

Bill Faw

What We Know and What We Don't About Consciousness Science

A Review of ASSC-9 at Cal-Tech, June 24–27, 2005

General Information about the Conference

How often have you said you will not attend conferences where your pre-conference workshop was not accepted or your proposed prime-time paper was turned into a late-night poster? Given that propensity, it was great to see several prominent consciousness scientists and philosophers attending ASSC-9, even though they played no (or only a minor) official role. Their active involvement is a tribute to ASSC conferences being *major gatherings of the 'consciousness community'*. Many of them were more officially involved in the pre- or post-conference satellite meetings: 'Neurophilosophy: The State of the Art' (June 21-23) and 'Problems of space and time in perception and action' (June 28). In terms of greats in the field, the assembly honoured the late-greats Francis Crick and Joseph Bogen.

Christof Koch hosted the programme for his home-town 'technical school', giving announcements and introducing introducers. At times Koch must have felt like he was herding solipsists, especially once when, because we were running late, he announced that a scheduled 30-minute coffee break would be 'a short 10 minutes'. Needless to say, it was a full half hour before he could resume the sessions. **Patrick Wilken**, in his organizational remarks to the conference, called us a *membership conference* of an *Academic Society*, mentioning that our membership has grown from 340 last year to 480 this year, with about one-third being graduate students. In response to the latter fact, the organizing committee developed a student prize presentation and a student social event this year. They also lined up the **Mind-Science Foundation**, who served as a conference sponsor and gave **Tom Slick Research Award in Consciousness** grant money to the five scholars comprising the first plenary symposium of this conference. (The

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Foundation is waiting to hear from YOU regarding YOUR research project!) Related to Wilken's reminder that we are an *Academic Society* was conference science-committee member **Tim Bayne**'s comment, in his talk's Q&A, that the Right Hemisphere is not a 'vast zombie system'. To say that, Bayne continued, would be to say that aphasics and monkeys are zombies, and '*as the consciousness community*, we don't want to do that!'

There was less talk than often about first-, second-, and third-person perspectives at this conference, but the dynamic interaction among these three perspectives came into play in many ways. **Allan Hobson** started out his morning talk on sleep with a wonderful *first-person revelation*. He woke up that morning with a sense as to how to cut his lecture in half, to fit time constraints. His unconscious and conscious were in constant communication — the conscious being a way of reading the rest of the brain, he reported. In the Q&A of Henrik Ehrsson's talk **Tom Metzinger** talked about his own *first-person experience* as a subject in a rubber-hand experiment.

Many have said that more important learning at conferences occurs from active *second-person dialogue* with other conference participants than from passive *third-person lectures*. I had especially good talks with some people I have talked with at repeated conferences, such as Luxembourgian Claude Pasquini, Don Dulaney, Bernie Baars, Axel Cleeremans and Ned Block, as well as a new friend, Stewart Sanson. I will especially cherish long talks with Pasquini about animal consciousness, during which his enthusiastic 'pan-sensationalism' and 'pan-sense-of-self' views kept bouncing off my harder-nosed suggestion that *frogs* might not even have perceptual consciousness. We'll pick up that dialogue later.

I experienced a couple of powerful experiences of sudden *second-person encounter* leading to strongly focused *first-person self-consciousness* (a robust finding in social psychology's 'Objective Self Awareness' — a 4-decade-old research programme in self-consciousness, strangely ignored in modern consciousness science). First, I spent most of the conference sitting in the front row so I could take digital photos of many of the PowerPoint diagrams projected onto the screen, so that the substantive part of this report would have some rootage in fact, for a change. But when Koch sat beside me, I had a strong inner conviction of the moral ambiguity of such intellectual piracy and refrained from taking pictures for *that* session. When Hakwan Lau sat next to me during the *next* session, I resumed my shady practice. My second experience of second-person encounter leading to first-person self-focus was the time I stood in front of the middle of five fully-occupied urinals, placed 6 inches apart!

The Non-Theme of the Conference

This seems to be the first time that the Association for the Scientific Study of Consciousness (ASSC) has not had a theme (such as ASSC 1-8's themes: Implicit Cognition; Conceptual Issues; Self; Unity of Consc.; Contents of Consc.; Language; Models & Mechanics; and Empirical Issues). Instead, the

conference claimed to feature the most recent developments, especially of issues that have only been tangentially addressed at previous meetings. Clearly no one of its annual meetings can deal with all aspects of consciousness science, but that should be the goal of the ASSC over time.

State Consciousness vs. Access to Contents of Consciousness

There were several mentions in the conference of at least two different uses of the term ‘consciousness’, each of which has its own neural correlates. I am going to recklessly abandon the carefully-planned chronology of the conference and organize this review of plenary talks into basic aspects of consciousness science. This might be helpful in plotting ASSC’s coverage of the field in next year’s conference and beyond.

In the grand biblical tradition of ‘the last shall be first’, we begin our review with the last address, by **John Searle**, ‘Dualism Reconsidered’, not to address his familiar battle against both materialism and dualism, but to address a conviction and a poignant concern. Searle’s *conviction* is that ‘consciousness’ is one of the rare philosophical problems that will have a scientific solution. (Wouldn’t that be special!) His *poignant concern* is that, in seeking the scientific solution, it is more important to find the neural correlates of *what makes creatures conscious* (versus in a deep asleep, coma, vegetative state, etc.) — what Searle calls the ‘*unified fields*’ question (‘state consciousness’) — rather than the more frequent task of finding the neural correlates of *perceptual consciousness* (contents of consciousness), which merely modify the pre-existing conscious field — which Searle calls the ‘*building blocks*’ line of research. THE neural correlates of consciousness (NCC) are involved in getting to be conscious in the first place, and should advance the field more powerfully than the search for the building blocks.

State Consciousness

So, let us first see what this conference said about ‘state’ consciousness. Several speakers made brief reference to this basic use of the terms ‘conscious/ unconscious’, with its various questions: (1) is the person ‘clinically conscious’ or ‘clinically unconscious’ when awake, asleep, in a vegetative state, or coma? And, *if* conscious, (2) what *kind* of conscious state is s/he in (awake, sleep, trance, etc.)? And (3) what inputs, contents, and control can that person have in that state? They then contrasted the ‘*state*’ question with the ‘*content*’ question: given the normal waking state, what neural correlates determine the ways various perceptual or other ‘contents’ have ‘access’ to the consciousness of a person in a conscious state? Then *almost everyone* dealt with the content/building-block questions.

There were only two talks that directly addressed the ‘states’ issues: **Allan Hobson**’s on the so-called normal conscious states of waking and dreaming and **Steven Laureys**’ talk on pathological states involving wakefulness with limited or no awareness. Most people agree that basic wakeful and dream-sleep brain

arousal occurs through an ascending brainstem acetylcholine circuit projecting through thalamic-intralaminar nuclei to all areas of the cortex — the ‘vertical’ network needed in states of consciousness (Dehaene). This seems to be Searle’s basic NCC. **Allan Hobson** mentioned acetylcholine being involved with waking and dreaming and the ‘amines’ (norepinephrine, serotonin, and dopamine) being active during wakefulness, but not sleep, and about brain-activation differences between waking and REM sleep. REM’s *deactivation* of posterior cingulate and primary sensory areas lessen attention-to and processing-of new sensory information. The downward decreasing of muscle tone prevents most motor output despite primary motor activity, while reduction of premotor and prefrontal areas decrease motor planning/preparation and reality monitoring. *Increased* activation of other perceptual and limbic areas increase the strength of fantasy. Hobson noted that, thus, the *dorsolateral prefrontal is correlated with Waking Consciousness, not with Consciousness per se*. We will come back to this.

Steven Laureys mentioned the ‘vertical’ *state-consciousness intralaminar thalamic-cortical circuits*, but focused much more on the ‘horizontal’ *long waking-state cortical-cortical connections*. more often related to the *contents* of consciousness issues. Brain scans when sleep-walking (imagine those logistics!), or in absence seizure, temporal lobe epilepsy, minimum conscious state, akinetic catatonia, and vegetative state, all show *reduced firing in these frontal-parietal networks*. In vegetative states (VS), there are just islands of cortical activation but few connections, compared to the same person (before and/or after) in the normal waking state. (**Dehaene** had also presented brain scans showing metabolism in a broad fronto-parietal-cingulate circuit correlating with the *state* of consciousness, between a waking and vegetative states, coma, slow-wave sleep and general anesthesia.) **Laureys** pointed out that, in distinction to VS and minimally-conscious-state patients, are ‘*locked-in syndrome*’ patients who are evidently aware of what is going on around them, but are unable to give responses except for eye lid movements. They seem to have intact cortical connections but have severe damage to brainstem motor output areas.

The first question in Laureys’ Q&A asked about specifics in the Terri Schiavo case (which had been listed in Laureys’ talk title, but about which Laureys said little) and the related *Panksepp* question regarding whether consciousness begins in the cortex or back in the brain stem. Laureys replied that he had been contacted by Terri Schiavo’s parents’ lawyer and decried the dominance of politics and religion, rather than science, in the debate. In regard to the Panksepp part of the question, Laureys stressed the need to seek consensus-based definitions of ‘consciousness’, as happened a few years ago with ‘pain’ in the pain community. Later, **Bernie Baars** suggested to Laureys and me the possibility of the ASSC sponsoring a small workshop with the top people in the field to work on such definitions — for at least the ‘clinical’ aspects of consciousness. *Perhaps this gathering could occur just before or just after ASSC-10 at Oxford!* Invite Laureys, Panksepp, and Frith for starters!

Access to Contents of Consciousness

Here the question is not ‘is this person conscious or not; or in what state?’ but ‘what does it take for a specific content — a percept, emotion, memory, mental image or bout of self-talk — to become a *content of one’s consciousness*, rather than being *processed unconsciously*?’ It is not at all that the person is in a state of *unconsciousness* until she sees the item projected to her left eye (Tononi). It is to this general category of consciousness that the multitude of experimental paradigms belong that involve such terms as implicit, masked, subliminal, binocular rivalry, attentional blink, change blindness, after images and effects, and various memory and attentional manipulations. These are Searle’s ‘building blocks’ methodologies. Many brain disorders also address this second use of the term ‘conscious’. But, instead of ‘VS’ or coma, one learns about the ‘access to content’ question from blindsight, neglect, extinction, agnosias, anomias, receptive aphasia, and the like.

Most ASSC meetings have put a high emphasis on *visual consciousness*, showing the strong influence of the Crick and Koch selection of that as a way to get at the NCC of consciousness. In fact, **Randolph Blake** began his talk by citing Koch’s observation that vision is a good modality to study — because it is easier to deceive than others! Indeed, most of the ‘content’ focus at this conference related to visual perception.

ASSC president, **Stanislas Dehaene**, spoke on the timing of conscious access, with special focus on the ‘*attentional blink: AB*’ (we cannot detect a second target in a sequence if it is presented within 200–300 ms of the first target). Dehaene sees the AB as a case of one stimulus temporarily blocking access to consciousness by the other stimulus. The detected and the ‘blinked’ target are both processed for more than 400–700 ms in the visual system and amygdala; but diverge in the characteristics of their evoked potentials at around 300 ms, when the conscious target activates additional ‘horizontal’ long-distance cortical circuits, involving anterior temporal, parietal and prefrontal areas. External sensory stimuli that gain consciousness have bottom-up feed-forward *propagation*, followed by top-down feed-back *amplification*. (On the light side: Dehaene, who is French, said that he was from ‘old Europe’ and had been afraid that becoming president of ASSC would mean too much work; but then he came to realize that in the United States, being a ‘president’ does not mean doing a lot of work.)

Christof Koch was one of several who dealt with the *primary visual area (V1)* — which he, for some time, has considered ‘necessary’ but not ‘sufficient’ for visual consciousness. Consistent with Dehaene’s report, stimuli that are *perceived* and those that are ‘masked’ or ‘blinked’ or ‘suppressed’ by binocular rivalry (BR) all activate V1 and much of the intermediate and some of the later visual areas, on their feed-forward propagation. Then only those stimuli that are *consciously perceived* involve top-down attentional mechanisms that move backward through the visual processing areas (from higher to lower, all the way to V1) to reactivate them. Activation then disappears when attention is directed elsewhere. In a crucial statement, Koch said that we are not sure we can differentiate a BOLD response to ‘*awareness*’ from ‘*attention*’.

Koch then talked about person/object-specific cells in medial temporal lobe, such as firing specifically to pictures of one of the following: Jennifer Anniston, Kobe Bryant, Mother Theresa, the Sydney Opera House or the Tower of Pisa. These code not for physical attributes, but for very abstract representations used for encoding new memories and assessing new stimuli for familiarity. (Koch commented toward the end that people will remember that ‘yesterday there was this weird scientist talking about Jennifer Anniston cells’. At one point, Koch got a bit tangled up in words and quipped: ‘with my accent, I talk like our governor does’. Koch’s comment was not the only reference to Cal-i-for-nia’s governor. During his Tutorial on emotion, Ralph Adolphs had a slide that compared brains of the tree shrew, monkey, chimp and human. In each case there was a diagram of the brain and a picture of the animal. For the human, he had a picture of Arnold.)

Also dealing with vision, **Randolph Blake, Geoffrey Boynton, David Leopold, and Shinsuke Shimojo** constituted a plenary symposium on visual aftereffects and the NCC. For a few years we have had presentations on *Binocular Rivalry: BR* (when visually-incompatible objects are projected to separate eyes, the objects alternate back and forth, about every 3–4 seconds, as contents of visual consciousness), but Blake, Leopold and Shimojo are now using binocular rivalry and ‘crowding’ to test various forms of visual aftereffects (AE) — sort of ‘higher order experiments’ — specifically to see what types of visual adaptation AE occur in the absence of visual awareness. The logic is that the AE will occur to a BR-suppressed stimulus only if the after-effect adaptation occurs *before* the site of BR suppression. If the AE is processed *later* in the visual system than suppression, then the AE should not occur to the suppressed stimulus. Some AEs, such as the ‘tilt aftereffect’ (look at 3 parallel lines tilted to left, then when shown vertical lines, they will appear to be tilted to right), *are not diminished* by BR-suppression, suggesting an early processing area for the tilt effect. Others, such as Face identity and expression are strongly diminished by suppression, suggesting a late processing area for them. Across these studies, there is evidence for BR suppression in *VI* but also in late processing areas. While the direction is not clear, BR suppression might *start* in higher processing areas and send activation back to *VI*.

Taking a different tack in the symposium, **Geoffrey Boynton** talked about ‘perceptual deterioration’, a specific perceptual adaptation, during a long day of being a hapless subject in visual experiments, which disappears with a change in the target orientation. This task shows fMRI reduction in *bottom-up stimulus-driven responses* to targets in *VI* (over the day), but not in *top-down attention effects*, nor related to general fatigue. It was nice to receive a new term for the brain numbness coming from compulsively trying to take in every word in a stimulating conference. Evidently being the *experimenter* of such tasks is also perceptually deteriorating, for Boynton said at one point: ‘I hate this task!’ (another great first-person report).

One of the plenary symposia was on *Space and Time*, with two-thirds of that in (what else?) visual perception. **David Burr** talked about how saccades (constant eye jumps to take in the visual scene) cause relativistic mis-perception of time

and space, using the selective suppression of the visual magnocellular pathway. Suppression of *space* is deformed when stimuli are flashed shortly before or after the onset of a saccadic eye movement. The apparent *temporal* separation of two briefly-flashed bars is halved when presented near saccadic onset, with *perceived temporal order consistently reversed*. Suppression may begin in the thalamus, but includes the parietal and prefrontal areas.

After Burr's talk, **Romi Nijhawan** dealt with motor space, visual space and the flash-lag effect (a flashed object presented in alignment with a moving object is seen as trailing behind the moving object). The motor flash-lag suggests that the visual, touch, and motor domains are 'differentiated versions of the same, undifferentiated, proto central nervous system'. This is consistent with the presence of dual-modal vision+action and vision+touch neurons in pre-motor cortex. An output of one modality (object-position given by visual system) can be related to output of hand-position given by motor system, but not to some idealistic 'really' given position. To me, what this points to is the fact that the intraparietal sulcus seems to code visual, tactile, and auditory input into 'egocentric' coordinates. We will pick up Burr's and Nijhawan's talks again under 'special relativity'.

Frontal-Parietal Connections: Consciousness or Control?

We have mentioned already **Laureys'** findings that in vegetative states there are just islands of cortical activation, but few connections; **Dehaene's** report of this fronto-parietal-cingulate circuit correlating with the *state* of consciousness and involved when conscious target *content* make it into consciousness; and **Koch's** finding that only stimuli consciously perceived involve top-down attentional mechanisms. In her concurrent address, **Lucia Melloni** showed evidence that both masked and visible words elicit gamma waves, but only the visible ones show phase locking *gamma synchrony* 100 ms after presentation. This suggests long distance synchronous activity.

In a symposium on *hypnosis*, **Graham Jamieson** focused on a *dissociation between consciousness and control* in hypnosis, with dual (not split) awareness of suggested and actual realities and absence of awareness of the self and hypnotist as intentional agents. *Gamma synchronization* shows less integration between cortical areas in hypnosis, indicating decline in executive control over representations. In the terminology we have been using in the last few pages, the long-range cortical circuits that bring perceptual objects or memory traces into our consciousness are manipulated in hypnosis. **Richard Brown** pointed to the dissociation, in hypnosis, of *posterior attentional* systems (that determine the contents of consciousness and trigger automatic behaviour) and *anterior attentional* systems (involved in self-awareness and willed actions). **Zoltan Dienes** used Higher Order Thought (HOT) theory to develop his 'cold control theory of hypnosis', whereby hypnotic responses involve *executive control without conscious intentions*. Even though Ned Block and I both said (in the Q&A) that we thought it absurd to see *Blindsight* as an un-noted mental state, Dienes'

approach to hypnotic mechanisms is among the more innovative HOT applications. These three presentations on hypnosis suggest that some (or much) of the erratic perception and memory processes caused by some post-hypnotic suggestions, can be explained by these frontal-parietal pathways that are often seen as linked to conscious perception.

But, let us remember **Koch's** statement that we are not sure we can differentiate a BOLD response to 'awareness' from 'attention'. Koch did not pursue this, but one can note that Parietal-Frontal lobe linkages are crucial for many *control* mechanisms, including linking posterior attentional areas in the superior parietal lobe to anterior attentional areas in the anterior cingulate and dorsolateral prefrontal. Because these pathways tend to be activated by objects that make it into *attention* (say by binocular rivalry techniques), the usual assumption is that these are crucial for us to have '*awareness*' of objects.

A couple of presenters at the conference open the possibility of this being more strictly an '*attention*' pathway that is triggered as or after objects come into attention. (This, of course, is the tricky thing about 'correlates' – the direction of causation needs to be settled!) Recall **Hobson's** observation that the *dorso-lateral prefrontal is correlated with Waking Consciousness, not with Consciousness per se*. Hobson seems to be saying that the long 'horizontal' pathways, lauded as being crucial for bringing perceptions into 'conscious' content (in the building-block theories), are not activated during REM sleep — when there is plenty of phenomenal consciousness, but limited control or access. Perhaps the long pathways are more crucial for control — than for consciousness as such? Perhaps consistent with this interpretation, **Hakwan Lau** reported that, in a visual manipulation, the condition that led to reported subjective awareness showed activation in *prefrontal area 46*, but *not* in the parietal, premotor or visual areas 'which are often thought of as parts of a widely distributed network central to consciousness'. Developing Lau's data, area 46 is widely seen activated in working memory (WM) tasks — as involved in holding representations in WM, even after they are no longer in on-line perception

Complexity and Consciousness

An interesting spin off of the standard findings of the *complexity of connections* needed for at least normal waking consciousness, were three talks about '*complexity*' itself. **Susan Greenfield's** self-acknowledged 'arrogant title' was 'The Neuroscience of Consciousness'. It was, more accurately, a 'case for complexity', with little specificity. Brain imaging on *anaesthesia* show that multiple sites are involved in conscious awareness. 'Enrichment' for rats leads to greater brain connections. The critical factor is quantitative: the larger the neuron assembly, the greater the depth of consciousness. Childhood, dreaming, schizophrenia, fast paced sports and raves are all associated with small assembly. Intensity of the senses, significance and arousal influence the formation of neuronal assembly.

Giulio Tononi also emphasized the need for neuronal complexity for consciousness. He raised two of his current favourite questions: (1) why is the

cerebrum and not the *cerebellum* (with even more neurons) correlated with consciousness? And (2) why is *wakefulness* and not deep *sleep* (with equivalent mean firing rates) correlated with consciousness? The answer to both is *complexity* due to *differentiation* and *integration*. Consciousness is proportional to the number of possible states. With mathematical derivation from an entropy formula, Tononi defined *phi* (ϕ) as a symbol for information integration, which is at its highest when there is integration over portions of highly differentiated sets. The ‘vertical’ *brain-arousing thalamic-cortical system* has high ϕ potential, allowing normal ‘*patchy*’ connections. Slow wave sleep and seizures show ‘*uniform*’ connectivity, with low ϕ . Alzheimer’s shows ‘*sparse*’ connectivity, with very low ϕ . Vegetative and minimally conscious states show islands of activation and thus very low ϕ connectivity. The ‘horizontal’ Parietal-Frontal network allows connectivity across very specialized areas. In fact, once our sensory systems have interacted with the outside world for a bit, we don’t even need the outside world to have conscious experience. Localizing the NCC is not an explanation; appropriately-high ϕ presumably would be an explanation. In fact, in his Q&A, Tononi made the strong statements that if a machine has high enough ϕ it would have subjectivity, and that consciousness IS the ability to integrate information, not ‘corresponds with’ that ability.

Tononi cited several specific pathways in the brain that are quite *modular* (and thus *differentiated* from other modules), but have *little connectivity* between neighbouring modules — and thus low ϕ : cerebellum (where ‘quantitative’ is, evidently, *not* the ‘critical factor’, vs Greenfield), afferent perceptual pathways, efferent motor pathways, and even cortical-basal ganglia-thalamic loops. In contrast, deep sleep has too much local integration and too little differentiation. Tononi closed with the slide: ‘*E Pluribus Unum!*’ In his Q/A Tononi made one fairly-safe comment about ‘animal consciousness’: that protozoa are not conscious.

Connected in a strange way to Greenfield’s and Tononi’s talks was one of the two major talks on animal consciousness, by **Jean-Pierre Changeau**, raising the question, ‘do mice have consciousness?’ Changeau demonstrated that ‘knock-out’ mice, missing the gene to develop the alpha-4-beta-2 site on nicotinic acetylcholine receptors, are deficient in one measure of working memory (they showed evidence of ‘locomotion’, but not of ‘exploration’), presumably stemming from a deficit in utilizing the ‘horizontal’ frontal-parietal circuits that Changeau considers to be crucial in allowing representations to become contents of consciousness. Therefore, Changeau seems to imply that these knockout mice become zombies. After this brilliant — but somewhat strange — case of using *third-person* consciousness logic to infer the lack of *first-person* consciousness, **Ned Block** asked the ‘mouse-first-person’ question: whether we really know that the mice could no longer experience the taste or sight of cheese? My concern would echo Ned’s and suggest that these knockout mice may actually show evidence of *conscious awareness* (in their retention of ‘locomotion’), but have lost some of the executive *control* that this pathway affords, in their loss of ‘exploration’.

‘Control’ Operations of Frontal-Parietal Long Circuits

Hakwan Lau claimed that Libet’s famous ‘onset of conscious intentions’ experiment is too conservative, and that the onset of *conscious intention* is too late for *it* to trigger actions. Lau found activation of the premotor area while the person is estimating the onset of intention, suggesting that the action has already been triggered. He has also used TMS *after* action execution to manipulate the conscious experience of intention. Lau suggests that the ‘central executive system’ operates in and outside of consciousness. In contrast, **Stanley Klein** concluded that Libet *did not come close to showing* that the *unconscious* response potential ‘urge’ *causes* the decision to move the hand. Klein also threw his hat into the religion and politics ring, encouraging neuroscientists to find ways to talk with ‘progressive theologians’,¹ who are people for whom God is a metaphor, symbol, or myth. In contrast, Klein suggested that more-traditional religious folks in our country are not so happy about Libet’s findings that limit the concept of our having free conscious will. He also said that he hopes that Bush will keep getting elected (sic) to keep psychologists working.

Animal Consciousness

Perhaps less crucial to the final picture of Consciousness Science — but of great and broad interest — will be an estimate of *what orders* of animals have *what types* of consciousness. Each basic question regarding various meanings of ‘consciousness’ needs to be brought to bear here. For instance, which orders have waking/sleep cycles? Which of these have REM? Do all of these orders — or a smaller or larger set — have subjective phenomenal awareness when ‘awake’? Which aspects of self-awareness are found in which families?

Besides Tononi’s mini-take on protozoa consciousness, **Derek Denton** pointed to the possible primal emergence of consciousness from awareness of *interoceptive* feelings of hunger, thirst, oxygen hunger, and the like. By careful manipulation and measurement of the drinking habits of sheep and cows, Denton found solid evidence of *conscious thirst feelings* being crucial in non-human animals. The key finding is that they can satiate thirst in 2-5 minutes through rapid drinks, long before the water can be absorbed and change the chemical imbalance that led to the drinking. This suggests that the *satisfaction of conscious thirst feelings* determines the amount of drinking. This has great evolutionary advantage in being able to get in and out of vulnerable drinking areas. The second major talk on animal consciousness was by **Jean-Pierre Changeau**, raising the question ‘do mice have consciousness?’ which we have already examined.

One key insight on animal consciousness came out of my informal discussions with afore-mentioned Claude Pasquini. Rene Descartes probably could not conceive of different components of consciousness, so his denying it to non-humans

[1] Maybe this is somewhere that the *Journal of Consciousness Studies* might make a contribution, having one such theologian as its managing editor.

was an all-or-nothing decision. Being able to distinguish sleep-wake, perceptual consciousness, and various types of self-consciousness gives us the ability to conceive of animals of various CNS complexities having different aspects of consciousness. This option seems so much better than an ‘all’ (even protozoa have self-consciousness) or ‘nothing’ (even bonobo chimps do not have phenomenal consciousness) option.

The Putative Role of ‘Special Relativity’ — ASSC’s ‘QM’?

We have already reported on the symposium on Space and Time. What I want to call attention to here, are the speakers’ appeals to Special Relativity. **Nijhawan** framed the Special Relativity issue in his introduction to the symposium. **Klein** talked about Libet’s ‘subjective time’ experiments, quoting Libet to the effect that *the timing of a sensation* is subjectively referred to the early signal given by the primary evoked potential, *not that the conscious sensation itself jumped backwards in time*. (This would seem to me to argue *against* a Special Relativity explanation.)

We have mentioned **Burr’s** report on saccades compressing space and time. This makes sense, that if we use saccades to constantly scan the visual scene, we need to compress the space and time covered by the saccades so that the world does not look to us like that really-jumpy Blair Witch Project movie. But also, his mention of the *magnocellular pathway* suggests that we may be looking at the space and time gaps between the ‘ventral’ visual stream that gives objects *allocentric* time-and-space relations among each other (to create our changing picture of the world) and one version of the ‘dorsal’ visual stream that gives each object an *egocentric* relationship to our body/hand/eyes (to allow us to manipulate objects). The input from saccades has to fit into both calculations. Therefore it came as a huge jump when Burr suggested that these temporal and spatial effects can be explained within the framework of Special Relativity: that vision may be subject to relativistic effects, where a fast wave of cortical activity moves to realign the pre and post-saccadic perceptual world.

Finally, **Nijhawan** suggested that visual-tactile-motor neurons in premotor cortex subserve relativity. It seems to me that, by definition, ‘egocentric’ coordinates are entirely ‘relative’ to the body/head/eyes/hands; whereas the ‘allocentric’ coordinates attempt to re-create an ‘idealistic really given position’. That’s their respective jobs! Why import the macro-universe dynamics of special relativity? I know we are in the Centennial year of Einstein’s theory, but that seems like quite a quantum leap (pardon the expression)! **Klein** specifically said that *quantum mechanics* were not needed to explain this. But is there any more reason to assume that *relativity*, which operates on macro-scales, has an impact on brain operations in the middle range, than *quantum mechanics*, which operates on micro-scales? Perhaps ‘Special Relativity’ will become the ASSC esoterium while QM remains the Tucson esoterium!

Input from Outside the Consciousness Community

Renowned geneticist **Fred Gage** may have given the only plenary presentation by someone ‘outside’ of ‘the consciousness community’. In fact, when he began his talk he said, ‘I don’t know enough to bring consciousness into my talk’. I can well remember many speakers saying that in the earliest ASSC conferences, when people had to slant their talks so they somehow dealt with ‘consciousness’. The fact that most presenters today are dealing with consciousness straight on, shows how far our science has come. Gage’s talk was quite helpful for our science. It seems to be crucial to the forming of new memories that the dentate gyrus (the port of entry for material into the hippocampal formation) has about 1000 stem cells dividing to form new neurons each day (in mice), with the amount of neuro-genesis dependent upon the creature’s experience — whether enriching or stressful. Each stem cell divides into two, with one remaining a stem cell for further dividing, while the other becomes a neuron, taking about three months to mature. Each mammal species studied, including humans, have these.

Closing Observations

I don’t know if it was the effect of ‘quantum observation’ or ‘Objective Self Awareness’, or just cases of Humean ‘illusory correlation’, but several printed comments made in previous ASSC conference reviews have seemed strangely correlated with subsequent changes in conference behaviour. Four such ‘correlations’ come to my feeble mind. Two conference reviews made comments about stark conference-housing conditions in Duke and Memphis dormitories. Voila: no dormitory options in this year’s conference — to the financial detriment of cheap attendees such as myself. (Be careful what you ask for!) Second, the Duke review commented on the very uneven value of Commentators at the end of symposia. Voila: the use of Commentators was dropped!

Third, the Memphis conference review shamelessly named names of the half-dozen people (including myself) who asked the most questions during plenary sessions (in the order of 15–25 questions per named person). Voila: those named persons who attended the next year’s Tucson conference asked almost no questions. The effect wore off, however, as they were back in the constant questioning mode this year. (By the way, a tip for those, like ‘R.B.’, who tried over and over again to be called on at one of the workshops — if you *wave* your hand, rather than just sticking it inertly into the air, you will activate peripheral magnocellular cells which alert the superior parietal attention area of the speaker. It works!)

Fourth, the Memphis conference report even more shamelessly commented on how very few of the questions were raised by female participants. Voila: that percentage has grown over the last Tucson and this conference. Again, this may be ‘illusory correlation’. Heck, I really don’t know if more than 5 people (plus editor Freeman’s British spell checker and miserly word counter) even read these darn reviews, let alone believe a word they read! Still, granted that writing

conference reviews is the second-lowest form of prose (sub-passed only by a certain literary form named after a county in Ireland), what power they may possess!

The *last* shall also be *last*. Let us close with a few of the always powerful and always hilarious things that Searle said in his final talk. (By the way, I took no photos of Searle's PowerPoint projections, because he used the high-tech approach of writing with markers on transparencies. Then he stood right in front of me and coerced me into handling his transparencies.)

- 'Consciousness' is one of the rare philosophical problems that will have a scientific solution — philosophers need to get out of the way.
- Current students feel the angst of post-industrial man under late capitalism — and wonder why I don't!
- I can will my hand to rise and it goes up. I don't have to say 'some days it goes up, and some days not!'
- One hears 'the physical world is physically closed' as a rationale for dualism. You don't hear it here, but you hear it in Tucson all the time.
- 'Uncle Freud'
- We ARE denying the existence of a soul! (So much for giving biblical quotes re. Searle!)

At the end of each day: Boynton's perceptual deterioration! At the end of the conference: perceptual deterioration! At the end of reading this article: !!!!!