

Bill Faw

Are We Studying Consciousness Yet?

*Toward a Science of Consciousness
Tucson Conference, April 4–8, 2006*

Is ‘Tucson’ turning too tame, as the reviewer of the last ‘Tucson’ conference Charles Whitehead (*JCS*, 2004, 11:12) feared? Or is it still wild and wonderful and weird as my earlier review in 2002 reported (*JCS*, 2002, 9:7)? Stay tuned!

Some 850 souls, psyches, animae, selves, and/or reflexive-beings (I’m not sure how many of each) attended the seventh biennial Tucson ‘Toward a Science of Consciousness’ conference; about 550 paying guests and some 300 students. Some students gave papers and posters and asked great questions (again I’m not sure how many of each!). Since one of the steps in developing a science of consciousness is to develop courses and students, the presence of so many students might be the greatest triumph of this conference — whether tame or weird.

Tucson hosted the usual array of pre-conference workshops on Monday and Tuesday, on philosophical theories of consciousness, William James’ contributions, visual neuroscience, empathy and ethics, entangled minds, reading EEGs, brain imaging, psychoanalysis, contemplation, skilful introspection, quantum aspects of consciousness, virtual environments, synaesthesia, and two methodological workshops: teaching consciousness and a guide for conference presenters (the latter by the erstwhile guide of my review). One wonders if Anthony offered¹ a workshop just to make sure that there were at

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[1] Just for the record, Anthony Freeman’s scheduled workshop on guidance for conference presenters was cancelled for lack of support. *Sic transit gloria* ... — Ed.

least *three* Freemen on the program (along with Walter and Ralph). I have never been able to go to a Tucson *workshop* because I would have had to miss 9 hours of teaching instead of just 5.

From Tuesday afternoon through Saturday afternoon there were 12 plenary sessions for a total of 26 speakers. In my usual compulsive conference-review mode, I missed only the first part of the first of those plenary speakers. Was I ever bored? Well ... Did I ever wish I were elsewhere? Never. The plenary sessions were almost as varied as the workshops, with foci on neural correlates of consciousness, a 'dream debate' on Freud's century-old theories, consciousness and vegetative states, cosmology and biology, meditation, distributed consciousness, higher-order theories of consciousness, John Searle (a topic in himself), visual fading, consciousness and the world as 'virtual reality', and a first-person talk by the highest-functioning autistic person I have ever heard of. All my comments about conference content will deal with plenary sessions, so that other conference goers have a chance to say, 'how the heck did Faw get THAT out of what xxx said?'

For conference goers still standing, there were buffets (what ever happened to smorgasbords?) of concurrent sessions on three afternoons, comprising 21 concurrent sessions, generally with 5 speakers each. Of course there were also 169 posters scheduled — but who's counting. You do the math! Giving so many opportunities for people to share their passionate contributions to our field encourages folks to attend and hear other people. Are you getting some sense of how much work the Center for Consciousness Studies of the University of Arizona puts into these extravaganzas? **Stuart Hameroff**, the conference director (and very active introducer and questioner), was assisted by other U of A stalwarts, Al Kaszniak, Uriah Kriegel, and Jim Laukes, and other associate directors. Many of us were delighted to see Tucson's prodigal son, **David Chalmers** — loaned out to Australia National University — in as big a public role as ever. (At the end of the last session, Hameroff thanked 'Dave for being Dave'!)

Instead of giving a plenary play by play, I will group consciousness content by basic themes, introducing plenary speakers along the way. Also, instead of inventing all kinds of cute opportunities to impress you with my wit, I will weave in the many humorous utterances given by speakers and questioners. The key to sparkling conference reviewing is to sit there quietly and write down everything interesting! Then if you convey it right, everyone who was not there this year will sign up for 2008. Stay tuned!

‘What’s Consciousness Got To Do ... Got To Do With It?’ Basic Questions About Consciousness

Walter Freeman started us off with his field theory approach to the big ‘C’, with three levels of analysis: the ‘microscopic’ level of analysis of neuron firings and connections, the ‘macroscopic’ level of correlation of behaviour with brain scans and waves; and the in-between ‘mesoscopic’ level of local field potentials and electrocorticograms measuring dendritic currents. Walter was followed by his ‘non-relative’ **Ralph Freeman**, who addressed neural-metabolic coupling in the central visual pathway. Ralph quipped that ‘consciousness is in the ascending aorta — if severed one loses consciousness.’ He used to tease about people searching for the ‘center of chocolate in the brain’ — only to find a publication on that. Ralph’s approach combines Walter’s microscopic and macroscopic levels in the LGN and V1 areas of monkeys. In V1 columns, visual stimulation leads to neural *activation* but an initial *lowering* of oxygenation, followed by a positive peak. Even activity-dependent cerebral blood flow occurs on a different spatial scale than oxidative metabolism.

Hakwan Lau concluded the first plenary by raising the awkward question that I shamelessly stole for my review title, ‘Are we studying consciousness yet?’ Lau had given the William James lecture at the last ASSC conference and appears to be Generation XYZ’s ‘wunderkind’ of consciousness research — taking that role away from the ‘aging’ David Chalmers, who has held that title for the past 12 years. The ultimate passing of the baton occurred when Lau mentioned that he had read Chalmers’ book 10 years ago, as a teenager! Oh my!

In terms of his title phrase, Lau showed a picture of activation of the frontal-parietal network which is often related to consciousness, and said that masked words activate the back of the brain, while visible words activate all over. Localizing consciousness too narrowly is wrong or useless or both — almost like saying that there is a lot of difference between a living man and a dead man. He agrees with Chalmers that visual consciousness includes not only acquiring information, but also phenomenal feel. Since some blind-sighted individuals can process a lot of information, we must not equate consciousness with information processing. Lau stated that dorsolateral prefrontal Brodmann Area 46 is the place where the dorsal and ventral visual streams converge; but that this might just represent the Neural Correlate of *Information Processing* (the ‘easy problem’) — not of *consciousness* (the ‘hard problem’). Perhaps global workspace theories,

Tononi, and others are just pinning down information processing, so that we are working in the ‘middle ground’. Lau remarked that he was not educated enough to discuss quantum mechanics.

In the Q/A, Allan Hobson mentioned that Area 46 is the only cortical area deactivated in REM. Another suggested that Area 46 activation is more related to goal completion than consciousness. W. Freeman criticized all talk about the brain ‘processing information’: with no numbers in the brain, there is no information. Instead, we describe what the brain does — by numbers. R. Freeman asked the other two if there is any agreement as to what ‘consciousness’ *means* or how to measure it. The audience laughed and Lau said ‘no’.² Lau went on to say that he doesn’t mean that *nobody* studies consciousness. Indeed, he made several comments about being a ‘devil’s advocate’, a ‘bad guy’; that he doesn’t want to be so mean, nasty, negative. (It occurs to me that we have never heard Dan Dennett — who I believe is the protoplasmic counterpart to Robo-Dennett [*JCS*, 2005, 12:12] — apologize for assuming all of those negative roles, all of the time.)

Continuing to raise basic questions about consciousness, in a much later plenary, Uriah Kriegel, David Rosenthal and Bob Van Gulick talked about what distinguishes *non-conscious* mental states from *conscious* states. **Kriegel** asked how ‘a slab of meat’ can have consciousness. Some see an *ontological gap* between brain and mind. He showed pictures of Descartes and Chalmers and commented that ‘all *dualists* must have the same hairdos’. He then showed a picture of *materialists* Dretske and Rosenthal and said that they are ‘more reasonable looking people.’ In Kriegel’s Self-Representational theory of consciousness, unconscious thoughts are just of the *world*, but a *thought* representing *itself* becomes *conscious*, with at least peripheral meta-awareness. Kriegel showed pictures of Koch, Farah, Tye and others who do not believe that consciousness requires meta awareness, with the comment that ‘being good looking does not do it’. He contrasted his view with Rosenthal’s ‘higher order theory’, in which meta awareness is *external* to the original mental state. Kriegel suggested a brain linkage for visual consciousness, with V4 representing ‘green’, dorsolateral prefrontal (DLPF) being activated by V4, and then V4 and DLPF being synchronized into a single brain state representing both.

In the Q/A, one questioner disagreed with consciousness requiring meta-awareness, fearing that it would rule out other species. Kriegel

[2] See pages 7–36 above for further evidence of the truth of Lau’s answer. — Ed.

responded that while Carruthers holds that most animals are zombies — ‘and says it happily’ — most other higher-order-thought folks maintain that there is some basic meta awareness in many animals. Hobson mentioned that in REM dreams the DLPF was off, so that meta awareness was low — and yet there is still consciousness. Kriegel insisted that the DLPF being ‘shut down’ is relative; but conceded that the presence of consciousness in REM does not fit nicely in his own theory, and that he is aware of this problem. (Good, because I do not believe that DLPF is even *needed* for ‘phenomenal consciousness’, just for high level ‘access’!)

David Rosenthal explained his ‘transitivity principle’, which states that a mental state M is conscious only if subject S is conscious of that state. One is conscious of the first-order (FO) mental state through some form of higher order thought (HOT) or higher order perception (HOP) upon the FO state. This HOT is conscious of the FOS, but not of itself. While the FOS might be a perception — without an attitude — the HOT may be a thought, wish, desire, doubt, or fear — *with attitude*. No content of the HOT is itself conscious, unless one directs a *third order* thought toward the second, in which case one is being introspective.

Bob Van Gulick’s theory is called HOGS (higher order global states). He talked about the ‘Ho’ in ‘Hogs’, which I assume was not the beginning of a gansta’ rap song. He begins with the FO state of Rosenthal and then an HO state, but the FO and HO are blended into a globally integrated complex. Thus HOGS are not reductive as HOTs are. He agreed with Kriegel that brain areas V4 and 46 might integrate their brain states, yielding non-local neural correlates of consciousness. The ‘meta’ in HOGS does not represent a separate state, but a global state. HOGS ‘present’ the content of the FOS, bring a unity to experience, and are self organizing. Van Gulick added to Kriegel’s statement that the ‘meta-awareness’ in his HOGS was not ‘too fancy’ (in distinction to Carruthers’ HOT) to be used by children and animals. Van Gulick believes that the ‘hard problem’ will be answered in the end. He concluded that since it is Tucson he would show a picture of local hogs (ground-hogs?). In the Q/A, Van Gulick maintained that there is at least a pre-reflexive self awareness in all conscious states.

In the panel-Q/A, Hobson seemed a bit frustrated with the sparse discussion of empirical data in this plenary’s presentations, asking the three HOT/HOGS if they read experimental journals and what they would look for in the brain. They all mentioned some of their reading, but Rosenthal added that he is sceptical about jumping straight from the brain to psychology. Max Stamenov mentioned that there are

different aspects of consciousness being addressed: Kriegel's primary consciousness; Rosenthal's cognitive secondary consciousness, and Van Gulick's relation between the two. A final questioner suggested that the one who mentioned the brain the least (Rosenthal) was the closest to how the brain works.

John Searle gave his speech on 'dualism revisited?' that I reported on in such delighted detail in my review of the ASSC last June. (Of course his was not the only repeat from ASSC to Tucson — Lau's and Tononi's sounded awfully familiar.) Hameroff began his introduction of Searle by observing that philosophers are using PowerPoint now — with one noticeable exception. Indeed, Searle used only two hand-written overhead transparencies in THIS speech. Searle admitted that his use of overheads was pretty pathetic, but that he had not been given a blackboard! He eschews use of PP out of sheer egotism — he wants people looking at him; rather than his being a guy wandering around in the dark while we look at the PP, which repeats what he is saying, anyway. Searle defined consciousness as states of feeling and awareness that start when you wake up and continue until you are knocked on the head, fall asleep or die. Except that dreams are a form of consciousness. Every conscious state is qualitative (even thinking that $2+2=4$); has first-person subjectivity, even to animals; has a unified field; and has intentionality, representing the world and ourselves to ourselves. In addition, subjectivity is irreducible (even the *illusion* of consciousness is conscious); consciousness is caused by and realized in the brain; and consciousness functions causally, leading to behaviour, and is thus not an epiphenomenon ('I decide to raise my arm and the damn thing goes up' — not: 'some days she goes up and some days she doesn't'). There are three stages in seeking neural correlates of consciousness (NCC): discover correlations between conscious states and brain states; test to see if it is causal — if one can turn consciousness on and off; and derive a theory.

Drawing general comments from speech fragments:

Guilio Tononi posited a 'common sense definition of consciousness' pretty close to Searle's: as what disappears when we fall into dreamless sleep, are anaesthetized, or hit in the head. Everything goes away. When we are skiing and focusing on our path we are in 'regular consciousness'; but when we are self reflective we are in higher order consciousness. He projected a consciousness ellipse with consciousness of the environment and higher order consciousness as small ellipses within it.

Doug Hofstadter mentioned this conference to his airport-shuttle Tucson Cab Driver, with the latter suggesting that ‘consciousness’ is ‘what is different between a telephone pole and a human’ (a rough definition of ‘creature consciousness’).

Peter De Weerd suggested that the components of consciousness are an awareness of things, objects, and ideas around us, and the ability to interact.

‘Shaboom, shaboom, Life Is But a Dream, Sweetheart’ Non-Waking States of (Un)Consciousness

Searle believes we are still in the early ‘correlation’ stage in finding NCCs, because we are not looking for the NCC of the unified conscious field (separating wakefulness from sleep), but for specific conscious content. Perception does not *create* consciousness, but just *modifies* the conscious field. In response to a questioner, Searle said he was not closing off other lines of research, but just challenging us to put more focus on conscious states. Under further questioning, Searle said that dualism might turn out to be true and we end up living after our bodies die, but the chances are not serious.

Q: How do you judge that?

A: Because I know a lot.

Hobson called Searle’s speech ‘music to my ears’, and then discussed Libet’s ‘free won’t’ findings with Searle. Searle closed by admitting that the search for ‘contents’ of consciousness makes it fun: ‘Like Wagner, the music isn’t as bad as it sounds!’

The cutely named ‘Dream Debate’ between **Alan Hobson** and **Mark Solms** (on the thesis that *‘Freud’s dream theory is misguided and misleading: It should be abandoned’*), at times turned into a *nightmare* debate with both clever and cutting comments back and forth. **Hobson** began with an appreciation about this meeting — which is similar to early sleep meetings, being truly interdisciplinary. Then he made several interesting statements about Freud. Freud was 50% right, because he called attention to dreams and to scientific study of the mind; but 100% wrong, because his dream theories were based on 1895 neuroscience. You do the math! If Freud were here, he would be delighted to learn what we have learned about dreams. Freud’s dream theory maintains that (1) dreams are fulfilments of wishes; which (2) are disguised and censored by the ego so as not to interrupt sleep; and (3) dreams are best interpreted by Free Association. These propositions are ‘misguided’ because they are based on 1895 neurobiology, which led Freud to state that people dream only

just before they wake, that brain and mind are stimulus dependent, and there are no brain inhibitory mechanisms, all of which are wrong. (Solms was later to dispute Hobson's reading of Freud.) Freud's theories are 'misleading' because Freud's content analysis was not rigorous. Hobson presented his own ASH and AIM theories of cholinergic modulation and aminergic demodulation during sleep, with brain activation in sleep being the dream instigator, not wishes. The loss of DLFP activation (re. Lau and Kriegel) represents not the loss of consciousness but the loss of the awareness of awareness (secondary consciousness), and selective limbic lobe activation — not repressed infantile sexuality — triggers emotionality in dreams. Hobson went on to say that it takes psychoanalysts 6 months to get meaningful dream reports, which Hobson's nightcap and dream diaries can get them in 3 weeks. Also, that psychoanalysts today do not use Freud's dreams as examples.

Solms 'gave back' in terms of repartee. He had not chosen this topic, and would have preferred that Hobson defend his *own* dream theory; or at least that Solms could defend *his* own dream theory. But, Solms could defend Freud, in scientific fairness, because Hobson has done an injustice to Freud. Hobson seems to have a strong need to prove Freud wrong. Solms suggested several ways in which Freud's dream theory can map onto modern neuroscience. The dominance of 'drive' and the quiescence of the Ego during dreams, map onto the dominance of the limbic system and quiescence of executive control systems. Dreams *are* the royal road to the unconscious, rather than being meaningless. The hallucinatory nature of dreams because of reduced Ego, ties in with the shutdown of prefrontal areas and the blockage of motor output in sleep. Dreams represent thoughts turned into pictures, and dream interpretation attempts to turn the pictures back into thoughts. The 'repression' of dreams is equivalent to the Ego coming back when awake.

Several times Solms accused Hobson of shifting between a number of different views of dreams, from (1) dreams being identical with REM; (2) dreams being epiphenomenal; and (3) REM causing dreams. More than once, Hobson responded: 'Show me the quotes.' Solms presented evidence of a double dissociation between REM and dreams, including that some 20% of dreams are held outside of REM, and lesions that stop dreaming are in the forebrain (cortex), not in the brainstem which is the trigger of REM. Because Hobson places both REM and dream instigation in the brainstem, his theory is wrong. Indeed, while Hobson accused Freud's theory of being un-falsifiable, he proceeded to try to falsify it.

They went back and forth during the rebuttals and final statements, adding some light but more heat. In what seemed to be an unfortunate charge, Hobson claimed that Solms never publishes articles in peer review journals, but, like Freud, only publishes books. Solms mentioned his own 300 or so articles and called Hobson's comments 'bad manners' — to wide applause. Last, and definitely least, during the discussion, Stephen LeBerge, livened-up the stale metaphor of scientists in a dark room trying to describe the elephant that they are touching, by suggesting that Freud had the elephant by the balls!

At the beginning of the Dream Debate, Chalmers alerted the audience that he would ask for a vote at the end on where people stand, and whether they had switched sides because of the debate. The estimated vote: 50 favouring Hobson's side (against Freud's theories); 100 or so favouring Solms'; and about 50 in-between. A fairly small number said they had changed their mind, with those who changed their mind to Solms' position about double those switching the other way. Chalmers, of course, reassured us that 'settling truth by democracy' should not be taken too seriously.

Nicholas Schiff, Melanie Boly (for Steven Laureys), and **Orlando Castejon** constituted a plenary on Consciousness and Chronic Vegetative States. **Schiff** talked about neuro-imaging of disorders of consciousness. In *vegetative states (VS)*, the thalamus is damaged, with severe bilateral grade 2 and 3 diffuse axonal injuries. In contrast, only 11% have diffuse cortical damage and brainstem damage is uncommon. The brainstem is trying to send sensory signals through the thalamus, but they are stopped, resulting in low frequency EEG. The wider thalamocortical structures are blocked. There is minimal awareness of self and environment in *minimal consciousness states (MCS)*, but no thalamus or white matter connectivity damage, and a pretty normal EEG. But there is grade 3 diffuse damage, often involving the corpus callosum; also leading to a functional loss of long-distance cortical networks and cerebral integration, beyond early critical areas. Thus, coherence between cortical areas is very low — when the patient is awake; while normal when asleep. During both vegetative states and MCS, there is only about 50% of normal cortical metabolism. Under questioning, Schiff said he would be surprised if stem cell therapy could form the networks damaged in these conditions.

Melanie Boly projected a graph whose Y axis was labelled awareness of contents of consciousness; and X axis level of conscious wakefulness; with various stages of wakefulness, sleep, coma, anaesthesia, MCS and vegetative states graphed into these two dimensions.

MCS and VS were listed as low in ‘awareness of content’, but high in wakefulness. In VS, the cortex is turned way down. In slow wave sleep and under the anaesthetic Halothane, brain activation is down to 45-65%. In *Vegetative States* there is severe bilateral damage to medial thalamus; and activation is especially low in frontal, anterior cingulate and parietal lobes, while the temporal lobe is almost normal. VS patients show little activity in the ‘pain matrix’; while those with MCS show normality. Auditory perception is low in VS but close to normal in MCS. MCS patients are responsive to their own name, thus self-aware. In recovery from VS, some of the thalamocortical and cortical–cortical connectivity is restored. In the *locked-in state (LIS)* the amygdala is hyperactive, presumably reflecting their anxiety and fear

Orlando Castejon spoke about severe brain trauma, explaining damage to just about every aspect of neurons, glia, and even blood-brain-barrier. Much of the pyramidal neuron membrane damage comes from excessive glutamate emitted into synapses, opening up post-synaptic calcium pores, and damaging calcium-dependent proteins. This damages dendritic spines, axons, myelin sheaths, microtubules, and vesicles. In this flurry of detail, Castejon mentioned two things clearly correlated with *loss of consciousness*: synaptic disassembly due to the calcium influx and damage to the blood-brain barrier. In the general discussion, Ralph Ellis asked whether the damage to synapses that led to loss of consciousness involved *inhibitory* as well as excitatory cells. A: glutamate excitatory cells. Stu Hameroff and Schiff discussed anaesthesia effects on GABA-B metabotropic receptors. I expressed my surprise to Castejon that damage to the blood brain barrier was specifically linked to loss of consciousness. I also asked Schiff if he agreed with Boly’s diagram that showed VS with high wakefulness (arousal). He said that VS has been *traditionally* linked with ‘wakefulness’, but that the slow-wave EEGs do not suggest that.

‘Ariggato, Mr. Roboto’ Complexity and Gamma Oscillations

Giulio Tononi gave a keynote address on his information integration theory of consciousness — in sharp contrast to **Walter Freeman’s** insistence that the brain does not process ‘information’. He gave a quick history of attempts to localize consciousness including a succession of different views by **Crick and Koch**, from 40 Hz, bursting neurons, layer V neurons, a mere set of 100 neurons, a particular gene,

neurons projecting to the prefrontal cortex, distributed neurons and the cortical-thalamic system. But Tononi cited **Freud** (positively) that localization is no explanation. He then cited his now-famous conscious versus unconscious contrasts: the cerebrum but not the cerebellum and wakefulness but not slow wave sleep. He identified as key aspects of phenomenal experience: first-person subjectivity and differentiation and integration. He defined (ϕ) as the amount of information integrated in a system, which is determined by a combination of differentiation and integration in a network. *Random* networks (as in seizures), '*uniform*' networks (where everything is connected to everything), *isolated* networks (as in the cerebellum, early sensory and motor areas, or even cortical-subcortical loops) and '*sparse*' networks (as in Alzheimer's) all have very low ϕ . High ϕ is found in '*patchy*' connections, where many small systems have extensive potential interactions (as in the thalamocortical system). In a statement that would make Dennett proud (but make W. Freeman and Lau cringe), Tononi declared that 'consciousness is a system's ability to integrate information'.

In a quick treatment of disorders of consciousness, Tononi cited as causes of *PVS* either losing gray matter in much of the cortex, thalamic loss that feeds to the cortex, or the white matter connections. His key neuroscience point was that the frontal to parietal lobe connections are deactivated in pervasive vegetative state, sleep, or generalized anaesthesia — presumably because they greatly reduce the high ϕ , *that IS consciousness*. What was not as clear, at least to me, was his explanation as to why consciousness is not divided when the brain is split (something about one ϕ of 72 being split into two ϕ s of 61 — you do the math!). Some very persuasive evidence comes from activating the right premotor area with transient magnetic stimulation and recording the pattern of MEGs — as activation travels from the stimulated spot. In deep sleep, a slow-wave activation remains quite local and dissipates in 150 ms; during wakefulness a fast-wave activation spreads widely and lasts for 300 ms. Information integration is clearly reduced in deep sleep. If consciousness IS a certain level of complexity, then we should be able to build a conscious automaton, and be able to detect specific qualities of consciousness at different levels of connectivity.

In the Q/A, Tononi maintained that there will always be *synchronization* at different time scales as an inevitable byproduct, but neither necessary nor sufficient for binding nor consciousness. Jaak Panksepp asked how Tononi's theory explains the fact that humans have emotional feelings even if their cortex is removed. Tononi

replied that he cannot explain all facets of consciousness; and that consciousness is graded. Hobson stated that REM and waking represent two states of consciousness with different patterns of connectivity. Tononi mentioned that TMS stimulation during REM led to a wave that moved around – but not as much as in waking, and that some of the later wave components are missing. He is not sure if the prefrontal area is less activated in REM. Later Tononi asked why people are afraid of the sentence: ‘*consciousness IS information integration*’; to which Hakwan Lau asked whether something as complex as ‘China’ would have high phi and thus represent one consciousness. Tononi replied that ‘China’ would be like the internet or the cerebellum; one has to have both specificity and integration.

Well after Tononi’s session, I thought of my ‘perfect responses’. Tononi is an extreme functionalist. If you get sufficient phi complexity you have consciousness. But his contrastive studies between wakefulness, sleep, vegetative states, and the like, all involve people with ‘wetware’ (not silicon hardware) and specific circuits connected in specific ways (not just ‘complex circuits’ in general). It may be that protoplasm and the linkage of specific patterns — as well as extent of complexity — are crucial for consciousness. Then, when the protoplasm is lesioned and/or specific patterns are disconnected, we have unconsciousness. It seems to be a huge leap to assume that it is only the phi of connectivity that IS consciousness.

Michael Bennett presented the one absolutely new thing I heard at the conference: that the famous *gamma oscillations*, which are generated during higher level processing in the nervous system (and which many — but not Tononi — link with consciousness, itself) are synchronized by *electrical synapses* between neurons. Most neurons have the connexion genes for electrical transmission and the genes for chemical (neurotransmitter) transmission. Early in development most genes develop the gap junctions used in electrical transmission, which only a small minority retain in the adult. Most cortical neurons can release either glutamate excitatory or GABA inhibitory neurotransmitters. Electrical gap junctions allow GABA cells also to be excitatory and to synchronize with other GABA cells. GABA interneurons are the pacemakers of gamma oscillations, so that projecting neurons and down-stream neurons are synchronized by inhibition. There is not much coupling between pyramidal cells. Bennett began with the revelatory statement, ‘I think I’m conscious.’ He said this because of alleged instructions to presenters from Hameroff and Chalmers, to (among other things) ‘deal with consciousness’. At the end of his speech he cited Cajal’s century-old comment that Teddy Roosevelt

was the US's most pugnacious president. Bennett said he wasn't sure we have not surpassed that now.

'You're Nobody Until Somebody Loves You' First And Second Person Relations

Having long forgotten that **Doug Hofstadter** was the co-author with Dennett of *The Mind's Eye*, a book I had read 20 years ago and thoroughly enjoyed, I thought from the title of his speech, 'Strange Loops, downward causation, and distributed consciousness', that Hofstadter would deal with quantum effects and other esoteric issues. It was, instead, a very lively but mainline presentation. Chalmers introduced Hofstadter as having been his dissertation advisor and as having led Dave to get into this field (partly through *The Mind's Eye*), as well as having drawn many into the philosophy-of-mind field. In response Hofstadter said that he admired Dave, even though they did not see eye to eye. Hofstadter called his talk horsey and doggy — personal and down to earth. He called himself a 'vegivore', protesting that 'we don't protest at dog pounds' as we should. He confessed that he still swats mosquitoes (which he considers one notch above a thermostat) — without worrying about it. He also wondered what 'is it like to be a' tomato. Hofstadter illustrated the fear of self-references and loops by reporting that a video camera salesman tried to stop him from pointing the camera to the monitor to which it fed, shouting, 'You'll break it'. This led to the heart of his talk: that we are all 'distributed souls', represented in many other brains. Our own brain has the largest representation of ourselves. If we had more representation in others, perhaps that would become our brain. Hofstadter paused to confess that he is not sure if he got that insight from Dennett or made it up himself. In a thought experiment called 'Twinworld' he suggested that newly-born twin boys were called 'Two-Son'.

In the Q/A, Hofstadter maintained that, consistent with Dennett's 'intentional stance', in some sense there is no 'I' there at all; but to think of ourselves, we need an 'I'. To which someone responded, 'No one lives in me or I in them.' A questioner mentioned that Terri Schiavo existed more in the press than she did in her own mind — toward the end of her life. But, Hofstadter maintained that Schiavo was much more feebly in the press than in her parents' and husband's brains. Chalmers challenged his mentor, by asking why he was a vegetarian when he admitted that animals do not have much self-representational abilities. Hofstadter mentioned a time when he saw several chickens running around and realized that he could not kill a chicken

— or a fish. Chalmers then asked about a person lacking in intelligence with no interaction — would Hofstadter kill that person? Hofstadter responded to Chalmers, ‘what you are saying is incoherent’ — which brought some applause.

One of the special treats of Tucson conferences is their **First Person Key Note Address** by someone who has some special irregular aspect to her conscious life — but is coping quite well and has studied a lot in consciousness studies. That person at this conference was **Temple Grandin**, whom Hameroff called the ‘world’s most accomplished autistic’. If she had not called herself autistic, I would have assumed that she had Asperger’s, except that she had no speech until she was three. She designs livestock equipment and teaches in animal sciences at Colorado State. Grandin’s title and theme was ‘I think in pictures instead of language.’ She claims that all of her thoughts are images — as must be the case with animals — but that language serves as a narrative for the images. (Autistic persons with visual cortex disorders do not think in pictures.) She claims to think with what would be for others the *subconscious* part of their brain. She has only specific images. She has certain basic emotions, but she has had to learn how to be emotionally related with others. Still, she can make decisions without emotions — in contrast to Damasio’s theory. She reports that she is very poor at foreign body language. Grandin invited the audience to ‘google’ her images by giving some word or phrase. Some examples: ‘materialist metaphysical paradigm’ triggered images of Madonna, a fortune teller, and a travel agent. ‘Nevertheless’, triggered Captain Hook in Never-Never Land; ‘invisibility’ triggered the Invisible Man. Chalmers suggested ‘consciousness’, which triggered an image of Dennett’s book. Chalmers also proposed ‘zombie’, which triggered an ambient pill.

‘On a Clear Day, You Can See Forever’ Illusions and Virtual Reality

Susana Martinez-Conde, Daniel Simons, and Peter De Weerd spoke on Visual Fading (Plenary 10). **Martinez-Conde** talked on the role of fixational eye movements in visual awareness. ‘Visual fading’ refers to some peripheral object becoming invisible, while we are fixated elsewhere (Troxler Fading), as well as to objects disappearing while we are fixating on them, without eye movements, through retinal stabilization techniques ‘Filling in’ is bringing in surface information that is not really there (like in a blind spot of the retina). In addition large eye-movement saccades, our eyes make smaller motions called

microsaccades, slow drift, and micro-tremor. It now seems clear that binocular micro-saccades (with neuronal responses in the LGN and V1) prevent fading. Through use of a visual jitter illusion, she finds evidence that the suppression of micro-saccades is not in the LGN or V1, but in the dorsal stream, seemingly in LIP.

Follicle-challenged **Dan Simons** made us homesick for Alva Noë. It was announced that Simons' work on change blindness had landed him one of the Ig Nobel Awards. Simons talked about the upsurge of interest in the counter-intuitive 'failures of perception', such as visual fading, change blindness, inattention blindness, repetition blindness, attentional blink, and motion induced blindness. Such 'blindness' and 'un-awareness' often involves shifts of attention. After mentioning Troxler fading and retinal stabilization, he introduced 'induced fading', in which entire scenes fade to a uniform hue during normal fixation and attention. When there are flashing dots in the scene, the fading is greater. This seems to be due to contrast decrement. Then Simons showed several scenes of change blindness (CB) — the opposite of fading, because one does not see what has changed — where awareness is limited by attention. Simons criticized Noë's interpretation of CB as suggesting that we really form sparse representations. Noë's view is 'at best not clear and at worst completely wrong', since CB tells us nothing about representation in the head — whether sparse or rich.

Peter De Weerd talked about perceptual filling in. Our retina and visual system focus on edges and other transitions. An awareness of surfaces is a reconstructive process. Dissociating consciousness from physical stimuli allows us to study the circuits that usually drive perception. Normal surface perception and 'filling in' probably use the same mechanisms. He showed evidence that early stages in the visual system (probably V2 and V3) are involved in filling in — in areas where the cortex magnifies foveal processing areas. Attentional mechanisms are also in play.

In the last plenary session, **Marie Sanchez-Vives** spoke on the use of virtual reality to study consciousness. She presented pictures of several virtual reality tasks, where people put on the headset and interact with various situations and people in immersible virtual environments, such as the 'cave', pit room and a virtual audience for public speaking. She measured for 'presence', which means acting and responding as if the setting were real — even when they are visually sparse or cartoonish. In the 'pit room', most people walk gingerly around the edge of the room, avoiding the virtual 'pit' drop off covering the middle of the room. Most interesting were virtual audiences.

Participants prepared a brief speech prior to the virtual experience. In the latter, they had a virtual audience which either showed positive audience behaviour — like paying attention, nodding, vocalizing and applauding — or negative behaviour — like avoiding attention, falling asleep, or walking out. Participants showed autonomic changes consistent with the experimental condition, and said consistent things during and after the experience — commenting how much the positive audience ‘loved me’ and made me ‘feel great’; and getting upset with the rude audience, even yelling at them and telling them to sit upright. Sanchez-Vives considered different explanations for ‘presence’, such as: ‘virtual experience works because reality is virtual’; we don’t use much information in real encounters (as in various illusions); and perception is an active process relying on sensory correlation (such as in the rubber hand illusion).

Steven Lehar began his talk, on the dimensions of visual awareness, with the obvious fact that visual experience is spatially structured, but then asked if that is a characteristic of the ‘experience’ or of the ‘outside world’? He explored ‘direct perception’ theories which posit the latter: ‘indirect perception’ which puts the spatial characteristic in the ‘representations’ (so that the world is virtual reality); ‘projection theory’, in which the spatial structure is created by the brain and then projected out to the world; and ‘eliminative materialism’ in which the spatial experience is an illusion. Lehar concludes that visual experience is spatially structured. He ends up with an indirect perception representationalism, from considering the ways in which the visual system uses perspective and size/distance tradeoffs to encode infinite space into finite experience.

‘Still Crazy, After All These Years’ Those Things That Make Tucson, Tucson

So far the exposition of the conference seems to confirm Charles Whitehead’s fears that Tucson is turning too tame. But Tucson was still Tucson. Just watch. The following comments were scattered throughout the conference, but collected here for impact. Some of the issues and comments were made by plenary speakers and some from questioners.

In response to a question about *hallucinatory drugs* and consciousness, Walter Freeman said that Huxley’s *Doors of Perception* (where hallucinatory drugs were thought to *clean* the doors) is a misconception. Huxley saw the disordered products of his own mind — not raw sense data. In further response, Ralph Freeman cited Colin Blakemore

as talking about ‘the stoned age’, saying that ‘there is no revelation there’.

A questioner suggested to Ralph that consciousness can be in a *pure form* — a state where all neuro-centres are active. Ralph did not dismiss this comment but suggested ways of studying levels of consciousness. In response to a question about the *placebo effect*, Ralph mentioned the recently published ‘*prayer*’ study, showing no difference in medical recovery among those who knew they were being prayed for. Another questioner added that in that study, those being prayed for actually showed adverse reactions. That questioner went on to mention research with subjects being shown pornographic and neutral pictures, where they found brain responses BEFORE porno pictures would be shown — a pre-response to stimuli. Walter responded to that, suggesting there might be a Libet effect.

In Michael Bennett’s Q/A, a questioner talked about near-death experience as if she had no metaphysical doubts: wherein the patient, who is dead on the table, is alive and well on the ceiling, recovers and tells about the surgery. She suggested that this means that consciousness is completely separate from the brain and that we can function without it. Consciousness can affect brain activity. There really is a ‘ghost in the machine’. Consciousness precedes matter and is all explanatory. To which Bennett replied, ‘That would not help me in my research.’

Plenary 5 was on Meditation and Consciousness. **John Dunne** gave extensive description of some Tibetan meditation techniques and several methodological issues in brain research on it. Research on meditation needs to bracket the metaphysical claims — since they are not scientifically tractable now. Still, several of the claims and experiences of meditation techniques relate to more mainline consciousness theories and may be testable, such as the experience of meditation ‘training the mind — developing traits by cultivating states’; focused attention; claims of ‘emptiness’ or lack of content in some conscious states; and the assumption of reflexive aspects to any instance of consciousness.

Antoine Lutz followed with a focus on neuroplasticity resulting from meditation’s ‘training the mind’, and the neural correlates of first-person subjective experience. Lutz reported on EEG studies of practised meditators and briefly-trained novices, during episodes of ‘resting’ and ‘meditation’, in which they measured both the amplitude and long-distance synchronization of gamma (25–42 Hz) waves and lower amplitude alpha waves (4–13 Hz). Practised meditators showed higher amplitude and greater synchronization of gamma during

meditation than the controls and showed greater gamma carried over to next baseline — showing short-term plasticity. They also found high correlations (e.g., $r = 0.69$) between gamma activation and self-report of ‘clarity of mind’ during meditation. In fMRI work cortical activation was found during Compassion Meditation in areas involved in rewards, experiences of emotion and social behaviour and Theory of Mind.

The session’s third speaker, **Marilyn Schlitz** is involved in a wide range of research in bridging western science and eastern meditators, studying contemplation, prayer, and so forth, with the Institute of Noetic Sciences. Schlitz thanked Hameroff and others for ‘holding ground for consciousness studies’ and for selecting her to ‘help with gender balance’ (she was one of 5 women out of 26 plenary speakers). Schlitz also referred to the Tucson conference’s focus on integrating first and third person perspectives on the phenomena of mind. She referred to the intelligence of the heart and gut. She challenged the statement made by Dunne that some things cannot be studied scientifically. Schlitz mentioned experiments where caregivers held compassionate feelings for their cancer patient loved one in the other room. Autonomic nervous system measures changed when they ‘held compassion’, with a corresponding ANS change in the patients. When asked by a questioner for specific ANS measures and results she said that she had not expected to be asked about data (what was *her* view of the Tucson conferences, I wonder?), but knew it was related to GSR, HR variability, respiration and skin-temperature. She is also involved in distant healing, prayer, compassionate intentions and heart-opening practices. In response to a Sudanese questioner, Schlitz agreed that the heart is a sense organ (and not only a pump) and that it embodies consciousness. Another questioner asked about glossalia and training children in ‘spiritual speech’. Schlitz has not done this.

Paul Davies’ lecture was on ‘life and consciousness as emergent phenomena’. He laid out many basic quantum terms and phenomena in a clear way: quantum indecision, superposition, entanglement, quantum clock, coherence, decoherence, and gravity. Then, in an admittedly wildly speculative tone he suggested that the conditions for life and consciousness might be limited by quantum effects, and that the former might have harnessed quantum effects to improve performance, so that quantum mechanics might be their midwife or at least helper. Time keepers in cells might be quantum clocks; proteins might fold at a quantum edge; decoherence may be the killer; and thoughts move muscles through downward causation. He closed with the challenge to find the physics of consciousness, not just the

neuroscience. One questioner talked about the role of cosmologists who work with such concepts that only 4% of the matter in the universe is like what we observe on earth, and that there may be many universes, with ours just happening to be good for life.

Paavo Pylkkänen, who drew something of a short straw as the final plenary speaker, talked about the phenomenal structure of consciousness in the ‘implicate order’ framework. He began by promising to say something about the *hard problem* at the end, because he is at this conference and wants us to feel that we get our money’s worth. He suggested that phenomenal studies show consciousness to be *virtual reality*. Consciousness is the virtual reality association between brain and body. But this seems counter-intuitive. ‘Objects’ appear to be out there. He raised issues of infant and animal consciousness, anaesthetic states, religious and sexual experiences, and altered states — including the ‘End of Consciousness Party’, just announced by Hameroff. Pylkkänen explored David Bohm’s ‘implicate order’ framework and Pribram’s holograms-nature of conscious brain states. He speculated about quantum holography, in which real space and time are derived from deeper structures. Then he closed with his promised remarks on the ‘hard problem’ — with ‘1.51 seconds left’ in his talk. Consciousness as virtual reality helps. The hard problem is how we are conscious of these representations. Proto-panpsychism might help; perhaps electrons have proto consciousness. He then plugged the Quantum Mind 2006 conference coming up in Salzburg.

In his Q/A, someone asked about ‘stillness’.

A: The right thing to do would be to be quiet!

Q: Might there be more than 4 dimensions?

A: 3 + 1 will do.

Hameroff asked about some form of coherence. One questioner referred to the Dire Straits song line: ‘we have just one world but we live in different ones’. One student who was often taking mics to questioners asked the last question: Is the brain itself a construct? Pylkkänen suggested that if we do not need the brain we are left with solipsism. If we assume there is no real world, why talk with other people? We need one fundamental level, but that might be consciousness or the brain.

Still Tucson, after all these years! See you in 2008!