Article

The Cosmology of Conscious Mental States (Part I)

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ABSTRACT

We explore the diversity of mental states, and examine to what extent these are both a product of specific known brain processes and yet may access a complementary aspect of existence to the cosmology of the physical universe and its natural biosystems, potentially giving mental states an existential cosmological status. The case is made that the cosmology of mental states reflect a deeper physical principle connecting quantum entanglement with the brain wave processing evolved in higher organisms to solve the computational intractability of open environmental dilemmas, which go beyond Bayesian statistics and causal prediction, into multiple nested Schrödinger cat paradoxes, hinting at a meta-evolutionary paradigm of conscious cosmological integration.

Part I of this two-part article contains: A Natural Classification of Mental States; The Physiology of Mental States; & Subjective Consciousness – What are Mental States For?

Key Words: cosmology, conscious, mental state, brain process, existence, physical universe, biosystem, quantum entanglement, brain wave processing, computational intractability, Bayesian statistics, causal prediction, Schrodinger's Cat.

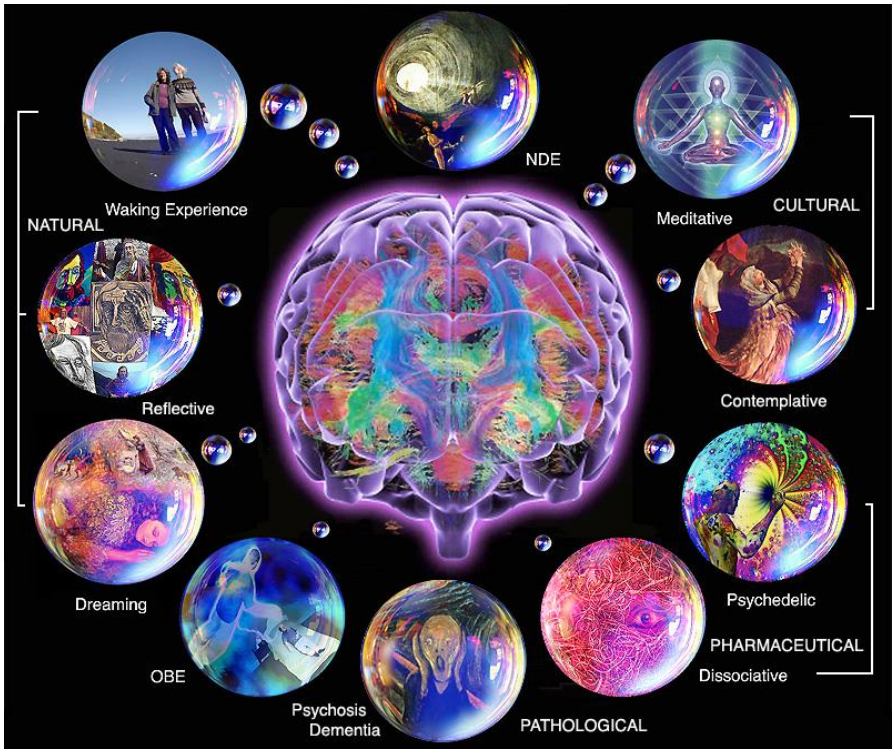

Fig 1: A representative spectrum of prominent mental states

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A Natural Classification of Mental States

Human conscious experience involves a spectrum of mental states surrounding the everyday waking condition. Some of these are biological, associated with essential processes, including reflection, reminiscence and daydreaming associated with the so-called default network (see fig 2), the dreams and nightmares of REM sleep, and 'out of the body' (OBE) experiences associated with hypnagogic states. Others are culturally-based associated with devotional practices, including meditation, prayer, religious vision and spiritual contemplation. Still others are pharmaceutical, associated with changes of subjective consciousness induced by psychotropic substances, such as psychedelics and dissociatives, either synthetic molecules, or associated with certain plants or fungi. Finally we have a number of pathological states involving extreme medical conditions, from schizophrenia and dementia to epileptic seizures, particularly in the temporal lobes, and the near death experiences (NDE) associated with heart attacks, drowning, and severe trauma, such as traffic accidents.

While some have a natural origin in circadian rhythms, and others a cultural origin, others still a chemical origin and yet others a medical origin, all of them arise from specific brain states physiologically, which, despite their different origins, fall into a natural classification.

However this doesn't mean brain physiology is all there is to mental states. Indeed our description of reality and the physical world is founded first and foremost on our subjective conscious mental states, whose actual basis remains the most confounding and unfathomed question facing the scientific description of the natural world. We may thus find in the diversity of mental states clues to the existential cosmology of the conscious universe - hence the title of this article.

The Physiology of Mental States

All mental states, from natural to cultural, are accompanied by specific physiological changes to the brain, which are signature of the state concerned. This applies equally to drug-induced states and states which people may associate with higher spiritual practices or religious experiences, showing these too can be seen to have a biological origin.

The transition from wakefulness to the onset of light and deep non-dreaming (non-REM) sleep, interspersed with phases of dreaming or REM sleep, occurs naturally in waves over the night's slumber. While the electrical activity of the EEG of non-REM sleep shows theta spindles and deep slow delta waves, different from the high frequency, low amplitude, beta activity of waking attention, the beta EEG of dreaming sleep is remarkably similar to the waking brain. Dreaming phases lasting up to 30 minutes indicate phases of dreaming experience last a similar time to their subjective experience. Brain scans of the metabolic activity of the dreaming brain using PET and fMRI show an active brain with increased activity in visual areas and reduced executive control in frontal areas, consistent with the rich visual experiences and lack of full voluntary control over the events in dreams.

These changes are driven by major ascending neural pathways from the brain stem to the

cerebral cortex, and other descending pathways, which together mediate major changes in alertness and attention, facilitated by specific neurotransmitters and receptors. The reticular activating system contains pathways mediating full arousal. In the waking condition, both the cholinergic acetylcholine and adrenergic norepinephrine pathways are active. In non-REM sleep, norepinepherine and serotonin ascending pathways are active. At the onset of dreaming these go silent and acetylcholine pathways in the pons become active, having the effect of shutting down brain stem centers facilitating motor activity, putting the dreaming subject into a state of atonia, or sleep paralysis, preventing them acting out their dreaming experiences, except for the rapid eye movements for which REM is named. This also has the effect of making the dreamer often feel transfixed in their dream, while at other times feeling they are floating or flying. The exotic, intensely perceived and bizarre mental states accompanying dreams and nightmares are thus clearly related to fundamental physiological changes orchestrated by brain stem centers in interaction with the entire cerebral cortex.

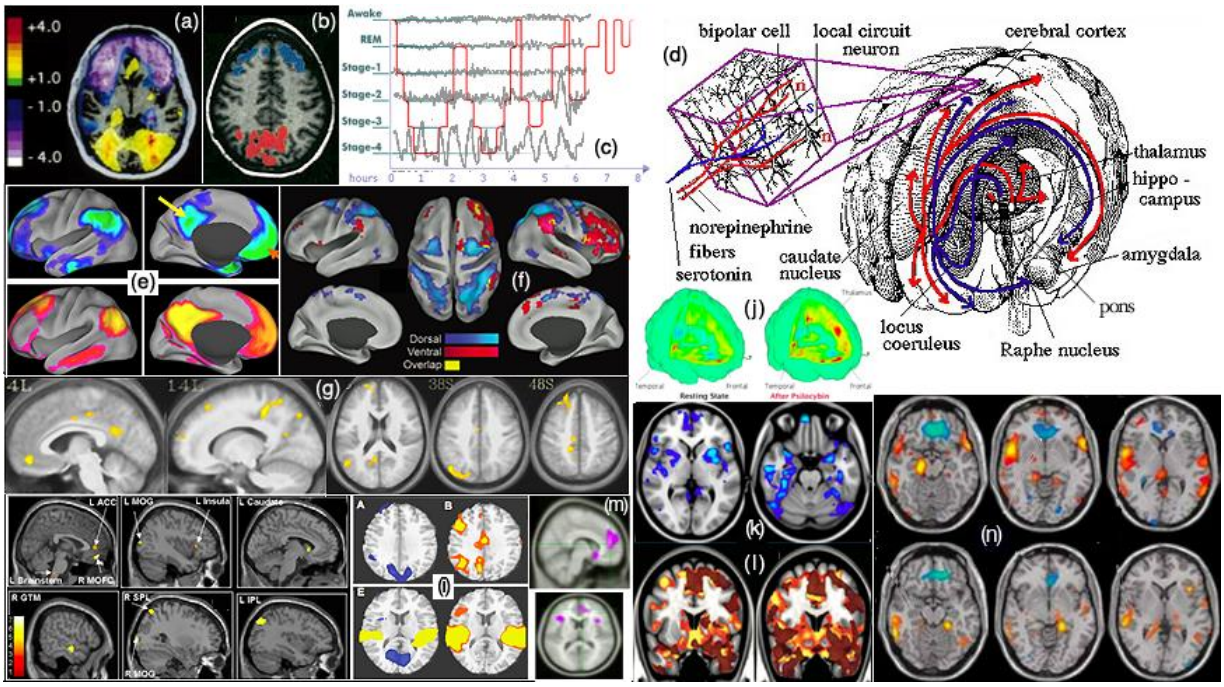

Fig 2: Physiological underpinnings of a variety of brain states. **(a,b)** fMRI and PET scans of REM (dreaming) sleep show increased occipital (visual) activity and reduced prefrontal (executive) function, with an EEG similar to the waking brain (Braun). **(c)** Sleep phases of REM and non-REM sleep alternate in waves. The EEGs are on a time scale of seconds, the sleep waves in hours. **(d)** Sleep phases are driven by ascending serotonin and nor epinephrine pathways from the Raphe nucleus and Locus coeruleus. **(e)** The default network associated with worry and recollection of events to prepare for the future shows depression of activity during task performance and increase during rest (Raichle et al, Raichle & Snyder, Mason et al, Fox D, Horovitz et al, Buckner et al, Marshall). **(f)** There are believed to be two attention systems in the human brain (Fox et al.) a bilateral dorsal attention system (blue) involved in top-down orienting of attention and a right-lateralized ventral attention system (red) involved in reorienting attention in response to salient sensory stimuli**. (g)** Zen meditation studies (Pagnoni et al, Ritskes et al) in which subjects are asked to switch from a verbal task to contemplation show transient activity consistent with the default network which is more quickly suppressed by experienced meditators more effectively inhibiting verbal thought. **(h)** Carmelite nuns entering oneness with God show fMRI activations in areas in specific frontal, parietal, temporal and basal areas consistent with directed control (Beauregard & Paquette). **(i)** Tibetan Buddhists performing compassion meditation for other people's suffering show specific activation in limbic regions including cingulate cortex and insula, consistent with an empathic

response to another's pain (Lutz et al 2008). **(j)** PET study of psilocybin taken orally shows frontal activation by comparison with a resting state (Vollenweider et al). **(k)** fMRI study during the 12 minutes after intravenous administration of psilocybin shows reduced activity in medial frontal cortex (mPFC), posterior cingulate cortex (PCC) and other areas (Carhart-Harris et al 2012a, Lee & Roth) suggesting suppression of the default network as the effects come on. **(l)** Increases in activity associated with autobiographical memories on psilocybin right over placebo (left) (Carhart-Harris et al. 2012b). **(m)** Increases in fMRI in frontal and paralimbic brain regions in an ayahuasca session (Riba et al 2006). **(n)** Above ketamine induces a decrease in ventromedial frontal cortex (blue) and increased activity in mid-posterior cingulate, thalamus and temporal cortical regions (yellow-red) consistent with its dissociative effects. Below inhibition of ketamine activity by lamotrigine, a sodium channel blocker that decreases glutamate release (Deakin et al).

While many theories have been proposed for the function of dreams, particularly in relation to the reencoding of hippocampal memories into compactified strategically effective forms in the cortex, the extreme variation of REM and of sleep duration in different mammal species and the ambiguity of studies of sleep deprivation leave the purpose and existential status of dreaming still awaiting a full explanation.

Key psychotropic agents also act on specific neuroreceptors, inducing physiological changes in brain dynamics by altering the receptor-mediated activation of excitatory or inhibitory neurons. For example, psychedelics, are believed to act as super-agonists of the 5HT2a serotonin receptor, setting off a different form of activation from serotonin itself, in which a push-pull coupling with a second receptor mGluR2, for the principal excitatory neurotransmitter glutamate, alters the stability of excitation in such a way as to evoke the 'fractal' instabilities associated with the kaleidoscopic visions of the psychedelic state. Both of these receptors are slow acting G-protein-linked 'metabotropic' receptors whose changes in dynamics are measured in hours – the life of the drug effect. They do not directly cause changes in ion flow, but trigger a protein cascade altering long term dynamics. Other psychotropics, from cannabinoids to datura-containing deleriants such as scopolamine, are positive agonists, or negative antagonists, of other key receptors, respectively the anandamide CB1 cannabinoid receptor and the muscarinic acetylcholine receptor.

By contrast, ketamine acts to block the pore in a fast acting glutamate NMDA ionotropic receptor, directly altering ion flow and excitability in target neurons, resulting in global changes in excitability which appear to dissociate the subject from their bodily sensations, so that, while remaining technically conscious, they become relatively oblivious to an operation being performed on them and at the same time experience dislocated out of the body experiences, some of which have profound impressions, similar to classic near death reports.

In fact the situation is vastly more complicated than this description. Psychedelics, for instance, activate a broad spectrum of many serotonin (5HT), norepinephrine and other receptors, to varying degrees, in a manner similar to pressing a large number of keys on a polyphonic keyboard, resulting in a variety of simultaneous effects, from sensory hallucinations to anxiety reactions. Paradoxically agonism of the 5HT1a receptor in the psychedelic tryptamines silences the Raphe nucleus responsible for serotonin innervation of the cortex (Braden, Nichols 2011), as occurs in REM sleep, resulting in a close parallel with the dreaming state. In addition, a given receptor type can have differing actions depending whether it is on an excitatory e.g. pyramidal cell, or an inhibitory interneuron, so a psychotropic agent may have simultaneous excitatory and

inhibitory effects on different cells, or on distinct brain regions.

Still other psychotropics such as the releasing agents methamphetamine and MDMA and reuptake inhibitors such as fluoxetine (prozac), principally affect the transporters that carry neurotransmitters to the synapse and remove any excess after release, inhibiting re-uptake or causing reverse dumping, rather than activating or de-activating receptors directly, as agonists and antagonists do.

Nevertheless psychotropic drugs and sacramental species act on brain dynamics broadly through the same receptors and some of the same pathways we saw driving natural changes in the sleep wakefulness cycle. This involvement of sappy neurotransmitter molecules in what would otherwise be electro-chemical neurodynamics is very ancient, and key neurotransmitters, from serotonin to cyclic-AMP, trace their evolutionary origin right back to chemical signaling in single celled eucaryotes and have similar or parallel function in diverse animal groups, from arthropods to vertebrates, acting on major modes to keep neurodynamic function biologically attuned to the survival of the organism.

Many spiritual practitioners and religious believers consider their experiences to be states of attainment far beyond mere physiology, requiring devoted concentration and higher forms of consciousness, as different from lowly dissipated drug experiences as gold is to lead. However research exploring states of meditation and religious devotion show that these states fall into a physiological spectrum as clearly as natural and pharmaceutically induced states do.

When it comes to the investigation of mental states associated with spiritual and religious practice using brain scans, we find clear physiological indicators related to the particular practice engaged by the subject. By contrast with the rich and bizarre nature of dreaming, mental states associated with prayer and meditation tend to involve focused control and suppression of the wandering mind through limiting the verbal thought process, or one-pointed concentration. While these mental states are highly varied, they share common features of intentional control of the mental process. Zen meditators in fMRI studies show more rapid and complete suppression of the mind-wandering of the default network (Pagnoni et al), with increased activity in the prefrontal cortex and basal ganglia and decreased activity in the occipital (visual) cortex and anterior cingulate processing emotion (Ritskes et al). In EEG studies they showed a significant increase in frontal alpha and occipital beta power, whereas an average increase of theta power was observed in controls, indicating loss of concentration (Huang et al). Consistent with one-pointed concentration, Zen meditators recalled more subliminal messages than controls (Strick et al).

Tibetan Buddhist meditators in PET and fMRI studies have increased blood flow in the cingulate, inferior and orbital frontal cortex, dorsolateral prefrontal cortex and thalamus (Newberg et al 2001, Hanky). EEG studies show greater activation in attentional regions, including fronto-parietal, cerebellar, temporal, para- hippocampal, and posterior occipital, possibly due to the attended spot (Brefczynski-Lewis et al). They have also been found to enter high-amplitude gamma-band oscillations with high phase-synchrony during meditation, consistent with a one-pointed concentration with heightened attention (Lutz et al 2004). By contrast, compassion meditators under PET show similar activations to a person feeling empathy

for a person in pain (Lutz et al 2008). In a more recent fMRI study contrasting "focus-based" and "breath-based" practice, in the first, blood flow increased in the medial prefrontal cortex and left caudate, but decreased in parietal and occipital regions. The second induced activation in several limbic structures and the left superior temporal cortex (Wang et al).

Investigation of Transcendental meditators by PET (Newberg et al 2006b) also found bilateral prefrontal activation associated with relaxed attention on the mantra, other increases in frontal, occipital and parietal areas and a decrease in the thalamus and hippocampus. An fMRI study centered on the capacity of the relaxed state to be helpful in dealing with an induced painful stimulus saw reductions in the prefrontal cortex, anterior cingulate cortex, and thalamus (Orme-Johnson et al), and has been suggested to be linked to hormonally induced increases in the inhibitory neurotransmitter GABA (Elias et al). Catholics observing a Marian image saw increases in the ventrolateral prefrontal cortex and brain stem leading up to the thalamus (Wiech et al).

Brain studies of Carmelite (Beauregard & Paquette) and Franciscan nuns (Bielo) in professed 'union with god', which they admitted was difficult to achieve in a noisy MRI tunnel, show different structured activations, with increased activity in the caudate nucleus associated with learning, memory and falling in love, the insula processing body sensations and social emotions, the inferior parietal processing spatial awareness in contradiction to the Zen studies, the medial orbito-frontal and prefrontal cortices dealing with emotional and executive decision-making, and the middle of the temporal lobe. Most prevalent brain waves were long, slow alpha waves such as those produced by sleep, consistent with a relaxed state.

By contrast with the prefrontal control evidenced in Buddhist meditation, during speaking in tongues, by Christian women who had practiced glossolalia for more than 5 years, there was a decreased blood flow in the frontal lobes bilaterally and in the left caudate, indicating relaxation of executive controls (Newberg et al. 2006a).

In comparing these highly varied and contradictory results, one can conclude that claimed states of higher spirituality are varied products of different forms of concentration, which share the feature of overall focused control, but otherwise look like distinct humanly-generated states of mind, rather than convergence on the 'divine'. One thus needs to consider the possibility that the profound transformations of the cortical dynamic induced both by dreaming and by psychotropic entheogens may give rise to every bit as deep a potential for exploratory existential processes, which might nevertheless be enhanced by contemplative repose.

Moreover, certain pathological states, such as temporal epilepsy, are associated with states of religious fervor bordering on the mystical and become experiences which the patient, while suffering from the effects of such seizures, regards as having overwhelming significance, which they are reluctant to part from. In one subject's description "Triple halos appeared around the sun. Suddenly the sunlight became intense. I experienced a revelation of God and of all creation glittering under the sun. The sun became bigger and engulfed me. My mind, my whole being was pervaded by a feeling of delight" (Naito and Matsui). The incidence of these states caused the neuroscientist Vilayanur Ramachandran to coin the term the 'god spot' for the region of the temporal lobe bordering on the limbic emotional system amygdala, suggesting that stimulation of

this region could cause both the intense significance and meaning of temporal excitation and the ecstatic fulfillment of positive centers in the amygdala, whose function is to do with orienting to intense emotional conditions, from flight and fight to peak fulfillment. Neuroimaging studies of individuals suffering from schizophrenia with religious delusions similarly found over-activation of the left temporal lobe during religious delusions (Puri et al).

Religious conservatism may also be a product of social evolution, as the moral deity reinforces a situation of inhibiting intra-social conflict through fear of an omniscient god's punishment, combined with repression of the infidels, resulting in inter-social dominance, permitting larger human groups to remain stable and to become dominant over their neighbors - a not entirely holy outcome!

On a slightly different tack, several researchers have drawn attention to the idea that genetic differences in neurotransmitter dynamics could underpin human religiosity, in particular the generalized monoamine transporter VMAT2, which is essential for carrying dopamine and serotonin to the synapse. Dean Hamer in "The God Gene" suggested that genes expressing higher levels of the transporter resulted in spiritual individuals favored by natural selection because they are provided with an innate sense of optimism, the latter producing positive effects at either a physical or psychological level. The dopamine receptor DRD4 (Comings et al) and various other receptors have likewise been cited as enhancing a measure of spirituality called 'self transcendence'.

Intriguingly removal of tumors from two brain regions, the left inferior parietal lobe and the right angular gyrus, was also associated with immediate increases in self-transcendence (Weaver). Significantly these regions are involved in processing one's body image, so the loss of function could well evoke feelings of spiritual merging. The questionnaire tapped into three main components of self-transcendence: losing yourself in the moment, feeling connected to other people and nature, and believing in a higher power. Examples include: "I often become so fascinated with what I'm doing that I get lost in the moment - like I'm detached from time and place" and "I sometimes feel so connected to nature that everything seems to be part of one living organism."

Out of body experiences or OBEs also have direct physiological correlates. Many of the reported experiences appear to arise from hypnagogic states, when a person is on the borderline of sleep or partially awakening from REM sleep, but are still in a state of sleep paralysis, leading to the impression of floating, while perceiving they are able to witness their body from a distance.

My most classic OBE was practicing for lucid dreaming by trying to look at the backs of my hands in a dream. Many times I had awakened realizing I had seen my hands in a dream, for example climbing ladders, and not registered. Eventually one night I looked at my hands in a dream and made the connection. This set off an immediate and powerful reaction. I found my consciousness split in three, one self was lucid dreaming, but lost in the dream universe. I looked up at the deep blue sky and realized it was not the ordinary sky of the waking world and no galaxy out there was the one I had come from. I became desperate to find my way back to life. I was standing in bright daylight on a promenade by the ocean. I saw a woman with dark eyes staring at me. I walked up to her, grabbed her by both shoulders and stared down deep into her

dilated pupils, silently begging to know how to find the way back, but she just stepped back and shook her head smiling. No way back to Ixtlan! At the same moment a blast of sea breeze hit me. I was wearing a light Indian shirt and I could feel every one of the droplets of spray that hit me lucidly with crystal clarity. At the same time the gust was a force like a levitating tornado sending me shooting up faster and faster in some other space. However again at the same time, I realized I was bumping on the ceiling of my bedroom, reassuringly witnessing my body asleep in the bed below, saying to myself silently "It's all okay! You are down there sleeping peacefully on the bed!" Afterwards I realized all these experiences had started simultaneously and ended simultaneously. I had been in three places at once!

The brain is richly endowed with mirror neurons which are essential in our social function and cause us for example to get shivers down our spine when we see someone else get injured. Several studies, including under MRI brain scans, have confirmed that the temporo-parietal junction, one of several regions involved in helping to integrate visual, tactile and proprioceptive senses with the signals from the inner ear that give us our sense of balance and spatial orientation has altered function when experiments are performed to simulate out of body experiences which are perceived to result in a full or partial OBE by the subject. Various forms of experiment where the subject receives tactile stroking while watching a mannequin which has camera-mounted eyes relayed to goggles worn by the subject can cause such brain areas to integrate these perceptions into an OBE (Ananthaswamy 2013).

We finally come to the physiology of NDEs or near death experiences. Many people undergoing cardiac arrest, suffering extreme trauma, such as a car accident, in which they have become comatose, or in drowning, report experiences involving one or more of a spiraling tunnel, often with light at the end, a sense of 'telepathic' communication with a higher conscious being, who may at the same time be themselves, a sense of leaving their body and perhaps seeing departed friends or relatives or seeing their own body being resuscitated, and a sense of being drawn back to life rather than departing to the realm of death, before coming back to consciousness. These experiences are often reported as life-changing and have become the subject of intense debate between people who believe it is evidence of a conscious afterlife and skeptics who see it as an hallucinatory physiological phenomenon. Some people have even reported seeing objects like shoes in inaccessible places which later proved to be there, stoking ideas that such experiences possess super-natural powers, however events of this type such as Maria's NDE are so rare that there remain only a handful of such accounts. British psychiatrist Peter Fenwick who set up messages in inaccessible places to test this hypothesis in such patients has found no confirmation of the effect (Ebbern et al), nor has a review of research studies into NDEs (Mobbs and Watt).

Beauregard (2012) describes an iconic account concerning a woman who was operated on for a brain stem aneurism by being chilled to the point of cardiac arrest, her blood drained from her body to avoid a hemorrage, and her EEG going into flat line for a full hour. She recalls floating out of the operating room and traveling down a tunnel with a light. She saw deceased relatives and friends, including her long-dead grandmother, waiting at the end of this tunnel. She entered the presence of a brilliant, wonderfully warm and loving light, and sensed that her soul was part of God and that everything in existence was created from the light (the breathing of God). But this extraordinary experience ended abruptly, as Reynolds's deceased uncle led her back to her body—a feeling she described as "plunging into a pool of ice."

The difficulty with assessing NDE reports is that they only come to light after the person regains consciousness, so we don't really know exactly when they occurred or whether they occurred in the deepest phases of coma or in the transition zone back to consciousness. Under cardiac arrest the loss of blood rapidly causes the EEG to fall to a flat line. If consciousness is simply suspended at this point the subject might experience a continuous transition from the onset phase to the recovery phase accompanied by the NDE experience in transition, a little like the rebirth process in the Bardo Thodol or Tibetan Book of the Dead.

Significantly, both psychedelics and dissociatives induce experiences sharing many common key features with NDEs, including the tunnel, experience of clear light communion, out of body perceptions and a sense of transformative meaning. The work of Griffiths et al shows the spiritual rejuvenation experienced by ordinary people under psilocybin is lasting and beneficial. Similar improvements have been found in the terminally ill. The fact that so many of the key elements are shared strongly indicates the NDE is a natural physiological manifestation of the way the brain processes consciousness under the kinds of close encounters with death we are dealing with, including any or all of deprivation of oxygen, or glucose, changes in neurotransmitters such as norepinephrine (Mobbs and Watt), and other stresses including those resulting in neuronal hyper-excitation.

My most recent sacred mushroom experience came on with a symphony of shrilling vibrations that, as they overtake me, spiral me into the visions. It is a synesthesia, which is sensitive to my mental awareness, listening and looking, so I can enter the existential kaleidoscope and fall into the 'other' reality beyond. Visions come and go of impossible experiences I know I have had and witnessed first-hand yet know I could never have happened. As Maria Sabina says: "And you also see our past and our future, which are there together as a single thing already achieved, already happened . . . I saw stolen horses and buried cities, the existence of which was unknown, and they are going to be brought to light." Mushrooms have given me extraordinary visions whose significance I still ponder to this day. I had a horrific vision that my firstborn daughter would be doomed to an obstruction to her fertility. Then years later, her first offspring was born with Downs syndrome. My impression from inside these experiences is that all conscious life is interconnected across space-time and that the sacred mushroom brings us closer to unraveling the bundle of life that locks us into our personal egos, so that for a minute, or an hour or two, we can see, through the disembodied eye, the way the universe perceives disincarnately and ever-compassionately of the mortal coil. It is a feeling that gives great reassurance to the travails of life. At the peak I feel as if I am suspended in a state of light-induced electrocution, searingly high and at the same time utterly pure. As I sit breathless in the living room, non-ordinary reality comes bursting out of my sub-conscious and across my peripheral vision so I feel as if I am simultaneously in about five places at once. Next morning I am fresh and clear in the sparkling sunshine. A new man in a world reborn with the youthful freshness of a new day, my creativity and sense of emergence rekindled. "But I, I am lord of two ways. I am master of up and down. I am as a man who is a new man, with new limbs and life, and the light of the Morning Star in his eyes." D H Laurence The Plumed Serpent.

After the first few minutes of my ketamine experience struggling not to swallow the bitter insufflated substance for fear of nausea, I realize I am entering a state of peace. The anesthetic

effect is taking me deep into a reverie through what has become a kind of yogic breathing. I fall deeper into the dissociated state and I realize that it is an experience of simply awesome depth. A depth so inscrutable, you are touched by it, swept into silent awestruck oblivion - but still conscious - still there - still aware - somewhere in the aether, as the void breathes its delicate structured emptiness. I continue to recognize the depth and mystery of what I am witnessing. But then things take a more sinister turn. My mind is becoming memory-less. It's as if all my brain and memory circuits are reprogramming themselves and all the needles are beginning to point every which way. I know it's going to be alright, but it sure feels as if I am going to be stark staring mad forever. So I decide just to ride with the experience and then suddenly its as if the dials have connected to the master index of all my life experiences, and here they are, flashing before my eyes, just as they say about someone who is drowning, but its not just my life experiences, but the very peak experiences, like the chain of the Himalayas. I realize I am looking back down on them in the same way Moses might look down on his life and the life of everyone from the mountain top, and that all the experiences of my life are coming into one cosmic focus of meaning and destiny. At this point I suddenly realize that everything I have ever done and everything I will ever do has been brought to this very moment of truth and this very experience, and it is 'God', and my destiny coming to its true destination at this point, which is beyond time and space, coming from the very beginning, and for ever. I have this overpowering feeling of having been taken so far it is the full age of the universe and I have so far to get back to the land of the living. It is the same thing I have read about where one feels one is uniting with the universal self and could go with it or return to the incarnate world of individuals. But at the same time it is the universal mind coming to know and understand itself. At this point it seemed almost as if my life was now over. I had made the connection which gave my life its central meaning and though I might in future do nothing else and maybe I would never be able to come to this point again, my life had meaning in giving ultimate meaning to the totality witnessing and knowing itself.

Even though NDEs may be physiological, this does not mean these experiences are just hallucinatory, or in any sense unreal. On the contrary, dreaming experiences, and many psychedelic and dissociative experiences, as well as NDEs, share a fundamental feature that the subject experiences them as veridical realities that they have actually seen in the same way as a waking person experiences the real world around them. They are not imagined, but perceived with the full integrity of perception of existential reality and occasionally do subsequently appear to correspond to physical events and realities.

We thus need to come to terms with a fundamental question: “What is the existential nature of conscious experience?” Is it merely an internal model of reality constructed by the brain, having no status above an epiphenomenon, a mere shadow constructed by a biological brain, or is it a fundamental component of the cosmology of the conscious universe?

Subjective Consciousness – What are Mental States For?

Subjective consciousness poses the deepest dilemma for the scientific description of reality. While we have discovered the Higgs boson and are tantalizingly close to decoding the theory of everything orchestrating both large-scale cosmology and the fundamental forces of nature and

have decoded the human genome and the molecular basis of biological organisms, we still have no idea of how the brain generates subjective consciousness, or even how or why such an elusive phenomenon can come about from the physiology of brain dynamics.

The problem is absolutely fundamental because, from birth to death, the sum total of all our observations of the physical world and all our notions about it come exclusively through our subjective conscious experiences. Although neuroscience has produced many new exciting techniques for visualizing brain function, from EEG and MEG to PET and fMRI scans, which show a deep parallel relationship between mental states and specific modalities of brain processes, these go no way in themselves to solving the so-called 'hard problem of consciousness research' – how these purely objective physiological processes give rise to the subjective effects of our conscious experiences. Philosopher Jerry Fodor famously complained that: "Nobody has the slightest idea how anything material could be conscious. Nobody even knows what it would be like to have the slightest idea about how anything material could be conscious" (Deacon).

Fig 3: Existential reality presents as a complementary paradox. While we acknowledge our subjective consciousness is somehow a product of our biological brain, which is in turn a fragile product of physical forces on a cosmological scale, all our experiences of reality, including our perceptions of the physical world, as well as dreams memories and reflections, come exclusively and totally from our subjective consciousness. This suggests that existential cosmology is a complementarity between subjective consciousness and the physical universe, in which both are fundamental.

Although, from a commonsense point of view, we are forced to acknowledge that our conscious life is dependent on or fragile biological brain and that we will pass out and lose consciousness if we are struck on the head or sever our blood supply, really all our experiences of the physical world come as consensual subjective conscious experiences of the world shared by sentient beings. Indian philosophy declares that consciousness is more fundamental than the grosser accumulations of physical matter, essentially because it is only through subjective consciousness that the physical universe becomes manifest.

This leads to another critical question: "Why did nervous systems evolve subjective consciousness?" If nervous systems are able to fully provide adaptive solutions simply as heuristic computers, there is no role for extraneous brain functions that simply add a subjective shadow reality with no adaptive function and presumably a physiological cost. A digital computer is a purely functional entity, even when processing probabilistic optimizations, so has no role for a subjective aspect, no matter how complex it becomes.

The fact that animals share physiological properties, which, in humans, are accompanied by subjective consciousness, implies that subjectivity is a critical survival attribute, which has been reinforced by natural selection. Its key role has to be anticipating threats to survival and key

strategic advantages. Problems of strategic decision-making in the open environment are notorious for being computationally intractable because of super-exponential runaway in calculation times, as exemplified in the traveling salesman problem, whose calculation time grows with the factorial of the number of cities involved.

All animal nervous systems appear to work on a common basis of edge-of-chaos excitation that arose in excitable single cells before multi-celled organisms evolved Vertebrate brains have a common mechanism of massive parallel processing using wave phase coherence to distinguish ground noise from attended signal, accompanied by transitions from the edge of chaos to an ordered outcome, in diametric opposition to the ordered serial and digital processing of classical computers.

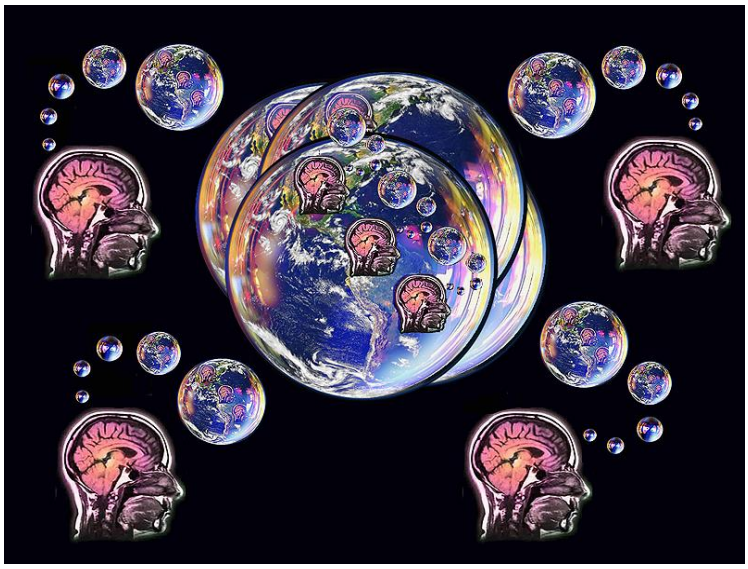

Fig 4: In the veridical way existential reality is generated, subjective experience is primary. In the consensual overlap of our subjective experiences we gain a common experience of the physical world, which we then interpret as containing biological brains, which may also be able to have subjective experiences. However, attempted construction of reality from the physical universe and its brains remains incomplete because there is no explanation of how the brains can also have subjective conscious experiences – the hard problem of consciousness research.

The organization of the cerebral cortex and its underlying structures, consist of a series of microcolumns acting as parallel processing units for an envelope of featural characteristics, from the focal line orientation and binocular dominance of visual processing and tonotopic processing of sounds through somato-sensory and emotional representations, including those of the body, to abstract spatial, temporal and semantic features, leading to the strategic executive modules of the prefrontal cortex and our life aims and thought processes. Attempts to find the functional locus of subjective consciousness in brain regions have arrived at the conclusion that active conscious experiences are not generated in a specific cortical region but are a product of integrated coherent activity of global cortical dynamics, in which the cortical modules we see activated in brain scans correspond to the salient features of conscious experience we witness subjectively.

This implies that the so called Cartesian theatre of consciousness is a product of the entire active cortex and that the particular form of phase coherent, edge-of-chaos processing adopted by the mammalian brain is responsible for the manifestation of subjective experience. This allows for a theory of consciousness in which preconscious processing e.g. of sensory information can occur in specific brain areas which then reaches the conscious only when these enter into a wave synchronous neuronal activity integrating the processing. Three regions associated with global workspace have been identified as key participants in these higher integrative functions, the thalamus which is a critical set of relay centres underlying all cortical areas and possibly driving the active EEG, the lateral prefrontal and the posterior parietal (Bor).

Baars' global workspace approach (1997, 2001) suggests that consciousness is associated with the whole brain in integrated correlated activity and is thus a property of the brain as a whole functioning entity rather than a product of some specific area, or system, such as the supplementary motor cortex (Eccles, Fried et al, Haggard). Furthermore, the approach rather neatly identifies the distinction between unconscious processing and conscious experience in terms of whether the dynamic is confined to local or regional activity or is part of an integrated coherent global response. It is also consistent with there being broadly only one dominant stream of conscious thought and experience at a given time, as diverse forms of local processing gives way to an integrated global response. A series of experiments, many by teams working with Stanislas Dehaene, involving perceptual masking of brief stimuli to inhibit their entry into conscious perception (Sergent et al, Sigman and Dehaene 2005, 2006, Dehaene and Changeux,De Cul et al 2007, 2009, Gaillard et al), studies of pathological conditions such as multiple sclerosis (Reuter et al, Schnakers), and brief episodes in which direct cortical electrodes are being used during operations for intractable epilepsy (Quiroga et al) have tended to confirm the overall features of Baars' model of consciousness based on the global work space (Ananthaswamy 2009, 2010). EEG studies also show that under diverse anesthetics, as consciousness fades, there is a loss of synchrony between different areas of the cortex (Alkire et al). The theory also tallies with Tononi's idea of phi, a function of integrated complexity used as a measure of consciousness (Barras, Pagel).

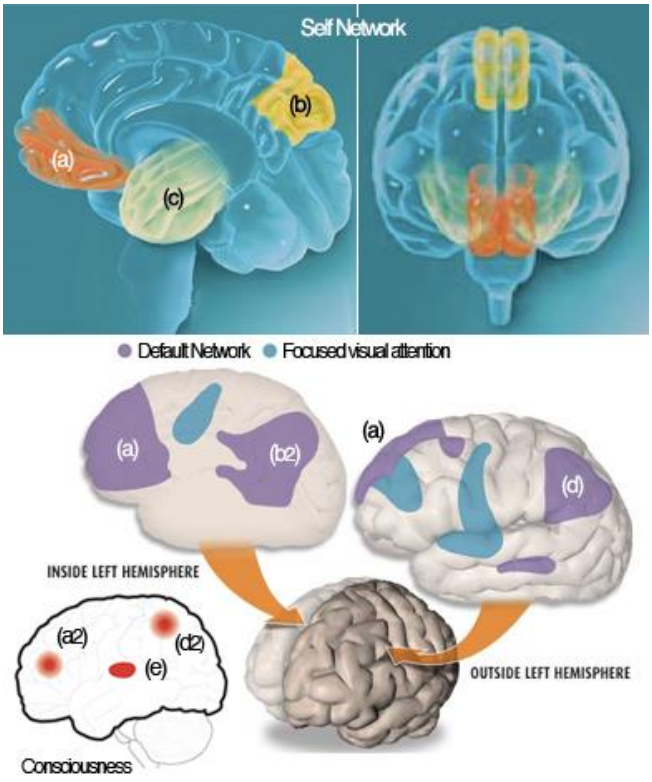

Fig 5: Common regions involved in the self, the default network and alert consciousness. Above: regions in the self network (Zimmer). Lower right: the default network (Fox). Lower left disruptions of active consciousness (Bor). (a, a2) Medial/Lateral prefrontal (b,b2) Precuneus/ Posterior cingulate (c) Anterior insula (d,d2) Lateral/Posterior parietal running to the temporo-parietal junction (e) Thalamus.

Although subjective consciousness involves the entire cortex in coherent activation, brain scans highlight certain areas of pivotal importance, whose disruption can impede active consciousness. These include prefrontal cortex executive functions, spatial integration in the parietal, and the central information pathways of the thalamus.

When we turn to self-consciousness, and the ongoing notion of 'self', which is the shadowy actor-agent behind all the manifestations of conscious states, we find a close association between the default circuit activated in idle periods, believed to be adaptively envisaging future challenges, and brain regions involved in our sense of self.

These include the medial prefrontal cortex and the cingulate cortex and neighbouring precuneus. The default network encompasses posterior-cingulate/precuneus, anterior cingulate/mesiofrontal cortex and temporo-parietal junctions, several of which have key integrating functions.

The ventral medial prefrontal (Macrae et al.) is implicated in processing risk and fear. It also plays a role in the inhibition of emotional responses, and in the process of decision-making. It has been shown to be active when experimental subjects are shown experiences which they think apply to themselves. The changes in Phineas Gage when a tamping iron destroyed his left prefrontal lobe (O'Driscoll & Leach), leading to him becoming a side-show attraction, show how such damage can lead to subtle changes of personality and difficulty in making constructive life decisions, even when localized prefrontal damage does not significantly affect classical IQ tests.

The precuneus (Cavanna & Trimble) is involved with episodic memory, visuospatial processing, reflections upon self, and aspects of consciousness. Adolescents have the same activations as adults in the medial prefrontal when they think about themselves, but less in the precuneus than if they were thinking about a third party, suggesting their theory of mind/self is active but still under development (Zimmer).

The insulae are also believed to be involved in consciousness and play a role in diverse functions usually linked to emotion and the regulation of the body's homeostasis, including perception, motor control, self-awareness, cognitive functioning, and interpersonal experience. The anterior insula is activated in subjects who are shown pictures of their own faces, or who are identifying their own memories, and uniquely in a woman subject who experiences watching other people being touched, as if she herself is being touched, suggesting it plays a critical role in the sense of self. The temporo-parietal junction is known to play a crucial role in self-other distinction and theory of mind. Damage to this area, or electrical stimulation of it, has been implicated in producing OBEs.

The mind is naturally partitioned between features we usually assign to be external, such as visual and auditory, and those that usually function as part of our bodily sensations and reactions, such as somatosensory, emotional and motor – those we associate with 'self'. Self also has a specific relationship with voluntary motor activity. All intentional actions lead both to direct motor outputs and to systems that monitor these actions so we have an integrated sensory-motor experience of action.

Nevertheless the relationship of 'self' and our body image can become dissociated in bizarre and disquieting ways, which show us that the 'self' is very much a dynamic representation in the brain. Amputees sometimes suffer a phantom limb, feeling a limb is still sometimes painfully present, possibly due to new circuits invading the brain areas that previously served the limb. Conversely, people with body integrity identity disorder and xenomelia seek to cut their limbs off because of the oppressive feeling that one or more limbs of one's body do not belong to one's self. Again this may have a physiological basis in cerebral anomalies in the body image map. An even more convoluted form of 'self' dissociation, apotemnophilia, involves sexual arousal based on the fantasy of becoming an amputee. Schizophrenics likewise can become catatonic and refuse to move, believing their limbs are under the control of unseen forces and people with certain forms of cortical injury suffering hemispatial neglect refuse to recognize that one side of

their body is their own and, depending on the extent of damage, may completely neglect the left-hand side of their entire sensory and attentional left field without even recognizing half of reality is missing.

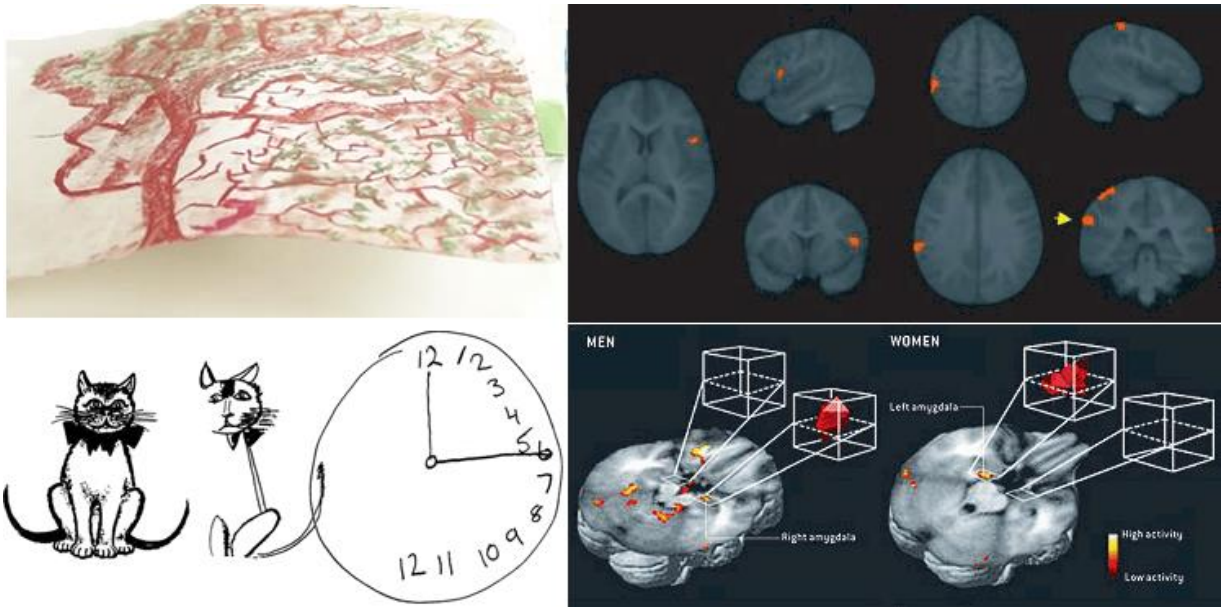

Fig 6: Top right: Activation of left frontal and right parietal areas involving mirror neuron activity (Iacoboni). A set of brain areas to do with both empathy and one's reactions and behavior in relation to others associated with 'reading the minds' of others (Motluk) has been discovered in the form of 'mirror neurons' which, although they may be in areas we usually associate with motor function, intentional action or even the expression of language, contain a population of neurons which react in the same way when the same action is being performed by another individual. Lower right: Response to an unpleasant experience, in the amygdala, differs between men, who respond in the right amygdala and are drawn to central features, and women who respond in the left amygdala and remember more of the context (Cahill). Left: Forms of hemispatial neglect.

We have seen already that OBEs are a function of changes in the way we integrate experiences, and that OBEs can be induced by tricking the brain into perceiving an external sensation as being part of 'self', e.g. through combining visual experience of another person being touched with somatosensory impressions of being stroked.

In a more general way we can see that the nature of 'self' and hence of self-consciousness is both a function of social interactions with others (Bond), and is also a 'sense' we attribute to others, both in terms of our mirror neurons, which provide direct sensations of what others might be feeling, and in terms of our intuitive assessment of others 'self'-assumptions. Social emotions such as admiration or compassion, which result from a focus on the behaviour of others, tend to activate the posteromedial cortices, important in constructing our sense of self (Immordino-Yang et al.), something Antonio Damasio calls the "social self". One can thus see that our personal idea of self is part of a larger adaptive strategy – an intuitive 'theory of mind' to understand self-organized behavior in others, something essential for our social survival. People can sustain up to five or six successive layers of indirected attribution of mind - "I think that he believed she was intending to go to the movies with him" - similar to their digit span.

This social idea of 'self' also shows differences across cultures (Brealey). Researchers

examining autobiographical memory, have found Chinese people's recollections are more likely to focus on moments of social or historical significance, whereas people in Western countries focus on personal interest and achievement. This is similar to the sex differences in response to an unpleasant experience in the amygdala, which differs between men, who respond in the right amygdala and are drawn to central features, and women who respond in the left amygdala and remember more of the context (Cahill). Both these show us that the 'geography of the self' varies from culture to culture just as it does between the sexes. Intriguingly, babies as young as seven to fifteen months appear to be able to intuitively sense false beliefs in others, suggesting this kind of circuitry has an innate basis (Onishi & Baillargeon, Kovács et al.).

Research is now beginning to suggest there may be two forms of 'theory of mind', one fast and intuitive, developing almost from birth, and the other more complex and based on using experiences in life to provide more finely attuned adaptive responses (Weir). People diagnosed with Asperger's syndrome, a high-functioning form of autism, show they have the explicit system, yet they fail at non-verbal tests of the kind that reveal implicit theory of mind (Senju et al.). Evidence for a social theory of mind is also reflected in the relationship between social network size, orbital-prefrontal cortex volume and theory of mind performance (Powell et al.). Studies using transcranial magnetic stimulation implicate the right temporo-parietal junction in enabling mental states perceived in others to participate in making moral judgments (Young et al.). A study of people with right parietal damage likewise found them to have enhanced spirituality consistent with a cortical lateralization notion of the right parietal dealing with 'self' and the left with 'other', with decreased right function leading to 'self-transcendence' (Johnstone & Bodling).

We thus come full circle to the dual problems of space-time anticipation and the notion of 'free-will' – can subjective conscious experiences actually lead to changes in physical outcomes by affecting the outcome of our biological brain states?

Many scientists tend to a classical view of physics and a reductionistic assumption that all human activity must be a product of brain function alone and that any notion of free will, in which subjective consciousness can act to induce a change in outcomes of objective brain states is delusory. This flies in direct contradiction to our subjective feelings that we are autonomous beings with voluntary control over our fates. To claim otherwise in all honesty leads to a catatonic outcome where no purely conscious volition can lead in any way to an active brain state of any form of behavior. It also contradicts the assumptions of legal accountability, where we assume a person of sound mind is responsible for the consequences of their consciously intentional actions.

The classical way around this impasse is then to claim that the subjective impression of voluntary autonomy is a kind of delusion necessary for an organism to maintain an active life in adaptive survival, but this itself is a contradiction, because it assumes subjective consciousness does have an adaptive advantage of some kind.

Many physicists, from Arthur Eddington's citation of the uncertainty of position of a synaptic vesicle in relation to the thickness of the membrane on, have drawn attention to the fact that the quantum universe is not deterministic in the manner of classical Laplacian causality and that

quantum uncertainty provides a causal loophole, which might make it possible for free will to coexist in the quantum universe. This in turn has led to opposing pleas from classical reductionists that the law of mass action would condemn any fluctuations at the quantum level to become swamped and that no quantum effects can possibly interfere in the cellular level processes of neurodynamics. This position is obtuse and incorrect.

Biology is full of phenomena at the quantum level, which, far from being swamped by mass action, are essential to biological function. Enzymes invoke quantum tunneling to enable transitions through their activation barrier. Protein folding is likewise an effective manifestation of quantum computation intractable by classical computing. When a photosynthetic active centre absorbs a photon, the wave function of the excitation is able to perform a quantum computation, which enables the excitation to travel down the most efficient route to reach the chemical reaction site (McAlpine, Hildne et al). Quantum entanglement is believed to be behind the way some birds navigate in the magnetic field. Light excites two electrons on one molecule and shunts one of them onto a second molecule. Their spins are linked through quantum entanglement. Before they relax into a decoherent state the, Earth's magnetic field can alter the relative alignment of the electrons' spins, which in turn alters the chemical properties of the molecules involved (Amit, Courtland). Quantum coherence is an established technique in tissue imaging, demonstrating an example of quantum entanglement in biological tissues at the molecular level (Samuel, Warren).

Although many processes in the brain need to be resilient to quantum noise, in the event of a critically poised dynamic in which there is no stable determining outcome, known brain processes, from chaotic sensitivity, through and the amplifying effects of chandelier cells, to stochastic resonance are able to amplify fluctuations at the quantum-molecular level to the neuronal and ultimately to a global change in the dynamics (King). Hence a change of a single ion channel can lead to threshold activation of a hippocampal neuron and in turn to a change in global brain activity.

Karl Pribram the founder of the idea of the holographic brain has drawn attention to the suggestive similarity between phase coherence processing of brain waves in the gamma frequency range believed to be responsible for cognitive processes and the wave amplitude basis of quantum uncertainty in reduction of the wave packet and quantum measurements based on the uncertainty relation $\Delta E \Delta t \approx h$, where the relation is determined by the number of phase fronts to be counted (see fig 8). This raises an interesting spectre, that the evolution of nervous systems has arrived at a neurodynamic process forming a model of the quantum processes at the foundation of physics, suggesting that quantum entanglement in brain states may be a basis for active biological anticipation of immediate threats to survival through the forms of subjective consciousness the brain generates.

To get an idea of what this advantage might be, we need to examine more closely the kinds of survival situation that are pivotal to organisms in the open environment and the sorts of computational dilemmas involved in decision-making processes on which survival depends.

Several researchers have highlighted various aspects of consciousness in an attempt to understand how it evolved (Wilson). For example higher integrative processing associated with

global workspace has been extended to a few other animals such as apes and dolphins. Another strand suggests that making integrative decisions socially would have aided better environmental decision-making concerning hard to discern situations involving the combined senses (Bahrami et al). However both these ideas pertain to integrative capacities of brain processing and don't provide any direct explanation of why consciousness also evokes the Cartesian theatre of subjective experience. We need to try to unravel the much harder problem of why subjective experience occurs at all, even in a parallel integrative brain.

Open environment problems of survival are intractable not just because they involve super-exponentiating contingent factors which would leave a digital antelope stranded at the crossroads until pounced upon by a predator, but because they are prone to irresolvable structural instabilities, which defy a stable probabilistic outcome.

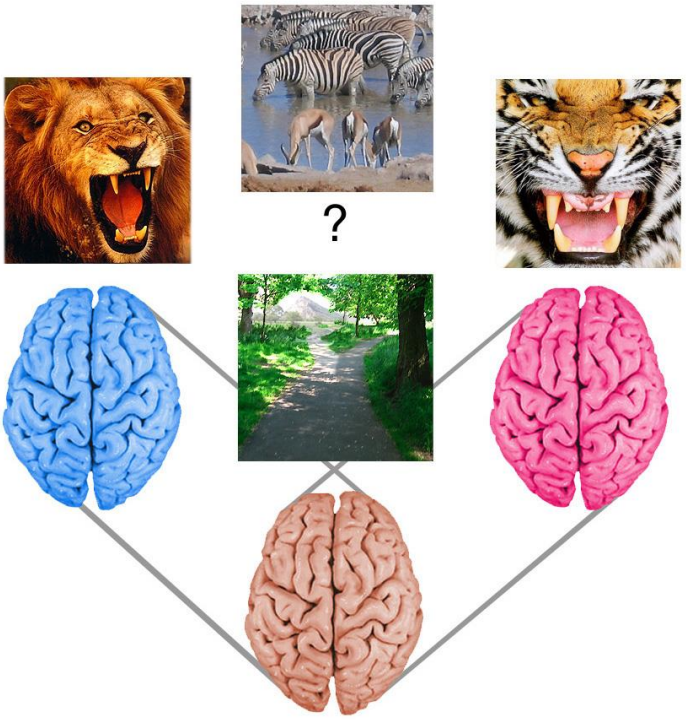

Fig 7: Decision-making in the open environment involves computationally intractable problems, which cannot necessarily be solved by probabilities alone. Which path should we take to the water hole today? There could be a tiger on the shady path or a lion on the stony path. Both of these animals are also trying to out-manoeuvre us by changing their decision-making.

Suppose a gazelle is trying to get to the waterhole along various paths. On a probability basis it is bound to choose the path, which, from its past experience, it perceives to be the least likely to have a predator, i.e. the 'safest'. But the predator is likewise going to make a probabilistic calculation to choose the path that the prey is most likely to be on i.e. the same one. Ultimately this is an unstable problem that has no consistent computational solution.

There is a deeper issue in these types of situation. Probabilistic calculations, both in the real world and in quantum mechanics, require the context to be repeated to build up a statistical distribution. In an interference experiment we get the bands of light and dark color representing the wave amplitudes as probability distributions of photons on the photographic plate only when a significant number have passed through the apparatus in the same configuration (see fig 8). The same is true for estimating a probabilistically most viable route to the waterhole. But real life problems are plagued by the fact that both living organisms and evolution itself are processes in which the context is endlessly being changed by the decision-making processes. Repetition occurs only in the most abstract sense, which is one reason why the massively parallel brains we have are so good at such problems.

Finally, in many real life situations, there is not one optimal outcome but a whole series of possible choices any or all of which could lead either to death or survival and reproduction. A central enigma of quantum reality is the Schrodinger cat paradox, in which a cat set to be killed by a radioactive scintillation in quantum reality is both alive and dead with differing probabilities, but in our subjective experience, when we open the box the cat is either alive or dead with certainty. This is the renowned problem of the causality-violating reduction of the wave packet.

Come back for a minute to the animal tracing a path to the waterhole. Animals and even people are quite lousy computers with a digit span of only six or seven and a calculation capacity little better than a pocket calculator. We all know what we do and what conscious animals do in this situation. They look at the paths forward. If they have had a bad experience on one they will probably avoid it, but otherwise they will try to assess how risky each looks and make a decision on intuitive hunch to follow one or the other, depending on how thirsty and desperate, or distractedly oblivious they have become by the sunlight and green shoots in the glade.

In a sense, all their previous life experience is being neatly summed up in their parallel processing awareness and their semantic and episodic memory, but the real role of consciousness is to keep watch on the unfolding living environment, to be paranoid to hair-trigger sensitivity for any hint of a movement or the signs or sound of a pouncing predator. The absolutely critical point here is that their consciousness is providing something completely different from a computational algorithm, it is a form of real time anticipation of threats and survival that is sensitively dependent on environmental perturbation and attuned to be anticipatory in real time just sufficiently to jump out of the way and bolt for it and survive. So the key role of subjective consciousness is an integrated 'holographic' form of space-time anticipation.

How could this come about? One way is by quantum entanglement. In quantum mechanics, not only are all probability paths traced in the wave function, but past and future are interconnected in a time-symmetric hand-shaking relationship, so that the final states of an entangled pair on absorption are determining boundary conditions for the interaction just as the initial states that created them are. Thus when an entangled pair are created, each knows instantaneously the state of the other and if one is found to be in a given state, the other is immediately in the complementary state no matter how far away it is in space-time. This is the 'spooky action at a distance', which Einstein feared because it violates local Einsteinian causality. The transactional interpretation of quantum mechanics expresses this relationship nicely in terms of offer waves from the past emitter and confirmation waves from the eventual absorbers, whose wave interference becomes the single or entangled particles passing between.

The brain explores ongoing situations which have no deductive solution, by evoking an edge-of-chaos global entangled state which, when it does collapse, results in the 'aha' of insight learning, but otherwise remains sensitively tuned for anticipating any signs of danger. This is pretty much how we do experience waking consciousness.

The key thing about quantum entanglement is that it cannot be used to make classical causal predictions, which would formally anticipate a future event, so the hand-shaking is only good so long as we maintain an entangled state. This suggests that the brain may use its brain waves and

phase coherence to evoke entangled states that carry quantum encrypted information about immediate future states of expereince as well as immediately past states, in a kind of quantum 'present' which we witness as subjective experience encoded through the parallel feature envelope of the cerebral cortex. The idea then is that his provides an intuitive form of anticipation which cannot however be crystallized into a fully causal classical prediction algorithm because it would collapse the entanglement to do so.

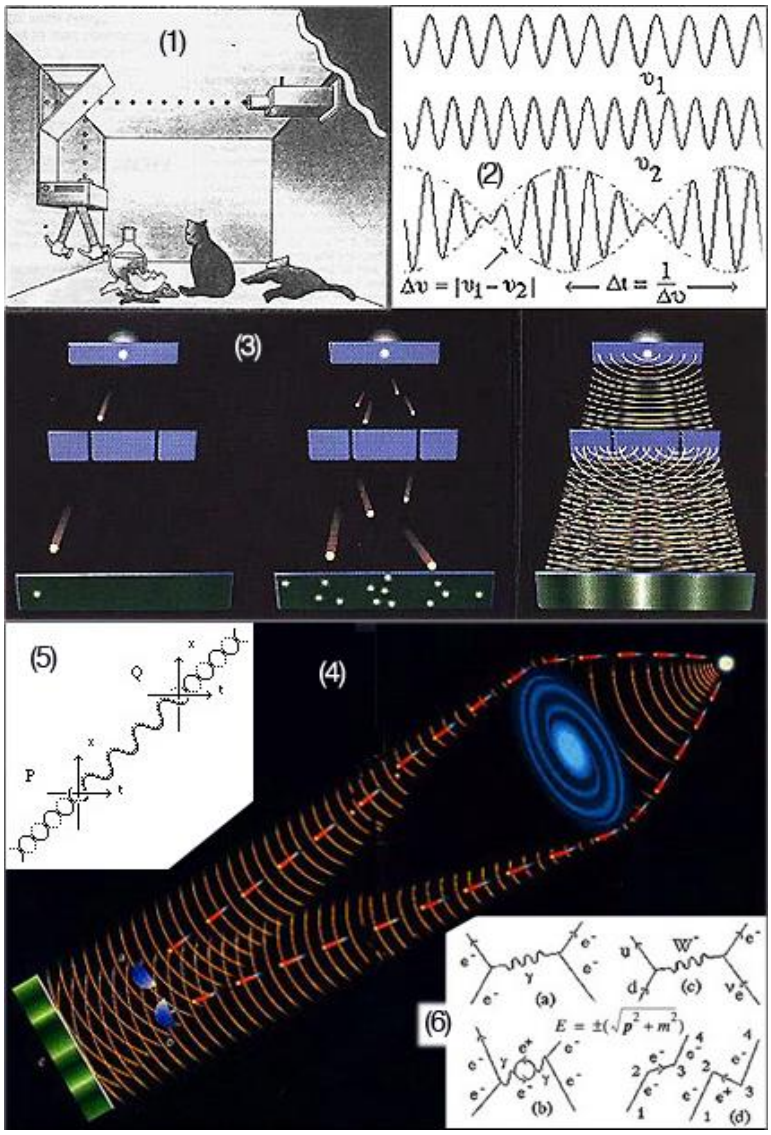

Fig 8: (1) Schrodinger cat experiment has a cat in a box with a radioactive scintillation counter, which works by quantum tunneling out of the nucleus triggering a hammer to smash a cyanide flask pronouncing a cat alive and dead with differing probabilities according to the tunneling wave function of the nucleus potential well. However we find the cat is either alive or dead with certainty. (2) The uncertainty relation $\Delta E \Delta t \approx h$ is derived directly from the counting of wave coherence beats, since energy is related to frequency by $E = h\nu$ and $\Delta t \approx 1/\Delta\nu$. (3) Quantum interference experiment shows wave-particle complementarity and reduction of the wave packet occurs statistically (centre) according to the amplitude of the wave function (right) although the wave-particle reduction of individual quanta (left) is unpredictable. (4) Wheeler delayed choice shows time reversed boundary condition. A cosmic scale version of the interference experiment using galactic gravitational lensing can be adjusted at the detector after the photons have traversed space to either sample a particle going one way round, or a wave interference going both ways. (5) The transactional interpretation visualizes an exchanged particle wave function as the interference of a retarded usual time direction offer wave and a time-reversed advanced confirmation wave. (6) Time symmetric interactions also occur in quantum field theories where special relativity allows both advanced and retarded solutions because of the energy relation $E = \pm\sqrt{\mathbf{p}^2 + m^2}$. (a,b) Virtual photons and elecctron-positron pairs deflecting an electron in quantum electrodynamics. Since the photon is its own anti-particle, a negative energy photon traveling backwards in time is precisely a positive energy one traveling forwards. (c) weak force exchange (d) An electron scattering backwards in time is the same as positron creation-annihilation.

But there is more to this cat paradox situation. In the quantum universe we have multiverses. Quantum mechanics appears to preserve all the conceivable outcomes in parallel so that, not only is Schrodinger's cat both alive and dead, but Napoleon has both won and lost the battle of

Waterloo. Many of these strategic outcomes, indeed all the accidents of history, depend on uncertainties that go in principle right down to the quantum level.

There is continuing debate among physicists about how and where in the causal chain, reduction of the wave packet actually occurs. While decoherence theories suggest this may occur simply through interaction of single or entangled states with other particles. e.g. in the experimental apparatus, in a fundamental sense the wave function of the entire universe appears to one single multi-particle entangled state and so the whole notion of a single line of history unfolding seems to be something only our conscious awareness is able to determine. Several of the founding quantum physicists adhered to this view. John von Neumann suggested that quantum observation is the action of a conscious mind. That argument relies on the view that there is something special about consciousness, especially human consciousness. Von Neumann argued that everything in the universe that is subject to the laws of quantum physics creates one vast quantum superposition. But the conscious mind is somehow different. It is thus able to select out one of the quantum possibilities on offer, making it real - to that mind, at least. Max Planck, the founder of quantum theory, said in 1931, "I regard consciousness as fundamental. I regard matter as derivative from consciousness." Werner Heisenberg also maintained that wave function collapse—the destruction of quantum superposition—occurs when the result of a measurement is registered in the mind of an observer. In Henry Stapp's words we are "participating observers" whose minds cause the collapse of superpositions. "Before human consciousness appeared, there existed a multiverse of potential universes. The emergence of a conscious mind in one of these potential universes, ours, gives it a special status: reality" (Brooks). This is effectively a complement to the anthropic principle of physical cosmology in which conscious observers are selective boundary conditions on the laws of nature in the universe (Barrow and Tipler).

Thus another idea of the role of subjective consciousness is that it is a way the universe can solve the super-abundance of multiverses to bring about a natural universe in which some things do happen and other things don't. One of the most central experiences of our transient mortal lives is that there is a line of actual history in which each of us, however small and insignificant our lives, are participating in bringing the world into actual being, albeit sometimes somewhat diabolically in times of selfishness and exploitation, but with some reflection on our own transience, perhaps reaching towards a more enlightened existence, in which the passage of the generations is able to reach towards a blessed state where the universe comes to consciously understand itself ever more deeply and completely.

This brings us to a nub question: "Can consciousness anticipate physical reality, let alone influence it through will?"

(Continued on Part II which also contains the references)