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Does SoS Theory Provide a Basis for a Plausible and Testable Account of Consciousness?

Abstract: *Some implications of the metric time incorporated in relativity theory strongly suggest that there is a need to accord separate ontological status to both of the concepts of time that were described by John McTaggart over 100 years ago; namely his 'untensed' and 'tensed' times. Quantizing 'tensed' time leads to a proposal for a panprotopsychist theory (SoS theory) which avoids the 'binding' and 'combination' problems to which most theories of this type succumb when envisaged as providers of a basis for our form of conscious experience. For this reason, SoS theory is regarded as relatively plausible, while it has empirically testable implications for both a potential means of inducing general anaesthesia and for the probable manifestation of brief violations of objective energy conservation.*

Keywords: consciousness; energy; Heisenberg uncertainty; quantum theory; relativity theory; time.

1. Introduction

There are two analogies for the flow of our conscious experience that may be thought especially apt. The first, proposed 80 years ago by Sir Charles Sherrington (1940), pictured the seamless tapestry of our experience as emergent from a weaving together of fluxes of 'electric messages' in what he nicely called 'the enchanted loom' of our brain.

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The second analogy, with multiple sources perhaps as old as humanity itself, sees our experience as like a waterfall or cataract in which evanescent whorls, braids, and other patterns are constantly manifesting, imaging fleeting conscious content. Tapestry or waterfall, woven pictures or chaotic patterning, the two analogies have a lot in common and own a sort of poetic or fairy tale truth one may suppose. Is it possible, as Keats accused Newton of having done, to 'unweave the rainbow' of experience that they describe and reveal mysteries like those demonstrated by spectography — a method able to reveal the essence of rainbows which *are* natural spectrograms?

I shall argue in what follows that a plausible approach to unweaving the rainbow involves taking a radical view of the nature of time. It requires envisaging the 'tapestry' to be woven, not *in*, but *of* time, while the 'waterfall' is a cascade, not of material particles or fields, but of temporality itself. Clearly the metric 'time' of Newton or general relativity isn't up to this task; my first step necessarily involves, therefore, looking for some variety or concept of time that might suffice. Lest readers suppose that this is about as sensible a quest as was the hunting of the Snark, I need first to point out one very basic fact. This is that, while Newtonian or Einsteinian times provide a framework for objective reality, neither of these times is a 'quantum observable'. And quantum observables comprise everything else, other than the fundamental laws of nature, that is at the basis of our objective existence (i.e. energy, momentum, position in space, charge, spin, etc.). Quantum theory encompasses, in other words, all that manifests in nature *except* for time, natural law, and the very consciousness that allows us to appreciate nature.

As Raymond Tallis (2017) has pointed out, time provides a 'container' for our existence. Despite being thus a principal cornerstone of our world, it isn't contained within our most comprehensive and fundamental theory of the world. Quantum theory *uses* a temporal metric (which is basically Newtonian with adjustments to accommodate special relativity) but doesn't tell us anything about the time being used, other than that it is in some sense another side of the coin of energy since metric time and energy share a non-commutative, 'Heisenberg uncertainty' relationship. The theory's treatment of time is quite unlike its treatment of space, despite our habit of eliding the two in Minkowski's 'space-time'.

Time, for quantum theory, is a 'given' *governing* evolution of the wave function. It plays a part similar to that of other 'rules' of quantum theory (linearity, unitarity, etc., etc.) and thus has the

apparent status, in relation to the government of the world, of an arbitrary act of God or random outcome of possibilities inherent in a 'multiverse'. Space (or at least spatial position) can be extracted from probabilities *described by* the wave function via suitable 'measurement' operations. The likelihood of some particular position in time manifesting can't be predicted from the rules of quantum theory; the theory tells us only that the precision of any measurement of the time at which some energetic event happens must be in inverse proportion to the precision of any measurement of the actual energy of the event. In contrast, the probability that some particular position in space will manifest on 'measurement' *can* be predicted from theory, with the proviso that position measurement precision will be reduced by any associated momentum measurement. Since time in a sense governs quantum theory, rather than vice versa, a suitable temporal 'Snark' capable of forming a cataract of temporality may indeed be lurking somewhere just outside the remit of contemporary physical theory. We need to try to hunt it down.

2. Of Time and Temporality

The universe can be viewed as a vast assemblage of tiny clocks since every particle in it has its own de Broglie frequency. However, contrary to Newton's proposal, there is no common 'time' that is measured by these clocks. Relativity theory, backed up by implications of innumerable empirical observations, shows that each little clock may be 'perceived' by others as having a quite different frequency from its 'perception' of its own frequency, depending on the relative velocities, accelerations, or ambient gravitational fields that are involved. The 'perceptions' that are involved, if they 'measure' one another's frequencies, require transfer of some sort of information manifesting in its Batesonian guise as a material 'difference that makes a difference'. It therefore follows that the 'time' component of the 'space-time' of general relativity has to be regarded as no more than a purely notional contributor to a mathematical function (the Einstein tensor) which describes an important 'law' governing the classical causal relationships that are involved in information transfer. The apparent reality of this sort of 'time' depends on classical causality itself. Einsteinian time has a relatively elaborate role, but one that is of the same general type as that played by the principle of conservation of momentum, for example, in relation to other aspects of causal behaviour.

Black hole event horizons can be used to provide an especially striking illustration of the purely notional 'reality' implicit in Einsteinian time since they entail the apparent paradox that inspired Leonard Susskind (2008) to comment that 'physics shouldn't behave like that'. Given a sufficiently massive black hole, anyone unlucky enough to fall into it would notice nothing at all unusual on transiting its event horizon (assuming that she was adequately protected from radiation and that the hole was indeed sufficiently massive to allow her to survive tidal effects at the horizon). To an outside observer, however, the faller would: (a) take an infinity of 'time' to cross the horizon and (b) would appear to be 'smeared out' all over it and reduced to her smallest (Planck scale) spatial components. Various implications can be drawn from this apparent paradox (Nunn, 2018), but the main one to emphasize here is that Einsteinian time can't be 'real' in any everyday sense because there's a circumstance in which it could unfold normally for one person while she would appear to another not only 'frozen in time' but also reduced to a random assemblage of component spatial parts. The black hole can be pictured as a huge 'microscope' enabling observers to see the minimal spatial components of an object when all process and relatedness is squeezed out of it. Nevertheless time, 'the old enemy', is all too real as far as everyday experience is concerned. What could provide the origins of its experienced reality?

The point here is that the maths of Einsteinian time tells us that there could be fleeting circumstances in which one person could seem quite normal to herself while another, sharing a connected spatiotemporal framework (since she never actually crosses the event horizon from the observer's point of view), would perceive her as a sort of squashed insect; a splattered component of spatial parts from which all 'time' in the sense of sequential process had been eliminated. The unlucky faller would be perceived as no more than an insignificant contributor to the Bekenstein-Hawking entropy of the black hole. What sort of time could contribute to the actuality of her ongoing experience in circumstances in which she could be perceived by onlookers to lack any sort of coherent existence? The purely objective causal stories involving the information transferred to observers *aren't* paradoxical here since they are fully consistent with general relativity.

It is hard not to feel, however, that the differing experiential stories are less easily reconciled. The key to resolving the apparent conundrum may lie in the epithet of 'actuality' applied above to our faller's ongoing experience. For what is directly 'actual' to us is experience

itself. The world out there can be, and is, *represented* in the content of consciousness, but any perceived 'actuality' that may be attributed to it is indirect and dependent on the primary actuality of conscious experience. I don't of course wish to imply here that the objective world isn't 'actual'; merely that how it is represented in consciousness depends on conscious experience itself and only indirectly on properties of the objective world.

It is therefore not unreasonable to ask whether an attribution of independent reality to time might be connected somehow with the actuality of subjective experience, leaving our *notion* of time as a sort of shorthand term for an aspect of the actuality of objective causal relations. There's an old distinction, made by a Cambridge philosopher and follower of Hegel (McTaggart, 1908), between 'tensed' and 'tenseless' time; the former divided into past, present, and future while the latter refers to concepts of earlier than, simultaneous with, and later than. McTaggart himself argued that incompatibilities between these two concepts 'proved' that time is unreal. However, it seems more likely that the incompatibility he identified is due to the two concepts of time having different referents. 'Tenseless' time is the concept preferred by physicists, and is consistent with the time of relativity theory, while the 'tensed' variety corresponds to our experience of time (see e.g. Primas, 2003; 2009, who suggested that 'tensed' time may be what he termed the 'carrier' of mentality). 'Tenseless' time is therefore the variety that refers to an aspect of the processes involved in classical causal relationships having no intrinsic or independent reality of its own, which leaves the status of 'tensed' time open to question.

It is often assumed, of course, that our experience of 'tensed' time derives entirely from the 'tenseless' variety via complex causal happenings in our brains. And it's certainly true that much of our experience of time derives from direct and indirect experience of a wide range of neural, biological, and environmental 'clocks'. As we've already seen, however, 'tenseless' time lacks independent reality, being no more than a measure of how classical causality behaves. Therefore any assumption that the 'tensed' time of our experience *must* be a wholly secondary phenomenon carries an implication that conscious experience itself is entirely a product of objective classical causes; any such assumption has to imply, in other words, that eliminative materialism is true. And eliminative materialism, popular in some circles 30 years ago, is becoming ever less popular as appreciation improves of the many problems with it.

Perhaps 'tensed' time is in fact a partially independent phenomenon, as indeed all those little clocks ticking away everywhere might suggest, normally related to 'tenseless' time only via sequences of causal happenings — thus allowing the separation into *contradictory* streams of experience of our faller and those observing her in the special circumstances provided by black holes. The present or 'now' component of 'tensed' time is certainly a centrally important aspect of the 'reality' of our experience but could it conceivably *provide* the reality of our experience?

The question above points back to the curious fact that something so central to our existence as time isn't a quantum observable. Maybe it isn't an observable because it constitutes *a basis for* observability, rather as it is impossible to see the cornea through which one is seeing. This possibility certainly fits with quantum theory's treatment of time as a 'given'. Probably the simplest way of picturing how 'time' might contribute to observability is to conceive of episodes of the 'nowness' of 'tensed' time as *being* proto-experiences. 'Tensed' time, or at least its 'present' component, *is* the originator of subjective experience on this view, which is developed in SoS theory (Nunn, 2013; 2017).

3. SoS Theory

The theory is a variant of panprotopsychism, dependent on the basically monistic ontology described in Pereira *et al.* (2018). The idea is that elementary units of 'awareness' assemble in brains into the sort of consciousness that we experience. Examples of previous proposals for such 'units of awareness' have dubbed them 'psychons' (e.g. Popper and Eccles, 1977) or 'qualions' (e.g. by Tal Hendel in an unpublished paper, 2009). It seemed appropriate to coin a new term (i.e. 'Scintillae of Subjectivity' or 'SoS') as the concept of an SoS differs from concepts behind alternative terms. SoS theory takes protopsychist 'units' to be elementary episodes of subjective 'nowness', whereas Popper and Eccles' psychons refer to ill-defined mental elements able to affect probabilities of neurotransmitter release from synaptic vesicles. Hendel's qualions are related to SoSs in that they are expressed in the temporal formulation of the equation of the Hamiltonian operator (see appendix) but lack the centrally important 'nowness' concept because they relate to metric, 'untensed' time.

SoS theory too relates to energy and in particular to energy measurements. The rationale for this is twofold. First, 'energy' in its

various manifestations *comprises* the world that we inhabit except, as noted previously, for time, conscious experience, and natural 'law'. If one takes a basically monistic view of reality such as that given by the Pauli/Jung conjecture (Atmanspacher and Fuchs, 2014) it follows that any split between the various features of reality must be due to a breaking of very fundamental symmetries. Second, the Heisenberg uncertainty relation between time and energy points to energy 'measurements' as providing the likely site of a 'time' versus 'objective world' split. The 'time' referred to in this uncertainty relationship is often dismissed as an almost trivial outcome of practical difficulty in making precise temporal measurements along with precise energy measurements. But that view must be incorrect because sufficiently brief uncertainties of this 'time' allow manifestation of the virtual particles which play such important roles in quantum field theory. If virtual particles are physically 'real', as indeed the Casimir effect seems to confirm, some sort of 'reality' must equally be attributed to the 'time' shown in the Heisenberg equation as the flipside of their manifestation. SoS theory equates this temporal reality with subjective expression of 'nowness'. Each energy 'measurement', on this view, is accompanied by an 'atom' of protopsychism.

Some points made in the paragraph above may need clarification. The Pauli/Jung conjecture is roughly equivalent to Russellian monism, but may be thought preferable as it attributes *no* separate or discernible qualities to the *unus mundus*; all differentiation follows from later breakdowns of an original perfect symmetry, while Russell himself seems to have been possibly a bit less clear on this issue. SoS theory depends on the claims itemized below:

(a) The 'time' to which we ordinarily refer relates to the outputs of a range of natural, neural, and mechanical clocks; the reality that it describes is an aspect of objective (classical) causal relationships.
(b) Causal relationships are real, but the temporal metric is notional. What's real about time is its 'nowness' which relates to classical causality via outcomes of quantum 'measurements', most likely energy 'measurements'.
(c) If (b) is true, energy measurements are associated (via Heisenberg uncertainty) with quanta of temporal 'nowness' to which objective durations can be attributed.

(d) As quanta of ‘nowness’ aren’t observables, it’s reasonable to think they might be subjectables — i.e. protopsychist elements (SoSs).
(e) Because many objective events in the brain are likely to be associated with unusually large subjectable durations (for reasons given in Nunn, 2013, and below), the latter can map patterns of causal activity in brains and thus elaborate into conscious experiences.

The physical picture implied in a, b, and c above is fairly straightforward and likely, perhaps, to be true; the most speculative step is the attribution in d of real, albeit ‘subjective’, status to the time referred to in the Heisenberg time/energy uncertainty relationship. Readers will no doubt come to their own conclusions about its plausibility, but I’d ask them to postpone making any firm judgment until reaching the end of the paper!

Just as virtual particles can be ignored for all practical purposes, so too can most SoS’s which will normally be of almost infinitesimal duration. There’s no practical possibility that volcanos erupting, raindrops falling, or nerve impulses firing for that matter, will have sufficiently well defined energies to allow any meaningful associated psychism. The Heisenberg relationship shows that an energy measurement uncertainty of only 10^{-31} joules would be required for association with an SoS duration of 1 msec. Most SoS’s occurring out there in the world will be of $<< 10^{-12}$ seconds duration and of no more relevance to the sort of consciousness that we experience than is a virtual particle to the digestion of our food. They can be thought of as providers of ‘nowness’ for causal happenings in the sense of ‘endorsing’ the fact that a happening is presently manifesting in the classical world. They ‘certify’ the actuality of an energy manifestation rather as the virtual particles pictured in Feynman diagrams act as enablers and mediators of causal happenings to which ‘nowness’ is being attributed. But SoSs generally will be no more ‘visible’ from our point of view than are virtual particles.

The situation is different in biological systems, especially brains, however, as these encompass huge numbers of rather precisely defined energetic events (e.g. ATP dephosphorylation, ion bindings, phonon manifestations) occurring in ordered patterns on timescales overlapping those of (hypothetical) SoS durations. For instance, EEG activity in the frequency range 10–100 Hz reflects energetic events many of which might very plausibly have ‘measurement’

uncertainties[1] of the order of 10^{-32} to 10^{-33} joules and thus be associated with SoSs having durations of 10 to 100 msecs. The theory therefore shows how patterns of objective energetic events in the brain could be translated into patterns of subjective 'nowness', forming the content of conscious experience.

There is a proviso, however; namely that our form of conscious experience is memory dependent in the sense that it requires introspectibility (we can never know that we have had a conscious experience unless we can introspect it!) and it is unlikely that all SoS patterns will meet this additional requirement, leaving some as 'unconscious' in the sense of not introspectible. Such patterns will be fleetingly 'present' to themselves but, unless incorporated into some larger flow, will remain subliminal. Of course we have many experiences that we don't introspect, in the sense of saying to ourselves 'I'm having this experience', but it seems likely that a potentiality at least for doing so is generally characteristic of our states of consciousness even if we often don't make use of it. Introspectibility is certainly a requirement for *reportable* consciousness, which is the only sort that can be studied objectively. Benjamin Libet showed convincingly, in his many publications with results that have been well replicated subsequently, that it takes ~0.3 secs for consciousness of information reaching the brain to 'gel', which implies that objective, short-term neural memory processes have to be involved in the formation of conscious content.

The timing of SoSs is inherently 'fuzzy' from an objective point of view, but that couldn't account for the 'Libet' delay because the 'fuzziness' is distributed in both earlier and later metric time directions, not exclusively in the 'later' direction. It seems, therefore, that our form of conscious experience requires a neurally mediated ability to report the occurrence of a 'conscious' state (i.e. a neural pattern that has been mapped into an SoS pattern).[2] But the conscious experience of a neural pattern that is mapped in an SoS pattern will itself be an evolving SoS pattern — the two patterns will be seamlessly interwoven as a consequence of the overlapping SoS durations

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1 I'm assuming here that some form of 'objective' state vector reduction or equivalent is responsible for 'measurement', such as that envisaged in decoherence theory or Penrose's 'gravitational' collapse hypothesis.

2 This requirement is reminiscent of HOT (higher-order thought) theory's proposal that consciousness depends on a (possibly unconscious) appreciation that one is having an (unconscious) experience.

involved — thus showing both how very apt Sherrington's 'enchanted loom' analogy may have been and how the 'binding problem' (the problem of how it is that activity in temporally and spatially separate parts of the brain can give rise to unified experiences) is circumvented by SoS theory.

If Sherrington's analogy points to how the 'binding problem' might be circumvented, the 'cataract' analogy suggests a possible answer to another puzzle; namely the question of what could possibly differentiate one quale from another; why isn't red experienced as blue, for instance, or the sound of a bell or a tingle in one's toe? We know from cases of synaesthesia that quale differentiation is dependent on neural representation of the world out there, not on inherent characteristics of the 'objective' world itself. What's needed, in the context of SoS theory, is to envisage how distinctive aspects of primarily spatial 'representations' occurring in the flux of neural activity could survive translation into primarily temporal representations in the flux of SoS patternings.

4. Qualia

There are good arguments for supposing that what correlate most closely with our 'mentality' (conscious and unconscious) are patterns of ionic flux in the brain of which calcium ion flux is among the most important (Nunn, 2017; Pereira *et al.*, 2018). These occur over a very wide range of spatial and temporal scales, from that of dendritic spines to that represented in EEG activity. There is ever accumulating evidence that astrocytes support scales of flux intermediate between those occurring in neurons and those reflected in EEG fields. These fluxes have various characteristics; some are wave-like and may show interference effects; many are channelled by anatomical features such as dendrites and gap junctions, while they are initiated and constrained by synaptic activity, voltage gated channels, and the reciprocal interactions of different types of ion. A chaotic cataract provides a good analogy for all this extraordinarily complex activity. But does this 'cataract of the mind' harbour features analogous to the patterns that can manifest in flowing water?

In fact our minds harbour two centrally important and distinguishable, though interrelated, varieties of pattern; first, the attractors that Walter Freeman in particular researched (e.g. Liljenstrom, 2018), which can often be viewed as expressions of neural memories; second, patterns that directly 'represent' the flux of experience supposed here

to be embodied in spatially ordered characteristics of ionic flux. The latter patterns are the ones most immediately relevant to questions about the characteristics of qualia. It's likely that many 'why' questions about qualia — why is red red? Why is pain painful? etc., etc. — have answers dependent in principle on evolutionary psychology, as Nick Humphrey proposed in *Seeing Red* (2008). The question most relevant in the SoS connection isn't a 'why' but a 'how' one; namely how could characteristic(s) of neural patterning plausibly survive translation into SoS patterns while retaining distinguishability? Patterns in the 'cataract' of ongoing neural activity must map somehow onto the content of conscious experience, but what geometric or topological property of neural patterning could possibly bridge such a mapping?

A whole range of ephemeral patternings manifest in cataracts of water, dependent on channelling characteristics and flow rates. The same is no doubt true of ion fluxes. One type of pattern, however, is particularly well suited to embody uniqueness and mappability, as well as fitting nicely with Sherrington's 'woven tapestry' analogy; namely braidings. Braids are equivalent to knots, while prime knots are just as irreducible to one another as are prime numbers. But, just as prime numbers can combine to give all rational numbers, so prime knots can combine to provide all possible braided or knotted patterns. Braids, along with associated knot equivalents such as Seifert surfaces, are thus well suited to represent essential distinctions between qualia while also allowing the composite qualia that we habitually experience (e.g. combinations of emotions with cognitions and perceptions). Whether they in fact have this role is an open question that may one day be answered, perhaps via visualizing brain-wide patterns of calcium ion flux if this should ever become technically achievable.

At present perhaps the most intriguing available hint that properties of qualia might indeed relate to knot theoretical description of SoS patterns is provided by mathematical arguments that 'quantum knots' are topologically equivalent to classical knots, while the structure of any Hamiltonian (energy function), however complex it may be, has been said to correspond with some specific quantum knot.[3] Just

[3] The maths behind this idea is way beyond my competence to discuss or even properly to understand. The argument outlined here is, however, spelled out in a little more detail in Nunn (2017, chapter 7).

possibly, therefore, there may be a direct connection between SoS patterning and knottedness, since SoSs are envisaged to be the 'flip-side' of energy eigenstates and therefore also have origins in Hamiltonians. The hypothetical, classically mediated, SoS pattern/knottedness relationship via braided patterns of ion flux could then be regarded as a secondary classical manifestation of a primary, pre-'measurement' knottedness. Research into issues of this sort would, however, depend on availability of methodologies that may be developed in the future. Is there any prospect that SoS theory might be open to investigation with currently available technologies?

5. Testable Implications

There are two fairly straightforward implications of SoS theory that could help towards differentiating it from other theories of the basis of consciousness, would provide refutation if not fulfilled, and are probably not beyond the scope of contemporary research methodologies. The first has to do with what might induce general anaesthesia and the second with conditions necessary to maintain the 'law' of energy conservation. I'll introduce them in that order.

General anaesthetics range from atomic elements such as the noble gas xenon to quite complex organic molecules such as ketamine. They appear to have little in common with one another except for lipid solubility. It is generally supposed that they disrupt neural correlates of consciousness, and/or ability to introspect or recall such correlates, via a wide range of effects such as enhancing inhibitory neural activity (especially GABA activity), binding to stimulatory receptors, or physically blocking ion channels of various sorts. Xenon, which is an especially effective anaesthetic agent, is presumably a channel blocker since it lacks chemical reactivity. In the context of SoS theory they can all be envisaged as disruptors of consciousness-associated 'patterning' in the flux of neural activity. However, SoS theory takes consciousness to be also dependent on very precise 'measurement' of a proportion of the energy eigenstates that accompany neural activity, which suggests that there ought to be a means of inducing general anaesthesia that is independent of direct effects on neural 'patterning'; it should be possible to induce anaesthesia by reducing 'measurement' precision so that SoS durations are also reduced to an extent that no longer match neural frequencies. And precision ought to be reduced by electromagnetic waves tuned to nearly, but not quite, the energies of the appropriate 'measurements'. The prediction to be made,

therefore, is that consciousness should be impaired, and perhaps even abolished, by fairly intense electromagnetic irradiation of the brain at some precisely tuned (but currently unknown) frequency or frequencies. If such an effect could be found it would allow us to infer which particular energetic events in the brain are most closely connected with SoS durations great enough to 'map' the flux of neural activity.

The second implication, to do with energy conservation, is even more straightforward, though also more radical. Noether's theorem tells us that the 'law' of energy conservation is a consequence of the indifference of physics to *smooth* translations in metric (i.e. 'untensed') time. Since SoS theory introduces a quite different ('tensed') time, composed of 'quanta' having measurable durations in the context of biological systems, it follows that the conditions for Noether's theorem to apply (i.e the smoothness of temporal translations) may be violated, at least for periods comparable with the relevant SoS durations. Therefore the 'law' of energy conservation may sometimes *appear* to be violated in biological systems, though it can be argued that the 'law' should simply be *extended* to cover subjective correlates of energy as well as the objective ones that are normally considered (Pereira *et al.*, 2018). The suggestion here is that brain oscillations are like pendulums whose frequencies and kinetic energies depend on gravitational potential energy; SoS patterns may be thought to provide a source of both variable and *objectively invisible* potential energy for brain oscillations, and will therefore affect oscillation frequency and manifest energy. If gravitational potential energy were equally 'invisible', ordinary pendula would appear to violate energy conservation. Thus it should be possible to find, according to SoS theory, consciousness-associated *appearances* of energy anomalies. These will usually be brief (perhaps ~0.1 secs) and thus hard to identify. Possibly fluctuations in local ATP dephosphorylation rates, relative to expectations of these rates derived from calculations or measurements of energy requirements, might give a detectable signal of anomaly occurrence.

6. Conclusions

Any plausibility attributable to SoS theory depends on taking a radical view of time, albeit one that has a long history. The fact is that our contemporary habit of supposing it to be a 'dimension' little different from spatial dimensions has to be incomplete because position in time,

unlike position in space, is not a 'quantum observable'. Implications of treating relativistic time as offering a complete account of temporality suggest that what is missing from the concept relates somehow to (local) *experience*, leaving relativistic time as a measure of the structure of classical, objective causal relationships. When looking for a 'home' in fundamental physics for experiential time, it's hard to ignore the Heisenberg time/energy uncertainty relationship; attributing ontological status to *both* sides of the relationship leads directly to a concept of the manifestation of experiential units or 'quanta' of 'nowness' — i.e. to SoS theory. Is it a proposal with plausible implications?

The theory is a panprotopsychist one, since it attributes ontological status to units of *experiential* time that manifest along with energy eigenstates. I hope to have shown that it evades the 'why aren't rocks conscious?' question that creates problems for some panpsychist ideas, and that it also offers a consistent account of how protopsychist units might combine in brains to provide a seamless flow of conscious experience. But of course the proof of the pudding will lie in the testing. Luckily the theory 'predicts' at least two phenomena that, if found to occur, would be hard to explain on any basis other than the theory offered or one closely related to it.

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Appendix

The equation below expresses the Hamiltonian (energy function) as an operator acting in metric time:

$$\hat{H}_t = ih\frac{\partial}{\partial t}$$

whereas in equation (2), the Hamiltonian is expressed as an operator acting in space:

$$\hat{H}_r = -\frac{h^2}{2m}\nabla^2 + V(\mathbf{r})$$