

## Charge difference theory of consciousness

Consciousness is brain activity. The brain contains billions of neurons and when neurons receive chemical stimulation they become electrically charged. More specifically, there is an influx of sodium ions across their plasma membrane. There is then a charge difference between the interior of the neuron as opposed to the exterior. This is called firing. When a neuron fires it releases neurotransmitter from its synaptic vesicles into the synaptic cleft between the end of its axon and the neurons it is connected to. The neurotransmitter reaches and binds to receptors on the plasma membrane of neighbouring neurons and causes them to become depolarised. There are networks of neurons like this in the brain.

Note: an ion is an atom which has either gained or lost an electron.

So when the brain receives stimulation through the sensory organs, neurons fire. For example when light enters the eye messages are sent to the visual cortex and neurons there fire. The result of this could be perception of a colour.

Is quantum mechanics involved in consciousness? The brain takes in information from the environment through the senses and computes it via the firing of neurons. According to Shannon, information is the resolution of uncertainty. And in quantum mechanics systems go from a superposition of states (uncertainty) to a definite state when the superposition of states becomes mixed up with the states of the environment (decoherence). However, the environment of the brain is too hot and noisy and so decoherence happens in picoseconds, meaning that quantum computing - such as a neuron being in a superposition of firing and not firing - is not possible. Instead classical, definite states arise in the brain because, as according to Quantum Darwinism, there is a record of states in the environment. This means that during the flux of ions into the neuron, the position of the ions with regard to the interior and exterior becomes definite.

Does brain activity explain qualia? Qualia is everything we perceive. Qualia can be thought of as a screen with images on. The images are our perception. Each bit of information in the brain - whether a neuron is firing or not - can be thought of as a pixel on the screen and so we see from this analogy that brain activity explains qualia.

What about sense of self? The brain has evolved as receptors to the sensory organs. The senses probably co-evolved and the brain developed as their command centre. We can therefore think of sense of self as arising from a switchboard like procedure between all of the senses, with thoughts being a result of the language system. This means that sense of self is like a ghost in the machine - an emergent phenomena.

Not all of the brain is responsible for conscious sensations. If information does not reach the cerebral cortex then it is not consciously processed. It has been theorised that other areas of the brain are linked through different routes to the cerebral cortex.

Qualia is said to have a phenomenological character. What does this mean? When we perceive light of a certain wavelength it is blue while when we perceive light of another wavelength it is red, and so on. The fact that one is blue and the other is red - that there is a difference - is qualia. The phenomenological aspect of qualia is the blue or the red and that

is contingent on the wavelength of light that goes into the eye. The wavelength of light is the information.

Let us be more explicit about information. The information that the sensory organs receive is due to something physical about the world that gets translated into another physical form. For example, when light enters the eyes it is absorbed by retinal cells. This energy is then translated into a chemical message which stimulates the optic nerve translating the signal into an electrical signal which reaches neurons in the visual cortex by a chemical message which is translated into electrical signals.

At some point amongst all of this there is the phenomenology of, for example, blue that is perceived. Where is this phenomenology? Perhaps it is the totality of the signal at every stage of translation. However, as has been said, an element does not come into awareness if it does not enter the cerebral cortex. This presumably means that if the connection between the optic nerve and the visual cortex was somehow severed then there would be no conscious perception of the colour, for example, blue. Therefore, the phenomenological character is not a character of the information as a whole.

What is it a phenomenological character of? In some conceptions of consciousness it is information that has phenomenological character and this is extended to all types of information. This does not seem sensible. Perhaps the physical substrate has phenomenological character? Which part of the physical substrate? It could be the whole neuron or it could be, for example, the plasma membrane of the neuron.

Returning to what we know: We know that information in the cerebral cortex is perceived and that information in other parts of the brain is relevant to that. Likely, the place to look is the structure of the neuron and the surrounding brain environment. The place which would alter the signal in the neuron is the charge of the plasma membrane. If the movement of ions were disrupted then the signal would be deteriorated. Therefore it is the charge which matters. More specifically, it is the charge difference between of the plasma membrane interior and the exterior brain environment. It is a difference in charge that makes the signal. A charge difference is the information. We suggest that it is this, in vast networks of neurons, which has phenomenological character.