The UNiversal Correlates of Consciousness
(an attempted deconstruction of experience)

Stephen R. Deiss[1]

Abstract:

Science, common sense and most religions assume that nature is governed by blind mechanistic laws. The machine has no experience nor choice. This creates the hard problem and leads to problematic options of eliminative materialism, emergence, or epiphenomenalism. A different view of natural laws gives a fundamental role to observer-agents as natural systems with elements of experience and self knowledge, though not equivalent to ours in richness or complexity. This conclusion is inevitable if one takes an empirically tough minded look at physical law.

This argument progresses from well established facts about perception and a systematic analysis of how things acquire meaning. On this basis natural laws are recast as "nothing but" impotent generalizations. Without governing laws we are left with spontaneous self-organization in all systems and a natural place for sentience and consciousness.

What is an observation? Let's look at the data. Can one do that without prejudging?…..

Introduction: Applying Cognitive/Systems Neuroscience to Science

Herein is an attempt to remove a thin veil that clouds our view of nature and of ourselves. The veil consists in an adaptive metaphor that made us survivors, but which is overextended to create metaphysical confusion. Removing the veil by exposing the metaphor and presenting a viable alternative solves the hard problem [Chalmers, 1996]. This hard problem arises because the physical world seems to be explainable by mechanism and reductionism without any required reference to qualitative experience as either cause or effect. So according to some thinkers conscious experience is not real, or it is a useless epiphenomenon, or it is for all practical purposes "nothing but" physical processes [P.S. Churchland, 1986, P.M. Churchland, 1988, Crick, 1995, Dennett, 1991, Koch, 2004].

Yet our conscious experiences are the only unequivocal route we have to knowledge other than animal conditioning. This is true even if our experience is merely the last step in a long sequence of events in an enormous complex impersonal experimental apparatus. Someone has to read the meter and take the data. They have to see where the dial is pointing, distinguish the pointer on the dial from the tick marks, note the position, see the contrasts, and then interpret the reading. If all qualia[2] were somehow taken away from us, we would no longer have any basis for making any distinctions. We would be unable to see and read the meter. Qualitative differences are how we would know one thing from another, the roots of all knowledge. We cannot conceive nor talk about the world or ourselves without them. Without qualitative differences scientific measurement would be impossible, and there would be "but nothing" physical, or otherwise, for us to discuss.

The Universal Correlates of Consciousness (UNCC) that will be presented here derive from the nature of raw sensation, perception by inference, associative memory that constitutes expectation as constraints that guide inference, how things are interpreted inferentially to give meanings, concepts that guide and sometimes hijack our perception, and how these all dynamically work in conscious brains and all other manner of systems. The argument is based in widely known psychophysical principles, basic cognitive neuroscience, dynamical systems theory, and a coherent philosophical interpretation of what all these are telling us. The foundation for a science of consciousness must take into account all of the above along with a clear understanding of how scientific observations are interpreted. The science must not undermine itself. Ultimately we must look carefully at how science is really getting done in contrast to any romanticized preconceptions.

[1] Applied Neurodynamics, 1472 Via Terrassa, Encinitas, CA, 92024-5382. Email: deiss at appliedneuro dot com
[2] "Qualia" here refers to the qualitative differences in sensation used for making simple perceptual discriminations.

Part I: Sensation, Perception and Conception

When we experience the world we see objects, hear voices and songs, taste foods and feel identifiable events and objects or conditions through our bodily senses. *Or do we?* In the strictest sense we can directly extract no more information than meets our retina, vibrates our eardrum, or touches our skin etc. The rest of our experience must result from inference, filling in and interpretation of this information. Our blind spot goes unnoticed because we infer what is missing using expectations [Ramachandran & Blakeslee, 1999]. Starting with basic vision, taking data involves beliefs in the form of assumptions and inferences. Yet change blindness shows this can fail us when our expectations override to excess or are otherwise fooled [Simons & Levin, 1998]. Perception is a process of extracting meaning from, or more precisely, assigning meaning to our qualia, our most basic sensations. Meanings[3] are the things that we take to follow from the givens, in this case sensations. We do this based on our expectations, assumptions, and a learned theory of reality. It is a type of pattern completion process going beyond the givens through synaptic associative 'mechanisms' studied in neuroscience [Squire & Kandel, 2000]. The usefulness of our filled-in world experience depends on how good we are at interpreting what little data we do acquire. It is amazing how much experience we derive from so little sensation. It is even more amazing how unaware we are of the whole process almost all the time. Inferences are so fast that we actually feel we experience what we infer. This gives us a sense of reality "out there." Those of our ancestors not so quick to judge were often eaten by predators.

We prejudge reality constantly. What we are given is subtle qualia, small relative sensation differences that make a difference to us when we are able to attend to them and interpret them. Our beliefs, not all verbalized, are based upon associative expectations generalized from much past experience (and culture driven hearsay) that starts in infancy. We have long forgotten learned inferences and generalizations we made in the crib or crawling and stumbling about in our infancy. 'Forgetting' is somehow an inappropriate term here since our brains were not even finished during those critical periods. We have 'forgotten' how we learned to associate agency with others we interacted with and how we later managed to infer our own continuing identity from the learned invariant body centeredness of our experiences and actions. Such thought habits became so automatic that they are beyond personal review without the most rigorous training.[4] We all have an operational theory of reality. The common sense view is by definition one we all share, and the scientific view is rapidly supplanting it, though with occasional setbacks.

The first important observation then is to realize that we go way beyond what we are given when we experience the world, any hypothetical culturally sanctioned world, "out there." There are lengthy complex cascades of micro-associations, most outside our integrated awareness, that are triggered when we interact with something and this interaction is guided by our expectations. Associative expectations are the foundation of how we experience even those things that we take for granted as direct experiences. Consider how we see a tree. What we are presented with is patches of green and brown with a certain orientation relative to our vestibular sense and a characteristic immobility plus many other qualia, that is, relative qualitative distinctions. (If everything in the universe was the same shade of red, it would be invisible! It is the contrasts that inform us.) Furthermore, these sensory contrasts are changing constantly. We turn that raw data into a 'tree' based on past experience that is held in our memory via a process of perceptual learning long forgotten and locked into our developing brain during infancy. This is a process of generalization of similar past experiences resulting in the concept of a tree. Perception is conceptual. It is just as much 'top down' as it is 'bottom up' if not even more so. In milliseconds we size up this particular qualitative configuration, and we fill in many more qualities not given to create the experience of seeing a tree. The tree experience is the meaning or interpretation of a configuration of sensory qualities. The tree we see is, 'in reality' an interpretation, a theoretical entity, and in that sense "seeing ***is*** believing." Only the sensory qualia, the expansive moving greens and browns, are immediate. Some use the word illusion to describe such experience, but that goes a bit too far. We experience our theoretical entity as if out there in reality. Just because qualia are immediate and we depend on them for all knowledge does not mean they are more real than the world we infer beyond them. It just means they are more immediate and primary sources of information prior to inference. Science has begun the study of the processes of qualitative observation in perception fundamental to science itself. Even without a science of

[3] The meaning of X given Y to Z is the set of expectations Z has on encountering X in context Y [Deiss, 2005a].
[4] There are meditators who have skills to tone down these automatic inference processes accompanied by stress reduction. I am skeptical of the traditional metaphysical spins that are often placed on such modes of experience. Yet clearly meditation can physically and emotionally change people in beneficial ways [Mind & Life, 2005].

consciousness, science is at its essence the collection of a vast record of qualia, and the public debate over their interpretation with theory. An estimated 99% of that theory is never debated. Naïve realism, scientific materialism, and much theology results from reification of these theoretical entities we infer.

When we learn how to start seeing consistent patterns in the way things behave, one thing we begin to notice is how objects that are thrown skyward usually fall back to the ground (other things being equal [Cartwright, 1993]). In school this consistent pattern is given the name 'law of gravity.' By the time we learn such principles in school we have become so automatic in the way we look at and prejudge events and processes going on around us that we have little difficulty 'seeing' that the law of gravity is out there in the natural world right alongside that tree. After all, one cannot defy gravity by will. It is independent of us. Moreover, if we are smart we can engineer ways to use it for our ends. Then follows the water driven grain mill, the pendulum clock, and many other innovations. These reinforce our perceptual bias. These patterns in nature's behavior become 'laws' in a second order reification.

This is precisely where we start to create the hard problem. We recognize consistent patterns in nature, and we begin to believe that the patterns themselves have a second order life of their own above and beyond the theoretical entities they would govern (massive objects in the case of gravity), themselves reified patterns. The law of gravity is seen as a basic part of reality. It is reified. In fact, since it seems true everywhere there are massive bodies regardless of their size or constitution, the law of gravity seems more universal and real to some than even earth or Newton's apple itself. There are all kinds of apples that come and go, but there is only one very simple law of gravity that holds everywhere it has been tested (adjusted for relativity). While we might not know the final theory yet (maybe some quantum theory of gravity or string theory of the future, goes the story), it is assumed that there is a true final theory out there in the world awaiting discovery. The final theory is more real to most theorists than the phenomenal world it would explain. What if this second order reification is fundamentally wrong? It will now be shown how denying that reification permits a robust and elegant place for mind and consciousness in nature.

To understand the meaning of something is to have associated expectations. If we cannot infer anything from it, we cannot know what to do as a result nor what it signifies. It is very difficult to imagine anyone except maybe a newborn having sensations of uninterpreted qualia, and then not for long. For them at first everything is brand new. For adults whole objects are actively inferred and experienced from incomplete sensory qualities, thereby making our novelty detectors harder to excite. Perception requires beliefs to go beyond the given. Science teaches us that we really cannot step into the exact same river twice. But that does not prevent us seeing a constantly changing sensory stream as if it were a fixed thing conceptually, an abstraction from the sensory swirls, eddies, and rushing sounds we actually sense. The meaning of a sign or symbol or event or sensory quality is all the expectations we have when we sense it. These expectations include what we expect to do, say, or experience in the future given the sensation, including counterfactual what-if scenarios we would agree with. It is a set of prejudices, beliefs and action propensities that go together as an interpretation of the sensation. These are by no means all explicitly conscious. Often they are experienced in summary form as an intuitive 'feeling of knowing' or 'feeling of understanding' or a sense of competence. Intuitive feelings are an extremely important and underrated aspect of all our conscious experience [Damasio, 1999]. As very complex perceivers we cannot possibly attend to everything at once explicitly that contributes to any experience. But we can have an intuitive sensation associated with a lack of conflict when things are understood. One conjecture is that such intuition is a real sensation of internal resonance among consistent implications that create an uninhibited readiness to act out.

When we have shared expectations from common experience and common enculturation, we are able to invent concepts and categories and dictionaries and talk to each other about the shared reality we believe in. Science is a way of formalizing this process, but it is still dependent on collecting the sensed data and then interpreting it. The scientific process is more public and, being interpretive requiring consensus and refereed publication, it is a highly political process.[5]

To summarize the first stage of removal of the veil clouding our view, the main points are:

1) Perceptual experience beyond mere sensation of qualitative differences is an interpretive process guided by both past experiences and biases through the hearsay and education that accompanies cultural immersion.

[5] Given how far the view expressed here is from the current consensus, no one will be more pleasantly surprised than the author if the reader discovers this paper in a refereed science oriented journal.

2) Developmental processes can even lock many biases into our cognitive architecture thereafter changing how we perceive.
3) Interpretation is assignment of meaning based upon expectations in the form of learned associations, assumptions or presuppositions, and biases all of which are often culturally reinforced to produce a common sense theory of the real world that lubricates social function and facilitates adaptation.
4) Our natural laws are an extension of this process from the realm of events and inferred objects reified by perceptual interpretation to the second order realm of patterns reified in the events and object behaviors so perceived. Both the physical world and natural laws are reifications of patterns of sensed contrasts.

There is no denial here that there may be a reality that corresponds in some way to our interpretive experience. Modern interpretations of quantum theory seem to suggest that this is just not so. However, that is not a settled issue of interpretation, though the facts are seldom disputed [Rosenblum & Kuttner, 2006]. Classical physical theory and common sense both work historically well for adaptation to most environments, and it is seductive to believe there really is some kind of independent reality we participate in. However, it is important to realize that perception and experience are theoretical interpretive activities, not direct apprehension of the way reality is, even if there is one independent of our looking at it. Science is based on observational experience, and it does not escape this fundamental fact. Scientific objectivity is not based upon being able to see reality without bias. It is being willing to submit theory to experiment and have the results subject to peer review, verification, and public interpretation in order to reach consensus about what the observations mean, reality or no reality. Taking data in the lab is a very theory laden process, a fact that many experimentalists just cannot appreciate. The only real data are scientists' personally sensed qualia-contrasts which cannot be shared publicly. They can only be assumed recreated in others, and we can probably thank our mirror neuron system for that [Rizzolatti & Craighero, 2004].

Part II: Laws of Nature

The second step in removing the veil is to realize that the laws of nature we have created in numerous acts of generalization are just that, "*nothing but"* generalizations. This is very difficult for many scientists and philosophers alike to accept because it defies common sense. This conclusion is a direct and obvious result of applying the lessons of the last section to the scientific way of creating meaningful scientific assertions and verifying them.

Detractors from the science of consciousness enterprise note that we cannot directly observe consciousness, not even our own reliably by introspection. However, no one ever observed, much less discovered, a law of nature either. Rather such laws are theoretical regularities in our observation record posited by induction. It is not just that they are approximations to some final theory subject to change. Rather I claim that which they are presumed to approximate does not exist in a metaphysical sense even if we had a final theory all worked out [Deiss, 2006]. This is a classic application of Occam's Razor with many side effects. It goes against a current that has been running strong ever since Pythagoras and Plato.

This non-transcendental view of laws of nature is not at all new. It goes by the name Regularism [Schwartz, 1985, Dorato, 2005]. In the radical form endorsed here it denies that laws of nature are anything more than regularities in what nature does. That is, they do not have any power over nature. Nature does not obey nor conform to them, nor computationally execute them, nor do they exist in any transcendental realm, nor the mind of the gods or a God. Nature just does what it does, period. We can generalize about the regularities, and there really do seem to be regularities in our observations. However, that only means at most that natural phenomena occur in regular ways, not that nature obeys laws governing its behavior. What nature does is the only laws of nature there can be.[6]

Mere mention of the idea that there is no lawful necessity in natural phenomena makes many scientists and theologians, both Eastern and Western, roll their eyes. There are two reasons for this. Part of the story in the West began when science started to usurp the authority of the Church. The popular notion of governing laws of nature evolved as a conceptual half-way-house compromise that allowed the enterprise of science to proceed without completely pulling the metaphysical rug out from under everything that the prevailing cultural bias taught, i.e., the theological common sense of that day [Dorato, 2005]. It also kept (some) scientists off the hot seat in a literal sense.

[6] The UNCC view is congenial with some types of Scientific Pantheism. For an overview see [Harrison, 2004]. UNCC is also a variety of Panpsychism [Skrbina, 2005]. The distinguishing UNCC feature is antisupernaturalism.

It has allowed science and religion uneasy coexistence for centuries. This is also what makes it so easy for many otherwise sanguine scientists and engineers to still endorse the notion of 'Intelligent Design' without any sense of inconsistency with science. If nature were governed by laws, then it is natural to ask who made the rules, or at least where did they come from and how are they enforced.

However, this is more than just a sleight of hand accommodation by science to avoid the consternation of the Western Christian Churches. Laws are so ingrained in common sense that many cannot imagine any other possibility. There is something very basic about human cognition that leads us to this view. The explanation lies in our associative memory and expectation-based thought processes and how they build on sensations by completing patterns to create a world view. This point was already illustrated in the last section. New things remind us of things seen before because we remember. Even when we do not consciously recall seeing similar things before, familiarity produces a priming effect so that we tend to recognize, classify or respond to similar things more quickly. This is obvious and a well established experimental fact [Wiggs & Martin, 1998]. That is one reason we see 'things' like trees as outside us and having a continuing identity and existence. It is a case of moment to moment re-cognition even though the sensory input is in total flux with the leaves and branches of our tree waving in the wind under variable lighting as the cloud cover and seasons change. So it goes with recognition of repeated event sequences giving rise to notions of processes of cause and effect and natural law. Another way of conceptualizing what is happening is to consider it a process of pattern completion. We have a tendency to think of this as recognition of a pattern that is 'out there,' but we have no direct connection with the great 'out there.' Rather we have complex sets of sensed contrasts which we complete into larger patterns via neural networks inside us. These patterns can lead directly to actions and memory changes at the same time.

The summary of the second stage of veil removal is that we need to reject the belief that there need be anything outside of nature that makes it do what it does. The reader may wonder what added advantage there is to not posit the laws out there in the real world or in some transcendental realm. It was argued earlier that the real world may include something like the objects we infer, though it is not crucial to accept that here. Why not the laws we infer too? The reason is that if this skepticism can be seriously entertained, then a radical possibility opens up for integrating awareness into nature. It makes the 'hard problem' a non-problem. Such skepticism is difficult. Even those who favor Regularism find it hard not to habitually reify lawful causal patterns. The metaphor permeates our language. It takes some effort to select words that do not mislead by calling to mind the traditional schemas.

Part III: Beyond Blind Mechanical Causality

If nature is not governed from outside by gods nor transcendental laws, the question is why does it do what it does in the systematic way that it does it? Why does it seem so regular?[7] If there are no laws of nature other than whatever nature does, what does that do to the notion of causality? How can anything cause anything else if there is nothing that makes things happen? Why do things ever change? For that matter, why is there something rather than nothing? How do we approach the process of explanation if we cannot appeal to universal laws that explain things in terms of causes and effects?[8] We habitually interpret the world causally. When we hear the answer to a "Why?" question, it always starts with "Because…" We are up against the main pillar of common sense.

The prevailing view of physical theory based on laws of nature is that one thing blindly causes another according to the mechanistic laws. This provides the backstop for all scientific explanations. The logic of explanation goes something like this: A always causes B, and B always causes C *because* of the laws. A happened. Therefore C was inevitable (again, other things being equal [Cartwright, 1993]). A-B-C is a mechanism based upon cause and effect. Cause and effect is because of the laws. No one at A had to think, make a decision, nor have experiences to cause B and then C. However, if there is no transcendental necessity to the laws of nature, the concept of causality will clearly need radical adjustment. If nature just behaves, then even if it is regular it is fundamentally spontaneous and self-determined, though obviously not random and capricious. The root cause of every event in the final analysis would seem to be energetic, self-organized, whole-system-synchronized spontaneity. What is self organization? How do systems get synchronized to move effectively with a direction or evolve? Whence is this energy? What would a non-causal answer look like? This is hard to even discuss without self-contradiction.

[7] Hypothetical quantum variability at the Plank scale is ignored here.
[8] The old approach has a similar problem. What caused the laws of nature? … and that?…etc. ad infinitum.

Perhaps we should start with a more basic question first. What is a change? Wherever an event is detected, something changed. That is because detected events are changes that occur on a contrasting background of non-change or a differing background rate of change. A universe that was totally static might as well not exist. It would be undetectable and irrelevant. A change that was, in principle, undetectable would not ever be part of the empirical world except as theory or fantasy. The change must occur along some dimension (color, spatial location, etc.). Therefore there are dimensions of contrast. Detection of change requires concurrent sensitivity to the world configuration along that dimension of contrast so that there is a detectable difference, or else it requires concurrent activation of a memory representation of the contrasting side, a model. In other words, in order for there to be a difference that makes a difference there has to be two or more things that can be differentiated and compared by the system that would respond to the difference. Likewise systematic non-random change itself requires memory to occur in the first place. The seed of the next state or behavior must be present in the current state and behavior even if there is a dynamical nonlinearity. In its most simple abstract form such memory is a form of resistance to random change. It is basically the foundation of 'inertia' in the general sense. Therefore, in order for there to be any detectable change, there also has to be contrasting inertia. Without any change, there would be no such thing as time because change is the basis for building clocks. All this leads to rather interesting conclusions. Nothing detectably endures and exists with inertia unless something else is detectably changing by contrast. The change implies some kind of dimensionality. Nothing is changing unless something else, relatively speaking, is static and enduring. Inertia, dimensionality, time and change define each other, always accompany each other, and are relative to each other. None of these are ever conceivable in isolation without all the rest. Contrasts are fundamental. Until detected somewhere, changes and contrasts are irrelevant and do not make any difference.

What then is an observer? In order for a change to make a difference, it has to be detected. The detection of such change requires a sensitivity to the contrast in question. People can sense red-green contrast. Complex cortical V1 cells respond to small oriented patches of luminance contrast. Retinal cones respond to photon wavelengths differentially. For all these there is a difference that can make a difference. Most of us readily acknowledge that there is a qualitative (quale) aspect when people sense red-green contrast. But the almost universal bias is to deny any such sensation to the complex cell or the retinal cone cell. Why? As long as we assume laws of cause and effect, we can deny any need for sensation in the simpler systems. But that leaves us with the hard problem of where the sensations enter into experience that we undeniably have. Occam's Razor has been implicitly used to deny sensation or conscious experience anywhere but in brains, and there are those who question it even being there as well. However, if we instead use Occam's Razor to cut away the supernatural transcendental view of laws of nature, then there is little reason to assume that the universe is divided into sentient versus only mechanical systems. It is more consistent to assume that <u>any</u> system that can respond to a contrast has sensation of it as it responds. If the contrast cannot in principle be sensed by any matched detector system, then it is irrelevant since nothing could ever happen as a result. The universe is made of differences that can make a difference to some observer (information). It is natural to ask if such primitive system sensations are conscious the same way our own are involving our whole brain and body. This question is motivated by an intuition of fundamental panexperientialism [Skrbina, 2005].

First, it must be noted that not all of our own sensations are conscious. We sense things around us and respond to them in real time constantly, often without being consciously aware of them. As our attention shifts, various sensory modalities come into awareness in various combinations as part of our flowing stream of consciousness, and then they disappear again. One moment we are attending to the itches on our foot, and the next moment we are attending to the itches inside our head, our thoughts. We seem to only be conscious of things that matter or make a difference? Why do some of our sensations matter and not others? To answer this requires a clearer idea of what consciousness is. This is a concept used in the literature with seldom even a feeble attempt at definition. We can and must do better. The following is offered, as if by a discontinuous conceptual leap, as a new best effort definition. The motivation behind the leap may seem obscure at first but will slowly become clearer.

Consciousness is a process of assigning forward-looking meaningful interpretations to contrast-based sensations by acting on them or at least recording them in memory to make a future difference in action. Meaningful interpretations of sensation in turn are sets of consistent relevant expectations (implications) about what is, will or could happen and the selection of plans guiding what to do (action oriented decisions), accompanied by execution or preparation for execution. Interpretation gives the sensed patterns of contrast meaning by filling in implications.

In summary, consciousness is an interpretation of sensory contrasts that make a difference to behavior. If granted that sensation is ubiquitous in nature, then consciousness is the very essence of nature's unfolding self-organization. This is true whether it be unfolding in simple systems or complex brains. Interpretation of meaning, or conscious experience, is really a prediction, decision and action/memory process. In our brains the expectations and plans are based upon associative memory that provides implications to work with. The decision process involves synchronizing and orchestrating conflicting sets of associative expectations and the associated action plans to produce a coherent and executable or realizable result. The result is recorded in the actions taken and the change in system state which results in synapse and ion-gated channel based memory changes in our brains. The resolved expectations/anticipations resulting from the process make the total experience.

We saw earlier that our naïve view of real objects and their vicissitudes comes from interpretation of sensed contrasts. Then we saw that laws of nature are an added layer of interpretation on top of that. This definition is a natural extension of these insights to clarify what conscious experience is. A normal state of conscious awareness is not a passive process of data collection and representation on a stage. It is intentional with an outward direction into the future. Some terms from folk psychology may actually apply after all, without dualism nor supernaturalism nor anthropomorphism.

Perception involves going beyond basic qualitative sensory contrasts. Consciously experiencing something involves putting an interpretive spin on what is being sensed, crudely speaking, "what it means to me." Where infants might see green-brown wavy patches of color, a child may see a tree, and the adult may see a forest. In each case the interpretation relates to what one might then do: reach to explore, reach to climb, or reach for a camera respectively. This immediately suggests why the enterprise of search for the NCC has so far been sterile. The whole brain and the whole body are involved in being conscious because interpretation of meaning is a whole system function drawing heavily on all the memory in the whole system, not just synaptic memory either [Deiss, 2005b]. As any neurologist will confirm, being quadriplegic, for example, results in a greatly altered state of awareness. Interpretation is synthetic and holistic at a system level. I will leave the 'system' notion undefined except to say it involves internal structure, stereotypical orchestrated action, and a boundary of functional separability for practical purposes or analysis.

Returning to the question of why some things we sense and react to never reach consciousness, the answer has to do with the creation of new interpretations by a decision process that resolves ambiguity. If there is no ambiguity in the significance of something and the system response is obvious, the meaning assignment and response is more automatic and less unconscious. It is built into our memory and reflex associations as internal constraints. Only when there is ambiguity through novelty or a conflict to resolve is there a need for disambiguation and new coding to create a new meaningful interpretation. We then encode new memories of how we interpret what we are attending to, and those are our remembered experiences that guide us. New interpretations being encoded into memory are the conscious 'state changes' for brain systems. We can remain oblivious to things that are over-learned and require no new interpretation. One should not therefore conclude that elementary systems like atoms have no consciousness since they behave mechanically. If quantum theory teaches us anything, it is that nothing at that level is classically mechanical, and perhaps not on any other level either. Quantum systems have ambiguities (superpositions) as their state evolves, and wave function collapse is required for something to actually happen.

If an arbitrary system is going to change state (memory) or behavior (action) by interpreting an event and do so without lawful guidance, then it must first detect the event using a contrasting reference frame. The system itself is such a reference frame. It has inertia in the form of its relatively static state and behavioral momentum. If it had no inertial state nor behavioral momentum relative to other things, it would not exist as an identifiable system. It has internal structural constraints that provide state continuity. The reference frame used for interpretation can therefore be the system's own reference frame or a model of an external one, which is the same thing since the model must be internal to its reference frame. The model can be built-in from past events to provide a basis for detection of change. A system reacting to an event or change is implicitly comparing what is going on now with inertial extrapolations from its own state-encoded past. That too is a type of expectation. It thereby senses a contrast between the way things are (current sensed contrast) and the way things are expected to be based upon the past (memory prediction). Expectations are a direct result of inertial momentum in a system. System state and behavioral inertia provide constraints. The act of interpretation of a sensed contrast involves deciding and acting in a structured way guided by the internal constraints. The structure in that action need only depend on the system's internal operation. This is a kind of self-determined constraint satisfaction process usually involving generous feedback. Therefore, a reference

frame is more than an abstract geometric point in the physical world. To respond to an environmental contrast such a system must have inertial state memory which (with variable degrees of complexity) encodes or models the results of the system's relevant past interactions with the rest of the world. The classical concept of an observer in theoretical physics is the ultimate example of a Cartesian disembodied mind. Real observers are systems with inertia interacting with others to interpret and create events. They are a reference frame with self-reference acting according to internal constraints. A key feature of this description of contrasts, sensation, self-reference, state memory, interpretation and action is that it applies to any kind of system ranging from what is normally considered the mindless physical to the goal directed biological to the self aware human. Every functioning system is a self conscious process in a self organizing universe.[9] It likewise applies whether the system can be treated as classical or requires quantum mechanical description. Different types of natural systems have evolved that sense different kinds of contrasts and respond differentially. This means that sentience and consciousness are both basic to the natural world, and the universal process of consciousness as defined above is what is left after supernatural laws are subtracted out. It also means that it does not require a brain to be either sentient or conscious.

Rather than think of natural systems as pawns of causal laws mediated by forces, we should think of them as simply acting out their nature so that what a system does depends only on how it is structurally defined relative to other systems. For example, an electrical field does not effect neutrinos. They have no charge. It is not in the neutrino's nature to interact with electric fields. The electron's internal nature is such that it does interact with an electric field. But the field does not 'cause' it to do anything. The field just is what it is, an electric field. The electron and neutrino just are what they are. Each has a nature defined by what they do or what happens in this circumstance when the charge and field are brought together. It is not that the field causes the electron to move. It is the nature of the electron to start moving in the presence of a field, thereby defining a key aspect of being an electron. The notion of causal powers [Molnar, 2003, Mumford, 2004] is not straightforward.

This approach does require changes in how we explain things. If there is no causal necessity, then the electron must behave as it does according to its internal structure or nature, i.e., *by definition.* To explain how the electron behaves, we look at how it is defined. We use recursion[10] to a deeper level of theory that explains the electron's behavior the same way we should explain other more complex molecular systems by recursion to the electron level. The end result of looking at natural systems this way is realization that they do not react passively to outside causal influences. They act out their nature when in certain environments as if having preferred behaviors. They are only constrained internally by definition. Every system seems to have one or more limited degrees of freedom in how it can act. If it did nothing, it would not be detected, i.e., sensed. If it could do anything at random, it could never be identified as a consistent phenomenon. There are some things that it does not do, and some that it always does. Elementary particles have few degrees of freedom. People have vastly more. When we explain system behaviors we are not finding causes, we are describing them in lower level terms of more basic theoretical systems that comprise them and which define them relative to other systems. This is a process of explanation focused on descriptions rather than causes. Nature is what it is. But we can only know it conceptually in so far as we sense and interpret the sensations. All systems in this view are actors, not passive machines. Systems at all levels are self-similar in respect of having sensation upon interaction and a tendency to interpret what is happening in a self-referencing way to channel behavior or change.

Summarizing this section, a better kind of science would explain all of nature and its action recursively by the relative actions taking place among its most fundamental constituents which are to be illuminated by theory and experiment. The manner in which they act defines the entities and relationships between them. Causality is no longer the central theme in giving natural explanations. Recursive definitions replace causal explanations. Nature is self-similar bottom to top with no need for discontinuous emergence of consciousness. To those who would claim that our conscious awareness is nothing but the mechanistic activities of billions of nerve cells the reply would be that our conscious experience is a process of sentience and meaning interpretation that is happening at all theorized system levels in the natural world.

---

[9]This view of sentience and conscious interpretation in all systems has radical implications for the proper interpretation of double slit experiments, wave function collapse and decoherence in quantum phenomena which has been so troublesome since the Copenhagen interpretation and Von Neumann's mathematical analysis. However, there is insufficient space to fully explore that here.

[10] I am not proposing that reality is computational by use of 'recursion.' I mean it in the sense of a hierarchy of system definitions. The recursion is in the process of reading out the definitions for explanatory purposes.

Part IV: Self Similar Sentience

If systems act out their nature in their environment rather than being passive pawns of their environment, how do they know the environment and how do they act. Where does their agency come from? This is where the key thesis comes into play. Every theoretical natural system has a state reflecting its history. Its state tends to evolve in characteristic ways in certain environments and produce behaviors. But is has to detect the environment to interact with it. There has to be an interaction. The interaction is defined by the nature of the environment's proxies (photons, sound waves, etc.) and the nature of the system receiving them. If the system does not interact, there is no sensation. With no sensation there is no behavioral result. In this view, neutrinos are nearly senseless, but most other elementary systems in nature from quarks to galaxies are strongly interacting with their environment and thereby sensing it. Interaction-sensation and the state changes it leads to are the beginnings of experience

Whenever a system interacts with its environment there is a simple sensation of a quale uniquely defined for that system and that interaction. In the same way that we get a sensation from a photon striking a rod photoreceptor in a dark adapted eye, an electron gets a sensation when it is violently impacted by a photon from its environment. If photons striking our eyes can lead to seeing, then there must be something it is like to be an electron absorbing a photon. It has some kind of sensation. If the photon made no detectable difference to it, there would be no interaction in the absence of laws of nature governing. There would be nothing to do. Without natural laws sensation is a necessity. For this reason it makes sense to ask what it is like to be a electron.

When that sensation is then interpreted by the electron's state update process to decide how to change state and/or behave, it thereby creates an interpretation of the incoming photon just as seeing a flash of light might make any shy animal withdraw and hide. The change of state and behavior is a prototype of assignment of meaning to the photon by the electron, just as our assignment of meaning to a complex visual scene is done by us on interaction with many photons. It is a difference in complexity of sensors, more internal state, and more behavioral degrees of freedom. It is not a fundamental difference in kind. This is a key aspect of nature's self-similarity.

All systems interact with their environment in specific ways that result in changes of state and emitted behavior. What they do defines them to us. If they never did anything and never interacted, they would be undetectable and indefinable. Being able to sense some parts of the environment is a cornerstone of this ability. Volumes have been written about 'signal detection' theory, billions spent on 'particle detectors,' and design is ongoing for all manner of electronic and other 'sensors.' These metaphors are suggestive of a kind of low grade sentience throughout nature and our technologies. It makes no sense at all to claim that neuroscience can explain human experience in terms of neurobiology and neurochemistry, and then also claim that there can be no sentience or consciousness anywhere but in whole intact brains. In addition to being excessively self-congratulatory this creates an artificial problem of emergence. The main reaction to that problem has been the eliminative and epiphenomenal strategies. Simpler systems may not have complex nervous systems nor the same kinds of highly differentiated qualities of experience we have nor the ability to report them. It does not follow that they have no sensation or experience.

Claiming that only brain-like systems can have qualitative experience, and that all other systems in nature are purely mechanical is what created the hard problem. On the other hand, eliminative materialism denies the only thing we can know for sure, the qualities in the contrasts we encounter. As already shown it is from these that we infer and construct the theoretical scientific world that eliminative materialism appeals to. Without qualitative distinctions, materialists have no data for scientific study. Consistent eliminative materialism eliminates materialism and thereby reduces itself to metaphysical oblivion. The current heavy research emphasis on the NCC, or neural correlates of consciousness, will no doubt help us understand our own primate awareness better. However, this needs to be augmented by a search for the universal correlates of consciousness, the UNCC. Without addressing the hard problem, one would be able to look at the NCC, if ever found, and ask "Yes, but why does *that* make it conscious?"

Simple natural systems are no more mechanical than we are. They are agents like we are. They just have fewer degree of freedom in behavior, and much less state information to draw upon and keep as a history for future reference and action. When we give a recursive explanation of human experience and behavior, at no point do we need to cross a line from a realm of sentience to one of blind mechanism. We and the rest of nature are of the same sort oozing with sentience everywhere in the recursive hierarchy. We are all actors and part of the action. The dualistic separation we feel from the world is partly the result of our bio-culturally inspired superiority complex. It

was easier to rise to the top of the food chain while believing that everything else is nothing but a food/energy source or some kind of ammunition/tool. Now the world reaps the consequences.

Part V: Connecting Sentience to Consciousness via Memory

The final step in removing the veil of the hard problem requires thinking more about the relationship between sensation, memory and conscious awareness. There is no record of anyone ever having a conscious experience that they were unable to remember for at least a few minutes. This includes the famous neurological patients H.M and E.P. [Squire & Kandel, 2000]. Such patients are afflicted by medial temporal lobe damage (Hippocampus and associated structures) affecting their long term memory At the same time there are many examples of drug induced comas under general anesthesia for which there is no memory and no conscious awareness. There are numerous examples of people awaking from a multi-year coma with recall of everything almost up to the point that the coma state started. There is an intuitively obvious link between being conscious and laying down perceptual, if not declarative memories. When people are asleep they remember little of the dream experiences they have through the night. The memory differences between coma, sleep and wakefulness are exemplary showing a fundamental role of memory in awareness.

Having a memory trace that lasts beyond the immediate fleeting sensation creates a dilemma. A new interaction opportunity with the environment may arrive while the system is holding a trace of the previous interaction. However, if the system is capable of encoding the sensation and incorporating it in its state and behavior as it happens in real time, then this overwrite problem can be solved. By updating global state and global behavior in real time, the system is thereby interpreting the sensation and creating a kind of memory. Such a memory in a very simple system might not be retrievable for repeated experiencing the way we normally think of memory. However, if it becomes part of the system state, and the system state is referenced in all subsequent system action decisions, then past memory interpretation remains essentially on-line by having a lasting implicit effect. In that case it is an implicit memory creating a disposition toward certain future behaviors perhaps by conditioned learning. It could be called a prototype of an expectation whether the system is a brain or not. Referencing system state in subsequent system behavior is self referencing It is a prototype of our own elaborate and ornate self awareness where we reflect on the interpretations of our personal history.

The more system state that can be used for keeping a differentiated history of perceptions (perceptual memory) and interpretations of past sensations (the running episodic story in declarative memory) to factor into the interpretation of new sensations, then the more inner directed and adaptive the system can become. The more expectations it has accumulated based on past experience, the more aware it becomes of present implications by anticipating the future. The more degrees of freedom the system has in behavior apparatus, so also the more adaptive. But extra memory and extra degrees of freedom come at a price. The system then has multiple options for interpreting and responding in the present moment and a potential for conflicts in the expectations and preferences encoded. The more complex the system, the more complex the decision making, and correspondingly there can be more stress.

In the simplest physical systems, this may be the realm of the collapse of the wave function. In the most complex primate systems, it may be the reason for global thalamo-cortical oscillations or widespread field potentials in different frequency bands, and the general need for synchronization across a 'global workspace.' These may be required to achieve global sync [Strogatz, 2003, Singer, 2005, Pikovsky et. al., 2003] and get the whole brain in a multimodal consistent state that can lead to productive orchestrated behavior rather than useless and destructive flailing about. Movement of any complex system that has multiple subsystems in any coherent direction requires some kind of internal global synchronization. Amoebas do not have neurons. However, they do sense nutrient gradients. They have to move on that basis to survive. They have to put their best foot forward, so to speak. This is a kind of decision based upon sensory input. It was documented long ago that Planaria can learn based upon past experience with a very simple nervous system. By what logic do we assume such systems are not sentient and unconscious. Just because an organism does not recognize itself in a mirror, does not mean it is without basic sensation or conscious awareness. Consider an amnesic looking into the mirror upon awakening from a coma. Just because a system cannot talk about it's sensations and interpretations does not preclude having conscious experience. Consider an ambulatory wide awake patient with aphasia after a stroke.

Once accepted that all systems have sensation when in interaction with others, that they are not passive and mechanical, and that they can have varying amounts of state memory used to store and update behavioral

propensities, then we have a foundation for conscious experience and a rational mind, based upon the internal constraint structure guiding all such systems. Even the electron, once hit by a photon, changes state in a way that influences how it will respond in the future. All systems have state and behavior. All sense and interact with some subset of their environment in systematic ways. If they did not, we could not identify them as systems. This is true even for aggregates with very low degrees of freedom like rocks when viewed on a longer time scale. All natural systems have these fundamental properties of sensation interaction, state, behavior, and self update. That is all that is required to be sentient and self aware with some crude implicit expectations about the future. When we write down the set of partial differential equations that describe system behavior and we set the boundary conditions, we are not describing a mechanism. We are describing what we observe (other things being equal) and what we expect for future observation. The system itself is the embodiment of those expectations and the experience of their application.

There are several key ideas here that need emphasis. The system state is its memory, and the memory has process inertia that represents expectations as constraints on how future state changes and behaviors will evolve. The system state update process accommodates state/memory in the behavior and state change processes. This is, in simplest form, self awareness and self determination. The more that a memory architecture allows for associated memories to be active or have influence when there are sensory inputs, the more interpretation of meaning there is, and the more anticipation can be used to prepare a response ahead using predictions via the state evolution process. Memories allow re-experiences of past experiences adding to the present sensations by filling in missing details. They are what gives consciousness its presence and time span. In cases of extreme systems with very large memory, there arise plans anticipating the future.

There is a natural continuum of progressively more complex and differentiated conscious awareness. All systems have this in proportion to their complexity. Specifically then conscious awareness is what happens when a system synchronizes or distills out of many possibilities one course of action which is the meaning or interpretation of its current sensed situation and it then updates state with a ‘representation’ of that meaning. What distinguishes some conscious systems like people from simpler systems often characterized as ‘brain dead’ is not the lack of a brain or having a dead brain. It is the lack of a sophisticated functioning memory system, fancy sensors, and many behavioral degrees of freedom. These all have to be up and running as a coherent system, that is, behaving and updating by interacting with the environment. More sophisticated system memory enables associating a more rich and varied set of expectations about the future based on extrapolation from the past. That is what gives us such a rich sense of presence in the world and makes us more consciously aware of the nuances of what is happening all around us. As we take in new sensations we are constantly reactivating traces of past experiences which help interpret the new sensation and resonate with it to produce a familiarity. The continuity in this resonance from moment to moment, and its continuing renewal is the basis of conscious experience. The simplest systems have far less state usable as a source of resonance and a corresponding reduction in awareness.

There are no zombies. There could only be a zombie if a system were completely governed by mechanism of the type rejected here. The concept of a zombie comes partly from our human knowledge of sleep walking. Being as complex as we are it is often possible for some parts of our brain to not participate fully in the online behavior we produce. Some parts of us can carry on without others. In particular, some memory systems can stop updating some representations while others are still generating behavior and running the physical plant for movement. It is from such lack of fully integrated memory and behavior that we can imagine zombies, detect unconscious motives, automaticities and all the rest. These are all conscious states at some subsystem level but less integrated with overall system behavior, and remembered differently often in nonassociative ways.

This is the last step in removing the veil that blinds us to the ubiquity of consciousness in nature. The concept of passively ruled mindless mechanism is so ingrained in the current materialistic scientific world view, that it may be incapable of broadening to accept such a radical paradigm shift. To many scientists it may seem just too outrageous to even entertain. The only advice I can give those scientists is to paraphrase what many of them have said over the years to me. “Look at the data” and in this case what the data are telling us about how we interpret data. We know more today than ever before about how perception and conception work, and how they are comprised from associative memory. There is no longer any need for confusion about where consciousness fits into the natural world. It is everywhere. This is the time to reexamine the foundations of scientific epistemology and tune up its metaphysics. Science does have metaphysics, and ignoring that only leads to bad scientific metaphysics, especially so for a science of consciousness.

It is hard to prove any hypothesis correct, and much easier to prove it wrong. There actually are experiments one can do to clarify the relationships between memory and awareness using current methods. Close correlation between conscious perception reports and episodic memory formation would be supportive. Correlation between conscious perception and selection among stressful ambiguous choices would also be supportive. Comparisons of the reported character or flavor of experience as compared to how the experienced situation is interpreted would also lend support. Defining a metric of degrees of freedom in behavior and state memory complexity that spans many levels of system organization would enable us to explore a correlation with some agreed measure of awareness [Tononi, 2004]. We also need a better definition of what makes a memory a memory in the most abstract sense. A taxonomy of interpretation processes would help. Most helpful would be better understanding of how simple and complex systems self-organize to produce coherent, synchronized or orchestrated behavior from the quantum level on up. Much effort is going into that field already. Perhaps a better interpretation of quantum theory will also suggest more decisive experiments that support or refute this line of thinking.

We always start with assumptions and expectations and see what experimental predictions inferred from them show while evaluating how satisfying the worldview is that seems implied by the assumptions. We interpret the experimental data based on other criteria of what constitutes a good fit. If we really do perceive by inference from sensation and then theorize on top of that by further inference, it would seem to lend further support to this cognitive neuroscience inspired view since we cannot escape that as our basic way of doing science. Good science leads to meaningful interpretative explanations that have predictive value and useful implications for action. If anyone can prove that science can be done consistently any other way, that would be a critical argument against this UNCC view. That is a challenge I leave those inclined to be dismissive.

Part VI: Summary

The Universal Correlates of Consciousness or UNCC are systems theoretic properties of all natural systems including us, the universe and our artifacts. In summary:

1) Natural laws do not control nature. They describe it.
2) All systems sense their environments to varying extents in the interaction with them.
3) All systems are active agents rather than mechanical puppets.
4) All act or react on the basis of current state, a reflective step.
5) All update state creating thereby new memory.
6) All create coherent synchronized behavior or else disintegrate.
7) System state contains expectations and behavioral tendencies in the way internal structure constrains.
8) Decisions have to be made where there is complexity leading to inconsistent alternatives and conflict.
9) This ongoing process (sensation, interpretation, reflective state update, and state guided decision for coherent behavior) in every system ***is*** conscious experience, and all systems from elementary particles on up to brains are theoretically dynamical systems having all these characteristics with varying amounts of complexity.
10) The universe consists of nested systems, and in theory the whole universe can be defined recursively as a huge aware structure made out of fundamental aware constituents with a beautiful self-similarity.

Laws of nature are theoretical entities which once accepted create a wedge for mind-body dualism to get into science thereby creating a hard problem that science so far has mainly dealt with by denial [see Gray for an admirable exception, 2004]. This is also the root cause of the free will versus determinism conundrum.

There is no great mystery in how brains come to be conscious. Nothing need emerge. It was always there. There are no zombies. There probably is no simple isolatable NCC. Some systems have the memory capacity for storing vast associative expectations that can be activated extremely rapidly and applied to behavioral choice. Some elementary particles like neutrinos are very busy just keeping themselves going in a straight line. There is no "spooky stuff" nor "wooo-wooo science" in this view. Rather this view comes from exposing and getting rid of some of the spooky stuff that other so-called tough-minded scientific materialist approaches leave untouched.

There is still much room for awe and inspiration in this view of nature. One can view the ultimate theoretical agents in nature revealed by recursion, either metaphysically, theologically or phenomenologically. Depending on one's

proclivities this leads to the usual alternative stances: science, religion, or perennial philosophy respectively. But under the UNCC thesis these are different views of the same conscious processes with potential for a unification.

Acknowledgement

I wish to express appreciation to the many people who have read, commented and provided encouragement on this or related writings with particular thanks to Bill Bechtel, Andrea Chiba, Seanna Coulson, Jeff Elman, Jerry Josties, Paul Lincolnhol, Natika Newton, David Skrbina, and Marty Sereno.

References:

Cartwright, N., (1993) *How the Laws of Physics Lie*, (New York: Oxford).

Chalmers, D.J., (1996) *The Conscious Mind: In Search of a Fundamental Theory*, (New York: Oxford).

Churchland, P.S., (1986) *Neurophilosophy: Toward a Unified Science of the Mind/Brain,* (Cambridge, MA: MIT).

Churchland, P.M., (1988) *Matter and Consciousness*, Revised Edition, (Cambridge, MA: MIT).

Crick, F., (1995) *The Astonishing Hypothesis: The Scientific Search For The Soul,* (Scribner).

Damasio, A., (1999) *The Feeling of What Happens: Body and Emotion in the Making of Consciousness*, (New York: Harcourt Brace).

Deiss, S., (2005a) 'What It All Means: on the feeling of understanding' (Poster), McDonnel Project on Neurophilosophy: The State of the Art, California Institute of Technology, Pasadena, CA.

Deiss, S., (2005b) 'Where is awareness of meaning and understanding in the brain,' (Poster), Society for Neuroscience annual meeting, Washington, DC, Session 771.

Deiss, S., (2006) 'Why the natural world does not work without qualia and the consciousness of them,' (Poster), Towards a Science of Consciousness, Tucson, AZ.

Dennett, D., (1991). *Consciousness Explained*, (Little, Brown & Co.).

Dorato, M., (2005) *The Software of the Universe: An Introduction to the History and Philosophy of Laws of Nature,* (Burlington, VT: Ashgate).

Gray, J., (2004) *Consciousness: Creeping up on the hard problem*, (New York: Oxford).

Harrison, P., (2004) *Elements of Pantheism*, (Llumina Press).

Koch, C., (2004) *The Quest for Consciousness*, (Englewood, CO: Roberts and Co.).

Mind & Life Institute, (2005) *Science and Clinical Applications of Meditation*, (Boulder, CO, Proceedings available on DVD, Mind & Life Institute).

Molnar, G., (2003) *Powers: A Study in Metaphysics*, (New York: Oxford).

Mumford, S., (2004) *Laws in Nature*, (New York: Routledge).

Pikovsky, A., Rosenblum, M., Kurths, J., (2003) *Synchronization: A universal concept in nonlinear sciences*, (New York: Cambridge).

Ramachandran, V.S., Blakeslee, S., (1999) *Phantoms in the Brain: Probing the Mysteries of the Human Mind*, (Quill).

Rizzolatti, G., Craighero, L. (2004) 'The Mirror Neuron System,' Annual Review of Neuroscience, Vol. 27: 169-192.

Rosenblum, B., Kuttner, F., (2006) *Quantum Enigma: Physics Encounters Consciousness*, (New York: Oxford).

Simons, D. J., & Levin, D. T., (1998) 'Failure to detect changes to people during a real-world interaction,' Psychonomic Bulletin and Review, 5, 644-49.

Singer, W., (2003) 'Synchronization, binding and expectancy', *The Handbook of Brain Theory and Neural Networks,* Second edition, (M.A. Arbib, Ed.), , pp. 1136-43, (Cambridge, MA: MIT).

Skrbina, D., (2005) *Panpsychism in the West,* (Cambridge, MA: MIT).

Strogatz, S., (2003) *SYNC: The Emerging Science of Spontaneous Order*, (New York: Hyperion).

Squire, L., Kandel, E., (2000) *Memory: From Mind to Molecules*, (Freeman).

Swartz, N., (1985) *The Concept of Physical Law,* (New York: Cambridge).

Tononi, G., (2004) 'An Information Integration Theory of Consciousness,' (Free access online, Department of Psychiatry, University of Wisconsin, Madison, USA).

Wiggs, C.L., Martin, A., (1998) 'Properties and mechanisms of perceptual priming,' *Current Opinion in Neurobiology*, 8:227–33.