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The Brain Basis of Consciousness

Prof Mark Solms

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Summary by Dr Alan Priest

Prof Mark Solms delivered an absolute fascinating talk on the topic of the origin of consciousness and its location in the physical structure of the brain. Although guided by a handful of PowerPoint slides, he delivered his talk in a lively and spontaneous fashion, no doubt because of his familiarity with the topic and the tremendous depth of his knowledge as an expert in this field.

He started by saying that his talk was inspired by two ideas from Sigmund Freud. However, before exploring these ideas, he asked us to consider our experience of consciousness, inviting us to note that it is primarily visual and secondarily auditory, with the experiences of smell and taste somewhat in the background, if we are conscious of them at all.

Going back to 1994, Francis Crick, co-recipient of a Nobel prize for mapping the structure of DNA, noting this emphasis on visual and auditory consciousness, mapped out what he described as a simple model of consciousness, associating consciousness with the visual and auditory structures in the cerebral cortex.

Chalmers however disagreed, citing Jackson (1981), who invited us to consider a thought experiment in which neuropsychologist Mary, who has full and detailed knowledge of visual processing but who is functionally blind, has no actual *experience* of sight. It is only when, as if by some miracle, she achieves the power of sight, that she is one day able to actually *have the conscious experience* of sight. Thus, Mary has learned something entirely new about vision, something which previous knowledge alone, no matter how comprehensive, could not have explained or accounted for. Importantly, said Mark, this conscious experience is beyond explanation or any description of experience arising from explanation alone.

Noting this led Chalmers to coin the phrase “the hard problem of consciousness”; how is it that consciousness has this additional dimension beyond explanation, which must be experienced? As Mark put it, cameras on phones can process vision but without experiencing *anything*.

Nagel contributed to the debate (1974) by posing the question “what is it like to be and to experience consciousness?” However, most models of consciousness continued with the idea that it is the cortex which is the organ of consciousness. Mark argued that had we focused instead on the brainstem, this so-called “hard problem” could have been avoided or would not have occurred.

It was at this point that Mark turned to the first of his ideas originating from Freud:

Freud argued that most perception is unconscious: we can see and perceive and learn without being aware of what we have perceived and learnt (Kihlstrom). Of course, many of Freud’s ideas, including this one, were challenged over the years but perhaps in this regard at least, he was correct. Mark supported this by referring to the device known as a tachistoscope. In experiments with research subjects, this device flashes images onto a screen at a rate below the threshold of human perception. In one experiment, subjects are shown, alternatively, faces accompanied by a label of either “rapist” or “philanthropist”.

Again, Mark made the point that there is no way in which subjects could be aware even of the photograph, let alone the descriptions underneath.

Subsequently, the test subjects are then shown photographs of the two people (without labels) and are asked to indicate which of the two faces they prefer. Naturally, never having seen them before, most question how they can decide. However, when they are pushed by experimenter to express a preference based on, perhaps, “gut feeling”, a statistically significant greater proportion will say they prefer the face of the person seen previously, who was labelled as a philanthropist. This makes the point that we can perceive and learn without conscious awareness, which raises the question of the involvement of the cortical regions of the brain in consciousness.

Moreover, as early as 1949 Moruzzi and Magoun showed experimentally that a cat remains conscious when it is deprived of visual information by severing the link to the visual cortex. Indeed, it remains conscious even if the visual cortex is removed entirely. Again, this questions the emphasis on the cortical structures in the brain, in the role of consciousness.

Mark described how Moruzzi and Magoun’s work led to the discovery of the role in the brainstem of the reticular activating system (RAS) in the role of consciousness. When certain structures in the RAS are disturbed, it leads to the loss of conscious experiencing. In fact, the loss of just 2 mm^3 of mass in the para-brachial system is sufficient to completely *obliterate* consciousness.

However, and perhaps surprisingly, Moruzzi and Magoun interpreted the results, said Mark, in terms of quantity (cortex) versus quality (RAS). Perhaps this was because it was hard to explain the phenomenon of consciousness without recourse to cortical structures?

To use a metaphor, offered by Mark, they interpreted the cortex as still being a pre-requisite for consciousness, rather like a television set requires a power supply to deliver a picture.

In Mark’s view, this interpretation was incorrect, and he pointed out in a diagram (see fig. 1 below) that it is entirely possible for experiences in the RAS to be communicated to subcortical structures, without invoking higher cortical structures.

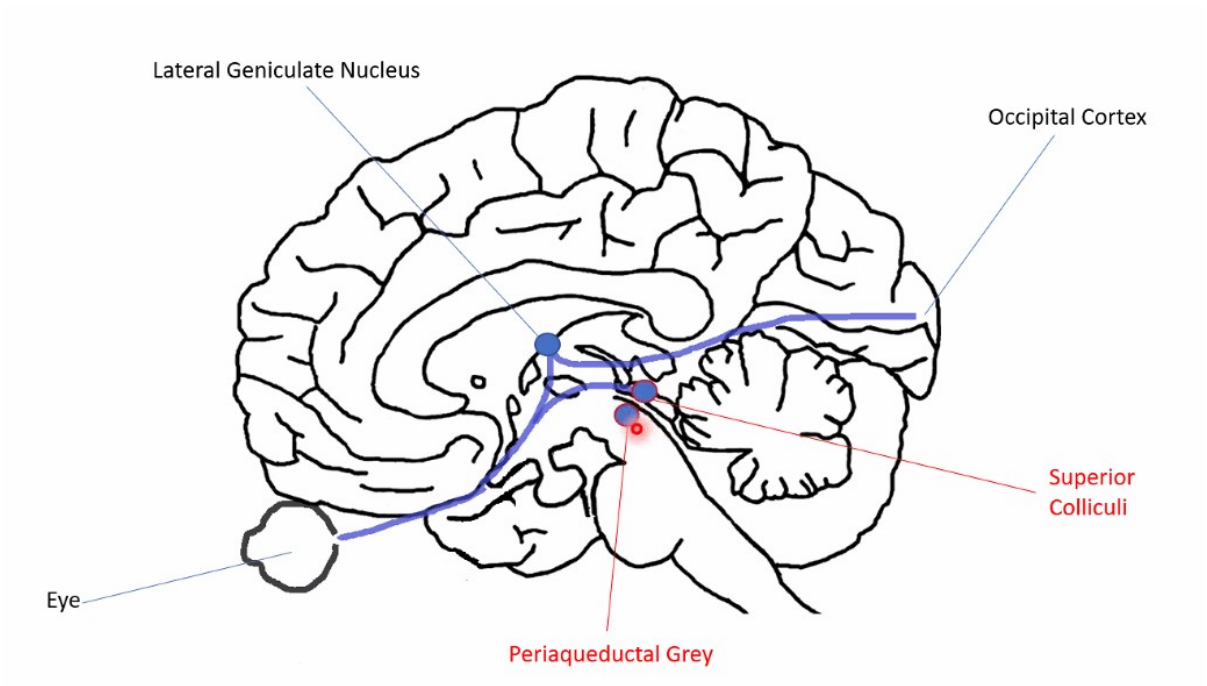
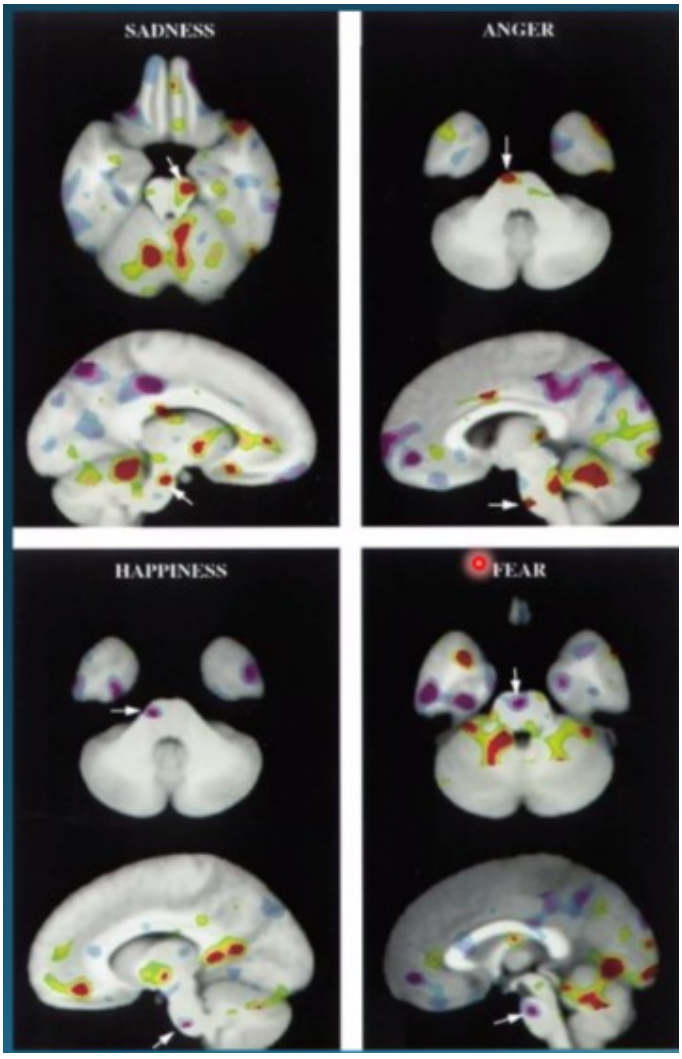


Figure 1 non-cortical processing of visual responses

As evidence, he offered two pieces of evidence. Firstly, if no cortex exists, then all consciousness should cease to exist in terms of content and quality. However, in the condition hydranencephaly, there is a brainstem but a fluid-filled void where the cortex should be. If the cortex is necessary for consciousness therefore, a child so affected should be in a state of non-responsive wakefulness – a so-called persistent vegetative state. But in fact, said Mark, such children are *not* non-responsive. As Merker (2007) and many others since then have demonstrated, such children are capable of an emotional response. In one example, a child reacts with obvious joy and happiness when her younger brother is placed in her lap and similarly, responds with displeasure when the little boy is taken away. Such responses are always situationally appropriate. This, said Mark, is evidence for consciousness without a cortex. Similarly, we need only think of preverbal babies or pets communicating their needs, in order to make the point that they are capable of experiencing hunger or distress, for example, without language or explicit expressions of consciousness.



Secondly, and as further evidence, Mark explained that the region of the brain stem known as the substantia nigra, when stimulated electrically, produces responses in conscious experience. It is necessary to probe and stimulate this brain area, he explained, when pursuing treatment for Parkinson's or the management of extreme pain, for example. Mark cited the case of a patient undergoing treatment for Parkinson's (tremor control) where the probing needle went a little too deep into the substantia nigra. At this point the patient instantly became profoundly sad, despairing and even suicidal. However, this depressive state disappeared less than 90 seconds after the stimulation was discontinued. With the patient's permission, stimulation was reintroduced, and the profound and incapacitating depression was again manifested. These were powerful and intense feelings, real emotions, consciously experienced. In contrast, stimulation at other sites did not elicit this response. This has been shown to be so now in hundreds of cases. In positron emission tomography (PET) imaging studies, it is possible to map the areas of the brain which are activated in response to different experiences (see figure 2 at left, from Damasio et al., 2000). Here it can be seen that feelings are manifested in the areas highlighted largely in the brainstem.

Mark also pointed out that targeted neurochemicals in cases of depression and anxiety – serotonin, noradrenaline and dopamine – are all sourced in the RAS.

Above: Figure 1 mapping emotions in PET

So, argued Mark, the brainstem is a prerequisite for consciousness. He also made the arguably powerful point that the brainstem has the capacity for affect and that all consciousness is basically emotion and *not* cognition.

Mark then went on to invoke his second Freudian inspired idea; you cannot have a feeling if you don't feel it. This, said Mark, is where we should be looking if we want to identify the organ of consciousness. As he put it, the part of the brain necessary for consciousness generates feelings.

"It is surely the essence of an emotion that we should be aware of it, i.e. that it should become known to consciousness. Thus, the possibility of the attribute of unconsciousness would be completely excluded as far as emotions, feelings and affects are concerned." Sigmund Freud (1915).

The functional mechanism of feeling is homeostasis, that is to say the regulation of responses to external conditions, designed to promote optimal opportunities for function and survival. In other words, homeostasis facilitates survival in uncertainty. It leads to a demand to do *something* and thus requires work (energy). In terms of consciousness, homeostatic needs are communicated by feelings. There is "un-pleasure" in uncertainty and conversely, pleasure is experienced in restoring homeostatic balance. Therefore, said Mark, feelings free us from purely reflexive responses. It adds responsiveness to survive in the unpredictable situations involved in life and living. Feeling is necessarily individual; that is to say, "is this good or bad for me?" It is intrinsically qualitative, involving categorical variables.

Mark closed his excellent talk with the statement, *"feelings would not be able to do their job if you didn't feel them."* In other words, we have to be conscious of them in to respond and this, together with the evidence he presented, points he says, to the origins of consciousness, not in the cerebral cortex as was long thought (and indeed is sometimes still argued) but rather in the reticular activating system of the brainstem.