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# *Six Keynote Papers on Consciousness with some Comments on their Social Implications*

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Six keynote papers presented at TSC 2009 — by Susan Greenfield, Wolf Singer, Stuart Hameroff, Jonathan Schooler, Hakwan Lau, and David Chalmers — are reviewed below in order to investigate to what extent social analysis can be usefully applied in different areas of consciousness studies. The six papers did not ostensibly address social aspects of consciousness; nevertheless I hope to show that it is often beneficial to consider the possible social implications in any consciousness-related work.

I will deal with the first three papers as a group because there are parallels between them, and the last three separately because the social reasoning is different in each case.

### Greenfield, Singer, and Hameroff

Several plenary talks emphasized the fleeting and shifting character of thought. The conference opened with a paper from Baroness Susan Greenfield on 'The Neuroscience of Consciousness'. Greenfield was critical of our current bias towards functional brain imaging, which lacks the time resolution (3 seconds at best) required to capture the 'momentary holistic states' that characterise consciousness. The necessary insights, she averred, are not to be found at the level of gross brain anatomy, nor at the level of individual neurones, but in the

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high-speed flux of 'neuronal assemblies' — coalitions of more than 10 million cells which shift their allegiances on a time-scale measurable in hundreds of milliseconds. This requires optical imaging using voltage-sensitive dies in thin *in vitro* slices of brain tissue. Certainly her film of such assemblies — spreading and flowing through brain tissue in high-speed clouds of colour — had the fluctuating qualities one would intuitively associate with the 'stream of consciousness'.

In similar vein, Wolf Singer ('Consciousness: A Special Dynamical State?') sought neuronal phenomena that would correlate with known features of consciousness, specifically mentioning three: 'its contents change fast and flexibly, our experience is unified, and access to consciousness seems to be limited'. A fourth requirement of a neural correlate of consciousness (NCC), Singer suggested, was that it should be at least partially separable 'from mechanisms serving other functions in the brain'.

He proposed gamma synchrony as the most plausible candidate. In the late 1980s, Singer and colleagues found specific, phase-synchronized EEG in cats' visual cortex which was strongly correlated with particular visual stimulation (Gray & Singer, 1989; Gray *et al*., 1989: cited in Hameroff, 2009). This rhythmic coherence occurred at around 40 Hz, within the gamma range (30–90 Hz).

Research by Singer and others, suggesting that gamma synchrony is indeed associated with consciousness, influenced Stuart Hameroff's latest theory, which he presented in his paper on the 'Conscious Pilot'. Hameroff draws an analogy with flying an aeroplane. Routine flight can be handled by the autopilot, but, if there is sudden turbulence or an alarm sounds, the human pilot takes over until the emergency is passed. Then the autopilot can resume flight control, and the human pilot can go back to reading a magazine or chatting with an air hostess.

Neurocomputation in the brain, as conventionally understood, represents the autopilot in Hameroff's analogy. This involves networks of neurones communicating by axon-to-dendrite chemical synapses. Consciousness is not required for such routine or habitual activity. However, dendrites can communicate 'sideways' with other dendrites via electrical synapses known as gap junctions. When a gap junction is open, there is cytoplasmic continuity between the adjoining cells, enabling synchrony between them. Hence gap junctions create 'dendritic webs' of synchronised neurones — on a potentially brain-wide scale — which can shift, change shape, and move rapidly around the brain as gap junctions open and close. Hameroff suggests that these shifting populations of neurones are responsible for gamma

synchrony, and that mobile 'envelopes' of gamma synchrony are the vehicle of consciousness — the human pilot in the aeroplane analogy — moving to any part of the brain where habitual activity is inadequate and conscious modulation is required.

There are common themes uniting these three papers, including some apparent similarity between Greenfield's neuronal assemblies and Hameroff's dendritic webs — they shift, change shape, and move rapidly through brain tissue in a similar way. However, we might question whether neuronal assemblies are a sufficient NCC. *In vitro* slices of rat brain seem unlikely to be conscious in the self-aware human sense, and neuronal assemblies are presumably characteristic of both reflectively conscious and unconscious (or non-reflectively conscious) brain processes. Of course neuronal assemblies may represent routine neurocomputation rather than gamma synchrony.

The phenomena reported by these three authors appear to be promising candidates for any theory of the relationship between consciousness and brain activity. But what would such a theory look like?

Susan Greenfield openly declared herself to be a physicalist — that is, she believes consciousness 'arises' from 'physical' processes in the brain. The words in quotation marks are problematic to say the least, and anthropologists have theorised that the origin of physicalism is political rather than scientific (Jordanova, 1980; Whitehead, 2002, 2006). 'Physical' implies a closed system which can, at least in principle, be entirely explained without reference to consciousness. But if this definition is accepted, then we do not have a 'hard problem' of consciousness — we have an impossible one. Committing oneself to physicalism is a premature step.

Supposing neuronal assemblies *were* a sufficient NCC, this should not be conflated with issues of causality, as Wolf Singer himself pointed out. Correlation is equally consistent with A causing B, B causing A, or C causing both A and B. Singer's comment suggests he may be less of a physicalist than Greenfield. In common with Hameroff, he assumes that consciousness has a *function*. The NCC, he suggests, should be separable 'from mechanisms serving other functions in the brain'. Hameroff is not strictly a physicalist — he is at least willing to entertain the idea that the ultimate precursors of consciousness may be a fundamental feature of the universe, along with mass, spin, and charge (Hameroff, 2009). Fundamental features of reality are not regarded as having 'functions' in physicalist science — where many believe that consciousness *cannot* have a function, since this would violate conservation principles and a non-social vision of the universe as purposeless.

Note also an apparent contradiction between two of Singer's criteria of consciousness: 'experience is unified' and 'access to consciousness seems to be limited'. If access is partial, then experience cannot be entirely unified, and we must have dissociated areas of awareness to which our self-aware mind has limited access. So we cannot rule out the possibility that all brain processes — or even all processes – are in some sense aware, though not necessarily aware of their awareness. In which case there will be no such thing as an NCC — there will only be neural correlates of *reflective* consciousness, and identifying those brings us no nearer to solving the 'hard problem'.

Of course, there are two senses in which consciousness might be described as 'unified'. What Singer refers to is the unity of specific experiences — different brain processes interpret the colour, orientation, or velocity of an object, but these are experienced as a single united percept.

Hameroff (2009), however, assumes that consciousness is unified in a more absolute sense. If dendritic webs are the NCC, he writes, then there should only be one such web operating in a single brain. He does note the apparent existence of dual consciousness in split brain patients, but seems unaware of psychological and hypnotherapeutic evidence for multiple selves in normal people, and that this is essentially a social adaptation (Hilgard *et al.*, 1975; Bliss, 1986; Brown, 1991; Mitchell, 1994; Whitehead, 2008).

None of the three speakers addressed the evidence that social behaviour is a precondition for reflective consciousness, or that 'all the contents of consciousness are the outcome of a social endeavour' (Frith, in press). They all treated consciousness as an individualistic phenomenon, although Singer does believe that self-formation is a social process (personal communication) and Hameroff did note that gamma synchrony characterizes dreams and daydreams – tacitly implicating 'theatre of mind' and the ability to model social scenarios with a cast of autonomous *dramatis personae*. Note that the human pilot, in his aeroplane analogy, does not lapse into unconsciousness when not required to fly the plane. He reads a magazine or chats to a stewardess — two essentially social activities. Hameroff's analogy might imply that this social behaviour is the 'default state' of consciousness — or what Schooler calls 'mind wandering' (see below).

But above all, the common thread uniting neural phenomena such as assemblies and gamma synchrony is the miracle of cooperation. One of the greatest errors in neo-Darwinism is the assumption that biology is fundamentally competitive. It is true that red squirrels compete with grey squirrels, but they do not compete with cows or oak

trees. An ecosystem is essentially mutualistic. It is equally true that alleles for blue or brown eyes compete with each other, but they do not compete with genes for bones or kidneys. In *The Selfish Gene*, Dawkins himself compared genes to oarsmen in a racing boat – to survive, they must pull together. At the very least they must not rock the boat. Without cooperation, there could be no biology, and life could not even have begun. Biology builds upon a 'social' principle that is written into the very foundations of reality: organisms co-operate with organisms, organs with organs, cells with cells, organelles with organelles, molecules with molecules, atoms with atoms, and so on — all the way down to the level of quanta and all the way back to the Big Bang. Emergent order in the cosmos depends on the combinatorial 'Lego block' character of matter, and the curious 'coincidence' that each level of order appears to be pre-adapted for the emergence of the next. This is just one aspect of the 'anthropic cosmological principle', which has led some scientists (e.g. Henderson, 1913; Hoyle 1959; Wheeler, 1977) to infer that, *contra* Copernicus, humankind — or at least life, consciousness, or 'observation' — really is at the centre of the universe.

Following Singer's talk, Marek Majorek asked him: 'How does the brain *know* that it is in synchrony?' With a wry smile Singer replied, 'That is... a hard question.' This opens a mystery perhaps as great as that of consciousness itself. What does it signify that the front of the brain, for example, should be in synchrony with the back? I may well accept that a long trail of gap junctions *enables* synchrony between distant cells, but what does that actually *do*? Information is about difference and rhythm is about sameness. Gamma synchrony is more like a performance than a communicative act. How can anything so simple — and so apparently contentless — accomplish *agency*? Does the envelope of gamma synchrony carry something else with it, or does it enable neurocomputation to somehow transcend its normal limits? Could some non-local effect be taking place? Such phenomena offer small comfort to physicalists, and hardly bring us closer to a reductionist explanation of consciousness.

## Schooler

Jonathan Schooler is recognised as a world authority and pioneer of research into mind-wandering. This has been classically understood in two senses — one being the shifting and fluctuating quality of thought noted by Greenfield, Singer, and Hameroff, which led William James to conceive of 'the stream of consciousness'. The other

refers to the great difficulty which most of us have in paying attention to a single task for a sustained period of time.

Schooler's talk — 'The Draw of the Internal World'— was concerned with the second kind of mind-wandering. He began with a well-known phenomenon: a person can be reading a book and suddenly realise that, although the eyes have been following the words, the mind has wandered off somewhere and the reader has no idea what the last paragraph or so was actually about. His research reveals two kinds of mind-wandering — one which we are reflectively aware of, and one which occurs without our noticing it. Interestingly, the non-reflective mind-wandering has a more distinctive neural signature.

Two important brain networks are involved when the mind is wandering. One engages prefrontal top-down 'executive control' functions. The other is the so-called 'default system'. Because these two important networks are activated together, Schooler suggests that mind wandering is not just functionless 'noise' generated by an idle brain, but is performing some useful and important function. He conceives of the brain as processing information to achieve goals. But some goals are short term and others more long term. Schooler suggests that we have evolved a means of disconnecting from the here-and-now in order to contemplate future objectives — a goal-directed executive task.

But brains do not exclusively engage in goal-directed 'work'. We also use our brains when we play. Play is self-motivating — it has a function but it does not have a goal, other than 'having fun' (Apter, 2008). Play may be a major reason for our large human brains (Whitehead, 2008).

Schooler's neuroimaging evidence is certainly interesting, but his belief that most thoughts during mind-wandering concern the future is questionable. People also reflect on past events and enjoy fantasy experiences precisely because they could never be enjoyed in reality (such as having illicit sex or murdering the boss).

Daydreaming — or 'theatre of mind' — is probably the most spectacular achievement of the human brain, since it involves running social scenarios in imagination, with 'toy people' who behave as though they have minds of their own. Theatre of mind is a role-play activity and presumably depends on childhood role-play, beginning around the age of two years. Schooler appears to be unaware of this, and focuses on peripherals rather than the social nature of human dreams, daydreams, and imagination. Mind-wandering, and the playful behaviour on which it depends, is no mere goal-directed planning process, but the mother of all human creativity.

## Lau

Hakwan Lau presented his 'Dynamic Threshold Hypothesis' according to which the intensity of a neural signal has to reach a certain threshold before we can become aware of it. The novel feature of his hypothesis is that the attentional threshold is 'dynamic' – the brain can set it at a high (conservative) or low (liberal) level. He claimed that this hypothesis provides a coherent explanation of 'three puzzles': (1) inattentional and change blindness; (2) the preconscious initiation of spontaneous decisions; and (3) blindsight. Social explanations, however, are at least equally persuasive.

(1) Kevin O'Reagan — based on his change blindness research — concluded that our subjective impression of seeing a complete visual field is a 'grand illusion'. He found that people fail to see major changes in a visual scene if they occur during a saccade or blink, or if a small 'mud splash' appears on the picture at the moment of change. The 'major changes', however, always affect socially meaningless details of the picture — the reflection of a mountain in a lake, or a railing behind a conversing couple. An eye-tracking study of the latter showed the viewers' gaze circling constantly between the faces and hands of the two people, the likeliest sources of social cues. They paid no attention to the railing. It would be interesting to test whether autistic children, with limited interest in social cues, had any difficulty spotting the 'major changes' involved in O'Reagan's research.

A social interpretation of change blindness might be further supported by Arien Mack's research into 'inattentional blindness', which showed that we are almost always blind to objects fixated by the eye if our attention is directed elsewhere — *unless the objects are socially meaningful*, such as a happy face icon, a human stick figure, our own name, and possibly the word 'stop'. This may be simply an example of the 'lunch queue phenomenon': we are not 'failing' to see things, but filtering out what is not socially relevant.

Hakwan Lau's explanation of inattentional and change blindness is that inattention causes the brain to lower the threshold for awareness, leading to an 'inflated sense of phenomenology'. I may have missed part of this argument, because I do not see how lowering the threshold for awareness can explain a lack of awareness.

(2) Libet famously demonstrated that the neural readiness potential when preparing to act preceded conscious awareness of the decision to act by around half a second. Many people have taken this to mean that there could be no 'free will'. Hakwan Lau explained Libet's findings on the basis of his own research suggesting that the conditions

under which we become aware of decisions would lead to a conservative threshold for awareness, hence the delayed access to consciousness.

The unconscious nature of simple motor decisions could equally well be explained by Hameroff's 'autopilot', though the social nature of self/other-awareness may also be relevant. The low-level actions used by Libet in his experiment — random hand movements — are egocentric. The high-level *social* decision — to collaborate in the experiment — has already been taken, and was taken self-consciously before the experiment began.

(3) Patients with blindsight report having no visual experience, but in many ways behave as though their vision is intact. If you toss them a ball they will catch it; they can navigate a room without mishap, correctly align a letter to post it through a vertical or horizontal slot, and so on. The dynamic threshold hypothesis explains this by proposing that damage to visual cortex reduces the signal strength below that required for consciousness. However, blindsight results specifically from damage to the ventral visual stream. Lesions in the dorsal stream induce the converse problem of *optic ataxia* — such patients do report having normal vision, but have difficulty catching a ball, navigating a room without mishap, posting letters at the correct angle, and so on. Furthermore, Goodale and Milner (1972) have shown that, even in normal people with no brain lesions, dorsal stream vision is equally unconscious. So we have two visual systems with dissociable functions. Dorsal vision deals with egocentric navigational and praxic actions – including the kind used in Libet's experiment — whereas ventral vision deals with a shared visual world — the one that others see. Egocentric vision is unconscious, whereas social vision is not.

## Chalmers

David Chalmers, in 'The Extended Mind Revisited', argued that artefacts used as aids to cognition could be regarded as extensions of the mind (though not necessarily of consciousness). He illustrated the idea with the story of Inga and Otto, both of whom intend to visit the Museum of Modern Art. Inga knows the way, but Otto has memory loss due to Alzheimer's disease, and needs to consult his notebook. Hence Otto's notebook performs the same function as Inga's memory, and could be regarded as part of his Extended Mind.

Chalmers' account of the philosophical arguments and counter-arguments certainly convinced me that the Extended Mind is a useful concept. However, I assume he chose to focus on the artefactual rather

than social implications because of the 'Brain, Mind, Technology' theme of TSC this year — although artefacts such as notebooks and writing are of course social products. Talking to other delegates afterwards revealed that they did not find the social significance of the concept self-evident. Apparently this needs to be spelled out. For example, supposing Otto lost his notebook and had to ask Inga the way, then Inga's memory would become part of Otto's Extended Mind. All human groups have shared memories, experiences, goals, values, and so on — and they will discuss their common interests fairly often. So all minds within any social group — whether a nuclear family, a football team, a nation, or the population of the entire world — are actually or potentially parts of each other's Extended Minds.

A fundamental mechanism underlying shared behaviour and experience in humans, apes, and monkeys is the mirror neurone system (or systems). Rizzolatti and his Parma team found that when a person smells a foul odour, or watches a video of someone else smelling a foul odour, common neurones are activated in anterior insula. Tanya Singer and colleagues at University College London found a similar effect of experiencing and observing pain – this time in anterior cingulate and anterior insula. It would seem that, in primates at least, brains are adapted to accommodate Extended Minds.

In the opening paragraph of their recent book, *The Sapient Mind*, the editors, Colin Renfrew, Chris Frith, and Lambros Malafouris (2009), emphasize 'the extended, distributed, embodied, and culturally mediated character of the human mind'. The Extended Mind has become a central concept in social neuroscience, which has seen a proliferation of new subdisciplines representing collaborations between brain scientists and social scientists of various kinds. Such collaborations have greatly advanced knowledge of the social brain and are transforming our understanding of consciousness.

## Conclusion

If collaboration with social scientists can lead to a 'social revolution' in neuroscience, it seems reasonable to suppose that similar collaborations could prove fruitful in other fields of research. Science is a social project, and at least some of the biases and errors that occur in science are of social or cultural origin. The six papers discussed above have social implications, and I hope I have shown that, at least in some cases, it is necessary or at least useful to take these into account.

The challenge of consciousness is such that we cannot afford to ignore any potentially useful approach, and I propose social analysis,

not as an alternative to other approaches, but as a useful tool applicable to all.

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