

Brain - Consciousness - Mind

## THE GRAND ILLUSION

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In September last year I attended a one day 'Master class' on Consciousness. Six excellent lecturers, lots of Q & A, group discussions, one-to-one chats with experts. I came away with the thought that I could generate a one hour talk on this subject. But trying to compress eight hours of material into one hour was wildly optimistic. So I have chosen some of the main points from that day. What follows then is an update on the brain - consciousness - mind arena.

We all have a brain, we know when we're conscious, we know our own mind, we know we have a self. We like to see ourselves as in charge of what we think, say, do - as free-willed, self-governing beings. Yet evidence is accumulating that we are being deluded.

\* Each of us knows our brain is complex. However, probably all of us underestimate the complexity by many orders of magnitude. This is difficult territory. It will probably challenge some of our ideas and opinions. There are many commonly accepted but flawed ideas.

\* IMPORTANT! Much is not what it seems. In trying to understand our brain, consciousness and our mind, we cannot trust our subjective experience.

What follows tries to unravel some of the complexities.

### \* Major research arena

Consciousness, the brain and the mind, is now one of the largest and most important research arenas with many thousands of researchers world wide.

There are 350 degree courses in the world in Neuroscience and Artificial Intelligence and two huge projects on the brain are underway, one in the U.S. the other in Europe. [90+ professional journals and an on-line directory of 7734 free papers in this field]. At 2015 Neuroscience Symposium in Chicago 30,000 neuroscientists attended.

In addition, this field overlaps the fast moving developments in cognitive science, robotics and artificial intelligence.

### \* Neurons and Synapses

Neurons are brain cells: there are many types. Neurons transmit nerve signals to and from brain at up to 200 mph. Synapses are junctions between neurons.

Brain signalling is vastly complex.

### \* Development of the brain

This miraculous process is a talk in itself; I will abbreviate:

Two weeks after conception, cells which become brain & spinal cord produced. At six weeks neuron production starts; brain waves detectable. Neurons are produced at 250,000 per minute. At 8 weeks synapses begin to form (baby is 1/2 inch long). At birth brain contains adult number of neurons but they are poorly connected.

By two years of age, a toddler's cerebral cortex contains well over a hundred trillion synapses; the brain is 80% adult size but has twice the number of synapses of an adult brain.

The number of synapses remains at this peak through middle childhood (4-8 years of age). Beginning in the middle elementary school years and continuing until the end of adolescence, the number of synapses gradually declines to adult levels.

At about 25 the brain is at last 'complete' and at its peak performance.

\* Brain facts

- The brain has c. 100, billion neurons.
- Each neuron contacts up to 10,000 other neurons. (some neurons in cerebellum have 200,000 synapses)
- Total number of connections, synapses, is between 500, and one thousand, million, million per brain.
- Inside neurons are many chemical neurotransmitters which alter signalling probabilities.
- Total length of fibres in brain: 150,000 miles+
- Number of signalling permutations of each brain is massive.

\* The brain lives its life entirely in a closed dark box

Hundreds of millions of years of evolution produced animal and human bodies - blood to distribute oxygen and nutrients, digestive system to transform food into nutrients, kidneys, liver and so on. And an overall system manager - the brain - the most important organ. So important, nature put the brain in a closed, armoured box - the skull. Thus the brain lives entirely in the darkness of the skull. It can never have direct contact with anything outside the box.

\* Our sensors

This next piece is extremely important and difficult to get your head round. However, I assure you, it is the standard interpretation by experts on human sensors and the brain.

Evolution developed sense organs to gather data from the outside (and inside) world to send to the brain. Everything that we are conscious of, at all times, starts with data provided by sensors of the body. These are the obvious five senses of: vision, sound, smell, taste and touch PLUS sensors of balance (equilibrioception), pressure, temperature (thermoception), pain (nociception), and motion all of which may involve the coordinated use of multiple sensory organs.

We all have a brain, and its activities are near magical. Yet it is largely taken for granted.

Data in the outside world is of various types. Photons and light frequencies, pressure waves, molecules, etc. Here is the tricky bit: there is no colour in the world out there. The data gathered by the sensors is converted (transduced) to a common brain signalling medium - electrochemical signals. The colour is generated by the brain. You will often see sound equated to pressure waves. But this is false. Pressure waves are pressure waves, they only become sound to us when detected and processed. Sound is created by the brain. The same is true of all sense data. The brain creates vision, colour, sound, smell, taste, tactile sense.

## \* VISION

More than 30% of the brain is used for vision. The process is vastly complicated. In extremely simplified form: light is focused on retina where photoreceptor cells (125 million per eye) convert light into electrochemical signals which are split and routed via many parts of the brain, each with a specific purpose. (controlling pupil size, dealing with colour, fine structure, etc)

If you hold your arm fully out with thumb upright the area seen in focus is the area of your thumbnail. To compensate, both eyes make simultaneous jerky movements (saccades) stopping several times, and moving very quickly between each stop.

In fact as we look at a new view over three or four minutes, our recollection of detail is poor only a few minutes later.

Sense data from all the many other sensors, are processed and brought together in sync.

## \* Consciousness is Amazing

When we awoke this morning something amazing occurred: we regained consciousness. Instantly we were aware of a continuous stream of fully immersive, technicolour, three-dimensional, multimodal - vision, hearing, smells, tastes, tactile - all synchronised.

With that consciousness came a complete sense of our existence, a complete sense of self, of 'I', of 'agency', and memories of where we are, of our families and friends, recent, and stretching back to childhood.

And so it continues all day long until we sink again into dreamless sleep when consciousness vanishes.

(The same sequence occurs when we are anaesthetised, or have sufficient trauma to the head.)

When consciousness is switched on we know what is 'out there' in considerable detail. We are aware of 'reality' - rippling green trees of the forest, blue sky, thunder and lightning, the seasons, the sounds of birds and orchestras, the smell of fish and chips and roses, tastes of curry and icecream, we can feel the textures of satin and wool.

Because of all this we know 'reality'. Or do we?

Conscious experience, is always 'a fiction of the brain' (Prof Anil Seth, Co-director Sackler Centre for Consciousness Science, Uni of Sussex). It is always the brain's 'best guess'. And there is no way we can improve on that, even with assistance of technology. For eventually the brain is the only interpreter.

## \* Consciousness and the mind

The brain -consciousness - mind arena is replete with mysteries and has for centuries resisted explanation and understanding, including through several decades of modern neuroscience but much still remains illusive.

The problem of commonly accepted but flawed ideas confuses us.

We all have brains of course, though we have no direct subjective experience of it or its activities. Interestingly we use the word 'brain' little in conversations except in relatively accurate references - 'he had brain surgery'.

Consciousness is also little used in common conversations except in statements of fact: he lost or recovered consciousness, she was, or was not, conscious of . . . ,

Consciousness, or its lack, is tightly connected with 'the mind' - if you have no consciousness you also have no mind. To put it inversely - you have to be conscious to be aware of 'your mind'. But there is a difference between your consciousness and your mind. At any moment your consciousness is a presentation by your brain of its 'best guess' from the continuous flows of data from the body's sense organs - vision, auditory, smell etc.

The person sitting next to you and looking in the same direction will have a similar set of conscious representations.

Mind is NOT the same as consciousness

Your mind is specifically personal to you. Your brain is generating a personal set of thoughts, ideas, meanings, in your mind. You know those 'mind' experiences are yours alone, and importantly, private to you.

The word 'mind' is widely used in conversations. There are c. 200 colloquial phrases using 'mind': e.g. a meeting of minds; a mind of its own; a piece of my mind; all in the mind; be in two minds

'Mind' is readily used as a synonym for brain, intelligence, intellect, wits, brainpower, psyche, mentality. We often use 'mind' as if it were a physical entity yet there is no evidence that it is.

It is almost universally accepted that the brain produces consciousness, and what we call 'the mind'.

Let me summarise and be specific:

- \* The activity of the brain is completely unconscious to us.
- \* We can only know (in the mind) about the world through activity of the brain.
- \* Whatever 'comes into your mind' is produced by the brain.
- \* The mind has no spatial existence. Except in the sense that it is generated by highly complex signalling via synapses which do have spatial existence in the brain.
- \* The mind is NOT a physical part of the brain, but is produced by the brain.
- \* The unconscious or sub-conscious 'MIND' does not exist
- \* It is widely held by leading neuroscientists that the mind cannot influence the brain.

Professor Patrick Haggard, Deputy Director of the Institute of Cognitive Neuroscience at University College London pointed out (at the 'Master Class' day) that as yet no-one has been able to explain how anything in the mind (which has been previously processed and produced by the brain), could have any effect on the infinite complexity of signalling in the brain.

## \* Agency - our sense of being in command

We now enter another important but difficult to understand issue.

The mind is closely associated with sense of 'agency' which we all have, that is a sense of being, in command of what we do, of deciding to do things, then doing them, making conscious choices, of being free agents.

This part of the brain - mind - agency issue is of special interest to research labs. Thousands of experiments have been made. Results point in the same direction. Again all is not what it seems. We cannot trust our subjective experience in trying to understand ourselves. The key idea is that brain activity always precedes consequent perceptions in the mind.

Remember that every perception you have, every thought you have, every word you say, every action you make has PREVIOUSLY been processed by your brain. Conscious perception is always at least 300 milliseconds behind the brain activity, and in some cases the delay is several seconds. This plays havoc with our understanding of what is happening based on subjective experience.

We could quickly get into the free-will debate, which we have had discussions on previously so my comments on free-will today will be brief.

There is no doubt that everyone feels they have free-will. In addition most people feel responsibility for decisions they have made, and law and religion are largely based upon this. If we don't have free-will it would cause huge problems all-round.

However, we surely can only be held responsible for our decisions if we take them consciously. All decisions, and a lot else, are processed and taken by the unconscious brain. The brain also decides what is made conscious in the mind. So if the brain takes a decision which we are not conscious of, can we be held responsible?

There are now many university departments of law and neuroscience, plus conferences and journals on the subject. Several accused persons have been found not-guilty on the basis of decisions apparently made (by the brain) that were not within the awareness of the accused.

Generally people believe, in time order:

1. I have conscious intention - I intend to make a cup of tea. 2. I make the tea.

Actually 1. There is brain activity 2. I have a feeling of conscious intention (created by brain). 3. I make the tea.

We like to see ourselves as free-willed, conscious beings and self-governing. Yet evidence is accumulating that we delude ourselves. Clever research at the MIT Media Lab (and elsewhere) has shown that 90 per cent of what people do follows habitual routines.

How we walk, amount of exercise, what we say and how we say it, hand and body gestures, eye movements, what we think about, the amount of analysis, reading, listening to radio, watching television, our unique 'life philosophy', our degree of emotionality (and much else) are all largely habitual.

However, a person is not accurately aware of most of this habitual behaviour, cognitive activity and emotional patterns so can only describe their 'I' or their 'self' as they subjectively perceive them.

A leading researcher, Professor John Bargh of Yale University, says "most of a person's everyday life is determined not by their conscious intentions and deliberate choices, but by mental processes put into motion by their environment - where they are, who they are with, the weather etc."

In other words, most of the time we are simply reacting unconsciously to the world around us.

### \* MEMORY

I have left until last probably the most mysterious aspects of the brain - memory. We all recognise that memory is absolutely fundamental to most aspects of our daily life. And as shown by Alzheimers, as memory fails, so do we.

Understanding memory has been, and still is, one of the huge challenges of neuroscience. Even after intense effort in many labs throughout the world, the science of memory is still unsolved. How can it be that memories persist over years, sometimes even a lifetime?

Currently it is widely assumed that the answers lie in synapses. There are 500 to 1000 million. million synapses per brain. Some neurons have 10,000 synapses, some 200,000 synapses. The chemistry and physics of neurons and synapses is headachingly difficult to understand. So I won't go there.

What is now well accepted is that the hippocampi - one on either side of brain are essential for laying down memory.

Memory is also known to be labile - liable to change. It seems current experiences may change, or cloud an older memory. It is also now well-known that false memories are taken up easily from the soup of flawed information and mis-information that we all swim in.

Recently, however some progress has been made in understanding the chemistry involved in memory processing - but it seems there is still a long way to go.

\* Which just leaves me to sum up:

**Your brain is amazing.**

### **References**

You probably know about TED - Technology, Entertainment and Design - thousands of interesting talks on almost everything, free and instantly available on line. Have a look at Dan Dennett, Sam Harris, Patrick Haggard, David Chalmers, Christof Koch, Antonio Damasio, Alex (Sandy) Pentland on today's subject.

Books used

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Prof Anil Seth, 30-Second Brain, 2014

Prof Patrick Haggard, *The Sense of Agency*, 2015

Prof Frances Crick, *The Astonishing Hypothesis*, 1994

Prof Chris Frith, *Making up the mind*, 2007

Profes who have worked on Quantum Physics of Brain:

David Bohm

Roger Penrose

Stuart Hameroff

H.P. Stapp

No quantum effects have as yet been detected

