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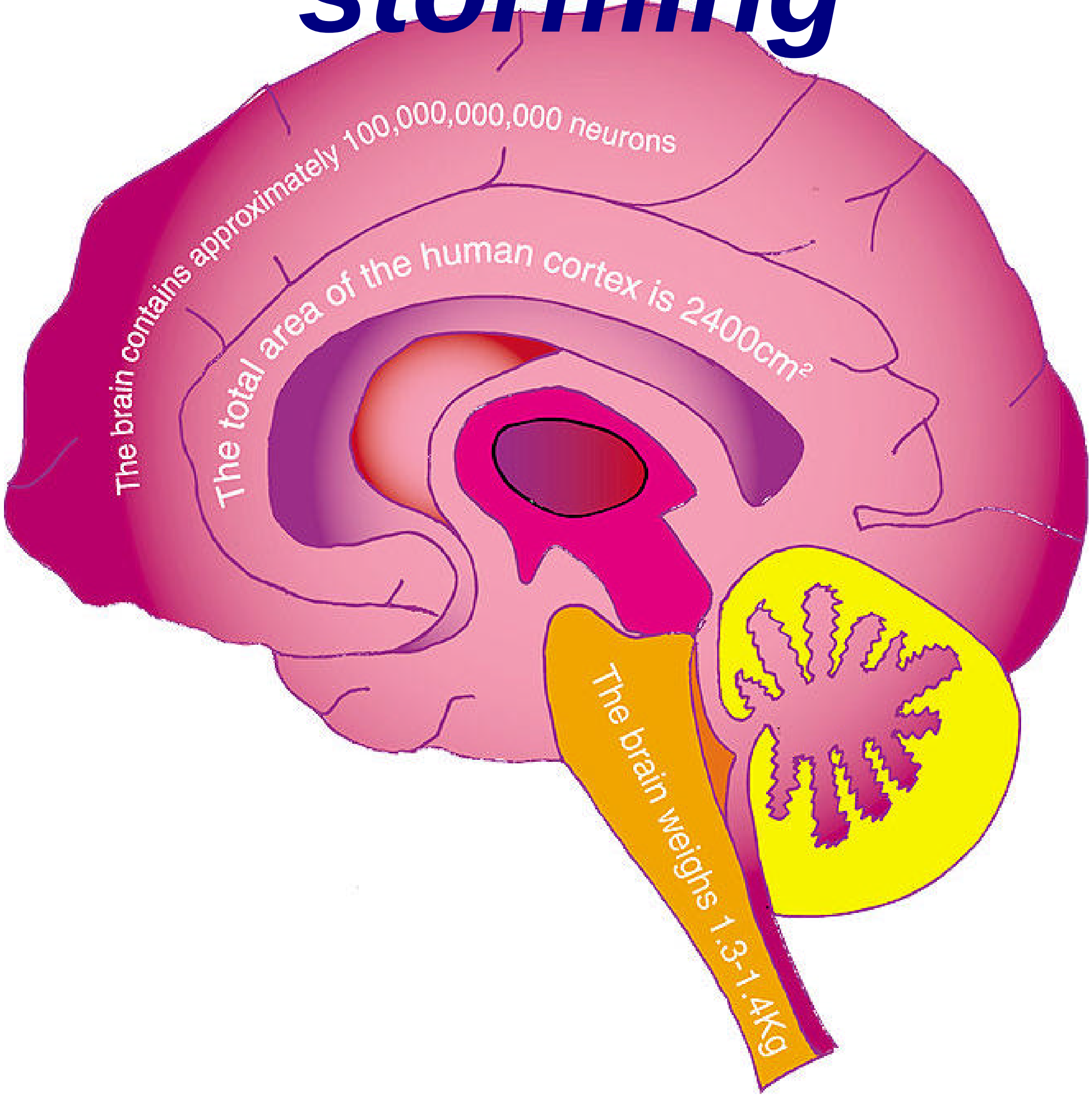
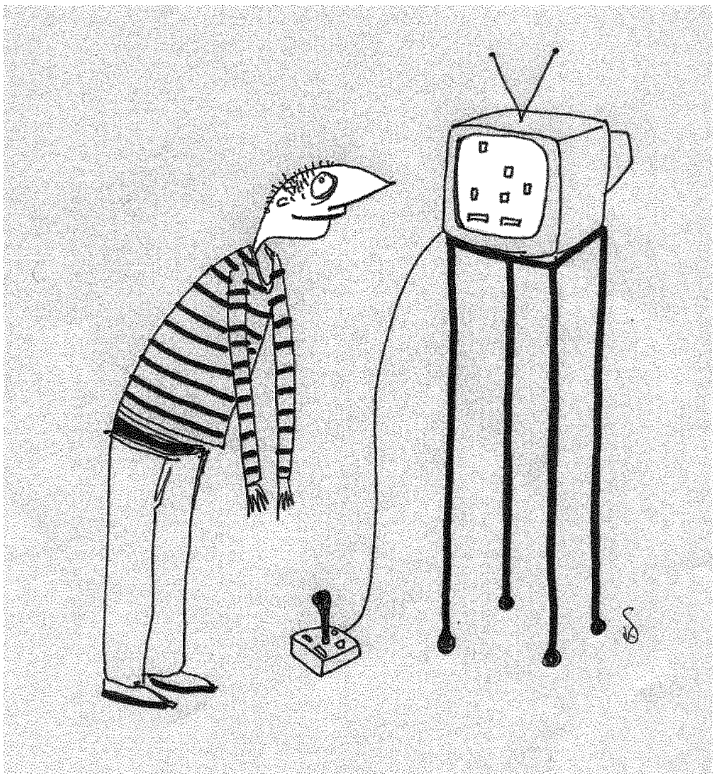
BRAIN *storming*



The 1990's was hailed as the decade of the brain. We ask, what do we really know about the elusive workings of the grey matter that we call the brain? Neuroscientists study the nervous system and the brain and how it can give rise to our thoughts and behaviour. They examine how the brain works and develops and what goes wrong in neurological diseases such as Parkinson's disease and Alzheimer's disease.

BRAIN CELLS

There are approximately 100 billion star shaped neurons in the brain and trillions of glial cells which are like glue and support the neurons. Signals arrive at the dendrites and then travel as electrical impulses along the cell. The long tail or axon is insulated by a fatty myelin sheath - impulses can travel along them as fast as 120 metres per second - that's as much as the length of a football pitch in one second! At the end of the axon, the electrical message is converted into a chemical message - chemical neurotransmitters are released in tiny packages into the gap (or synapse) between the end of one neuron and the start of the next. The neurotransmitters cross the synapse and fit into special receptors on the next cell and the signal is passed on. A "typical" neuron has between 1,000 and 10,000 synapses or connections - with 100 billion of them imagine the complexity!



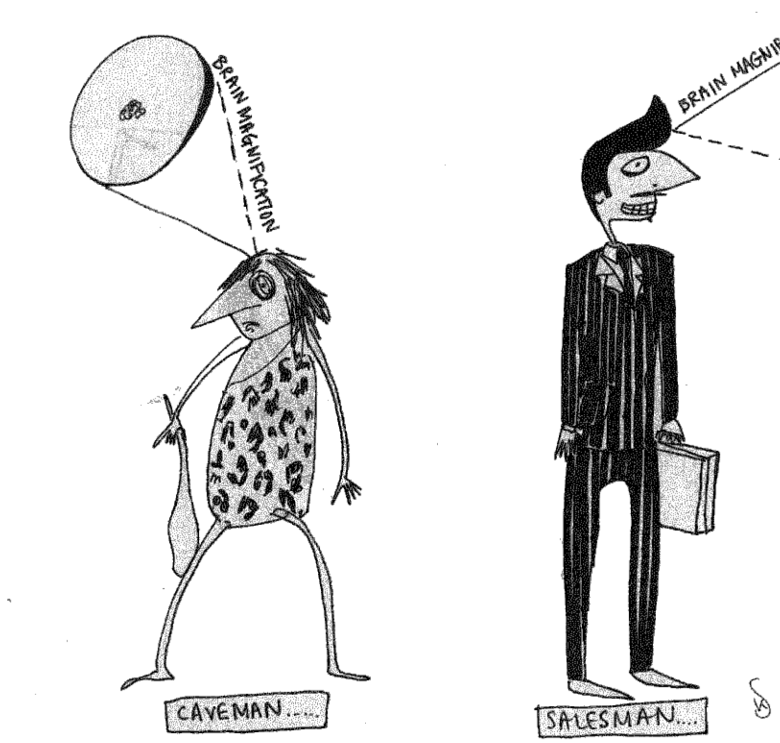
Adolescents may behave the way they do because their brains are not yet mature.

GROWING BRAINS

Although the basics of our brain circuitry are specified by our genes, our brain organisation is highly affected by our environment. Even identical twins, with exactly the same genes, have different brains by the time they are born because of their different experiences within the womb. During the first year of life, half of a baby's neurons die as their brain pathways and circuits take shape. Throughout childhood, unnecessary neurons continue to be pruned and the connections between the remaining neurons are fine-tuned. The brains of young children are highly adaptable compared to adults. If half of a child's brain is removed, the remaining half may take over the functions that would have been performed by the other half - this is called cortical plasticity. If an adult underwent the same operation, they would be severely disabled. Similarly, it is much easier for a young child to learn to speak a new language than for a middle aged person.

USE IT OR LOSE IT

The importance of a child's environment on their emerging brain organisation has led to many over-zealous parents frantically taking their children to zoos and museums to make sure that they are stimulated enough. Most of this stems from work with rats, which has shown that rats with "enriched" environments have more synaptic connections between their neurons. But this 'use it or lose it' mentality may be an exaggeration - a normal level of entertainment is probably quite enough to stimulate a young child's brain. Although adults brains are less flexible, experience can still change neuronal connections. It has also been shown that mental stimulation increases and stress decreases the survival and growth of brain cells. Physical exercise also appears to help. So, should we all be doing brain exercises to form the right neuronal connections and to help our brain cells survive? Before you start doing your daily half hour routine of algebra, normal levels of stimulation may be enough, but it's still a good excuse to turn off the TV once in a while and use your brain actively!



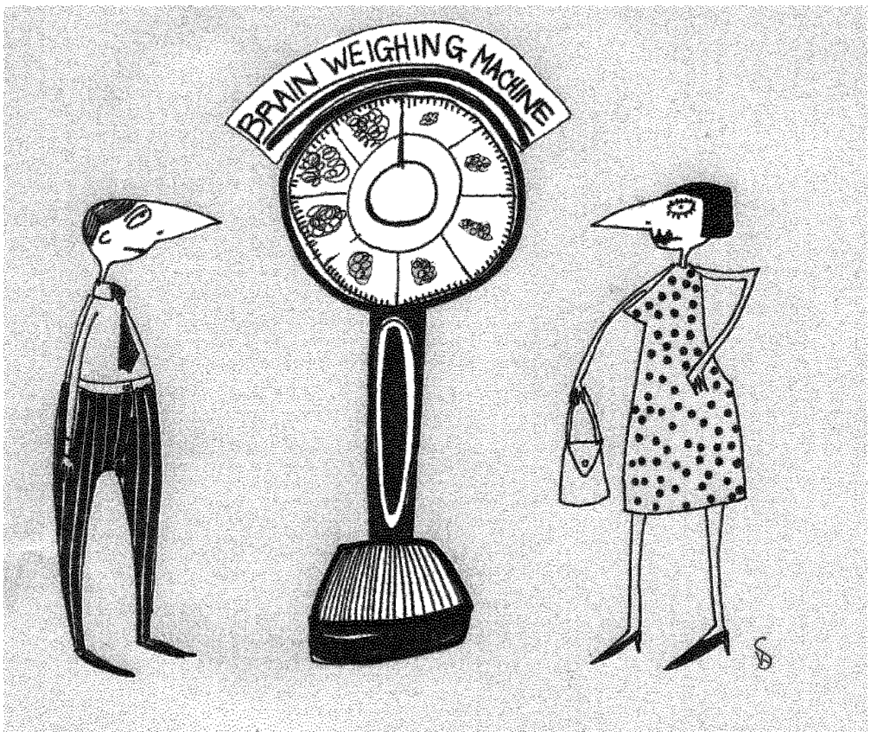
We might have evolved big brains so we could lie to other people.

WHY BIG BRAINS?

Three million years ago our ancestors had brains a third of the size of our own. The human brain is now 4.6 times larger than would be expected in an ape of our size. So why did we evolve such big brains? Bigger brains gave us more computational power and we may have evolved them to invent tools and language. We might also have evolved them to outdo other humans - skills such as lying and recognising others who lie would have been highly useful for survival in hunter-gatherer tribes. Another question is how did we evolve such big brains? Brain cells use up ten times more energy than the average cell, so how could we afford the energy for such big brains? One suggestion is that the human gut size decreased in size to allow us to evolve our big brains.

LEFT BRAIN RIGHT BRAIN

The cerebral hemispheres are divided in half into a right hemisphere and a left hemisphere. Sensory information goes to the opposite hemisphere, so the right hand sends information to the left hemisphere and the left hand to the right hemisphere. Some brain functions are performed almost entirely by one hemisphere and this is called lateralization. The left hemisphere is said to specialise in detailed analysis and logic and language and the right hemisphere in holistic processing and nonverbal skills such as face recognition and the appreciation of music. In America, you can buy self-help books 'to put yourself in touch with your more emotional and intuitive right hemisphere'. But this is an oversimplification. Although some functions are lateralized, the two hemispheres are in constant communication via a thick band of 200-250 million nerve cells called the corpus callosum. The two hemispheres work as a team rather than in isolation. Also, lateralization is not the same in everyone. In 95% of right-handed people and 60% of left-handed people the left hemisphere is dominant for language, but some people use both hemispheres for language or are right hemisphere dominant.



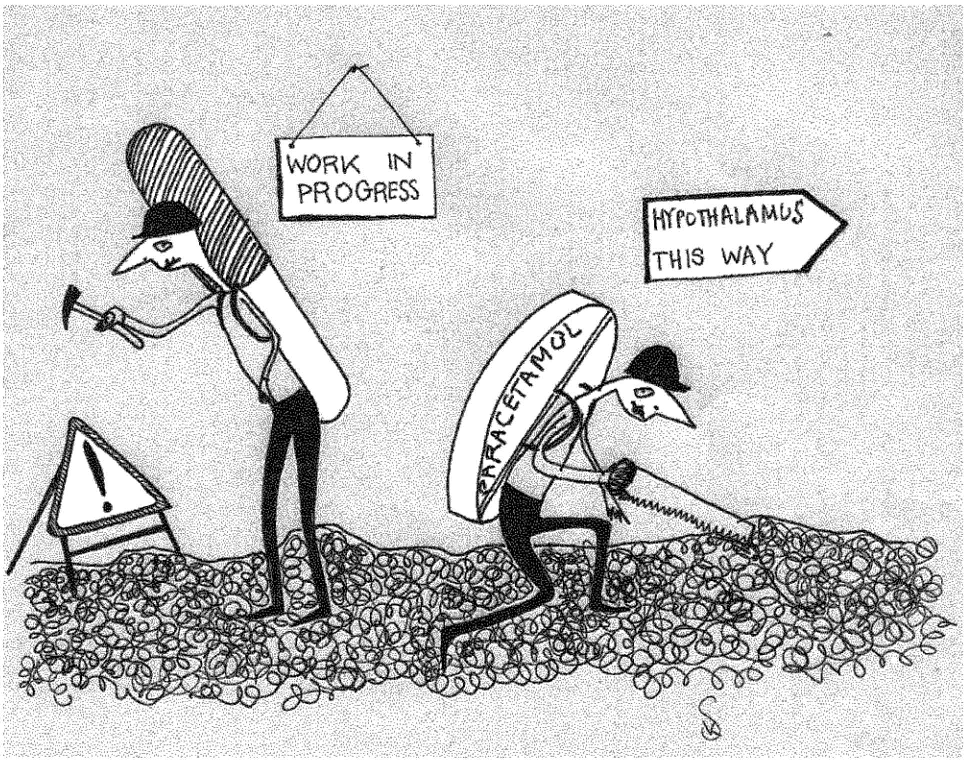
Is there a difference between male and female brains?

GIRL BRAIN BOY BRAIN

Male brains are, on average, approximately 10 percent larger than female brains. But, don't worry girls, your brains contain more cells in certain areas and brain size is a reflection of body size as well as intelligence (an elephant's brain weighs 6 Kg). There has been much research into differences between male and female performance on different tasks and how this may relate to brain organisation. Women perform marginally better on tests with words (could explain why men are worse at communicating!) and men are slightly better at spatial skills (could explain why women can't map read!). But researchers have found few meaningful differences between the male and female brain - there are much larger differences between individuals regardless of gender.

BRAIN BOXES

So what do all the different parts of the brain do? People have always tried to pin down different functions to different areas of the brain. Much has been found out using patients who have brain damage to a small area of brain. By seeing what it is that the patients cannot do, we can try to predict what this area is doing in a healthy brain. Damage to just a small area can have profound effects on a person (this disproves the popular myth that we only use 10% of our brains!) For example, a patient with damage to the amygdala (a specific part of the cortex) ceases to perceive emotions properly in themself and in others and one such patient could not understand why other people found soap operas of any interest! So, we can deduce that the amygdala is important for emotion. But this approach is tricky because many different brain areas can be involved in specific tasks.



Drugs working in the brain.

DRUGS IN THE BRAIN

Many drugs work because they are similar chemicals to neurotransmitters and so are able to fit into their receptors (see Brain cells) or prevent the breakdown of neurotransmitters. In 1973, neuroscientists discovered that the brain has receptors for opiods (such as morphine and heroin) and these are located in the areas of the brain important for breathing, pain and emotions. Nobody knew why we have these receptors in the brain until endorphins were discovered. These are the brains own opiods and are released in times of pain or stress. Commonly used drugs such as caffeine and alcohol also affect the brain. Alcohol acts on the same receptors as some anaesthetics and caffeine acts on multiple sites in the brain. Knowing about how neurotransmitters work in the brain and where the different types of receptor are located helps in the design of drugs to treat specific diseases such as Parkinson's disease.