects of the brain: the structure of the brain and the function of the brain. Functional imaging can detect the small changes that occur in the brain when we think, for example, of words beginning with a specific letter. This process is analogous to a video recording of a dark room in which a table lamp is switched on and off; likewise in the brain image we obtain a 'lighting-up' of the area that controls a particular thought. These images infrequently enter the public arena, perhaps because it is not possible to grasp their scientific meaning nor see the exciting concepts behind the images as there is a lack of understanding of how they are created. The images contained in this project are not just an abstract colourful representation of the brain, but ought to be viewed with an understanding of the forces necessary to create them and also of the thought processes of the mind within them. What follows is a brief description of the brain and the way in which these images are created, in order to realise fully the potential behind them.

The brain contains about 1000 billion neurons (brain cells), each of which has the potential to communicate with numerous others, creating a complex network of connections. It is these connections and the ability to change them that enable us to think, dream, laugh or cry. The basic structure of the brain does not vary between people; it is the subtle changes in the connections or pathways that make us individual. The brain works by opening these pathways to create an area of functional activity, which in turn may create changes of bodily function. If we are able to localise the functions of the brain to a particular area, whether this be a motor function such as a hand movement, or an emotion such as aggression, then we may be able to interact with this function.

Early attempts to localise function came in the eighteenth century, when the practice of phrenology suggested that you could describe characteristics of a person by palpating the irregular features on the surface of the skull, each area of the surface being associated with different attributes; not surprisingly this science fell into disrepute. More recently several approaches have been adopted in understanding the mind brain interaction: Cartesian dualism, behaviourism, reductive materialism and functionalism. This project deals with the structural and functional localisation of areas of the brain using a technique known as Magnetic Resonance Imaging (MRI) which comes closest to the classification of reductive materialism.

To understand the concepts of this technology a brief description of the equipment and its workings follows. The magnetic resonance scanner looks like a huge 'polo mint', 2 metres in diameter standing upright with a hole in the centre wide enough for a body to fit inside. This 'polo mint' is a large superconducting electromagnet. The body consists of 70% water, each water molecule containing two hydrogen atoms, both of which have a nucleus which consists of a positively charged proton. These protons possess the ability to spin, similar to the Earth around its axis, each with its own axis of tilt. When placed in a magnetic field, these protons behave like a compass and tend to align in the direction of the field. The protons can be knocked away from their direction by means of a radio wave directed into the patient. The radio wave is only sent for a very short time, after which the protons that have been knocked can be detected via an aerial or antenna around the patient. I have mentioned that the protons are in the water and that the water molecules are distributed throughout the body. The area of the body that the water occupies dictates what type of signal we receive. For example, if the water is in a tissue such as muscle we will receive a different amount of signal than if it were in a fluid. These characteristic signals, which depend on the environment of the water, allow us to distinguish between different areas of the brain. The final image provides us with a pattern of subtle variations in the distribution or properties of water, leading to high quality structural and spatial information of the brain.

The imaging of brain function requires a different MRI technique, which relies on a natural change in blood flow to the area of brain that is being used. Oxygen arrives in the brain via arteries, and leaves via veins which at rest contain a particular oxygen concentration. When an area of the brain starts to work (such as to control a hand movement) the local metabolic demand for oxygen increases, and the blood flow increases to accommodate this. The increase in venous or capillary oxygen increases the signal received in the MR image from the area of functional activity. To create the functional image, one image is acquired with the brain at rest and another in the activated state, the images are subtracted and the region that is different between the two images is the area of the brain associated with that particular function. It is this type of imaging that has generated interest in the field of neuroscience during the past 5 years, opening the doors to a greater understanding of the relationship between the human mind and the brain.

Another technique called Positron Emission Tomography (PET), which involves the administration of a radioactive pharmaceutical, also images brain function. Currently PET aids our understanding and care of patients who have problems ranging from mood and depressive disorders to functional reorganisation following a stroke. These novel technologies provide the opportunity to study such mental activities as perception, motor control, attention, memory and emotion.

In the clinical setting, MRI has been put to excellent use in understanding brain abnormality in epileptic children. Structural MRI combined with other investigations localise the area of abnormality in the brain initiating the fit, and if the patient cannot be treated by any other means, the area may be removed during surgery, with great success for the child. Functional imaging guides neurosurgeons in the removal of brain tumours, allowing them to determine the outcome for patients following the surgery. Clearly MRI is a powerful tool which offers a non-invasive image of both the brain and mind, and its clinical relevance cannot be understated at this moment in time.

In the future, greater localisation will identify more subtle changes in the mind; there could possibly be a day when the whole brain is mapped and all brain function understood. Definitions of 'normality' may become based on the functional brain and an individual's singularity revealed in a single image.

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