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Kicking the Psychophysical Laws into Gear

A New Approach to the Combination Problem

Abstract: *A new approach to the 'hard problem' of consciousness, the eons-old mind–body problem, is proposed, inspired by Whitehead, Schopenhauer, Griffin, and others. I define a 'simple subject' as the fundamental unit of matter and of consciousness. Simple subjects are inherently experiential, albeit in a highly rudimentary manner compared to human consciousness. With this re-framing, the 'physical' realm includes the 'mental' realm; they are two aspects of the same thing, the outside and inside of each real thing. This view is known as panpsychism or panexperientialism and is in itself a partial solution to the hard problem. The secondary but more interesting question may be framed as: what is a 'complex subject'? How do simple subjects combine to form complex subjects like bats and human beings? This is more generally known as the 'combination problem' or the 'boundary problem', and is the key problem facing both materialist and panpsychist approaches to consciousness. I suggest a new approach for resolving this component of the hard problem, a 'general theory of complex subjects' that includes 'psychophysical laws' in the form of a simple mathematical framework. I present three steps for characterizing complex subjects, with the physical nature of time key to this new understanding. Viewing time as fundamentally quantized is important. I also suggest, as a second-order conceptualization, that 'information' and 'experience' may be considered identical concepts and that there is no double-aspect to information. Rather, there is a single*

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aspect to information and it is inherently experiential. Tononi's, Chalmers', and Freeman's similar theories are compared and contrasted.

I. A Brief Overview of the Hard Problem

Chalmers (1996) described what he thought would be required of the eventual 'psychophysical laws' governing the relationship between mind and matter — which would collectively comprise the ultimate solution to the 'hard problem' of consciousness:

> [T]he cornerstone of a theory of consciousness will be a set of psychophysical laws governing the relationship between consciousness and physical systems… [A]n account of these laws will tell us just how consciousness depends on physical processes. Given the physical facts about a system, such laws will enable us to infer what sort of conscious experience will be associated with the system, if any. (Chalmers, 1996, p. 213)[1]

This paper attempts to provide just such psychophysical laws.

The key question in this psychophysical enquiry is: what is a subject? This question can be broken into a number of sub-questions: why is my awareness, my experience, *here*, and yours over *there*? What leads to the obvious difference? More generally, why is the universe split in two for each of us, into a subject and an infinity of objects, with a centre of experience, a subject, receiving information about the rest of the universe ostensibly 'outside' of *here*? Why are some things conscious and others apparently not? Last, what is the ultimate unit of subjective experience and how does human consciousness relate to these ultimate units?

Alfred North Whitehead's answer[2] to the hard problem is that the fundamental subject, the fundamental quantum of the universe, is, by definition, an 'actual entity'. This is both the most basic unit of

[1] Chalmers makes these requirements more explicit in Chalmers (1997): 'To have a fundamental theory that we can truly assess, we will need a fundamental theory with details. That is, we will need specific proposals about psychophysical laws, and specific proposals about how these laws combine, if necessary, so that ultimately we will be able to (1) take the physical facts about a given system, (2) apply the psychophysical theory to these facts, and thus (3) derive a precise characterization of the associated experiences that the theory predicts' (Chalmers, 1997, reprinted in Shear *et al.*, 2000, p. 420). I attempt to provide at least some of these details in the present paper.

[2] It is surprising that Chalmers, who is exhaustive in his book in so many areas regarding the relevant scholastic threads relating to consciousness, omits any mention of Whitehead, David Ray Griffin, his most prominent extant philosophical heir, or of 'process philosophy' more generally. Process philosophy, the term generally used to describe Whitehead's thinking, and the similar thinking of Henri Bergson, Fechner, and all the way back to Heraclitus, presents a solid framework for resolving the mind–body problem and suggests the way forward in terms of a research agenda, as described in this paper.

subjectivity and the most basic unit of matter. In fact, for Whitehead, a prominent twentieth century mathematician, physicist, and philosopher, they are the same thing — an actual entity is the basis for the apparent solidity of the physical world and it is also a 'drop of experience' (Whitehead, 1929, p. 18). Actual entities thus have both physical and mental aspects that oscillate with each moment in time. Actual entities include things as small as electrons and as large as God.[3] I have been inspired by Whitehead's framework and my proposal in this paper owes much to Whitehead and his intellectual heir, the American philosopher David Ray Griffin. Arthur Schopenhauer, the troubled nineteenth century German philosopher, has also been significant in shaping my thinking, as he was for Whitehead and Griffin.

I define *simple subjects* as the fundamental constituents of matter and mind. They are, then, actual entities in the Whiteheadian sense, but the class of actual entities also includes subjects that are not simple. *Complex subjects* are, in my framework, all subjects that are not simple. They are comprised of simple subjects. Complex subjects can form additional complex subjects in a hierarchy (or *holarchy*) of increasing complexity. The combined class of simple subjects and complex subjects together comprise the class of Whitehead's actual entities.

Positing experience, or consciousness, as a basic feature of all things in the universe is known as *panpsychism*, and this view is in itself a partial solution to the hard problem of consciousness. A generally synonymous term is *panexperientialism*,[4] and what term one uses is a matter of taste (I'll use the simpler term from now on). Skrbina's masterful history, *Panpsychism in the West* (2005), discusses the long and interesting chronicle of these memes in the western world. Skrbina also presents a number of compelling arguments in favour of panpsychism and rebuts various objections to panpsychism.

Many respected thinkers have subscribed to some form of panpsychism, including the ancient Greeks Heraclitus and Empedocles, Plotinus in the third century CE, to Giordano Bruno in the sixteenth century, Spinoza and Leibniz in the seventeenth century, Immanuel Kant (in his earlier work) in the eighteenth century, Arthur Schopenhauer and Ernst Haeckel in the nineteenth, and in the twentieth century William James, Gregory Bateson, the biologists J.B.S. Haldane, Sewall Wright, Charles Birch, and C.H. Waddington, the paleontologist and

[3] Not a traditional notion of God, by any means.

[4] David Ray Griffin prefers to use 'panexperientialism' because he wishes to distinguish in a general manner between complex human-like consciousness and the much more rudimentary 'experience' that all actual entities are thought to possess, as Whitehead himself stressed.

theologian Pierre Teilhard de Chardin, the physicists Sir Arthur Eddington, Whitehead, David Bohm, Freeman Dyson, Roger Penrose, and the philosopher Bertrand Russell (to some degree). More recently, Galen Strawson, Stuart Hameroff, David Chalmers, William Seager, Gregg Rosenberg, Jonathan Schooler,[5] and many others have advocated panpsychist or quasi-panpsychist views.

Positing experience as part of all matter answers the first part of the hard problem: how does experience arise from matter? The answer offered by panpsychism is straightforward: experience and matter go hand in hand, they are the inside and outside of each real thing. Each real thing is, then, a subject because of the inside that goes along with its outside. Each real thing's outside is an object for all other subjects, and so on, in perpetual oscillation as each part of the universe proceeds from subject to object to subject… This oscillation is what Whitehead calls the 'creative advance', the laying down of reality in each moment, and is described in detail in Whitehead's 1929 magnum opus, *Process and Reality*. The nature of time is key to Whitehead's system, as it is for the framework I offer in this paper.

The secondary but more interesting question, however, is: how do simple subjects combine to form complex subjects like gnats, rats, cats, bats, or human beings, all of which clearly have some type of unitary subjectivity presumably more complex than that of an electron or other ostensibly fundamental constituent of matter? This problem is known as the 'combination problem', the 'boundary problem', or the 'binding problem'.[6] I'll refer to this as the combination problem from now on.

To be clear: the combination problem is the key component of the more general 'hard problem' of consciousness. The combination problem is the main problem facing both materialist and panpsychist approaches to consciousness today because both have struggled to explain how simpler constituents combine into a unitary consciousness. There have been various approaches to solving the combination problem, but none that have proposed, in my view, a fully satisfactory philosophical solution alongside a proposed research programme.[7]

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[5] Schooler, Hunt and Schooler (2011).

[6] I have playfully labelled this the 'dead body problem' in other work.

[7] There are numerous proposals for resolving the strictly materialist combination problem: how do neurons produce a unified personality? These proposals may help us arrive at a solution to the combination problem with respect to the 'hard problem' of consciousness (explaining how the physical and phenomenal interact), but they are not themselves solutions if they deny or otherwise ignore the phenomenal realm.

And regardless of my personal opinion, no proposed solution to the combination problem has yet caught on as the prevailing theory.

Dennett proposed a purely materialist theory of consciousness in his 1994 book *Consciousness Explained*. Edelman and Tononi have proposed their own detailed materialist theory of consciousness, the 'dynamic core hypothesis', based on the idea of 'integrated information' (Tononi has further elaborated his views independent of Edelman, distancing himself from materialism, and I address his ideas further below). And there are many others. Materialist solutions to the hard problem will help us in arriving at a more complete theory of consciousness, but they cannot be candidates for the psychophysical laws themselves.[8] By definition, purely materialist solutions fail to explain experience itself. Rather, they explain the functioning of brains, the *neural correlates of consciousness* — not really an 'easy' problem, by any means, but a problem whose solution will still leave us without a theory of consciousness itself.[9] What is needed is a theory that explains experience *and* the neural correlates of consciousness — this is what is meant by the term 'psychophysical'.

As Schopenhauer pointed out almost two hundred years ago: 'Materialism is the philosophy of the subject that forgets to take account of itself.'[10] This doesn't require a dualistic approach, in an ontological sense, but it does require that we recognize the epistemological duality

[8] Crick (1994) states: 'I have said almost nothing about qualia — the redness of red — except to brush it to one side and hope for the best' (p. 256). Crick and Koch state, similarly: 'The most difficult aspect of consciousness is the so-called "hard problem" of qualia — the redness of red, the painfulness of pain, and so on. No one has produced any plausible explanation as to how the experience of the redness of red could arise from actions of the brain. It appears fruitless to approach this problem head-on. Instead, we are attempting to find the neural correlate(s) of consciousness (NCC), in the hope that when we can explain the NCC in causal terms, this will make the problem of qualia clearer' (Crick and Koch, 2003, p. 119).

[9] Dennett, as a thoroughgoing materialist of the 'eliminativist' school, argues that once we explain the functions of the brain there is nothing else to explain: 'Whether people realize it or not, it is precisely the "remarkable functions associated with" consciousness that drive them to wonder about how consciousness could possibly reside in a brain. In fact, if you carefully dissociate all these remarkable functions from consciousness — in your own, first-person case — there is nothing left for you to wonder about' (Dennett, 1997). This approach is only satisfactory, however, if we accept that explanations of objective phenomena such as the functioning of brains can in principle explain subjectivity. And this is what I can't accept because if we limit our explanations to objective objects we are, as Schopenhauer pointed out long ago, leaving out half the universe: ourselves.

[10] Schopenhauer (1819; 1844, pp. 19–21; see Schopenhauer, 1995). Schrödinger, a founder of quantum mechanics in the twentieth century, acknowledged explicitly what Schopenhauer and many others have warned against since, in discussing the philosophic method of quantum mechanics and physics more generally: '[By the "principle of objectivation"] I mean the thing that is also frequently called the "hypothesis of the real world" around us. I maintain that it amounts to a certain simplification which we adopt in order to master the

of experience/subjectivity versus the objectivity of the external world. The solution I propose in this paper is monistic instead of dualistic in that I assert that subjectivity and objectivity are two sides of the same coin. The 'coin' is the neutral substrate of reality, which I discuss further below.

Tononi has in more recent work, in which he fleshes out his 'Integrated Information Theory' of consciousness, been more sympathetic to panpsychism, at least by implication, and it may be said that his most recent work is 'quasi-panpsychist' (Tononi, 2008). He still shies from panpsychism, however, stating that it 'hardly has a solid conceptual foundation' (*ibid.*). I believe, to the contrary, that panpsychism rests on a more firm conceptual foundation than the crude materialist alternatives that are still popular today among many philosophers and scientists. I compare and contrast Tononi's recent work with my own theory below.

I am encouraged by the fact that panpsychist approaches to the hard problem are becoming more common. The tide is clearly turning in the right direction and much ostensible disagreement among schools of thought melts away when we drill down beneath the various terminologies offered and consider the key concepts themselves.

II. Chalmers' 'Double Aspect Theory' of Consciousness and Information

Chalmers has proposed a tentative solution to the hard problem, with a 'dual aspect' view of information as a key component of a broader 'naturalistic dualism'. He has also suggested a framework for a research programme (Chalmers, 1996; 2002; 2004). However, for reasons discussed in the present paper, Chalmers' proposed solutions may be improved and I attempt to improve upon his suggestions. I provide additional specificity with regard to the proposed psychophysical laws.

After providing a solid background in philosophical methods and epistemology, Chalmers suggests a 'naturalistic dualism' as his proposed solution in his 1996 book. The proposed dualism is at least two-fold: 1) between the physical and the phenomenal in a basic ontological sense; 2) as a more tentative proposal, information is posited to

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infinitely intricate problem of nature. Without being aware of it and without being rigorously systematic about it, we exclude the Subject of Cognizance from the domain of nature that we endeavor to understand. We step with our own person back into the part of an onlooker who does not belong to the world, which by this very procedure becomes an objective world' (Schrödinger, 1992, p. 118).

have a physical aspect and a phenomenal aspect (arguably, this second dualism is a type of neutral monism, with information forming the neutral substrate that produces both matter and mind; this is in fact the direction Chalmers has followed in more recent work).

Chalmers presents an extended argument as to why the physical and phenomenal are separate realms and, crucially, why the phenomenal realm is not logically supervenient on the physical. There can, accordingly, be no reductive explanation for consciousness. This doesn't mean no solution is possible. Rather, the solution must, according to Chalmers, be non-reductive. He argues later that the phenomenal is naturally supervenient on the physical, in that consciousness springs from the physical and has an obvious correlation with the physical. But he argues that it is not logically supervenient — that is, it is not the case that consciousness would be supervenient on matter in all possible worlds — and there is, therefore, not a simple one-to-one correspondence between the physical and phenomenal realms. He labels this view a type of 'non-reductive functionalism'.

His dual aspect theory of information is a tentative solution to the hard problem that provides a bridging construct between the physical and phenomenal realms:

> [I]nformation (or at least some information) has two basic aspects, a physical aspect and a phenomenal aspect. This has the status of a basic principle that might underlie and explain the emergence of experience from the physical. Experience arises by virtue of its status as one aspect of information, when the other aspect is found embodied in physical processing. (Chalmers, 1996, p. 27)

Chalmers acknowledges that this solution is tentative and 'may prove to be entirely misguided' (*ibid.*, p. 310). Rather than laying out a fully defensible and fleshed-out solution to the hard problem, Chalmers makes it clear that his goal is to present a tentative solution to at least get the conversation going. I appreciate his efforts and have taken up his challenge to present an alternative solution, following some of his own intuitions, but differing in important ways from his views.

III. A General Theory of Complex Subjects

III.A. Perception and Consciousness as Fundamental Features of the Universe

To be a subject means that there is a centre of experience that perceives and somehow processes perceptions. The terms 'experience' and 'consciousness' require an *object* of experience or consciousness, and a *subject* to perceive the object(s). There is no isolated experience; there is

always experience *of* something, consciousness *of* something. Schopenhauer said it well: '[W]ith the subject the object is also at once assumed (for even the word would otherwise be without meaning), and in the same way the subject is at once assumed with the object. Hence being subject means exactly the same as having an object, and being object means just the same as being known by the subject' (Schopenhauer, 1974, p. 209).

When we understand this insight, we realize as we cast our attention down the chain of being that far less complex things than humans, rabbits, snakes, etc. perceive the world around them. This is the case because 'perception' should not be mistaken to require the biological senses, with which we as human beings are intimately familiar. Rather, perception, when we think about what is really going on, should more generally be conceived of as *being influenced in some manner by the world*.[11] Perception is at its most basic the detection of an object by a subject. And if all objects are also subjects, as is the case in the panpsychist view of the world, all subjects perceive on their way to becoming objects for other subjects, and so on. We can, then, define perception as receiving information from the world, which is the same thing as saying that there is a causal influence between an object and a subject. Information and causation reduce to the same ontological category.

We may also arrive at panpsychism by realizing, as Schopenhauer did, that there is no subject without object and *vice versa*. As such, to have any objects at all, there must be subjects. As long as the universe has existed, it has, by definition, included objects — and by extension subjects. Accordingly, subjects have existed since the dawn of time. This is the panpsychist position. Whitehead expanded on Schopenhauer's insight by realizing that each subject oscillates in each moment between subject and object.

Regardless of how we define perception, information, or causation, however, it is clear that literally every life form and every speck of dust down to the smallest subatomic particle is *influenced* by the world through the various forces that act upon it. An electron is influenced by charged particles close enough to have an impact, and from objects that exert a gravitational pull — and the electron behaves accordingly. To exist, to be in the universe, means that every particle

[11] It is biologically chauvinist to distinguish 'perception' from 'reception' of causal influences/information more generally. This is the case because it is obvious that non-biological things receive information (they respond to forces around them) and, when we think deeply, we realize that at its root this reception of information is no different than biological reception of information — what we generally call perception.

in the universe feels some pull and push from the various forces around it — otherwise it simply doesn't exist. Thus, the electron *perceives*, as I have defined this term, and the electron is a subject.

This is, then, a dramatic re-framing of matter, perception, and consciousness, prompted by the failure of materialist theories, in principle, to explain consciousness. In the panpsychist explanation, all matter perceives and is conscious, to varying degrees. For most matter, perception and consciousness is extremely rudimentary, but it complexifies as matter complexifies, based on the rules I describe in this paper.

We may proceed even if we don't accept the panpsychist view as necessarily true. Whether we accept the panpsychist view of the world merely as a working hypothesis, and see what results, or as the gospel truth, a number of questions come to mind. For example, if electrons and humans are both subjects, how do they differ in terms of their experience? I have defined perception as necessarily experiential, and the experiential complexity is commensurate to the complexity of the perceptions and processing of those perceptions. So an electron and a human differ only in degree, not in kind, in terms of their experience. The well-known British-American physicist Freeman Dyson, with Princeton's Institute for Advanced Studies for many years, supports this view (which generally seems strange and counter-intuitive to those first encountering the idea): '[T]he processes of human consciousness differ only in degree but not in kind from the processes of choice between quantum states which we call "chance" when made by electrons' (Dyson, 1979).[12] David Bohm, a highly influential American physicist, wrote similarly in 1987: 'Even the electron is informed with a certain level of mind' (Hiley and Peat, 1987).

Even though the difference is quantitative and not qualitative, we may draw a distinction between the simplest of subjects and all other subjects. I present a framework below that fleshes out three steps for distinguishing simple subjects — an electron, for example — from complex subjects — a human, for example. This distinction is, of course, the key enquiry in this paper. The distinction between 'simple' and 'complex' is not arbitrary; rather, simple subjects are the most fundamental constituents of the universe (by definition, thus independent of whatever terminology physics prefers at a given point in time) and complex subjects are combinations of simple subjects. In many cases complex subjects can be combinations of other complex subjects or a mix of simple subjects and complex subjects. All subjects are a combination of mind and matter, phenomenal and physical,

[12] A similar point is made by Seager (1995) and Bohm and Hiley (1993, pp. 384–7).

subjective and objective. Simple subjects are the brute facts upon which my theory is built.

The idea that anything can be actual without being experiential (vacuous) is, for Whitehead, a fallacy. He called this concept 'vacuous actuality' (Whitehead, 1929, p. 167). Whitehead elaborates that 'apart from the experiences of subjects, there is nothing, nothing, nothing, bare nothingness'. Schopenhauer stated that the idea of objects without subjects constitutes a 'fundamentally false antithesis between mind and matter'.[13]

Besides providing a more natural explanation for consciousness, panpsychism also saves us from epiphenomenalism. Epiphenomenalism leaves what is most real to us — our own consciousness — as nothing more than a helpless observer. This is a discomfiting and discouraging philosophy, to be sure. Epiphenomenalism is, however,[14] not that uncommon among philosophers and scientists.[15] Panpsychism asserts, to the contrary, that material and mental are two aspects of the same thing, so no physical process takes place without some accompanying causal mental role. The mental aspect of each actual entity, or complex subject, is informed by each prior objective moment, but is not fully determined by these objective data. Each moment, and every constituent of the universe, is inherently creative and free.

III.B. Monism, Menter and Information

My proposed framework[16] is a type of physicalism, which is itself a type of monism. 'Panexperiential physicalism' is the phrase David Ray Griffin uses to describe his own view, based heavily on Whitehead's

[13] Schopenhauer (1851/1974, p. 212), cited in Skrbina (2005, pp. 120–1).

[14] Griffin (1997b): 'Honderich says of epiphenomenalism, "Off the page, no one believes it". Likewise Searle (1992), who includes "the reality and causal efficacy of consciousness" among obvious facts about our minds (p. 54), endorses the "commonsense objection to eliminative materialism" that it is "crazy to say that… my beliefs and desires don't play any role in my behavior" (p. 48).'

[15] Chalmers, for much of the discussion in his book, states that the physical world is causally closed, so there is no apparent causal role for consciousness. He seems to contradict himself later, beginning on p. 150, by suggesting various ways in which his naturalistic dualism may still allow for consciousness to have a causal role in the physical world. It seems that Chalmers was himself unsure on this topic, but ended up supporting epiphenomenalism: 'Epiphenomenalism may be counterintuitive, but it is not obviously false…' (Chalmers, 1996 p. 159). '[My] view implies at least a weak form of epiphenomenalism, and it may end up leading to a stronger sort' (*ibid.*, p. 160).

[16] Chalmers flirts with panpsychism in his 1996 book, but refrains from wholeheartedly endorsing the notion: 'If this [double aspect theory of information] is correct, then experience is associated even with very simple systems. This idea is often regarded as outrageous, or even crazy. But I think it deserves a close examination. It is not obvious to me that the idea is misguided, and in some ways it has a certain appeal' (Chalmers, 1996, p.

ideas, in Griffin's inspiring 1997 book, *Unsnarling the World-Knot*. (Griffin does not, however, agree with all of the ideas I present, so I am not suggesting a straightforward adoption of Griffin's views. Indeed, if we agreed entirely there would be no need to write this paper.)

While I prefer the physicalist label for my own views, it's important to realize that such labels can be distracting because sometimes ostensibly different labels may refer to what are in fact identical or very similar concepts. There are various types of monism, of which panexperiential physicalism is one. Idealism, more accurately labelled 'idealist monism', is another type of monism, which views the universe as fundamentally comprised of ideas. What I label 'crude materialism', the prevailing world-view among most scientists and philosophers today, is yet another type of monism, which views the world as fundamentally comprised of matter that gives rise to ideas (consciousness) when sufficient biological complexity is reached. All of these types of monism try to explain the data of our senses, the universe presented to us. We can label the data of our senses, or the inferred reality behind our sense-data, 'matter', 'mind', 'ideas', 'will', or 'spirit'. We can label them whatever we want. What is important is that we realize what we are trying to explain with our labels: our sense-data and possibly an inferred deeper reality behind these data.

Each monism focuses, by definition, on one type of thing that is considered fundamental. Then each system explains how all other non-fundamental things relate to the posited fundamental stuff. Crude materialism mistakenly focuses on the apparent solidity of our sensory perceptions, calls it 'matter', which is defined as inherently mindless, and takes this to be the primary reality. The subjective universe, our experience, is the other side of the coin that all metaphysical systems must also explain if they have any claim to completeness. Crude materialism has forgotten or ignored that there is this half of the universe. As Griffin writes, crude materialism 'lopped' off our subjective experience when it lopped off God and the realm of thought/spirit from Descartes' dualism (Griffin, 1997a, p. 13). Idealist monism, championed by Bishop Berkeley and some other philosophers, risks the opposite mistake: lopping off the apparent solidity of the material world, or, at the least, failing to explain satisfactorily how this apparent solidity differs from the mental realm.

293). On a personal note, it was author Hunt's first reading of *The Conscious Mind* in the late 1990s that got him thinking seriously about panpsychism as a solution to the mind–body problem.

Panpsychist or panexperiential physicalism, to the contrary, avoids these mistakes by acknowledging the objective and subjective aspects of reality as complementary and posits a natural relationship between these aspects of reality. Where Berkeley concluded that 'to be is to be perceived', the central point of his idealism, we can add: 'to perceive is to be.' Schopenhauer recognized this complementarity explicitly in his masterpiece *The World as Will and Representation*, almost two hundred years ago (1819; see Schopenhauer, 1995). The world is idea, because all knowledge of reality is presented to us by our senses, but the world is also will, because there is a deeper level of reality that gives rise to both ideas and matter, as Schopenhauer argued. Reality is dipolar (not to be confused with dualism in a Cartesian sense), with subject and object as two sides of the same coin, which alternate in each entity as time progresses.

I call this fundamental stuff of the universe *menter* (a neologism). Menter encompasses both the mental realm and matter — hence the term. For example, an electron, which is considered in mainstream physics to be purely non-mental, in this theory includes both the traditional physical properties of an electron but also a very rudimentary set of mental properties, which is at most basic level labelled simply 'experience'. We can't know what an electron's experience is like, but I presume that it consists of little more than rudimentary perceptions of the outside world, through its being influenced by the fundamental forces of electromagnetism, gravity, and so on, and a *choice* as to how to manifest in the next moment based on those rudimentary perceptions (recall that each subject oscillates between object and subject, requiring its re-creation in each and every moment). Indeed, for Whitehead choice is the key feature of actuality: '"[D]ecision" cannot be construed as a casual adjunct of an actual entity. It constitutes the very meaning of actuality' (Whitehead, 1929, p. 43).

Menter is similar to Schopenhauer's *will*, as the fundamental stuff of the universe, and to Whitehead's *creativity*. Schopenhauer described himself as a 'transcendental idealist' because of the different levels of reality within his system: the world of representation and the will that is the noumenal basis for all representation. The more general term, however, for both Schopenhauer's transcendental idealism[17] and the panpsychist physicalism that I advocate is 'neutral monism', because these philosophical systems posit a neutral stuff from which both matter and mind spring. Whitehead's system was also a type of neutral monism. Neutral monism is non-dual because it

[17] Other transcendental idealists include Kant, Fichte, Schelling, and others.

holds that that there is a non-dual (neutral) substrate to reality that produces the apparent duality of object and subject. In this view, duality rides on the back of non-duality. So while there is clearly a level at which reality is dualistic — my subjectivity is at some level of reality different than the objects of my senses — at the deepest level of reality, the level of the neutral stuff, reality is entirely non-dual. We can say accurately that *reality is epistemologically dual but ontologically non-dual*.

This paper builds on Schopenhauer's and Whitehead's monistic philosophies in attempting to explain how complex subjects arise from simple subjects, areas that these philosophers failed to address satisfactorily. As mentioned above, explaining how complex subjects arise (the 'combination problem') is the key problem facing both materialist and panpsychist approaches to consciousness.

Where does 'information' fit within this philosophical framework? The nature of information, whether it has a single or dual aspect, is ultimately less fundamental a question than analysing the true nature of matter/menter. This is the case because information is a non-fundamental concept: it is an abstraction, a construct, at least in so far as it has a place in my ontology. An analogy is found in calculus: a derivative equation is, well, derived from the original equation. It is a second-order creation. Information is, similarly, derived from the 'menterial' world, which is fundamental. This is the case because all information/energy flows are essentially descriptions and instructions of matter/menter. The movement, intertwining, combination, and re-combination of menter leads necessarily to new forms of experience. 'Information' is simply a way of describing reality in simpler terms; thus informational descriptions are a model of reality and should not be mistaken for reality itself.[18]

Information, as a concept, can of course be characterized in many different ways. Chalmers adopts and adapts the Batesonian definition of information: a difference that makes a difference (Chalmers, 1996, p. 278). In other words, information consists of changes in whatever context is at issue that lead to a difference in outcomes (when compared to the counterfactual). Chalmers didn't take the extra leap[19] in

[18] It is the case, of course, that all theories and use of language are models of reality, and not reality itself. While I recognize fully this deeper truth, the task in this paper, and in ontology more generally, is to create a model with language that is as simple as possible while avoiding self-contradiction and also explaining the full range of data. Words are imperfect, but they are the tools of philosophy and of science (along with numbers), so we must use the tools we are given.

[19] Though he did flirt with the idea in his book (see fn. 16).

suggesting that experience may validly be considered simply the flow of information; in other words, experience is simply the flow of information/causation through every part of the universe. If this is the case, to talk about information without experience is, then, impossible and — perhaps worse — redundant.[20] We are led, in this second-order framing of the world and the role of 'information', to a 'single aspect' theory of information — there is no duality. Experience is information and information is experience. Gregg Rosenberg has fleshed out this idea in *A Place For Consciousness: Probing the Deep Structure of the Natural World* (2004). As such, we could, if we prefer, eliminate the notion of information from even our second-order ontology, while still recognizing its usefulness as an explanatory concept.

Accordingly, I consider below a physics and metaphysics that include subjective experience, which is not the case with the prevailing theories of physics. In this re-framing, the psychophysical laws are really just physical laws because the physical includes the mental. It's all just menter.

Chalmers considers this possibility and rejects it:

> Certainly if we define physics [to include experience as a fundamental feature of the universe], experience will indeed qualify as a physical property, and the supervenience laws will count as laws of physics. But on a more natural reading of 'physics' and 'physical,' experience does not qualify. Experience is not a fundamental property that physicists need to posit in their theory of the external world; physics forms a closed, consistent theory even without experience. Given the possibility of a zombie world, there is a clear sense in which experience is superfluous to physics as it is usually understood. It is therefore more natural to consider experience as a fundamental property that is not a physical property, and to consider the psychophysical laws as fundamental laws of nature that are not laws of physics. (Chalmers, 1996, pp. 128–9)

I obviously differ from Chalmers on this point because I don't think it's 'more natural' to define physics as excluding the phenomenal, and I believe that physics is a closed system only through the invocation of unwarranted assumptions, not established fact. This is the case for the reasons described above — not least of which is my view that we, as conscious beings, do have an impact on the physical world, starting with our own bodies — but also because by defining 'physical' to

[20] Chalmers considers this worry, but seems to veer toward the ontological view of information, which I find problematic: 'To what extent will this framework reify information, or treat it as real? Does it claim that the physical, the phenomenal, or both, are ontologically dependent on the informational? I will leave all these questions open for now' (Chalmers, 1996, p. 286).

exclude the 'mental' we end up with physical theories that are incomplete, inaccurate, and run afoul of all sorts of contradictions and other problems.[21] The most glaring of these problems is the hard problem of consciousness itself: the mainstream notion of physics leads to a dead end in terms of explaining how matter defined as non-experiential produces or interacts with the mental realm.

To state my key point in another way: it is not so much a matter of creating bridging principles in the form of psychophysical laws as it is acknowledging that menter is all there is: it's all just one thing and we have confused ourselves for centuries, and perhaps millennia, by mistaking the conceptual possibility of matter-without-experience as being indicative of the actual universe we live in. This is what Whitehead means with his phrase 'vacuous actuality'. In the universe we live in, all matter is inherently experiential. Discussion of 'bridging' principles implicitly assumes a type of dualism between mind and matter. We should instead adopt Schopenhauer's and Whitehead's approach and realize that mind and matter are two aspects of the same thing, which I have called menter.

Of course, no proof is possible in this discussion because the only provable experience is our own individual subjectivity. Any subjectivity other than our own is inferred by behaviour and appearance. More generally, as the British biologist Gregory Bateson pointed out: 'Science probes, it does not prove' (Bateson, 1980). We must proceed in philosophy as well as in science, from logical inference, intuition, and aesthetics. In ontology, there are various ways of framing the same insights. Some ontologies may be considered superior to others, however, if we value consistency, comprehensiveness, parsimony, and empirical adequacy — traditional criteria for judging philosophical systems and scientific theories. I believe the ontology developed by Whitehead and Schopenhauer, which draws from many other great philosophers, including in particular Locke and Spinoza, is superior to the alternatives under these criteria. I have attempted to improve further upon the Whiteheadian and Schopenhauerian traditions in this paper.

III.C. Panpsychism in a Nutshell

The most compelling argument for panpsychism, the starting point for my broader framework in this paper, is rather simple: 1) experience exists and represents a very different feature of the universe than

[21] See my series of essays on 'absent-minded science' at http://www.independent.com/news/eco-ego-eros/

ostensibly unthinking matter; 2) it is far more likely that the potential for such a basic feature of the universe was present from the beginning of the universe in all matter, rather than the emergentist assertion that the subjectivity of matter simply appears in the universe when a certain type of complexity is achieved in life forms like us (or somewhere further down the biological chain). That is, the fundamental split between subject and object, a very basic feature of reality, suddenly springs into existence, emergentism (the most common type of materialism nowadays) asserts, at a seemingly arbitrary point in the history of the universe — and, similarly, at a seemingly arbitrary point in the development of each individual. This makes little sense to me. Why would it pop into existence right here (whatever moment 'here' is) and not a moment later or a moment earlier? In other words, why would it arise at time *t* rather than time *t+1* or *t–1*? As I developed in my mother's womb, with my brain and body steadily increasing in complexity, is there really a moment in which my consciousness suddenly sprang into being where it was wholly absent in the prior moment?

It is far more likely that there was some type of awareness in my embryo and fetus self, and in matter more generally, in all moments, in at least some rudimentary manner. This rudimentary consciousness develops in complexity as the biological form develops. Some biologists have subscribed to panpsychism, in large part because biologists recognize that the realm of life is a generally smooth continuum from less complexity to more complexity — and that consciousness is most likely a similar phenomenon. Sewall Wright, a well-known American biologist, stated in a 1977 article that 'emergence of mind from no mind is sheer magic' (Wright, 1977).

Griffin describes how the notion of non-experiential matter gained sway in the western world: '[M]aterialism lopped off God and the soul while retaining that worldview's idea of matter — even though this idea of matter had been constructed in large part [during the sixteenth and seventeenth centuries] precisely to show the necessity for an external deity and a different-in-kind soul' (Griffin, 1997a, p. 13). Recognizing this history, we see how we have been left in the twenty-first century with a Frankenstein view of reality, carved out of a previously untenable world-view (dogmatic theism), but made more untenable, not less, due to changed circumstances regarding the role of the classical notion of God in our world. We need a better world-view than 'dogmatic materialism' — one that doesn't do violence to the obvious reality of my (and your) experience.

Colin McGinn, no supporter of panpsychism, states as well as anyone why emergentism fails (though he ends up advocating the

mysterian point of view, which holds that there will never be a solution to the mind–body problem):

> [W]e do not know how consciousness might have arisen by natural processes from antecedently existing material things. Somehow or other sentience sprang from pulpy matter, giving matter an inner aspect, but we have no idea how this leap was propelled… One is tempted, however reluctantly, to turn to divine assistance: for only a kind of miracle could produce this from that. It would take a supernatural magician to extract consciousness from matter. Consciousness appears to introduce a sharp break in the natural order — a point at which scientific naturalism runs out of steam. (McGinn, 1991, p. 45)

To the contrary, in the panpsychist view all matter is inherently experiential because mind and matter are two aspects of the same thing. An electron in the deepest reaches of space, receiving data about the universe around it through the faintest gravitational and electromagnetic forces, experiences this data as a subject. Human consciousness, when compared to that of an electron, is not different in kind, only in degree.

But why, sceptics will object, is all matter inherently experiential? Some facts are simply brute facts. There are no additional answers below the level of brute facts and we just accept this and see where these brute facts take us.[22] I postulate, based on the arguments fleshed out here, that the stuff of the universe is inherently experiential. This theory leads to an intellectually satisfying world-view as well as greater compassion for the universe around us and all of its inhabitants. In this case, it is no tragedy, by any means, to accept that all things are inherently experiential and that experience complexifies as form complexifies. It is, rather, a very satisfying path between the dogma of traditional theism and the more recent dogma of crude materialism.

IV. The Speculative Framework: Psychophysical Laws are just Physical Laws Redefined

The rest of this paper fleshes out my technical solution to the combination problem. The benefits of having a fleshed-out set of psychophysical laws are numerous. These laws could help distinguish what is a complex subject and what is not. For example, some thinkers who have flirted with panpsychism have speculated that any substance or

[22] Chalmers anticipates this direction, as he alludes to or anticipates almost every facet of contemporary philosophy of mind in his wide-ranging book: ‘There will be something “brute” about [the psychophysical laws], it is true. At some level, the laws will have to be taken as true and not further explained’ (Chalmers, 1996, p. 214).

set of substances achieving quantum coherence may be experiential. Seager (1995, p. 258), as one example, speculates that liquid helium may be, upon achieving quantum coherence, conscious in some fashion. My proposed framework should, if successful, help establish what kinds of things are complex subjects and which are not.

Beyond philosophical and scientific curiosity, such a framework will be helpful in artificial intelligence research and related ethical issues. For example, when we reach the point that AIs are sufficiently advanced to pass Turing tests with some regularity, we will quickly enter into a debate about the metaphysical and legal status of such entities. Does an AI become a legally protected entity, with certain rights *vis à vis* humans and possibly other AIs by dint of its ability to make humans think it is in fact conscious? In other words, should some AIs be considered legal persons? If we can establish a framework that provides more certainty regarding the presence and type of complex experience in the AI at issue, such ethical questions become more tractable.

Similarly, and perhaps more practically, the proposed framework and research agenda may be able to help with ethical and legal conundrums related to coma patients. What kind of experience, if any, is going on inside a coma patient who can't tell us what is going on? Could normal experience arise anew in a coma patient given his/her current condition? The proposed framework may help with these and related problems.

A framework for establishing the presence and type of complex subjects could even help in the right to life/right to choice debate about the beginning of human life.

IV.A. Three Steps for Characterizing Complex Subjects

I suggest below three steps for assessing the presence of a complex subject, as opposed to a mere collection of simple subjects (a 'mere aggregate', to use Leibniz's and Whitehead's term): 1) perceptual unity; 2) internal connectivity; and 3) field coherence. As we will see, the physical nature of time is key to this new understanding. I will propose an experimental research programme that may support or refute this framework in a follow-up paper.

IV.A.1. Perceptual unity

For consciousness to be unitary, as it is in our own experience, there must be perceptual unity. In other words, all sensory data must be held together in one instant in order to be part of the experience at issue — a snapshot of the world around us. But this snapshot includes all

sensory perception, not just visual perception.[23] Quantifying perceptual unity can be thought of as measuring bandwidth — how much data can be collected in each moment by the subject at issue?

A simple subject is characterized almost entirely by its perceptions, as opposed to its internal processing of perceptions. For simple subjects (quark, string, holon,[24] what have you), perception is probably extremely simple. Most likely, each simple subject perceives the various forces acting upon it and exercises some limited choice regarding how to move with respect to these forces, as suggested by Dyson's comment, above, that electrons exercise choice.[25] The fundamental forces (gravity, electromagnetism, etc.) become, in this framing, suggestions (albeit very strong suggestions) instead of compulsions — in line, again, with Dyson's thoughts on the choices made by electrons, which most interpretations of quantum mechanics conceive of as pure chance. Most of nature behaves as though it were subject to laws, however, simply because the choices made by most objects are very limited due to the very limited mentality present, and are thus more likely to simply continue in the same vein as the previous iteration. Whitehead described the so-called laws of nature as more akin to habits.

The complex subject is, however, characterized to a higher degree by its internal connections, its processing of perceptions. The number and type of internal connections depend directly on the number and type of constituent subjects within the complex subject at issue. We cannot, however, ignore the outside world when it comes to complex subjects, even though complex subjects are characterized far more by their processing of perceptions than are simple subjects.

The interesting aspect of this first step in my framework is that, upon examination, we quickly realize that all things in our universe are connected with every other thing in some manner. This is the case

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[23] This concept is akin to Whitehead's 'prehensive unification'.

[24] Holons were introduced as a concept by Arthur Koestler, the writer and philosopher, as a general term for structure. The key feature of holons is that they always have other holons below them and others above — they look up and down. They are a whole that is comprised of parts, each of which is in turn comprised of other parts, etc. See *Janus: A Summing Up*, Koestler (1978).

[25] Whitehead describes the receiving of information about the universe as prehension. Prehension is for Whitehead a more basic term than perception. I have, however, continued to use the term perception but defined perception to include receiving information through any means, not simply biological senses. Whitehead also speculates that each simple subject (actual entity) has the ability to decide what perceptions it accepts and which it rejects, behaving in accordance with these choices. This places free will as well as experience at the very base of reality. I find this idea appealing, but won't delve further into the topic in this paper.

because to be 'in the universe' means to interact with other aspects of the universe; and through direct and indirect interaction literally everything in our universe is connected to every other thing — we exist in one vast causal web, Indra's Net, to use one poetic description from Hindu mythology, that comprises the entire universe.[26] Obviously, there are important distinctions in this sea of oneness (which may also be labelled *Brahman*, the ground of being, *apeiron*, ether, the One, or any of many terms expressing the same concept in various philosophical and spiritual traditions). This truth is made evident by the fact that we do each have a centre of subjectivity in which the universe is cleaved into a subject and an apparent infinity of objects.

But how does a sea of unity become cleaved in such a clean way when it seems that all distinctions in the universe, other than the most basic quantum level distinctions, are matters of degree, not matters of kind? Perceptual unity is part of the answer: each subject can only use what is available to its perceptions in order to be a subject in each moment. (Memories fall in the same category as 'perceptions' in this context because memories are perceptions of stored previous present moments.) And what is available to each subject at a given locus is dependent on what is going on elsewhere in the universe in all previous moments. It's all just one huge causal web of menter, flexing and fluxing its way toward the future, but causality/perception does not operate infinitely fast, leading to obvious differences in the ability of each subject to perceive what is happening in this causal web.

Consciousness consists, then, of a set of snapshots, or moments, which can be quantified in the manner described below. This is the case because we know that human consciousness is not continuous and we can suggest that this is a common feature of all experience because of the need, by definition and necessity, to have a *now* to have experience at all. In human experience, experiments have shown that the temporal resolution of our visual experience is about 60 Hz or $1/60^{th}$ of a second. But there is no reason to believe this particular duration is a limit that applies to subjects more generally, or even other complex subjects. I have posited experience as ubiquitous, so the 'seriality' of time must, pursuant to this postulate, also be ubiquitous.

Experience is here now, and now, and now, and now… If every real thing is indeed inherently experiential, this seriality must be built into the universe in a basic ontological sense. Whitehead calls this process, the creation of now, now, now, the *creative advance* and my conception

[26] See Rosenberg (2004) for an excellent overview of causation and a new theory of causal determination (as opposed to causal responsibility, the traditional focus of the philosophy of causation).

of this process is similar to Whitehead's (1929).[27] I adopt this Whiteheadian term to describe the perpetual laying down of experiential nows — and thus the entire universe itself. The universe consists, in its entirety, of each moment of perceptual unity (a *chronon*, described further below) summed across all subjects everywhere.[28]

IV.A.1.a. Measuring perceptual unity: The perception index

We may quantify perceptual unity by examining the types of perception (causal connection) available to each candidate complex subject. The Perception Index (*PI*, or π) provides a normalized value from zero to ten, indicating the degree to which a given subject, simple or complex, can perceive the universe outside of itself. Assigning a value in specific cases is easier conceived than completed, and is much simpler in biological organisms than non-biological subjects because we can focus on the various senses in each biological organism as opposed to the sum total of all physical forces acting on the object at issue. This quantification of perception is the start of a fairly simple mathematical model that I flesh out further below. A follow-up paper will suggest many practical ways to test this model.

[27] Whitehead explicitly denies a 'necessary seriality' in his conception of time and the creative advance. My conception of time, which affirms the necessary seriality, is a departure from and disagreement with Whitehead's system.

[28] Rosenberg raises the issue of perceptual unity and states that the theory of special relativity prevents any true simultaneity from being established with respect to the contents of any particular consciousness, in an objective manner (Rosenberg, 2004, p. 118). This argument fails for a number of reasons: 1) special relativity (SR) probably doesn't have any impact at the scale of human experience because human experience apparently consists of perceptual unity over the course of relatively 'fat' durations: $1/60^{th}$ of a second or so (this temporal scale is far too long to be subject to any SR limits given the small distances relevant to the human brain); 2) there are interpretations of the mathematical formalisms of special relativity that support absolute simultaneity — Nobel Prize winner Hendrik Lorentz's interpretation, for example; 3) even the Einstein/Minkowski version of special relativity may not truly be applicable in the real world because it only applies to 'inertial frames' (as opposed to general relativity, which applies in any frame moving in any manner with respect to other frames), which Einstein himself acknowledged later in his career cannot be shown to exist in the real world (Einstein and Infeld, 1938, p. 158).

I propose the following formalism for *PI*, similar to Edelman and Tononi's formalisms,[29] where *I* is information[30] passing to the subject (*S*) from each actual object of perception, *O*, among an infinite collection of possible objects of perception (hence the infinity superscript):

Eq. 1: $\pi(S) = \sum I(S, O_j^{\infty})$

In normal language: the perceptual capacity of a subject, in each moment, is the sum of all perceptual data between the candidate subject and the various objects of perception. An 'object' is literally any datum presented to perception. This measurement will in any interesting case not be simple due to the number of causal connections between the candidate complex subject and the rest of the world, and the difficulty in measuring the 'differences that make a difference'.

We can, as a working example in applying this framework, consider fruit fly perception. Much is known about fruit flies, so they are a good candidate for fleshing out this framework (a follow-up paper will focus further on fruit flies and other examples). To simplify further for present purposes, let's consider fruit fly vision only. Fruit flies have compound eyes with about 760 *ommatidia*, each of which have eight photoreceptor cells (Hardie and Raghu, 2001). If we assume 12-bit colour resolution for each photoreceptor, the visual bandwidth of the fruit fly amounts to about 72,960 (12 x 760 x 8) bits, the result of applying Eq. 1 for the visual system of a fruit fly.[31] This figure needs to be normalized, however. I will flesh out the normalization discussion in a follow-up paper, so for present purposes we can simply translate this 72,960 bit rate to a normalized value of 3 on the normalized scale from 0 to 10. The value we use for the normalized figure in this example is not particularly important at this time because it's simply an illustrative example. Hold that thought.

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[29] Edelman and Tononi (2000, p. 122) propose a similar concept, though from a purely materialist perspective. Their 'cluster index' ('*CI*') measures the internal integration of neuronal clusters in the brain. It is characterized mathematically as $CI(X_j^k) = I(X_j^k) / MI(X_j^k; X - X_j^k)$. *I* refers to information exchange within the subset of neural clusters at issue, and *MI* is 'mutual information', which refers to information exchange between the subset of neural clusters at issue and the rest of the clusters within the brain at issue. *X* is a set of neural clusters, X_j^k is a subset of clusters, so $X - X_j^k$ is the set minus the particular subset, which Edelman and Tononi describe as the 'complement'.

[30] We may adopt the Batesonian notion of information as a 'difference that makes a difference'.

[31] Fruit flies have low visual resolution compared to humans but very good temporal resolution, at about 200 'frames per second'.

IV.A.2. Internal connectivity

A complex subject must be capable not only of perceiving the world, it must by definition have some internal structure, which means it must consist of at least two simple subjects. Quantifying internal connectivity is the second step for characterizing complex subjects. Perceptual unity can be thought of as external connectivity, contrasted with the internal connectivity required for complex subjects to arise.

As discussed earlier, to 'be in the universe' means that the item at issue is causally connected to the rest of the universe. However, a nerve cell in my hand is much more directly connected to my brain, through the electrochemical pathways of my nervous system, than it is connected to my brain through gravitational forces. There is a gravitational connection, to be sure, but the informational/causal pathway of the first connection has a far greater influence than the very limited gravitational connection. I discuss in more detail in the following sections the type of connectivity required for complex subjects to arise, which rests on the idea of field coherence or harmonic resonance.

IV.A.2.a. Measuring internal connectivity: The connectivity index

Another quantification tool is used to measure internal connectivity: the 'connectivity index' or *CI* (pronounced 'cy' and symbolized ψ). Connectivity is, in this case, another term for causation — it implies the transmission of something internal to the candidate complex subject. This may also be characterized as information in the sense that Bateson and Chalmers use the term: a difference that makes a difference. *CI* quantifies the internal connectivity of the candidate complex subject, whereas *PI* quantifies external connectivity (perception). *CI* scores also fall on a normalized scale between 0 and 10.

A network (which can consist of literally any substance) would receive a *CI* score of 10 if all possible data from each node of the network could instantaneously transmit all possible data to all other nodes on the network. In other words, such a network would function as one unit because through its perfect interconnectivity it is in fact a single entity. A network with a *CI* score of 0 is the opposite: no information would move at all, so it's not really a network, at least not at that point in time.

This is a fairly simple concept, but it gets more complex when we attempt to describe what is the limit of possible information in each node of a given network and through what channels such information can flow to other nodes. For now, however, this very basic sketch is sufficient.

We must consider also the type of connectivity. In other words, what forces are present to connect the constituents of the candidate complex subject? In arriving at a general theory of complex subjects we must keep in mind that the constituents of complex subjects may be separated by large distances, contrary to our initial impulse to think of things like human brains as necessary for complex subjects to exist. The internal connectivity could arise from any of the four fundamental forces/interactions: gravity, electromagnetism, or the strong or weak nuclear force. Conceivably, it could also be a 'fifth force' or even other forces if such forces are found to be present in our universe. For example, some have speculated that the strong evidence demonstrating quantum entanglement[32] may be due to a new fundamental force that exerts its influence far faster than the erstwhile limit of the speed of light (~300,000 kilometres per second). Quantum entanglement is a potentially very important consideration in this framework because it suggests a way in which complex subjects may be extended over greater distances than would be allowed with only the four fundamental forces.[33]

The following equation formalizes ψ,[34] where *CS*[35] is a candidate complex subject, X_j^k is a subset of the candidate complex subject's

[32] Alain Aspect and his colleagues have, since the early 1980s, conducted a number of experiments demonstrating a faster-than-light influence in entangled particles. In 2008, a Swiss team led by physicist Daniel Salart confirmed entanglement and faster-than-light effects over a distance of 18 km (far further than in any experiment by Aspect or others before then) in an experimental set-up that makes alternative interpretations difficult. Salart calculates that the apparent information transfer between entangled particles is at least 10,000 times the speed of light (Salart *et al.*, 2008).

[33] Many thinkers have suggested a link between quantum processes and consciousness. For example, Penrose and Hameroff have postulated in their 'Orch OR' model a link between self-induced quantum collapse and the existence of consciousness (Hameroff and Penrose, 1999; in Shear, 1999).

[34] Edelman and Tononi offer a similar measure (2001, p. 130), described as 'neural complexity', but neither this measure nor their theory more generally have any direct bearing on phenomenal content. This is the case because, despite their assertions that their theory explains qualia as well as the workings of the brain, their theory is entirely materialist in nature and offers no link between functional explanations of the brain and phenomenal content. They do not offer any psychophysical laws or bridging principles between the physical and phenomenal realms. Their measure of neural complexity is characterized, building on the definition of mutual information described above, as:

$$C_N(X) = \sum_{k=1}^{n/2} < MI(X_j^k; X - X_j^k) >$$

[35] *CS* is used in Eq. 2 rather than *S*, as in Eq. 1, because Eq. 1 could conceivably be used for simple subjects as well as complex subjects, whereas Eq. 2 only applies to candidate complex subjects because simple subjects do not have any internal connectivity, by definition.

possible constituents, and *MI* (mutual information) is a two-way information/causal flow between the constituents:

Eq. 2: $\psi(CS) = \sum MI(X_j^k; CS - X_j^k)$

In normal language: the internal connectivity of a candidate complex subject is the sum of the information flows between its constituents. This is similar to Tononi's 'integrated information' measure, which he has fleshed out in work completed after his collaboration with Edelman (Tononi, 2004; 2008; Balduzzi and Tononi, 2009). My framework is different in important ways, however, in both its mathematical formalisms and in its philosophical basis. I address these similarities and differences in more detail below.

In thinking through the nature of complex subjects and phenomenal content we arrive at an additional simple, but highly important, equation, where π is *PI*, ψ is *CI*, and Ω (Omega) is the complex subject's capacity for phenomenal content:

Eq. 3: $\pi \times \psi = \Omega$

In normal language: the candidate complex subject's phenomenal content is the product of its perceptual unity[36] and its internal connectivity. This equation is a potentially very powerful tool for gaining real knowledge of subjective experience, in the same way that microscopic or telescopic knowledge of the very small and the very large has dramatically extended our understanding of the universe.

Keeping this model fairly simple, we can, as an example, focus on an artificial neural network consisting of 100 'neurons'. In this example, we can simply postulate a *CI* value of 2, to test the equation. This indicates that each node is not very quick at sending its possible data to all other nodes. And we assume that only electromagnetism is the energy/causal connection responsible for such information flow between these artificial neurons. We can also postulate a *PI* value of 1, based on the paucity of data we feed this information-starved mini-

[36] Perceptual unity doesn't necessarily mean perception external to the human brain, in the case of human complex subjects. For example, during dreaming there is clearly a high capacity for phenomenal content, with the external information supplied by certain parts of the brain instead of external perceptive data. In this formalism, the parts of the brain that supply dream-time data to the complex subject may be considered external to the dreaming complex subject.

network.[37] We arrive at an Omega[38] value of 2 (1 x 2 = 2), far down the scale from 0 to 100. Under the criteria described thus far, this simple network would have an exceedingly simple phenomenal capacity.

Let's also look again to the fruit fly for a more concrete example. The fruit fly's brain is mostly devoted to visual processing and contains about 100,000 neurons (Rein *et al.*, 2002; Chiang *et al.*, 2010). If we assume about 100 dendrites for each neuron, we have about 10,000,000 synapses, which are the internal connections quantified by *CI* in this case (we would also, to be comprehensive, have to determine what neural sub-units exist in the fly brain and quantify interconnections between neural sub-units in addition to the simple internal connectivity of all synaptic connections). For the purposes of this example, we can translate this calculation to a normalized *CI* value of 4 (again, the normalization rules will be described in a follow-up paper). Recalling the *PI* value of 3 for fruit fly vision, we obtain an Omega of 12 for the fruit fly's visual system. In actuality, of course, there is no separation of senses in the complex subject that is a fruit fly. But, again, this is just a dramatically simplified example to illustrate the formalisms.

The discerning reader will recognize, however, that this framework hasn't answered the initial question: what is a complex subject and what is not? All we've done with the *CI* and *PI* framework is define the phenomenal capacity of *candidate* complex subjects, with no bearing on determining whether there actually is a complex subject present or not. In my examples, I've discussed 'candidate complex subjects' without suggesting what makes an object a candidate complex subject — beyond the obvious examples such as humans or other mammals. We clearly need more constraints on our theory unless we are willing to ascribe consciousness to every object, which seems unwarranted, to be sure.

Empirically, we employ the third step, field coherence, as an initial screen for candidate complex subjects under the previous criteria. If we observe the required field coherence, we then 'check the box' and proceed to quantify *CI* and *PI*, and arrive at the Omega value.

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[37] I will ignore in this simplified model the possibility, which Whitehead raises, of every actual entity perceiving in some manner the entire universe in each moment. As with all models, simplifying assumptions must be made in development.

[38] This simple mathematical framework may be labelled 'Omega Theory', in homage to Teilhard de Chardin (Chardin, 1959) who has inspired me to no end. It should not, however, be misconstrued as representing any kind of final theory — this is clearly a putative theory and may be entirely wrong.

IV.A.3. Field coherence

I'm going to sum up the key thoughts in this section in one paragraph, which will probably be opaque upon first reading. The rest of this section, however, fleshes out these ideas.

'Field coherence' refers to the coherence in time of the various constituents of the complex subject. Reality is conceived as a series of snapshots — chronons — that represent an entire slice of the universe in each moment. Chronons are incredibly brief in duration — possibly as short (or shorter) as the Planck moment, which is about 5×10^{-44} seconds. Each constituent of the universe resonates at some chronon multiple. When different constituents near each other resonate at the same chronon multiple, they bind together into a single subject in addition to the constituent subjects. That is, as each constituent oscillates back and forth at the same frequency, they are bound together in such a way that a new larger-scale subject is formed. This process is, when conditions are supportive, hierarchical (holarchical)[39] and iterative. Simple subjects bind together to form a complex subject, then bind together again to form a higher level complex subject, and so on, up to the rarefied heights of human subjects and perhaps higher in the ontological chain. Each constituent of the complex subject at issue achieves synchrony through a jostling process that must occur within the time limits of the iterative process that constitutes the laying down of reality (the *creative advance*), like a sieve producing layers of dust, dirt, small pebbles, larger pebbles, etc. As more and more constituents become linked, and oscillate at the same frequency, the subject at issue becomes more complex. The limit on this process is the finite speed of information between the complex subject's constituents. As constituents become linked through connections that provide faster and faster information flows, the possible size of complex subjects increases. Quantum entanglement is the fastest physical connection we know of currently and it appears to operate at least 10,000 times faster than the speed of light (see footnote 32). This is still, however, a finite speed. Quantum entanglement may be a necessary condition for complex subjects.

Now let's unpack these ideas.

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[39] Wilber (1995; 2000) is adamant that the true nature of reality is hierarchical/holarchical all the way up and all the way down. I agree that nature is hierarchical/holarchical, but I differ with Wilber in that I do posit a lowest level holon, what I call 'simple subjects'. My rationale is simple: for there to be anything at all there has to be some initial ontological emergence from pure potentiality, particularly if we agree with Whitehead's views on time as the creative advance. Accordingly, this initial ontological emergence, which happens as each chronon ticks, produces my simple subjects.

All things perceive the universe, as I have defined perception, and many of these perceiving entities are also causally interconnected in a more immediate manner than the general interconnectedness that any thing in the universe enjoys merely by existing. For example, a rock is internally connected (electromagnetically and thermally) by the simple proximity of each molecule with others throughout the extent of its 'rockness'. Energy clearly flows through these channels — heat for example. And the rock perceives the universe in terms of the forces that act on it (heat from the sun being just one example of many). But it would be strange indeed to posit experience in the rock *qua* rock. Its fundamental constituents likely enjoy some very primitive type of experience, and I have made this inference a postulate of the broader theory. But the rock itself? It seems incredibly unlikely, given what we know about the behaviour and nature of the world around us — and of rocks, for that matter — that the rock itself would be a complex subject. I can't rule it out, just as I can't rule out the existence of experience in any candidate thing. But it does indeed seem unlikely. The same analysis applies to Seager's liquid helium that achieves quantum coherence. Why or why is it not a complex subject?

Similarly, John Searle's 'Chinese Room' thought experiment illustrates the perils of positing crude functional similarities as the only requirements for experience (Searle, 1980).[40] Searle's point is that information processing and apparent meaning and understanding result in some manner from the Chinese Room set-up, but there is surely no consciousness or true understanding present in the combined room/prisoner/set of instructions itself. I agree. The consciousness lies in the person who created the set-up. Crude functional invariance alone is highly unlikely to be a sufficient condition for complex subject status.[41]

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[40] In this thought experiment, a person in a room is given instructions for manipulating various Chinese characters such that when certain characters are fed into the room through a slot in the door, the instructions tell the man in the room what characters, among the many characters at his disposal, to feed back through the door as a response. The key ideas here are two-fold: 1) the man has no idea what any of the characters mean because he does not understand Chinese; 2) the responses the man sends out of the room are intelligible and meaningful to a Chinese speaker, based on the detailed set of instructions the man in the room is following.

[41] Chalmers (1996, p. 247) argues that it is one of the principles behind his naturalistic dualism and seems to argue (pp. 251–2) that it is a sufficient condition for experience. He also speculates, however, that there may be some limiting factor(s) on when experience arises that might rule out things like rocks or thermostats from having a unified experience: 'It might even be that a constraining criterion could restrict the relevant information spaces so that information in simple systems such as thermostats does not qualify. My own

It is for these reasons that I posit a third criterion for the existence of a complex subject: field coherence. More specifically, each constituent of the complex subject must resonate at the same frequency. Another word for 'same frequency' is synchrony. This means that functional invariance must be present in a more specific manner than the crude functional invariance suggested by Searle's thought experiment.

Fields may, for present purposes, be defined as *scalar* or *vector* quantities existing in a bounded region of space and persisting in some manner over time. For example, our sun projects a gravity field over an infinite swath of space, though its influence falls off relatively quickly per Newton's laws. This is a vector field because it has magnitude and direction — objects are pulled toward the sun and the strength of the pull is a function of distance from the sun. A scalar field, conversely, consists of magnitude without direction — a single value instead of two as in vector fields. Examples include temperature or air pressure over a defined area. In this conception of fields, all matter has an associated vector field. This is the case because all matter is both subject to one or more of the fundamental forces and a source of one or more of the fundamental forces.

Much has been written in recent years regarding the gamma waves in our brain, which oscillate at about 30–80 Hertz, indicating the binding of various parts of the brain into a single subject.[42] This type of field coherence is known as gamma synchrony. Hameroff states:

> The best measurable correlate of [mammal] consciousness is long-range (e.g., cortical–cortical) gamma synchrony. In animals and surgical patients undergoing general anesthesia, gamma synchrony between frontal and posterior cortex is the specific marker which disappears with loss of consciousness and returns upon awakening. In what may be considered enhanced or optimized levels of consciousness, highest amplitude, frequency, and phase coherent gamma synchrony have been recorded spanning cortical regions in meditating Tibetan monks. (Hameroff, 2009, p. 74)

The measured field in this case is a scalar field because it relies (generally) on one measurement: the wavelength of electrical activity emanating from cortical neural connections. Some speculate that this gamma wave coherence in different parts of the brain may lead to the

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intuition is that there may well be a constraint on the double-aspect principle but information in simple systems such as thermostats might qualify all the same' (*ibid.*, p. 301).

[42] Crick (1990) first brought this argument to the mainstream, developing it further in Crick and Koch (1994). See also Dennett (1993), discussing 'cerebral celebrity' and its relation to 40 Hz waves.

unitary sense of self by allowing these components to, effectively, be combined into one. This is just one example, however, if valid, of a complex subject arising through the process of field coherence. We are of course seeking here a general theory of complex subjects, so it is not enough to look only at human beings or other mammals as examples of complex subjects. The obvious benefit of the human brain example, however, is that we can obtain verbal reports about the nature of experience during most types of experience. And we can corroborate verbal reports with MRI or other imaging techniques to learn more about the correlation between observed brain activity and reported experience.

We must, for an adequate general theory of complex subjects, determine what 'field coherence' really means and what type(s) of field coherence leads to a complex subject. In the case of human experience, gamma wave synchrony is, as mentioned, electrical field coherence. This provides some support for Johnjoe McFadden's 'conscious electromagnetic information' (CEMI) field theory of consciousness and Susan Pockett's similar theory.[43] McFadden and Pockett speculate that it is the electromagnetic field itself that is the seat of complex experience, and that it can exert influence back on the matter from which it springs, in an interesting co-dependent information loop.

Benjamin Libet's (2003) 'conscious mental field' theory comports well in many ways with McFadden's and Pockett's theory. The key difference is that Libet explicitly denies that his conscious mental field is a type of electromagnetic field, due to the relative weakness of electromagnetic fields produced by the brain. Some experiments suggest that Libet may have been right in concluding that electromagnetic fields are not the primary conveyor of consciousness. An interesting experiment by Grinberg-Zylberbaum, with meditators in Faraday cages — which block all electromagnetic radiation — have shown correlations ('transferred potential') between meditators who establish a linkage through previous interaction in controlled experiments.[44] It may be the case, however, that electromagnetic linkages are simply the most dominant form of internal connectivity for complex subjects and that other forces not generally accepted yet are also

[43] McFadden (2002a,b,c); Pockett (2000).

[44] See Grinberg-Zylberbaum's research on transferred potential (Grinberg-Zylberbaum *et al.*, 1993).

involved, such as the feature of our universe responsible for quantum entanglement, as Grinberg-Zylberbaum suggests in his work.[45]

We have, then, at least one good example of electromagnetic field coherence in the formation of a complex subject — a human being. We can speculate about the features of the human electromagnetic field and extrapolate from these features to a more general theory by extracting the key features of what seems to be going on in the human example. The key feature is, of course, connectivity; but it is a certain type of connectivity. In particular, the temporal scale of this type of connectivity seems to be important. In the case of gamma synchrony, it seems that it is the electrical field coherence of different parts of the brain (gamma synchrony) that allows binding of these parts into unitary consciousness — though it does not seem to be electrochemical signalling pathways that lead to this electric field coherence, as discussed below. The binding may be achieved through a process analogous to superconductors or superfluids: the gamma synchrony creates a situation in which causal influence/information can flow without obstruction in the 'container' of the gamma wave field, or at least with highly reduced obstructions (no influence can, in my view, travel instantaneously). In other words, the rate of information flow seems to be important.

If this is the case, it is not any old network that produces a complex subject; it is a network that is capable of field coherence of the sort that can produce unfettered, or near unfettered, information flows akin to a superconductor. It seems also that the speed of information transmission is related to the fundamental nature of time. Lee Smolin writes in his excellent 2006 book, *The Trouble With Physics*, that 'there is something basic we [physicists] are all missing, some wrong assumption we are all making' (Smolin, 2006, p. 256). Smolin ventures a guess as to what he and his fellow physicists have been missing:

> What could that wrong assumption be? My guess is that it involves two things: the foundations of quantum mechanics and the nature of time… But I strongly suspect that the key is time. More and more, I have the feeling that quantum theory and general relativity are both deeply wrong about the nature of time. It is not enough to combine them. There is a deeper problem, perhaps going back to the origin of physics. (*Ibid.*)

[45] A recent paper on quantum entanglement in photosynthesis presents some additional support for the notion that quantum entanglement can arise and persist even in macroscopic features like the human brain (Abramavicius and Mukamel, 2010).

I believe Smolin is right with this intuition and I look to Whitehead's process view of time as a potential solution. As discussed above, we can deduce that time must be quantized in a fundamental sense, just as matter is quantized (this is what 'quantum' physics is all about).[46] Another term for 'time quantum' is *chronon*, regardless of the duration we assign for each chronon. If time is quantized, we may ponder what the shortest chronon/duration could be. We may never know, but a reasonable starting point, given our current physical understanding, is the Planck time. The Planck time, defined as the Planck length divided by the speed of light, is incredibly small: about 5×10^{-44} seconds.

I suggest that the field coherence that gives rise to each complex subject is the result of a shared resonance, a shared 'sampling rate', with respect to time.[47] That is, each complex subject experiences time as a particular chronon multiple. The gamma synchrony in humans is, then, a literal synchrony if this speculation is correct. The synchronization relates to the most fundamental reality, the realm at which matter and time are quantized. In this manner, each complex subject arises because each component of the complex subject shares the same experience of time, the same rate at which time progresses. This literal synchrony allows the components to be bound together in a shared, complex experience that springs from the underlying constituents. As Whitehead writes: 'The many become one and are increased by one' (Whitehead, 1929, p. 21).

If this is indeed the physical basis for consciousness in the most general sense, we must still resolve the question of how boundaries for each shared, complex experience arise. The ideas just sketched suggest a ready answer: the boundary of each consciousness is defined by each grouping of matter/menter that achieves the same sampling rate in each moment. How is this shared sampling rate achieved? The finite speed of information flow, alluded to above, is very likely the basis for the shared sampling rate. Another term for this general feature of reality is harmonic resonance or convergence. Each constituent subject of a complex subject achieves harmonic resonance (synchrony) by perceiving other constituent subjects. It is only when they achieve synchrony, however, that they become part of the same complex subject. While they will almost always begin out of synchrony (because of the huge range of possible oscillation rates given the incredibly fine temporal nature of reality), with the

[46] Skrbina (2010) makes a similar point about quantization of time and experience, appealing to James and Whitehead.

[47] I am particularly indebted to Jonathan Schooler for this idea, worked out in many stimulating discussions.

exchange of information (perception), which is a type of jostling back and forth, they arrive at the same sampling rate of reality and at that point constitute a unitary complex subject.

While what I am alluding to includes by definition both mental and physical aspects of each subject, the physical sifting metaphor is quite apropos. When dirt and pebbles are passed through an actual sieve by gentle shaking, the smaller particles fall to the bottom and the largest pebbles rise to the top. Intermediates move to the middle. Similarly, the ongoing 'sifting' of the creative advance (the flow of time) gives rise in each moment to a large number of subjects, the vast majority of which are simple subjects (fine particles), many of which are intermediate-scale subjects (tiny pebbles), and a few of which are highly complex subjects like human beings, bats, rats, or gnats (large pebbles).

I am not suggesting that this metaphorical sifting spontaneously gives rise to complex subjects without any other considerations. Rather, I am suggesting that the metaphorical sifting is akin to the creation of synchrony in structures that can support subjects of various types by having already achieved a certain level of evolved order, generally in the case of biological structures.

There is a physical structure already inherent in our sieve containing dirt and pebbles. Similarly, the development of synchrony between subjects that were not formerly in synchrony, through this information flow/jostling, requires that the previous moments, which necessarily inform the present moment, have already achieved a level of complexity sufficient to incrementally arrive at the types of subjects present in our 'sieve'. This process constitutes a single ongoing process of evolution. But this process is not limited to what we traditionally call 'life' — what we normally think of when we think of evolution. Rather, it is a process shared by literally all constituents (subjects) of our universe. It is, thus, the process of universal evolution.

A more concrete example will be helpful at this point, so let's consider again gamma synchrony in human brains. Biological evolution has led to the complexity of our brains. In this new framework, this evolutionary process includes both physical and mental evolution, from the most basic type of matter/menter to the most complex. Accordingly, the atoms, molecules, cells, and specialized regions of the human brain have all evolved 'menterially'. When we consider an actual human brain under various measuring tools, such as an EEG, we see that it reveals different levels of activity at different times. Gamma synchrony has consistently been observed during normal waking consciousness, and this synchrony is detected by observing

the similar rates (30–80 Hz) at which electrical fields oscillate in different parts of the brain. But how does this synchrony arise?

Freeman and his colleagues have demonstrated that gamma synchrony arises in rabbits and cats faster than the electrochemical signalling pathways of these brains would allow. Freeman states:

> High temporal resolution of EEG signals… gives evidence for diverse intermittent spatial patterns… of carrier waves that repeatedly re-synchronize in the beta and gamma ranges in very short time lags over very long distances. The dominant mechanism for neural interactions by axodendritic synaptic transmission should impose distance-dependent delays on the EEG oscillations owing to finite propagation velocities and sequential synaptic delays. It does not. (Freeman and Vitiello, 2006)

Hameroff (2009) concludes similarly, with respect to human brains:

> The seemingly instantaneous depolarization of gap-junction-linked excitable membranes (i.e., despite the relative slowness of dendritic potential waves or spikelets) suggests that even gap junction coupling cannot fully account for the precise coherence of global brain gamma synchrony. (Hameroff, 2009, p. 54)

These conclusions prompt the crucial question: if electrochemical processes are not the cause of the observed synchrony, what is? Much has been speculated about quantum coherence and its possible role in human consciousness. I indulge in similar speculation here, by necessity — we must ponder unconventional solutions when the conventional solutions are clearly inadequate.

Ho (1998) has contributed much to our understanding of quantum phenomena in biology and she believes that there is a role for quantum coherence in consciousness, as well as in biology more generally:

> [W]hat is it that constitutes a whole or an individual? It is a domain of coherent, autonomous activity. The coherence of organisms entails a quantum superposition of coherent activities over all space-time domains, each correlated with one another and with the whole, and yet independent of the whole. In other words, the quantum coherent state, being factorizable, maximizes both global cohesion and local freedom. It is that which underlies the sensitivity of living systems to weak signals, and their ability to intercommunicate and respond with great rapidity. Within the coherence volumes and coherence times of energy storage… organic space-time can be nonlocal. (Ho, 1998, pp. 213–4)

Ho adds to this highly suggestive passage (italics in original): '*The organism is, in the ideal, a quantum superposition of coherent activities over all space-times, this pure coherent state being an attractor, or end state towards which the system tends to return on being*

perturbed' (*ibid.*, p. 214). Ho's ideas on the nature of organisms are, then, entirely congruent with my suggestions regarding the field coherence and other criteria for formation of complex subjects. She recognized long before I began writing on these topics that the speed of information flows is key for the formation of complex subjects. She also briefly mentions Whitehead as inspiration for some of her ideas, but doesn't go as far as I have in this paper in employing Whiteheadian ideas about time and the nature of physical reality.

Freeman has taken us even further in understanding human consciousness, proposing (2006) that *spontaneous* breakdown of symmetry in the electric field formed by cat and rat brains — and by extension human brains — leads to beta and gamma synchrony. As mentioned above, he argues that electrochemical signalling in neurons operates far too slowly to explain the observed long-range correlations in his subjects. He appeals to quantum field theory's many-body dynamics to explain these phenomena. Freeman does not, however, make the connection between the faster-than-light entanglement effects observed in many experiments since Aspect's work in the early 1980s and the posited spontaneous breakdown of symmetry. Nor does Freeman attempt to extend his framework beyond mammalian subjects. Accordingly, Freeman's work is extremely helpful in providing quantitative analysis of my framework in particular contexts and in supporting my qualitative judgments in those same particular contexts.

Assessing whether the right kind of field coherence is present in a candidate complex subject will likely require an iterative inferential process that starts with known complex subjects like humans, rabbits, rats, etc. and catalogues the observed types of field coherence. This process will take some time. I will suggest further details in a follow-up paper.

Much more work needs to be done in fleshing out the framework I've outlined here, both theoretically and experimentally. This is, I hope, a good start to an empirically valid and theoretically sound set of psychophysical laws that sees all of nature as an unbroken continuum, and thus requires no miracles to explain the relationship between matter and mind. The research programme required to flesh out this theory will be described in a follow-up paper.

V. Comparing to Tononi

Tononi (2004; 2008; Balduzzi and Tononi, 2009) has developed a theory that shares some features with the framework developed here. As mentioned above, however, Tononi shies away from the panpsychist

implications of his theory — for now, at least. More importantly, my framework differs in that a certain type of connectivity is necessary for a complex subject to arise, whereas Tononi's theory concludes that consciousness is present wherever there is integrated information: '[C]onsciousness is integrated information' (Tononi, 2008). Integrated information requires a certain type of connectivity also, but the connectivity required relates to the interconnectedness of the nodes in the object examined, not the speed of transmission. Integrated information is 'the amount of information generated by a complex of elements, above and beyond the information generated by its parts'.

This notion of consciousness is, in my view, overly broad. It is thus ironic that Tononi shies from panpsychism because his theory actually suggests that a cell phone, table, or a cloud contains some consciousness — exactly the amount of consciousness quantified as the integrated information within these objects (this would be quite a small amount of consciousness, but consciousness nonetheless). My framework suggests that none of these objects would have any type of unitary consciousness because the information transmission pathways are highly unlikely to be fast enough to allow for a unitary subject to arise in such large macro-structures, preventing field coherence from arising. They are, in Whitehead's language, 'mere aggregates', comprised of many simple subjects and perhaps many lower level complex subjects. For unitary consciousness to arise in such large structures (like ourselves, for example), field coherence is required. Through various levels of bootstrapping, our holarchical structure as human beings allows for information flows to be extremely rapid — as Ho (1998) discusses in detail. There seems to be no such field coherence in a cell phone, cloud, or table.

My quantification framework is, however, similar to Tononi's (and Edelman's), as discussed above. I use basic information theory to quantify consciousness in complex subjects, as Tononi does. However, I am not suggesting, and I reject, the notion that information has any special ontological status in the manner Tononi suggests. Information, in my framework, simply represents the structure of matter/menter, and is a secondary concept derived from the more fundamental reality of matter/menter. Information is, then, a simplified description of reality rather than an ontologically separate feature of reality. Ho supports this clarification in her 1998 book: '"Information" is not something separate from energy and organization' (Ho, 1998, p. 120).

VI. Conclusion

I repeat, in closing, that there is no proof possible regarding my proposed framework. But 'science probes; it does not prove'. We must, each of us, proceed instead on available evidence, inference, and aesthetics. The available evidence for panpsychism, and my suggested solution to the combination problem, is, however, broader than many realize and is not limited to the fields of cognitive science or philosophy. A problem that plagues many fields in today's highly specialized workplace is compartmentalization. There are many outstanding Gordian Knots in various fields of science and philosophy. Cognitive science and philosophy may face the 'hard problem', but many other fields, including physics, biology, and philosophy more generally, face many of their own very difficult problems that continue to resist solution under the prevailing materialist metaphysics, all of which are related to the hard problem of consciousness. The proposed panpsychist solution offered here slices through many of these Gordian Knots like butter. The seeming universality of the panpsychist solution is a final line of reasoning highly suggestive of its validity with respect to the hard problem of consciousness.

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