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## **“Timely Thinking: A Philosopher Salutes Buzsáki, Llinás, and Merleau-Ponty”**

### **Summary and Introduction**

Two distinguished and pioneering neurophysiologists have recently described consciousness and its substrates in terms of time. “Timeness is Consciousness”<sup>1</sup> is one of the headings in Rodolfo Llinás’s *I of the Vortex*. György Buzsáki begins his recent *Rhythms of the Brain*<sup>2</sup> with the anticipatory punch-line that brains are predicting devices, in virtue of the rhythms they generate throughout time.

I agree with these scientists – against many of my philosophical colleagues – that empirical research must be the main means of exploring how consciousness is generated by the brain. And I am nonetheless entering the discussion because there are a few inherited philosophical presuppositions in these two works that might interfere with applying their insights fully, and that can be usefully tweaked into greater consistency with their approaches. In one instance, that of subjective time experience, I suggest that the standard account taken for granted as common sense since the Enlightenment should be entirely replaced by a more accurate description given by early 20<sup>th</sup> century French psychologist and philosopher Maurice Merleau-Ponty.<sup>3</sup> The results lead directly to suggestions for future studies by neurophysiologists.<sup>4</sup>

### **A Place for Philosophers?**

Topics such as the mind/body “problem,” the free will/determinism “question,” and the source of moral impulses were until recent decades regarded as exclusively the territory of philosophy. Now, these topics are rapidly being adopted by the physical and social sciences, themselves originally categorized as “natural philosophy” or “moral philosophy.” I applaud the greater accuracy and progress that this shift has frequently made possible. After all, the boundaries between western disciplines have always been fluid<sup>5</sup> and occasionally arbitrary and overlapping.

Currently, there is an increasing need for interdisciplinary cooperation in certain areas,<sup>6</sup> including neuroscience, which benefits from fields such as complex systems theory, physics,

<sup>1</sup> Rodolfo R. Llinás, *I of the Vortex: From Neurons to Self* (The MIT Press: Cambridge, MA), 2001, p. 120.

<sup>2</sup> György Buzsáki, *Rhythms of the Brain* (Oxford University Press), 2006, p. vii.

<sup>3</sup> In my reading of Merleau-Ponty I am entirely indebted to Forrest Williams, Professor Emeritus at the University of Colorado at Boulder, whose lectures on Spinoza and Merleau-Ponty are still spoken of with awe. Some of the content of this paper is drawn from my doctoral dissertation, directed by Williams and defended in 1994.

<sup>4</sup> Because this paper is addressed to scientists and philosophers both, I am not assuming any special knowledge of either. If what I am describing in any paragraph or section is familiar to you, please feel free to skip that paragraph or section. I am also reluctantly abbreviating many philosophical points, aiming to include only what is absolutely required for this discussion.

<sup>5</sup> E.g. molecular biology departments sometimes exist separately from organismic and environmental biology departments, and biochemistry has been gradually converging in content with molecular biology. Chemistry’s roots are in alchemy. And Aristotle is claimed by both philosophers and scientists as our founding patriarch.

<sup>6</sup> Besides neuroscience, another field which requires interdisciplinary collaboration, including contributions from philosophers, is ethical psychology/anthropology, as exemplified in Frans de Waal’s *Primates and Philosophers: How Morality Evolved*.

psychology, A.I.-related cognitive science, and more. In some cases, philosophers can be of service as well. With regard to neuroscience, philosophers can sometimes help the most by identifying tacit but questionable assumptions. Often, these are presuppositions introduced by our own philosophical predecessors and handed on as heirlooms when the biologists, chemists, or psychologists (especially psychologists) moved out to form their own disciplines.<sup>7</sup>

Both Buzsáki and Llinás are philosophically sophisticated, Buzsáki from the European Continent's schools of philosophy, and Llinás from the Anglo-American schools of philosophy; Llinás's spouse, Gillian Kimber, is a philosopher. I would like to think that this has contributed to their insights and originality. Certainly they have avoided or confronted and corrected many conceptual difficulties inherited by their discipline -- as has another neurophysiologist, Antonio Damasio, by challenging existing assumptions remaining from Descartes and others, and finding inspiration instead in Descartes' hitherto under-appreciated opponent, Baruch Spinoza.<sup>8</sup>

The suggestions that are made in this paper come from a handful of philosophers, including Spinoza, who could collectively be said to constitute an informal, attenuated counter-tradition.<sup>9</sup> They are less well known than the usual canon of Plato, Descartes, Kant, (or Hegel,) etc.; their ideas were less acceptable or convenient to previous societies, but they often apply beautifully to the modern biological sciences -- better than some ideas from the standard philosophical canon do. These figures are especially useful for providing *alternative* concepts for forming hypotheses for neuroscience, etc., when that is needed. These "counter-tradition" philosophers include the pre-Socratic Greek Heraclitus, the Enlightenment-era Spinoza, Nietzsche<sup>10</sup> and his predecessor Arthur Schopenhauer, and especially Merleau-Ponty, who assimilates and refines much of what is best in all of the earlier figures. Their time has come.

### **Buzsáki, Llinás, and Merleau-Ponty: Shared Axioms**

*I of the Vortex* and *Rhythms of the Brain* are books that someone like me, studying Merleau-Ponty in the early 1990s, could only hope for. I had encountered the philosophies of what I am calling the "counter-tradition," and found them compelling. I could not align myself to standard approaches of philosophy of mind (or psychology) that flatly ignored the obvious implications of Darwin in favor of a disembodied, atemporal, passive, isolated thinking thing, be it termed soul,

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<sup>7</sup> E.g. Semir Zeki describes how researchers assuming an erroneous Kantian approach (that the senses passively receive data which is then, in a discrete step, interpreted) slowed down their research greatly, in his "The Visual Image in Mind and Brain."

<sup>8</sup> Antonio Damasio, e.g. *Looking for Spinoza: Joy, Sorrow, and the Feeling Brain*.

<sup>9</sup> The term "counter-tradition" has caveats because the earlier figures did not influence one another, or did not admit to it. Early 19-century German philosopher Schopenhauer, irascible as usual, seems to have taken Spinoza almost as a 200-year-older rival, opposing Spinoza's serene impersonal pantheism -- god is nature, and we are adverbs of god -- with an almost Byronic pan-demonism -- nature is one, and it has serious inner conflicts. (Schopenhauer did anticipate Darwin's basic ideas, and was the first western philosopher seriously to consider humans as related to non-humans, and to acknowledge the importance of volition, drives, and subconscious factors in subjective experience.) Nietzsche did explicitly espouse Heraclitus, Spinoza, and Schopenhauer at various points in his intellectual life, and espoused *only* those three, out of all extant philosophy, with characteristic lack of humility. Merleau-Ponty, in the style of his contemporaries, tipped his hat most overtly to his most recent influences such as Edmund Husserl and the original *Gestalt* psychologists, and to some extent to Spinoza, while assuming a deep familiarity among his contemporary French academic audience with 19<sup>th</sup> century and earlier European intellectual history.

<sup>10</sup> That is to say, the lesser known aspects of Nietzsche such as his perspectival theory of knowledge and his psychology of endlessly multiple interacting "willings." The term "will" in Schopenhauer and Nietzsche does *not* mean the sort of conscious, "free," "top-down" force of previous philosophers such as Thomas Aquinas, but a sort of general purposiveness which can be entirely non-conscious or sub-conscious, pre-conscious, or fully conscious.

software, holder of propositional attitudes, radically free nothingness, or functionalist or behaviorist black box.

Damasio's widely read reintroductions of Spinoza in the context of neurological hypotheses of emotions and body maps, Oliver Sacks's moving clinical tales, and Temple Grandin's engrossing overviews of comparative ethology<sup>11</sup> alerted many of us scientifically literate non-scientists to the immense creativity now active in the neurosciences. Reading Buzsáki's and Llinás's stunning books has been immensely exciting for me. I address them together, since their work is mostly very compatible and even complementary: Llinás focuses his research and his book on the properties of single neurons as well as interacting groups of them, and Buzsáki emphasizes large-scale neuronal systems, the whole mammalian brain as approached by complex systems theory. In these two researchers, especially, I think that the rigorous, scholarly, and humane approach begun and exemplified in Merleau-Ponty's early work<sup>12</sup> has been revived.

Buzsáki and Llinás share several key positions which, while diverging strongly from many assumptions in the natural scientific English-speaking world and philosophical world of the past century or more, are plausible and fruitful, and which ultimately provide the most streamlined picture of human experience and mammalian neurophysiology.<sup>13</sup> These include:

*Starting points:*

- Consciousness as emerging from the physical organism, rather than separate or separable from it. Both Buzsáki and Llinás presuppose monism of mind and body. Since that is the consensus position among neuroscientists, if not among philosophers, I presuppose it here as well, for the purposes of this essay.<sup>14</sup>
- Consciousness (used here in the sense of subjective experience) as involving a developmental background and an experiential background of aspects that are not fully accessible to consciousness, so that cognitive introspection alone may not be a sufficient or even a reliable method for studying its nature or origins.
- The human brain as produced by evolution and thus as related to other mammalian and especially primate brains.

*Perception, motility, and context:*

- Perception as active, not passive, i.e. not a mere receiving of stimuli and mechanical, linear processing of them.
- Perception as developmentally and logically prior to abstract self-awareness.
- Motility, also known as motricity, as prior to perception, though intimately involved with it.
- Both perception and motility as goal-directed activities for the organism, which are involved in the key survival skills of prediction and decision-making, both of which are future-directed.
- Perceptions, actions, thoughts, plans, and memories as all occurring in one or more contexts of goals, comparisons, meaning, etc., ultimately in a context involving the organism's predictions and decision-making.

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<sup>11</sup> E.g Temple Grandin, *Animals in Translation*, 2005.

<sup>12</sup> Especially Merleau-Ponty's *magnum opus*, his early *Phenomenology of Perception*, originally published in French in 1945. His later works became less empirically oriented, dealing more with various political and aesthetic topics.

<sup>13</sup> Linguist George Lakoff and philosopher Mark Johnson also share some of these positions regarding the importance of the body, of perception, and of humanity's place in evolution, e.g. in their co-authored *Philosophy in the Flesh*. In this book they acknowledge their debt to Merleau-Ponty as well as John Dewey, describing them as "models of what we will refer to as 'empirically responsible philosophers'" (p. xi).

<sup>14</sup> I am not thereby begging the whole question. Instead, I am assuming, along with neuroscientists and many philosophers, *that* consciousness emerges from the brain's activity. From this axiom we hope eventually to understand *how* consciousness emerges from the brain.

- The organism as itself in an environmental context, interacting with surroundings via perceptions and motility.

*Consciousness and time:*

- Consciousness, or at least the probable substrates of consciousness, as occurring through time and involving temporal patterns of events, whose temporality is key to consciousness as we know it.

Merleau-Ponty also espouses each of these claims, developing them as far as the now sixty-year-old data available to him permitted. And ideas behind these claims can frequently be traced back historically to Spinoza, Schopenhauer, or Nietzsche, as well as to other thinkers such as Hegel. Occasionally these ideas were developed in overt opposition to the “standard” ideas from e.g. Plato, Aristotle, Descartes, and Kant. Thus, should Buzsáki, Llinás, or similar scientists require further historical or conceptual support for these claims, there are valuable resources at their service.

Let us go through these shared axioms.

### **Introspection Alone Will Not Suffice**

For example, in Chapter 10 of *I of the Vortex*, “Qualia from a Neuronal Point of View,” Llinás confronts philosopher David Chalmers on Chalmers’s approach to consciousness via introspection and analysis. This debate involves the notion of “qualia,” and thus a short excursus on this notion is helpful.

#### **On the Notion of Qualia:**

The term “qualia” (neuter plural) originates from the Latin adjective *qualis* (singular masculine or feminine, with *quale* as the singular neuter), meaning roughly “what sort of,” “of such a kind,” “as for example,” “the likes of which.” (E.g. “*qualis erat!*” “What a man he was!” or “*in hoc bello, quale . . .*” “In this way, the likes of which . . .”) Through 20<sup>th</sup> Century British-U.S. philosophy, the term “quale” (the neuter ending, with “qualia” as the plural neuter) began to be used to denote what have variously been described as “raw feels,” “the subjective aspect of sensation,” “the feeling aspect of consciousness,” “the way things seem to us,” “the color and smell of a rose,” etc.. (The sensation of color is a clearer example of subjective experience than, for example, measured wavelengths of light, because the color sensation is what John Locke called a “secondary quality,” i.e. a quality not existing in the red or blue object itself, but in the perceiver’s eye and mind.) In the past few decades, various Anglo-American philosophers have debated fiercely whether the notion of “qualia” is a useful one with a distinct meaning which can withhold scrutiny, or is sufficiently unknowable or otherwise problematic that we should avoid it.

E.g. various philosophers have attempted to prove that qualia exist by complicated thought experiments involving science fiction scenarios. Some philosophers aim to show in addition, by similar thought experiments, that qualia could not be identical to physical objects or events. Other philosophers use similar thought experiments to point out difficulties in the notion of qualia. For example, Daniel Dennett proposes a science fiction scenario in which someone undergoes brain surgery and as a result has his color perception “inverted,” with the sky appearing orange, and so on. Dennett holds that the change in qualia would not necessarily be clearly apparent to the patient; he could wonder instead whether his memories of the old qualia had been altered by the surgery. And since there is no way to verify whether in fact it was the qualia altered, not the memories, qualia is not a useful notion.

Dennett opposes the notion of qualia in other ways, as well; for example, he argues that it presupposes a problematic old model of the mind inherited from Descartes as private self, a homunculus, inside a “theatre” of the mind, viewing the qualia as if they were on a screen of representations of the “outside world.” (We shall see below that Merleau-Ponty

offers an approach which accommodates descriptions of something similar to qualia without Descartes' troublesome "representation paradigm.")

For the purposes of this paper, I am asserting that the notion of subjective sensation is indubitably a useful notion for *describing* experiences. It may *not* turn out to be useful for *explaining* anything or *determining* anything beyond itself (e.g. whether consciousness is fundamentally a physical event or not). Instead, we can simply note for now that the term "qualia" can be legitimately used as a *descriptive* term, even though it may resist being properly defined in terms of, say, its necessary and sufficient conditions, or its class and distinguishing characteristic.<sup>15</sup>

Now, Chalmers is one of the defenders of the notion of qualia as a coherent and useful notion which can be fruitfully analyzed for new insights into the nature of consciousness. And Chalmers<sup>16</sup> attempts an unusual sort of taxonomy of thought, separating out consciousness from various kinds of "cognition" acting on "qualia": e.g. categorizing and reacting to stimuli, focusing attention on something, being awake rather than asleep, accessing one's own internal states, controlling one's behavior. (He describes the cognitive activities as involving "awareness," yet stipulates that this is not the same as consciousness; he is defining "awareness" purely in terms of its functions, not its subjective experience.) Chalmers holds that explaining the various cognitive activities are "easy problems" since he believes that these capacities are each explainable in terms of computational mechanisms. These easy problems are contrasted to what he terms the "hard problem" involving sheer conscious experience. He then explores the relation between consciousness and the cognition involved in the various cognitive tasks, e.g. "In general, any information that is consciously experienced will also be cognitively represented . . . consciousness and cognition do not float free of one another but cohere in an intimate way."

Llinás points out that while the linkage between consciousness and cognition may be correct, it doesn't really tell us anything, and in fact *obscures other lines of questioning*. For example, the connection between consciousness and the "cognitive" capacities might be due -- not to their own characteristics as introspection seems to reveal them -- but to, e.g., relations in their substrate(s).

Llinás offers a plausible alternative scenario that Chalmers's method of introspection has simply and prematurely precluded: "qualia" may gradually arise from the living brain along *with* consciousness, *before* the more advanced cognitive capacities evolve. Indeed, as part of this alternative scenario Llinás offers an intriguing alternative genealogy of the "self": it develops as a useful centralization for *prediction*, for integrating perceptions and movements, rather than arising

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<sup>15</sup> Incidentally, this class/distinguishing characteristic way of forming definitions, also known as hypernym and hyponym, is inherited from Aristotle, and assumes that there will be a single defining, unique characteristic of a species which will also be the most important of its characteristics, the most central or "essential" to that species. Thus, Aristotle defines humanity as the "animal" (class or hypernym) "that has reason/language" (the Greek word *logos* that refers to both reason and language; *sapiens* is its rough synonym in Latin). Others have replaced this hyponym of "reason/language" with what they regarded as more unique and more central to humanity. Thus humanity has been variously defined as "the animal that uses tools," Thomas Aquinas's "the animal that laughs" (the saint had a good sense of humor), or as Johan Huizinga's "the animal that plays." By now, one or more non-human species have been found which share -- at least to some degree -- all these other purportedly unique human characteristics. Thus, I hereby offer my own candidate for *Homo sapiens*'s hyponym, which may have more anatomical and evolutionary basis than any of the others: "the animal with buttocks," that is, at different times, *Homo sedens*, *Homo saltans*, or *Homo obstinatus*. (It is either that distinguishing characteristic or menopause, which I suspect would be even less welcome, though the notion of "the animal with grannies" is delightful.)

Alternate approaches to definitions include making use of such admirably clear notions as logic's "necessary conditions" and "sufficient conditions" related to conditional statements ("if x then y"), which can be applied to candidates for membership of a defined group.

<sup>16</sup> David J. Chalmers, 1995, paraphrased by Llinás on op. cit., p. 210, and quoted by him on p. 211.

from some realm of pre-existing consciousness. Thus, the “self” would originally exist prior to its awareness of its own existence, prior to self-awareness (which *would* of course require consciousness in some robust degree, p. 23).

Buzsáki too raises doubts about Chalmers-type introspective strategies. He points out that we cannot assume that the brain is organized in the divisions we happen to make for describing our mental faculties. For instance, there has been a search for decades for a single word, a single faculty, that would capture the behavior associated with the distinct 4-10 Hz (“theta”) oscillations arising from the mammalian hippocampus. He wryly cites some of the many various candidates: attention, arousal, information processing, decision-making, volition, seeking, and his own suggestion, the relatively connotation-free “navigation,” p. 21.

I would add that the descriptive, informal categories we sort the mind by are changing and inconsistent, as well. For example, there may more than one kind of pain; Llinás elucidates the surprising, counterintuitive distinction between at least one kind of physical pain and the usually accompanying unpleasantness that may be far more distressing, and which is caused by stimulating the cingulate cortex. The cingulate cortex is also involved in the pain of seeing a loved one suffer, in the non-physical but terrible “deep pain” of some psychiatric patients, and in the distress of making errors! (p. 159). As another example, I would point out that the ancient Greeks had no notion of a separate capacity of volition; our modern concept of will, as in free will, derives from Rome, specifically the Roman legal system. The venerable concept of reason itself has been defined in many different and even incompatible ways, from Aristotle’s “active intellect” and Hegel’s all-encompassing orderly evolution of spirit in history, to mere self-consistency, or enlightened self-interest, or Bertrand Russell’s dismissive definition: “the ability to do sums.” Given all this, it would be a surprise were our currently most popular way of dividing up psychological experience to end up reflecting the brain’s own functional divisions.

Buzsáki has a further criticism of Chalmers-type introspective approaches: neither “consciousness” nor “awareness” has even been defined. Indeed, Buzsáki refers to the term “consciousness” as “the crutch of cognitive neuroscience” because it is nonetheless used to “explain” distinctions (e.g. between voluntary and automatic movements). Thus he suggests an indirect approach for studying how the brain produces consciousness: look at behaviors that are taken as signifying consciousness, identify which brain structures and functions are associated with these behaviors, and explore how they differ from other brain structures and functions.<sup>17</sup> (Llinás, exploring the qualities of individual neurons, would probably regard Buzsáki’s suggestion as a useful approach but one which is in itself incomplete, a net whose weave is too large, since he holds that simpler organisms than vertebrates may be experiencing “proto-qualia.”) Further, the major question is not how qualia are distinguished from the self, but the source of the feeling – be it simply consciousness or consciousness of a quale -- to begin with.<sup>18</sup>

The introspective approach exemplified by Chalmers and many other philosophers originated with the Enlightenment philosopher and mathematician René Descartes (creator of the Cartesian coordinate system), in a thought experiment widely known as the “*cogito*.” Descartes in e.g.

<sup>17</sup> This indirect approach would, for example, permit us to infer that non-human animals feel pain when they seek pain-relievers (only) if injured, as has been demonstrated in a variety of studies.

<sup>18</sup> Buzsáki and Llinás both reject the frequent metaphor of mind/brain :: software/hardware as misleading: Llinás points out that neurons are analog, with non-linear response properties and challenges such questions as “what is actually being computed when a neuron fires an action potential” as implying underlying assumptions that may not fit the brain and “may encourage misguided enquiry” (p. 114).

Buzsáki identifies as “the fallacy of the Turing Program” its failure to distinguish between the abstract concepts assumed to be the variables of thought and the actual substrate-dependent mechanisms that would be operating in a given medium (p. 23, footnote 44). While Buzsáki welcomes the insights that computer-modeling has given to e.g. complex systems theory, he is not hopeful about any “top-down” approach such as attempting to understand the brain simply by studying computers and drawing analogies.

his *Meditations* is playing with an armchair experiment; he will try to doubt, to reject, everything he believes. By doing so, he hopes to ascertain whether anything he believes is beyond doubt and thus absolutely certain. The one thing that passes his doubting test is *that* he is doubting, that he himself, as a doubter, a thinker, exists – because that is self-evident by the very fact of his doubting! “*Cogito, ergo sum*,” “I think, therefore I am.” He can doubt that he has a body, or that his perceptions are at all accurate, or all of his memories, but not that he is doubting, i.e. thinking, at this time. And he will then build his knowledge on that indubitable foundation.

This is admittedly a virtuosic conceptual riff on the part of Descartes. Unfortunately, however, by making his starting point and foundation a conception of the self as extensionless, timeless, disembodied, and private, he can never really *escape* the notion of the self as extensionless, etc.. From his starting point, it is pretty much impossible even to consider seriously a mind-body monism; dualism is already built in as the preferred attitude. Similarly, since he has tacitly defined consciousness as abstract and self-reflective, and as *pre-sensory*, he can only trust his senses reliably to represent the “outside world” to him by relying on a kind God who wouldn’t be willing to deceive him by such systematic, *Matrix*-like dissembling. (This is the “Cartesian theatre” criticized by Dennett. It is also known as “the representation paradigm” of the mind, i.e. a conscious private Subject, the outside world or Object, and a sort of screen of representations in the mind that we can only hope correlate homomorphically to the realities outside.<sup>19</sup>)

Many, though certainly not all, current and recent philosophers regard the Cartesian move as a turn into a blind alley from which they are trying to exit. (Descartes’ contemporary Spinoza was the first to confront it.)

The iconoclastic Nietzsche, one of the pioneers of the subconscious, preconscious, and semi-conscious, gives possibly the most devastating critique of the *cogito*. He points out that Descartes’ project *fails in its own terms*.

When I analyze the process that is expressed in the sentence “I think,” I find a whole series of daring assumptions that would be difficult, perhaps impossible, to prove; for example, that it is *I* who think, that there must necessarily be something that thinks, that thinking is an activity and operation on the part of a being who is thought of as a cause, that there is an “ego,” and, finally, that it is already determined what is to be designated by thinking – that I *know* what thinking is. . . .<sup>20</sup>

All of these assumptions could be doubted in various degrees, and Descartes overlooked them; they escaped his doubting test. In fact, the doubting test itself is not necessarily reliable. Elsewhere Nietzsche notes that “Hitherto one believed . . . that in ‘I think’ there was something of an immediate certainty . . . [But] However habitual and indispensable this fiction may have become by now – that in itself proves nothing against its imaginary origin: a belief can be a condition of life and nonetheless be false.”<sup>21</sup>

The extensionless, timeless, disembodied, pre-sensory thinking ego – which can nonetheless already reflect on itself – this is not a genuine starting point. It is a highly derived construct which is subtly smuggled in by Descartes’ *method*. Even though Descartes’ *content* does carefully start from scratch, his *method* doesn’t, and the presuppositions implicit in that method will be prematurely limiting his content. The *cogito* is not the raw data it purports to be; it is hypothesis and/or instrument read into the data.

Without going too far into the notoriously elusive Merleau-Ponty here, it is worth summarizing here one of the key points of his *Phenomenology of Perception*: that philosophers such as Descartes, Leibniz, even Kant had skipped the whole first layer of experience in their introspecting. In a sense, they had all failed by their own standards of introspection. Merleau-Ponty offers more than a critique, though; he offers an alternative. He does believe that there is a place in psychology for careful phenomenological scrutiny of our experience -- as descriptions, not as

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<sup>19</sup> Sociologist Norbert Elias has described the highly formal manners and social conditions for aristocrats in 17<sup>th</sup> century France due to which Descartes’ near-solipsistic approach would have made sense in his *The Court Society*.

<sup>20</sup> Friedrich Nietzsche, *Beyond Good and Evil*, 1966, # 16.

<sup>21</sup> Friedrich Nietzsche, *The Will to Power*, 1968, # 483.

explanations in themselves, and not as directly indicating the functional topography of the brain. We need both the third-person perspective of empirical, repeatable research, *and* the first-person perspective. (This has been referred to as Merleau-Ponty's "pincer strategy," using multiple perspectives, such as first- and third-person. It is extremely useful, though it relies on a very high standard of caution and self-honesty.) However, if we are going to gather data about human consciousness from within, we must set aside as many of our derived notions and ideologies as possible. Otherwise we may merely see those ideologies, and mistake them and their interrelations as genuine explanations, as Descartes and Chalmers seem to do. Instead, we must be prepared to acknowledge the role not only of perceptions, but also of our own actions and drives, our own "intentionality," or outward-directed attention. And, possibly the most difficult task, we must acknowledge *preconscious* influences and even *preconscious intentionality*. (It is worth emphasizing that by examining our first-person, "concrete" experience, Merleau-Ponty is not attempting, as e.g. Descartes and Chalmers do, to discover "objective" facts or to pursue hypotheses from introspection. Instead, he is simply trying to gain accurate raw data about what subjective experience is like *before* it is interpreted by hypotheses.)

Descartes, Leibniz, and Kant had missed the bodily-based perceptions and motions that were prior to the derived abstractions they erroneously regarded as foundational. They had overlooked the complicated process by which our perceiving is also simultaneously an active organizing – not a passive reception from the mere "sensory manifold" which *then*, as a separate step, has order imposed on it by the Understanding, as Kant thought. They had assumed that we simply experienced three-dimensional space, either as a given (since we adults take it for granted) or as an *a priori* form of Sensibility, as Kant contended, rather than noticing that we gain our notion of depth, the third dimension, from our motor activities, especially moving our hands as infants.

But Merleau-Ponty's approach makes room for all of these complicated, fascinating learning experiences of what he terms "the lived body." And by doing so he also makes room for the possibility Llinás mentions of a primitive "self" in non-human animals that predates self-awareness and perhaps even consciousness proper, that instead is the centralization of prediction, and which coordinates perception and movement.

### The Human Brain in its Evolutionary Context

Llinás holds that humans are not unique in having subjective experiences: Some in this field point out that because we cannot determine that animals do have subjective feelings (qualia), we can say that in fact they don't until it is demonstrated otherwise. It may be argued, however, that the burden of proof is on those who deny subjectivity in animals. For myself, I suspect that subjectivity is what the nervous system is all about, even at the most primitive levels of evolution. (pp. 112-113)

Buzsáki holds that a complex neocortex or something equivalent, generating interacting oscillations of the statistical  $1/f$  type (see below), is necessary to support consciousness. Thus he remains skeptical of whether we can attribute consciousness to sharks and early premature human babies, whose brain waves are not (yet) even continuous. He does infer that adult mammals and other animals of similar brainwave complexity would have varying degrees of consciousness, and he does cite studies indicating that some primates are capable of self-recognition in a mirror.

As primatologist de Waal puts, with all the knowledge we now have, researchers who continue to deny that non-human animals have subjective experiences are choosing what de Waal would term "cognitive parsimony" over the more data-informed "evolutionary parsimony,"<sup>22</sup> which

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<sup>22</sup> Cognitive parsimony, of the traditional American Behaviorist school, tells us not to invoke higher mental capacities if we can explain a phenomenon with ones lower on the scale. This favors a simple explanation, such as conditioned behavior, over a more complex one, such as intentional deception. *Evolutionary parsimony*, on the other hand, considers shared phylogeny. It posits that if closely related species act the same, the underlying mental processes are probably the same, too. The alternative would be to

takes phylogeny and the age of species' differences into account.<sup>23</sup> (Incidentally, paraphrasing de Waals would allow us to articulate even more clearly the wrong turn taken by thinkers such as Chalmers: they are choosing what they regard as *conceptual* parsimony over evolutionary parsimony.)

What precisely were the advantages that led to the vertebrate nervous system's evolution, and what might they tell us about human consciousness?

Llinás cites the example of the sea squirt's life cycle to indicate vividly the original evolutionary use of the nervous system: to move. The sea squirt in adulthood is a sessile creature without a centralized brain, but as a young larva it has a tadpole-like anatomy complete with proto-brain (a ganglion or two) and primitive "eye" which allow it to swim until it finds a good place to settle down and attach itself, at which point its incipient brain is digested from within (a description guaranteed to trigger squirming in any middle-aged human faced with the prospect of a stable residence and livelihood).

Llinás also gives examples of what might be called pre-neurons and proto-neurons as well as neurons proper at various stages of evolution, from the protozoan ciliate *Epidinium*, which can move its retractile fibers to take food into its single-celled body; to sponges, whose motor cells do double-duty as pressure-sensitive "sensory" cells, contracting at a touch; to sea anemones, which assign sensing and motion to two different kinds of cells; to the specialized vertebrate series of muscle cells, the motor neurons that activate them, sensory cells, and neurons connecting to other neurons.<sup>24</sup>

Similarly, Buzsáki mentions that motility *predates* sensation; some primitive sea animals are capable only of a rhythmic movement to bring nutrients, with no perceptual abilities at all (pp. ix and 30).

Llinás also mentions the bizarre case of the growing shark embryo. Here, the embryo requires that certain muscles move even *before* they are enervated, to ensure water flow and oxygen intake to the growing cells along the embryo's length. These muscles *do* contract, on their own, without nerves, and in unison with each other caused by their unusual electrotonic connection of gap junctions (most famously known from the heart's pacemaker cells), until the motor neurons grow to form synapses with them.

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assume the evolution of divergent processes that produce similar behavior, which seems a wildly uneconomic assumption for organisms with only a few million years of separate evolution. (de Waal, op. cit., p. 62)

<sup>23</sup> This approach incidentally would have been supported by Schopenhauer even in the early 1800s, before Darwin boarded the Beagle.

<sup>24</sup> Perhaps Llinás's most controversial claim, and one of his most intriguing, is with regard to invertebrates. Even single-celled organisms, he writes,

are capable of irritability, that is, they respond to external stimuli with organized, goal-directed behavior. It is difficult to ignore that such cellular property is probably the ancestry for the irritability and motricity displayed by sensory and muscle cells, respectively. And so we are left with the nagging feeling that irritability and subjectivity, in a very primitive sense, are properties originally *belonging to single cells*. (p. 113)

(Later, "Indeed, if a single cell is not capable of having a modicum of qualia, how then can a group of cells generate something that does not belong to a given individual?"(p. 218). Here he is technically committing a fallacy of composition, i.e. not considering the possibility of emergent properties. For example, Buzsáki believes subjectivity -- in the sense of consciousness -- is precisely an emergent property. On the other hand, that fallacy in itself does not weaken Llinás's proposal; it merely removes that one line from supporting it. And what I am calling Llinás's alternative genealogy of the self does state that the self needn't be aware of its own existence. Instead, it seems to reflect something closer to Spinoza's "conatus," or a generalized drive to live and thrive, or perhaps Schopenhauer or Nietzsche's generalized will.)

One of Llinás's section headings sums up his view: "Neurons Arose within the Space between Sensing and Moving: This Space Mushroomed to Become the Brain."<sup>25</sup> And sensing and moving share that space together in forming "sensorimotor images," experiences involving all sensory modalities and a future-oriented attitude leading to a desire for action, e.g. scratching an itch.<sup>26</sup> Ultimately, Llinás holds that these experiences ("qualia") and actions are centralized by "the self," which is not so much an entity as a symbol of centralization analogous to the U.S.'s "Uncle Sam." This self represents "something akin to 'I feel' that acts to mediate decision making" and prediction. They "represent the critically important space between input and output, for they are neither, yet are a product of one and the drive for the other" (pp. 221-222).

Merleau-Ponty describes basic human experience in similar ways. For him, "Consciousness is in the first place not a matter of 'I think that' but of 'I can'" (p. 137). It involves a *pre-reflective* "intentionality" (in the technical philosophy sense of "outward-directed," rather than in the sense of "intending to do something"). "My body appears to me as an attitude directed towards a certain existing or possible task" (p. 110).

For Llinás, motility underlies even our knowledge. Perception alone, even perception involving active categorizations, is not sufficient. "What I must stress here is that the brain's understanding of anything, whether factual or abstract, arises from our manipulations of the external world, by our moving within the world and thus from our sensory-derived experience of it" (pp. 58-59).

Buzsáki agrees. Indeed, one of the main claims of *Rhythms of the Brain* is his mentor Endre Grastyán's astonishing claim that the brain's *outputs*, movements, cognition, actually control its *inputs*, perception – a complete reversal of the usual order: stimulus perceived and leading to a reflex.

For all three, for Buzsáki, Llinás, and Merleau-Ponty, it is *movement* – which is always future-oriented – which is at the heart of all neuronal functioning in all species having neurons, and of human (and other vertebrate) consciousness. Perhaps Aristotle's approach to definitions is completely wrong. *Perhaps our most important characteristic isn't one that distinguishes our species from all other species; perhaps it is one that we have in common with other enervated animals.*

### **Llinás on Mind and Movement**

The motricity or motility that is key for our experience, Llinás argues, is organized by neurons' synchronous oscillation. For example, there is a constant "physiological tremor" in our skeletal muscles at 8-12 Hz, and even voluntary muscle movement is inevitably timed to begin at the start of the tremor's cycles. (This tremor cannot be explained by reflex actions or by the properties of muscle tissue.) Llinás hypothesizes that this tremor is caused by the intrinsic oscillation at 8-12 Hz of the Inferior Olivary Nucleus axons. These neurons are connected to each other electrotonically, by the same unusually direct channels, gap junctions, that embryonic shark muscle cells have. These channels allow depolarization to flow across neurons without the delays of the usual synaptic connection and its translation from electrical to chemical signaling and back again. As a result of the gap junctions, these neurons communicate with unusual speed, which helps them oscillate with precision. (Chap.4)

What might be the advantages of this periodicity, this synchronous oscillation of neurons and voluntary muscles, that would cause it to be selected for in evolution? Llinás give a whole list of possible benefits: it would be energetically efficient, it would help cue up neurons to act synchronously, it might give a little acceleration to break through any inertia in muscle fibers, it

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<sup>25</sup> Llinás, *ibid.*, p. 78. The examples here are from his chapters three and four.

<sup>26</sup> *Ibid.*, eloquently presented on p. 3. This "space" is made possible by Llinás's adoption of Graham Brown's view of the spinal cord as "self-referential," rather than William James's "reflexological" view of sensation linearly driving movement. The "self-referential" space ultimately, for Llinás, constitutes an internal world, a private or "closed" system which allows for subjectivity, semantics, and such.

could help bind sensory inputs and motor outputs in time to integrate them, and it would bring neurons closer to threshold. (Op. Cit., Chap. 2)

Now, Llinás describes another method of keeping movement as efficient as possible: motor “Fixed Action Patterns” (FAPs), distinct and complicated “habits” of movement built from reflexes, habits that we develop to streamline both neural action and muscle movement. These are not entirely fixed, despite their name; they are constantly undergoing modification, adaptation, refinement, and they overlap each other, so that we have an over-complete pool of movements, a large repertoire at our disposal. Hence, walking, running, dancing, recovering after a stumble, are all possible at a second’s notice, and none needs to be reinvented with every step. Llinás even argues that the extraordinarily precise motor control of Jascha Heifitz playing a Mozart violin concerto is composed of highly elaborated and refined FAPs, a description most instrumentalists would find absolutely plausible. In other words, playing music -- one of the most cognitively and emotionally demanding of all human activities, arguably one of the most definitively “human” of all activities -- is founded in carefully, creatively guided movement – not thought alone.<sup>27</sup>

If these sorts of motions are motor FAPs, Llinás hypothesizes that emotions such as fear and rage may be, analogously, *premotor* FAPs. I.e. activating the rhinencephalon, the amygdala, and the hypothalamus may be the setting up of premotor postures, *preparing* for movement, the running away or the turning and fighting.

Most intriguingly, Llinás carries this analogy one step further: “qualia” (used here by Llinás simply as synonymous to “subjective experience”) may be *sensory* FAPs, so that indeed, as he had written earlier, thinking would be exactly “internalized movement.” Note that qualia as conceived here would be a complicated pattern that the nervous system *performs* in relation to sensory input (perhaps roughly analogous to reading music), and that it would be a pattern extended through *time*, like playing a musical passage. But with perceptions, we face another puzzle not found in emotions and movement. This is sometimes referred to as “the binding problem”: How is it that we can receive sensory input in bits and pieces, say, different visual images of e.g. one’s grandmother, different sounds of her voice over the years, her perfume, etc., and integrate them into a single construct or “percept”? And do this accurately in different contexts of meaning, each giving it a different internal significance? This is much more complicated than coordinating a difficult jump over a boulder, or responding with necessary adrenalin to a drunken driver.

According to the usual view of the brain’s capacities, with its enormous neuronal networks, its spatial interconnectedness, even it could not be expected to do this enormous job. Computing all Grannie’s visual, auditory, etc., sensory aspects, in all relevant situations, in all possible emotional and attentional contexts (which we do every day with many different people) would require many times more space, more connections than a human brain has. However, Llinás expands the usual view of the brain to explain how it is that we can do what we do. If the brain’s vast spatial connectedness is still too limited to account for this, it may have patterns of connectedness in *time* superimposed on those spatial connections. “By making different time-interlocking patterns, neurons can represent a unity of reality by combining the individual, fractionalized aspects of reality that each neuron carries.” Whole modules of neurons would be electrically oscillating in phase, and this would form a global activity pattern which “should have all of the components necessary for a transiently useful, internal construct of the external world in the given, present moment” (pp. 120-121). So this *temporal* coherence could be the neurological mechanism underlying perceptual unity, underlying “cognitive binding.”

And indeed, empirical studies bear this out. The different components of a visual stimulus that are related to a singular cognitive object do result in temporally coherent, synchronous, gamma oscillations (of about 40 Hz), even when those oscillations are occurring in brain locations as much as 7 mm apart. (These gamma oscillations may arise from the thalamocortical system’s intrinsic 40 Hz oscillation.) This appears to be the mechanism for forming our sensations of Grannie into a single percept of Grannie, or in the terms of *Gestalt* theory, for forming a “figure” of Grannie distinct from

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<sup>27</sup> For a similarly evolution-centered view of singing, rather than instrumental music, see e.g. Steven Mithen’s insightful *The Singing Neanderthal: The Origins of Music, Language, Mind, and Body*.

the “ground” of the rest of our sensory field. (Gamma oscillations as solving the “binding problem” are also covered extensively by Buzsáki.)

It is worth taking a moment here to review the original *Gestalt* theory, as developed by K. Koffka and Wolfgang Köhler, and as extended by Merleau-Ponty. The original idea was that we do not perceive in isolated units, in a single “datum” or pixel, but always in patterns of at least two parts: figure (that which we focus on or give attention to) against a ground (which may never rise from preconscious status, but which will nonetheless influence how we perceive the figure). A *Gestalt* can occur through time as well as in space; if we are listening to orchestral music and focus on, say, the oboe melody, it has become a figure against the background of the other parts. We experience our own “lived bodies” as *Gestalten*; if we make a gesture, it is a figure against the ground of the rest of our body. And our whole bodies are experienced as figures against the ground of our surroundings.

Llinás seems to be implicitly using something like this traditional notion of a *Gestalt* when he describes the context of attention: when one is trying to listen to a speaker with someone talking behind one, “[e]ventually you phase them out and only give internal significance to the words you wish to hear” (pp. 118-119). The context of attention allows us to focus on some sensory inputs rather than others.

Thus, Llinás evocatively describes this dynamic nervous system as one that “addresses the external world not as a slumbering machine to be awoken by the entry of sensory information, but rather as a continuously humming brain” (pp. 123-124).

Now, there is one more way in which subjective experience as sensory FAPs would seem to be very different from emotional premotor FAPs or direct motor FAPs. Subjective experiences seem to involve an “internal” world, involving “representations” of the outside world. Could sensory FAPs possibly account for all this?

As we saw earlier, Llinás describes the “internal world” as the “space” between sensing and moving, made possible by the “self-referential” set-up of the nervous system, the fact that we don’t merely get input from senses directly from the “outside world,” but also from our own neural processing, so to speak. (In Buzsáki’s *Cycle*/chapter 7, he gives an example of this, the “higher order” thalamocortical nuclei which receive inputs not (only) from sensory receptors “below,” but also from cortical areas “above.”) And with regard to “outputs,” we act not only on the outside world, but also on our own neuronal systems. This “space” of self-reference is what gives us the sense of an “inside” and an “outside,” with the “inside” being the metaphorical origin of the “vector” of the first-person perspective. Sensory FAPs thus might be able to account for this aspect of subjective experience.

Regarding representations, Llinás describes the unified “percepts” as representations of the “outer world” in terms that invoke Kant, whose epistemological approach could be described, very roughly, as a much more sophisticated, qualified, and useful version of the original representation paradigm or “Cartesian theatre.” Llinás writes:

But what is an image? An image is a *simplification of reality* . . . a simplified representation of the external world *written in a strange form*. . . The brain is quite Kantian in the essence of its operation. It makes representations of aspects of the external world, fractionalized aspects, by making a useful geometry . . . with internal meaning that has nothing to do with the ‘geometry’ of the external world that gave rise to it. (p. 108-109)

“Consider colors, which are just the particular way we transduce energy at a particular frequency. A snake sees infrared, which is actually heat. It is very clear that the images in our head are only a representation of the world” (p.109).

Yet unlike Kant -- who held that we could *never* have access to reality itself but only our mediating representations of it, and thus we could not even infer information about reality indirectly by comparing different responses to it -- Llinás seems to be implicitly using something very like Merleau-Ponty’s perspectival<sup>28</sup> “pincer strategy”: making use of empirical scientific research *and* our

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<sup>28</sup> Nietzsche is the philosopher who introduced the term “perspectivism,” as an alternative to the Cartesian, Lockean, and Kantian approach which assumed an impossible eye, “an eye turned in no particular direction” (*On the Genealogy of Morals*, 1969, Part III, section 12). Yet Merleau-Ponty’s refined version of perspectivism is much more useful and plausible and avoids the relativism

own subjective experiences. He is incorporating both “the images in our heads” *and* the knowledge that snakes apparently see infrared, which is invisible to us.<sup>29</sup> Llinás seems to use *both* perspectives in the practical way that most of us would want – we have our own images, and we have data and hypotheses from scientific observation, based on common elements from the perspectives of *many* individuals, and aiming, in theory, at elements that would be common to any possible individual. Both sources of knowledge are useful, and the two are entirely different and must be dealt with according to very different rules, and the two can supplement each other.

Merleau-Ponty gives a theoretical support for this: he describes the first-person perspective of subjective experience as *concrete* knowledge, and the third-person perspective of scientific data and hypotheses as *abstract* knowledge. The “concrete” and “abstract” terms do accurately describe their origins. The “impersonal” scientific perspective achieves a sort of impersonality simply by being the abstracted commonalities of many individuals’ experience.

This approach is very different from the Cartesian *or* the Kantian use of “representations.” Instead, Merleau-Ponty would claim that there *is* no mysterious, incorrigible “screen” of static representations that mediate our experiences of the “outside world.” Instead, our brains construct many different possible maps of the world in which we exist and with which we interact, including the more concrete percepts, and the more abstract scientific hypotheses. And the view of subjective experiences as sensory FAPs might well account for these different maps, these perspectives, these contexts.

Indeed, the “subjectivity” involved in qualia, even when hypothesized as sensory FAPs, would also be found, in slightly different forms, in emotions as hypothesized as premotor FAPs and even voluntary motions thought of as motor FAPs. The epinephrine flood we prompt ourselves to make when we become aware of danger is arguably one of the most intense and immediate subjective experiences we can have. And coordinated motility for any vertebrate always involves exactly the kind of different possible maps of the space around us, eloquently described by Llinás as the original motor FAPs, that Merleau-Ponty aimed to articulate in our *perceptual* strategies and habits.

Llinás writes: “I say that I am a closed system but not a solipsist. I can’t be, because of the way I was built by evolution by internalizing the properties of the outside world” (p. 109). Here, he is embodying the Merleau-Pontian “pincer strategy,” with the benefit of both perspectives, while tacitly keeping them cleanly distinct. He acknowledges that, from the first-person point of view, he can’t take on a solipsistic attitude, and he theorizes from third-person scientific knowledge that that makes sense considering evolution since greater interaction with one’s surroundings are needed for survival.

### **Buzsáki on Brains, Systems, and Activity**

I must summarize Buzsáki’s book with ruthless brevity here. It is lengthy and technical, addressing mainly an audience of fellow scientists. There are two recurring themes in it that should

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inherent in Nietzsche’s approach. See David Schenk’s lucid and concise “Merleau-Ponty on Perspectivism, with References to Nietzsche,” 1985.

<sup>29</sup> A truly, superhumanly consistent adherent to the representation paradigm would have to frame evidence of snake vision as just another “image in our heads,” no different from any other except by being more complicated, and thus subject to the same limitations as any other subjective image we have. Thus, it could not be used to *supplement* our own directly perceived “images in our heads.” On the other hand, if we acknowledge our own direct, fallible but *corrigible* experience, and the means by which we *actually* correct it via more impersonal knowledge, e.g. the scientific understanding that the sun is not tiny and does not revolve around the Earth, and that a paddle halfway in water is not broken, we are acknowledging that we rely on both approaches as a kind of triangulation, to understand and interact with our surroundings more accurately.

be mentioned, however. One is the power residing in opposing forces<sup>30</sup>, including the contrast between predictability and unpredictability. The other is the pattern of cyclical though changing interactions within and among systems. Buzsáki titles his chapters as “cycles” to help lead his readers into this way of thinking. These are Heraclitean themes, and indeed Buzsáki quotes Heraclitus – an excellent inspiration for a scientist, since Heraclitus was a proto-empiricist if there ever was one,<sup>31</sup> and an astute enough observer of nature to perceive it in terms of actions and interactions through time.

Briefly, Buzsáki contends that the mammalian, not only human, brain is spontaneously active in multiple ways.

**First**, it can generate a great deal of activity on its own, from within, and organize that activity. For instance, certain key nuclei generate intrinsic electrical activity, e.g. the thalamocortical neurons which can be prompted to fire action potentials not only when depolarized below threshold, but also when suddenly released from hyperpolarization. These unusual neurons also contain certain rare voltage-gated channels which lead them to be repolarized – channels found in the heart’s “pace-maker” cells. These two opposing and balancing forces interact to generate a constant rhythm of spike bursts, an ongoing oscillation at 0.5-4 Hz, delta waves.

All neurons have the capacity to oscillate, with a variety of triggers and regulators. Neurons oscillating at one particular frequency will frequently be at least transiently synchronized with other neurons’ oscillations, whether they are in direct physical contact via synapses or gap junctions or not, as we saw in the example of the 40 Hz (gamma) oscillations of cortical neurons that temporally “bind” fragmented sensory input into a single percept, or figure against a ground in *Gestalt* terms. Neurons can “entrain” each other to oscillate exactly with the same frequency and matching the phases, in synchronous “coherence.” Or they can entrain each other to oscillate simultaneously but at different integers, “phase-locked.” (E.g. a drum marking only the downbeat of each measure in a waltz, though each measure has three beats.) Or they can retard or “precess” each other, if their oscillations are very similar. Or they can have far more complicated patterns of interference. They can enhance or neutralize each other (p. 354). Oscillation in itself tends to be very predictable, a good time-keeper – hence the pendulum clock.

Neurons can also alter each others’ functioning in other ways. There are three known methods of brain plasticity: a) by replacing neurons via neurogenesis, b) by dendritic spines slowly growing even in adults (Buzsáki describes this as “wiring-based plasticity” on p. 247), and c) by the more well-known synaptic plasticity, strengthening or weakening synapses with each other. (E.g. synaptic plasticity occurs via a post-synaptic neuron’s NMDA glutamate receptors, which, when fully activated, allow calcium ions to enter; the calcium ions then i) indirectly allow more sodium ions in, lowering that cell’s resting membrane potential and thus sensitizing it to future synaptic discharges,

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<sup>30</sup> After all, life as we know it relies on opposing forces. At the most basic level, electrons interacting with protons give us the characteristics of the periodic table, leading to molecular and ionic bonding. The interactions of water’s polar molecules, involving hydrogen bonding, result in water’s unusual life-supporting characteristics, from its being a good solvent for other polar molecules, to its surface tension, its resistance to rapid temperature changes, and its expanding when frozen so that lake bottoms are protected from freezing. The interactions between polar and non-polar molecules cause the formation of lipid bilayers which makes cells possible, and chains of more or less polar peptides within a long protein arrange for that protein to thread outwards through a neuron’s lipid bilayer cell membrane and arrange itself correctly within the membrane to form a channel for e.g. ions.

<sup>31</sup> Heraclitus of Ephesus, e.g. “Most men do not think things in the way they encounter them, nor do they recognize what they experience, but believe their own opinions.” (trans. by Charles H. Kahn on p. 29 of his *The Art and Thought of Heraclitus*, 1979) “Whatever comes from sight, hearing, learning from experience: this I prefer” (p. 35). “Eyes are surer witnesses than ears” (ibid.).

and ii) indirectly send nitric oxide to the *presynaptic* cell as a “retrograde messenger” to strengthen synaptic function from that side of the synapse.)<sup>32</sup>

Neurons’ behavior is determined by the number, location, and strength of their synaptic connections, and by the number, location, and type of receptors and channels. Because of this, one neuron can radically change another neuron’s behavior by altering its functional morphology, by shutting down even a whole dendrite. (I am expecting jokes about the analogy of what to do with one’s jazz band’s problematic or overly brawling drummer: put his left arm in a cast until after the big gig.)

Neurons do not interact only by exciting each other or refraining from doing so, as, e.g., the zeros and ones in computers’ binary code. Only a system of all excitatory neurons would work in that way, and any such system would be extremely limited and lead to repeated neuronal avalanches. Instead, there are also inhibitory neurons, which follow different rules. If there is a chain of inhibitory neurons, they inhibit each other’s inhibitions, in “disinhibition,” leading a targeted excitatory neuron to be *more* likely to fire an action potential. (I.e. they operate as a double negative does in English, not as it does in Spanish, where a second negative only emphasizes the original negative.) Lateral inhibition is an extension of disinhibition: here, when an excitatory neuron is activated, it recruits an inhibitory neuron to suppress the activity of surrounding excitatory neurons in a “winner-take all” mechanism. This helps to explain how neurons could entrain each other’s oscillations. If they are firing randomly, some will happen to fire together. Not only will they be firing together, they will also be suppressing the non-synchronous ones at that time. The suppressed ones will still be ready to discharge, and this will raise the probability of more and more of them discharging together at the next pulse, and so on. The oscillation would continue as long as a certain number kept firing together, exercising a dominance or attractor effect. And the resonating neurons would give us the advantages mentioned by Llinás, including being very energy efficient. The neurons would be kept close enough to threshold for firing to be sensitive, but without firing prematurely. The only limitation is that there are only short “windows of opportunity” rather than continuous readiness, which would be energetically too expensive (p. 74).

Because inhibitory neurons can act as an opposing force to excitatory neurons, they bestow several important benefits on neuronal systems. First, they can “balance” the excitatory neurons, so that these are neither trapped in excitatory avalanches, nor kept stifled and unable to react to inputs when needed. Rather, the excitatory neurons are kept in a “metastable” or critical state, with the safety catch off, so to speak, so that even a weak input can generate a strong response. (Note that this sensitivity contrasts to the predictable oscillation of, say, the thalamocortical neurons mentioned above.) And interestingly, despite the fact that inhibitory neurons are only about one-fifth of the neurons in the cortex, their great number of connections and their frequent activity result in their balancing out the number of excitatory post-synaptic potentials with almost exactly the same number of inhibitory ones. Second, the inhibitory neurons allow for the separation and functional autonomy of cell assemblies within the brain, which in turn allows for greater complexity overall. And third, when excitatory and inhibitory neurons are combined in chains, the results can involve so much interaction at so many levels that they become non-linear; their overall consequences are impossible to predict. To understand them, we must have recourse to neuronal systems theory, which, as Buzsáki writes, “is an offspring of general systems theory, a sort of modernized Gestalt concept in a quantitative disguise.” Systems theory is more than a highly complicated, statistics-informed version of the traditional *Gestalt* image, however. By keeping track of how past events affect a system’s current state, including its responses to stimuli, systems theory aims to understand how systems change through time, and “learn.” “Instead of looking at discrete moments in time, the systems methodology allows us to see change as a continuous process, embedded in a temporal context” (p. 15).

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<sup>32</sup> Learning of this self-sculpting of the lived brain would have thrilled Nietzsche, who in various books celebrates the human ability to create oneself as a work of art or as an embodiment of one’s values. E.g. *The Gay Science*, #290, 1974, and *The Genealogy of Morals*, 1969.

Buzsáki notes the inadequacy of the standard “stimulus-brain-response” approach here. Such an approach, inherited from the Behaviorist movement, regards the brain-state before the stimulus as mere random noise, and the brain-state response to the stimulus as noise-plus-response-signal. Yet studies do not bear this out. Instead, the pre-stimulus brain-state influences the response, and even whether there will be one at all. The timing of the stimulus relative to phases of oscillations is a major factor, as well. “Evoked activity may reveal more about the state of the brain than about the physical attributes of the stimulus” (p. 263). Note that Buzsáki is challenging the Behaviorist approach in an unusually *parsimonious* way, here. He is not positing some “inner” hidden entity, or some soul or mind with free will or Spirit. He is pointing out the previously overlooked *temporal* dimension of the brain, with its natural-selection-chosen benefits of learning, prediction, and above all, movement.

It is worth repeating the lesson he is giving us philosophers. In order to acknowledge the reality of mammalian subjective experiences, initiative, agency, emotions, *we do not need to resort to positing an “inner” Cartesian-type space, or a disembodied mind.* Instead, we make room for these experiences and attributes by noticing how we *change through time*, incorporating and even sedimenting old brain states, and how our *motility has granted us a kind of purposiveness*, and how in the more complicated mammals, we can even arrange, to some degree, to combine these aspects in order purposefully to change ourselves, as e.g. Spinoza<sup>33</sup> recommends. *None of this requires believing that we have souls, free will, or any kind of “reason” beyond what natural selection would be expected to give primates such as we are.* (It does come with a price, though. The price is that we abdicate some of the privileges we as a species have arrogated to ourselves and learn more respect for other mammal species. And this task promises to be extremely arduous.<sup>34</sup>)

**Second**, neuronal oscillations interacting with each other can create *emergent* properties, which the component neurons do not have. (E.g. the speed of my old car cannot be found in any of its components when disassembled: wheels, engine, gears, gas tank, steering wheel, etc.. However, the car does move, and speedily, when they are properly assembled and fueled. The car’s motion is an emergent property.) And the emergent properties resulting from the components’ combination and/or interaction can then, in turn, *reciprocally alter their components.* (The tires and gears get worn, the chemical energy in the gasoline is transformed into heat and motion, etc.)<sup>35</sup>

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<sup>33</sup> Spinoza himself would have resisted the emphasis on temporality; the science of his time did not lend itself to that kind of thinking. The most famous example of erroneous hypostasis by scientists, the theory of phlogiston, was invented by a contemporary of his. (Phlogiston was the hypothesized substance released by combustion, before it was recognized that combustion is not a thing and certainly not a single thing, even a single *moving* thing, but a process, an event that can occur with different substrates.)

<sup>34</sup> I have sometimes conjectured whether the unusual popularity of creationism in Texas and Kansas may be connected to these two cattle-ranching states’ having some of the worst animal-welfare histories for slaughterhouses, before Grandin’s reforms. Frequently economic forces do indeed shape ideology, as Karl Marx argued.

<sup>35</sup> Contrast this to the example of, say, copper wiring. Because of copper’s atomic properties, its electron shells, the fact that it can give up two of its electrons, it is both a good conductor of electricity and it is ductile, can be bent and stretched to form wires. These are not in themselves emergent properties, only the manifestation at a “macro” level of “micro-level” properties. If we arrange such wires into a house’s electrical network, the whole house, including insulating wires, breakers, etc., does now have the emergent property of supplying electricity to outlets and so on. It is not a “system” in the technical “complex systems” sense, however; the emergent properties do not in turn influence the components. It is merely a building with very valuable emergent properties. However, we can arrange for this building to achieve the status of “system” very temporarily by configuring the wires improperly so that the electrical current cannot flow adequately and builds up heat to the extent of melting the copper and igniting the house. Or, more happily, we can make *ourselves* part of the system and use the house’s outlets to power the tools (drills, etc.) we need to repair the wiring. In this case, we are a system embedded in another system.

An example that Buzsáki uses is an audience's applause. (So the drummer's cast restrained his exuberance just enough for a disciplined yet inspired performance.) Applause begins with random clappings, some of which happen to occur simultaneously. As this happens, more and more people tend to join in, at least for a while, i.e. their "degrees of freedom" constrict due to the influence of these "dominant" or "attractor" rhythms, and they become part of the whole. The emergent rhythm is in turn influencing the individual clappers. Also, when clapping in synchrony, a higher level of volume is reached at those peaks (not continuously, of course) than was reached by the random clapping, even though, as it turns out, the synchronized clappers are clapping at about half their usual speed. With synchronized clapping, a higher volume is reached even with about half the work. The energy efficiency of synchronized neuronal oscillations is analogous.

Some of the emergent properties of interacting neuronal oscillations are fairly well known and very well accepted, such as the oscillations involving muscle movement and those involving the binding of percepts such as Grannie as a figure against ground. Others are only beginning to be explored.

Buzsáki and a colleague, Markku Penttonen, recently examined how different neuronal oscillation frequencies in a single mammal's hippocampus are related. They found three independently generated frequencies in the rat hippocampus: one at 4-10 Hz, one at 30-80 Hz, and one at 140-200 Hz. Ultimately, they were astonished to find that in a wide variety of mammals, there are "bands" of frequencies, from 0.02 Hz to 600 Hz, generated by a variety of mechanisms across different structures in the brain, which are related not by an integer relation (as in our drum pounding the downbeat for a waltz) but in a ratio of the natural logarithm's base  $e$ , that is, 2.71828... (the same ratio famously found in a nautilus shell), with no gaps in this series of frequencies! Perhaps most importantly,  $e$  is an irrational number, meaning that no frequency in the series will be able to "phase-lock" any other frequency. In other words, the whole system of the brain is cooperating so as to permit the different frequencies *not* to entrain each other. This is understandable when we consider that a completely ordered, predictable system cannot itself predict or react or change very well.

Another key characteristic of the mammalian brain's oscillation spectrum is that if the log of frequency is plotted against the log of amplitude, a straight line results (down to the right, indicating an inverse relationship). This is known as a "one over  $f$ " spectrum, since it means that amplitude  $A$  increases as frequency  $f$  decreases, as in the equation:  $A \sim 1/f$ . This linear plot contrasts, for example, with a bell curve. Instead, it reflects the "power-law" "scale-invariant" relationships between the oscillations ("the mathematical telltale sign of self-organization" p. 121). It is caused largely by the delays in signal transmission, which mean that oscillators with lower, slower frequencies are more able to recruit more neurons, further away, and thus produce bigger amplitudes, than oscillators with faster frequencies (which are more likely to be on to the next phase of the cycle by the time their signals reach distant neurons). What is of interest to Buzsáki is that, when considered as "noise" (be it sound, light, or brain frequencies), this  $1/f$  spectrum refers to "pink noise," which is the mean between random, unpredictable, but high information "white noise" (with no relationship among the frequencies, a constant power density, and a flat spectrum described as  $A \sim 1/f^0$ ) and the more predictable and organized (at short intervals, at least), low information "brown noise" (with a spectrum described by  $A \sim 1/f^2$ ).<sup>36</sup>

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<sup>36</sup> Buzsáki compares this "golden" mean of predictability and unpredictability to music.

Perhaps what makes music fundamentally different from (white) noise for the observer is that music has temporal patterns that are tuned to the brain's ability to detect them, because it is another brain that generates these patterns. The long-time and large-scale note structure of Bach's First Brandenburg Concerto is quite similar to the latest hit played by a rock station or to Scott Joplin's Piano Rags. On the other hand, both high temporal predictability, such as the sound of dripping water, and total lack of predictability, such as

It appears that this system involves a very fine balance between unpredictability and predictability, between complex dynamics (which Buzsáki describes as half way between order and disorder) and transient order from the predictable, deterministic oscillations.

Order in the brain does not emerge from disorder. Instead, transient order emerges from halfway between order and disorder from the territory of complexity. The dynamics in the cerebral cortex constantly alternate between the most complex metastable state and the highly predictable oscillatory state: the dynamic state transitions of the brain are of the complexity-order type. When needed, neuronal networks can shift quickly from a highly complex state to act as predictive coherent units due to the deterministic nature of oscillatory order. (p. 135)

**Third**, according to Buzsáki, the brain is also active in that it is primarily the *source of motor outputs*, and only secondarily to this is it the *recipient of sensory inputs*. This is Grastyán's controversial change of perspective, and needs support. Buzsáki gives it.

Perception is secondary to motility *chronologically* both in evolutionary development, as we saw earlier, and in the individual organism's development. Buzsáki even defines "experience" for developing animals as "accumulation of knowledge or skill that result from direct *action*" (p. 221, his italics). "[P]erception is learned through the action of the motor system. Perception is not simply a feedforward process of sensory inputs but rather is an interaction between exploratory/motor-output-dependent activity and the sensory stream. It is something we *do*" (p. 228, his italics). "The basis of all spatial metrics in the brain derives from muscular action. Without the supervisor motor system, one cannot verify distance, depth, or any spatial relationship" (p. 221). Similarly, Merleau-Ponty had argued that we learn the third dimension of space, depth, from our moving in it. The somatosensory representation "gets anchored to the real-world metric relationships of the skeletal muscles" since it has to be custom-sized and updated for every body (p. 225).

Motility is primary to perception also in the sense of the activity we must take in organizing our perceptions. The original *Gestalt* theory of perception made that clear; we are actively constructing the objects we see. New data take this further: when looking at an ambiguous figure, one study found that neural activity alone couldn't explain the brain's verdict; continual surveillance by eye movements was required (p. 228).

But ultimately, Buzsáki is defending Grastyán's sequence of brain outputs, as actions or thoughts, controlling its inputs, perceptions, rather than vice versa. Thus, the meaning we give to our sensations is largely influenced by our (ultimately motor) goals.

Similar to the "space" for subjectivity that Llinás wrote had evolved between sensing and moving, Buzsáki describes a "gap" in a circuit that is "closed" by our action. Yet it is not a gap between sensing and moving, but between first moving and then sensing the results.

[T]here is a 'gap' between the neuronal connections controlling the outputs and inputs that transmit information from the sensors. The gap may be closed by actions exerted by the brain on the body and the environment, a process that 'calibrates' neuronal circuits to the metric of the physical worlds and allows the brain to learn to see.<sup>37</sup> (pp. 32-33)

Note that because of his systems approach, Buzsáki does not make the conventional distinction between "internal" and "external" that Llinás and other theorists do. Instead, "It is not always easy to distinguish between 'internal' and 'external' operators. The brain, the body, and the environment form a highly coupled dynamical system. They are mutually embedded rather than internally and externally located with respect to one another" (p. 11, footnote 19).

John Cage's stochastic "music" (essentially white noise) are quite annoying to most of us. (p. 123)

Amusingly, in a footnote to this passage Buzsáki cites studies showing that monkeys, dogs, and other species respond similarly to the predictability of sounds, complete with "the pleasantness-annoyance dimension [which] can be behaviorally measured." Some audiences make for a really tough gig.

<sup>37</sup> But Buzsáki cautions "Spontaneous activity alone does not give rise to consciousness, however. A brain grown *in vitro* ... without an ability to move [its] sensors cannot become conscious, in the sense that the neuronal responses evoked by the sensory inputs would not acquire or reflect meaning" (pp. 370-371).

Rather than the traditional image of the self or subjective consciousness as not just internal but *isolated* (usually treated as common sense but in fact an ideology traceable back to Descartes), Buzsáki is implicitly differentiating the self or lived organism from its surroundings by its aspects *acting* together as a system, and by that system *initiating* activity, and by its relative (and only relative) *autonomy* within its context.<sup>38</sup>

Buzsáki regards sleep – non-REM sleep as well as dreaming, REM, sleep – as a fertile activity, not merely a reaction to the day's stimuli or a temporary switching off. New evidence shows that non-REM sleep, *more* than REM sleep, is necessary to form memories and to help solve problems. One hypothesis is that in sleep the brain could "hold" the information long enough for the slower molecular mechanisms to encode it. One could even describe sleep as the "default" state of the brain in that it is the brain's self-organization without current external inputs, similar to the apparent brain-state of fetuses of a certain age (p. 229). Buzsáki asks, rhetorically, whether our daytime experiences determine our sleep "trajectories," "or does the self-organized process of sleep determine how the waking brain reacts to environmental perturbations?" (p. 206) And he answers: while the patterns of sleep can be perturbed by the day's waking experience, "[a]fter each day's experience, however, the brain falls back to the default pattern to rerun and intertwine the immediate and past experiences of the brain's owner" (p. 208). As Llinás suggests as well, rather than thinking of ourselves as inherently awake and disturbed unaccountably every 24 hours by a lengthy interruption, we should perhaps think of different sequential brain-states with different functions for supporting each other, including waking, dreamless sleep, REM sleep, and so on.

Similarly, in waking life an absence of input does not cause absence of brainwaves. Instead, if one disengages one's vision from the surroundings by closing eyes and not moving them, one will elicit the visual system's "idling" frequencies, alpha waves, from two independent sources, the occipital visual area and the frontal eye fields. These alpha waves are promptly blocked simply by opening one's eyes. And an absence of muscle movement also elicits a particular "idling" frequency, the "mu rhythm," which is not influenced by eye behavior, but which is blocked by even moving a finger or toe.

In summary, Buzsáki views the mammalian organism as the most complex system of nature's devising, one which is built from elements relying on opposing forces, including opposing sodium and potassium flows, inhibitory versus excitatory neurons, and the predictability of individual oscillation frequencies interacting with the non-predictability of non-linear interactions among neurons kept in a metastable condition. Mammals' brains can change their own cortical neurons' interactions via synaptic plasticity and via inhibitory patterns. And mammals (and presumably other vertebrates and intelligent non-vertebrates) initiate interactions with their surroundings while using their perceptions as feedback for their actions, embedding themselves as systems within the greater systems of their surroundings.<sup>39</sup>

### **Implications for Philosophy: A New Paradigm of the Self as an Ongoing Circuit of Agency and Perception**

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<sup>38</sup> This is how Spinoza defines bodily integrity as well: "Bodies are distinguished from one another in respect of motion and rest, quickness and slowness, and not in respect of substance." (Baruch or Benedict Spinoza, trans. *Ethics*, 1982, Book II, Prop. 13, Lemma 1.

<sup>39</sup> Ironically, Grastyán's circuit of "you move and then you get perceptual feedback" cycle could be said exactly to describe the actions of traditional 20<sup>th</sup> Century American Behaviorist scientists in studying the simple stimulus-reflex response of their experimental subjects, i.e. they were looking at the wrong end, so to speak, of the feedback circuit, while themselves constituting the right end to study. They were their own examples, and did not realize it. There is a *New Yorker* cartoon here waiting to be drawn.

The implications of this change of perspective based on Grastyán's circuit, for philosophy as well as for science, are vast.

For example, according to this view, it is not so much that humans are the species that sees the universe, the means of the universe's self-consciousness, as e.g. Hegel and Schopenhauer thought. Rather, mammals in general and humans especially can *change* and influence the world, *deliberately*, i.e. with informed consent, informed *volition*. (Contrast this to the usual traditional notion of "free will" divorced from any context, any causal relations, any sub-conscious elements, any non-human species.)

This shift from the model of passive perception traditional in most western philosophy (e.g. Descartes' *cogito*) to a model of *agency and perception as continuing circuit* has profound implications for specific philosophical questions, as well. E.g. even to the obsession-producing question of "the problem of evil": why does evil (e.g. "injustice" caused by non-human accidents, as well as inter-human injustice, and e.g. suffering in general of all organisms capable of suffering, sentient animals, from whatever cause) exist? The usual attempted reply will be formulated as an *answer*, a bit of further knowledge, a hypothesis, perhaps a metaphor intended to prompt a change of perspective. Yet the best reply I've found came from colleague (and spouse) William Simpson, who suggested that the "question" be answered by an Aristotelian *practical* syllogism, whose conclusion is not a statement, but an injunction to *action*. (E.g.

1. Drinking brackish water can make one ill.
2. This water is brackish.

Therefore, 3. Avoid drinking this water!

The conclusion to an argument regarding the "problem of evil" would likewise be something such as: Therefore, help this person!) Simpson's novel and compelling reply to the "problem of evil" strikes me as of a piece with the paradigm shift towards agency, originating with Heraclitus and developed most by Buzsáki, Llinás, and Merleau-Ponty.

I would like to think that this shift would also be a natural fit with and benefit the environmentalist, animal welfare, and anti-corporate-globalization movements, as well. We would then be coordinating our activities, as the most sophisticated mammals embedded in our biosphere's system, towards the end of improving lives throughout the sentient world.

### **Llinás and Buzsáki on the Brain/Mind as Temporal**

There are several different ways that consciousness involves time, according to Buzsáki and Llinás.

First, let us begin with a quote from Llinás that eloquently expresses the view of both him and Buzsáki:

Can you recognize the sense of future inherent to sensorimotor images, the pulling toward the action to be performed? This is very important, and a very old part of mindness. . . it was this governing, this leading, this pulling by predictive drive, *intention*, that brought sensorimotor images – indeed, the mind itself – to us in the first place. . . I propose that this mindness state, which may or may not represent external reality (the latter as with imagining or dreaming), has evolved as a goal-oriented device that implements predictive/intentional interactions between a living organism and its environment. . . Underlying the workings of perception is prediction, that is, the useful expectation of events yet to come. Prediction, with its goal-oriented essence, so very different from reflex, is the very core of brain function. (p. 3)

Consciousness, subjectivity, the self, the possessor and organizer of qualia, whatever we want to call it, is directed towards the future even at its most primitive origins in *movement*. (Similar to Llinás, Merleau-Ponty writes about movement as future-oriented: "I am already at the impending present as my gesture is already at its goal, I am myself time . . ." (p. 421). )

By the time the nervous system develops enough in invertebrates to adapt to change, it also relies on past experience. In that sense, consciousness does not really exist in the form of an isolated extensionless present, as e.g. Descartes thought it could (so that he could doubt his memories and

include only enough of the “present” to follow his arguments out to their end). Instead, consciousness is geared towards the future and past. Our memories affect our present experiences and future goals, both considered from the third-person point of view as non-linear complex systems and considered from the first-person point of view as our constantly growing and reinterpreting view of our own pasts, our “historicity” to use the phrase of the Heidegger-Gadamer school of thought (influenced by Nietzsche’s perspectivism and emphasis on change).

Second, consciousness is also *dependent* on the future and the past, in that, as Llinás and Buzsáki both argue, its substrate seems to be the ongoing processes of neuronal oscillations, which occur necessarily *through* time. (A particle, for instance, can be considered as it exists in a hypothetical extensionless moment. A wave cannot.) As Nietzsche’s philosophy suggests, we are more verb than noun. Thus, if it were possible to arrange for an extensionless moment of consciousness, the result would not be consciousness as we know it, any more than a waveless instant of music would be music.

Yet while oscillations must extend through time, as oscillations, they are not homogeneous, but have “beats.” And these cycles, with their beginnings and ends caused by neurons firing and recovering, can serve as cues for starting and stopping. Buzsáki writes: “[e]ach oscillatory cycle is a temporal processing window. . . In other words, the brain does not operate continuously but discontinuously, using temporal packages or quanta” (p. 115). Thus, the brain “‘chunks’ or segregates perceived events according to its ability to package information in time” using neuronal oscillation (p. 10).

Third, because of its oscillating substrate, consciousness does have particular limits regarding time and particular time-based capacities. Buzsáki notes that Benjamin Libet’s fascinating studies of experienced time reveal that “the somatosensory cortex had to be stimulated for 200-500 milliseconds for evoking a conscious sensation of touch.” Quicker events may give us unconscious information, i.e. contribute to our responding, but they will not appear to the conscious mind (Libet 2004, paraphrased by Buzsáki).<sup>40</sup> For example, when we are driving and a deer jumps out in front of us and we instantly brake to avoid hitting it, our brains process the reaction to brake *before* we are conscious even of the deer appearing. In retrospect, we *construct* the internal storyline of seeing the deer and thus braking, but our conscious minds did not actually experience the events in that sequence.

And our thinking, as well as the oscillations comprising it, requires temporal duration. “Recognizing somebody’s face and recalling her first and last names, her profession, our last meeting, and our common friends are events that do not occur simultaneously but are protracted in time, since larger and larger neuronal loops must become engaged in the process” (Buzsáki, p. 115). The tempo is also key. “Our best temporal resolution is in the subsecond range, corresponding to the duration of our typical motor actions, the tempo of music and speech,” writes Buzsáki (p. 8). For all languages, the average length of spoken syllables is 0.25 seconds. And not surprisingly, the temporal range of our experience corresponds, as Buzsáki notes, to the temporal range of the brain’s oscillators.

These oscillators provide advantages as well as limitations. In particular, gamma oscillations time the sending of messages in an efficient way:

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<sup>40</sup> Benjamin Libet, *Mind Time: The Temporal Factor in Consciousness*, 2004, paraphrased by Buzsáki on p. 116. Ironically, as Buzsáki adds, “[t]he delay between Libet’s ‘mind time’ relative to physical time is a favorite argument of philosophers to question the unity of the mind and brain.” (Ibid.)

Nietzsche understood the limits of consciousness more a century before Libet published his book. He writes:

“Inner experience” enters our consciousness only after it has formed a language the individual understands – i.e., a translation of a condition into a condition familiar to him. . . E.g., “I feel unwell” – such a judgment presupposes a great and late neutrality of the observer – the simple man always says: this or that makes me feel unwell – he makes up his mind about feeling unwell only when he has seen a reason for feeling unwell. (*The Will to Power*, 1968, #479.

neuronal assemblies in the waking brain self-organize themselves into temporal packages of 15-30 milliseconds [about 30-60 Hz]. They do so because presynaptic discharge within this time window appears to be most effective in discharging their downstream targets due to the temporal integration abilities of individual pyramidal cells. (p. 246)

This frequency range overlaps with another key limit: the gamma oscillations by networks of inhibitory neurons vary between 40 and 100 Hz, due to the decay time of their inhibitory postsynaptic potentials, mediated by GABA receptors.

Even more important, learning and memory, via synaptic plasticity, seem to depend on this crucial timing as well, since synaptic strengthening requires that the postsynaptic neuron be strongly depolarized, and its firing must be coordinated with the presynaptic neuron's cycle, and since these in turn rely on gamma-oscillation-mediated synchronization. Thus, "the critical temporal window of [synaptic] plasticity corresponds to the length of the gamma cycle" (p. 247).

Llinás and Buzsáki both seem to assume that the "beats" of the oscillations, the quantized cycles, so to speak, are reflected in certain discontinuities in our *experience* of time. Llinás writes that "consciousness is a non-continuous event determined by simultaneity of activity in the thalamocortical system" (p. 124). Buzsáki writes of a "segmentation of experience" that seems to correspond to the segmentation of oscillations, and attributes this idea of segmentation to William James, whom he quotes at length:

The unit of composition of our perception of time is a duration, with a bow and a stern, as it were – a rearward- and a forward-looking end. It is only as parts of this duration-block that the relation of succession of one end to the other is perceived. We do not first feel one end and then feel the other after it, and from the perception of the succession infer an interval of time between, but we seem to feel the interval of time as a whole, with its two ends embedded in it.<sup>41</sup>

Buzsáki comments on this quote: "James's observer is at an instant but embedded in the stretched time of the mind" (p. 115). The present instant is a *Gestalt's* figure against the ground of the duration's bow-end and stern-end. Thus, despite the segmentation, "[p]assage of time, that is, its duration, is felt as a linear event, slipping from one moment to another" (Buzsáki, p. 8). The observer-at-instant may skip from segment to segment, but the background of past and future provides an ongoing context.

It is this belief that time is originally and fundamentally experienced as a "line" that I would like to challenge. I believe that an alternate model of experienced time based on Merleau-Ponty would fit better with the rest of Llinás's and Buzsáki's approach to consciousness as temporal.

### **Merleau-Ponty on Experienced Time**

It is *almost* plain obvious common sense that we experience time as a linear event. That is one of the most common ways of representing the flow of time on paper, as in the usual x axis of any graph involving change: t for time. That is also the notion of time as a linear single-dimension analogous to three-dimensional space. Perhaps partly because of this, most westerners, at least, do use a line as an often semi-conscious metaphor for time in their own lives, whether stretching from their left for the past to their right for the future (as most western languages are read), or stretching from behind them ("put the past behind you") through and in front of them.<sup>42</sup> In fact, many people

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<sup>41</sup> William James, 1890, p. 609, quoted by Buzsáki on p. 115, footnote. 9.

<sup>42</sup> Psychologists Connirae Andreas and Steve Andreas, *Heart of the Mind*, 1989, Tad James and Wyatt Woodsmall, *Time Line Therapy and the Basis of Personality*, 1988.

George Lakoff and Mark Johnson cite the Aymara language of Chile as putting the past in "front" and the future "behind." They write that this spatial metaphor reflects "the experience of being able to see the results of what you have just done in front of you." (p. 141). Amusingly, in one of his fantasy satires British novelist Terry Pratchett had described the troll concept of time as running in the same direction, from front to back, since we can't "see" the future, though we can see the past. So for trolls

seem unconsciously to code their memories' sequence by their placement in such an imaginary dimension, however that dimension is oriented, back-to-front, left-to-right, circular (one acquaintance did report this! Unsurprisingly, he is notorious for not keeping to schedules), etc..<sup>43</sup>

Yet this notion of time as a straight line is not innate, but a historical invention founded apparently by the ancient Hebrews, and inherited and propagated by the Abrahamic religions. Many other cultures use the metaphor of a spiral or wheel, based on the cyclical seasons, rather than positing that the Earth has a creation and a future ending, with progress in between. It may be that some cultures do not view time as a line at all, straight or spiral.<sup>44</sup>

And by assuming that people originally experience time as a line because that is our usual image of it in Newtonian physics, we would be committing the same error that scientists in previous generations did when they assumed that people originally experience *space* as three-dimensional, rather than exploring it and achieving that experience by motility, as Buzsáki and Merleau-Ponty argue. In Merleau-Ponty's terms, we would be reading our "abstract" knowledge, from Newtonian physics-become-common-sense, back into our "concrete" immediate experience. We would be confusing our subjective experience of time with clock time.

Is it that our time experiences really are discontinuous, and fit more intimately with some of the brain's electrical oscillations? That discontinuity certainly isn't discernible to normal consciousness, whatever may be occurring in the subconscious mind. When I reach purposefully for the Scotch bottle over a period of half a second or more, I experience it as a single, ongoing, fluid motion, despite the physiological tremor of 8-12 Hz that helps to constitute that motion. It isn't that time is a line but just a dashed one rather than a solid one.

Instead, there seems to be something else going on, something that resists articulation in language.

To clarify how we experience time, Merleau-Ponty suggests that we avoid the metaphors of clock time and return, as immediately as we can, to our subjective, pre-hypothesized, "concrete" experience. And what he finds is unexpected, even though we read it with a shock of recognition. Experience itself, sheer consciousness itself (and all of its underpinnings of pre-conscious knowledge, habit, and action), is a *complex*, not an indivisible, homogeneous unity. Further, the experienced *present* is also a complex.<sup>45</sup> If this account seems counter-intuitive at first glance, we need only analyze the purest possible instant of self-reflection.

The fact that even our purest reflection appears to us as retrospective in time, and that our reflection on the flux is actually inserted into that flux, shows that the most precise consciousness of which we are capable is always, as it were, affected by itself or given to itself, and that the word consciousness has no meaning independently of this duality. (p. 426)

on Pratchett's discworld, one would back one's way awkwardly into the future, carrying one's club at the ready (*Reaper Man*, 1991).

<sup>43</sup> To elicit how a client may code his "timeline," Andreas and her colleagues suggest asking him to imagine, say, brushing his teeth yesterday, and then ask him to gesture where he "sees" that memory. Brushing his teeth last week, tomorrow, and next week will "plot" several points and give a general idea about that individual's metaphorical "timeline."

<sup>44</sup> Benjamin Lee Whorf and Ekkehart Malotki disagree about the Hopi notion of time, with Whorf stating that the Hopis have no distinct notion of time, but regard it as combined with space into the two forms of the "manifest" (the known past and local present) and the "unmanifest" (the future and the unknown due to distance), similar to Spinoza's and Merleau-Ponty's *natura naturans* and *naturata*. Malotki disputes many of Whorf's related claims (sometimes misrepresenting Whorf) in his extensive *Hopi time: a linguistic analysis of the temporal concepts in the Hopi language*, yet Malotki as well seems to accept the basic notion of *tunatya*, the verb of hoping/coming true, that underlies Whorf's description of the Hopi sense of time. Penny Lee has recently criticized some of Malotki's criticisms of Whorf in *The Whorf Theory Complex: A Critical Reconstruction*; the matter is not yet resolved.

<sup>45</sup> Here I am using "complex" not in the technical sense of "complex systems," but merely as the contrast to a simple unit.

Merleau-Ponty is drawing here on Spinoza's sense of nature having two aspects: Nature naturing (*natura naturans*) and nature natured (*natura naturata*), an active aspect and a passive or receptive aspect. And consciousness is a sort of intersection of these two aspects in a single organism. To experience this, we can simply touch one of our hands with the other hand: we will always experience one of our hands as the touching and the other as the touched. (And our perception will be structured according to the more "active" touching hand's sensing of the touched hand.) We can make them change roles in our minds, but we can never make them coincide; we can never be *perfectly* self-reflective or self-referring.<sup>46</sup>

Merleau-Ponty contends that our most basic, private, personal experience is always of the personal emerging from the impersonal. This is evident in our paradoxical experience of our own bodies, as *simultaneously* being impersonal weight (the foot in the wrong place that doesn't move in time), and a more "personal" circuit of motility and perception: we set about hanging a painting that we like, and we feel our toe getting hit by the falling hammer when we misjudge the angle of the nail and force required to put it in (the circuit isn't always perfect). This experience of ourselves as irreducibly complicated is precisely what made belief in mind-body dualism possible, but dualism misrepresents the experience as of a ghost in a cadaver, whereas it is of a lived body in which the personal emerges from the impersonal.<sup>47</sup>

We experience the personal emerging from the impersonal through time, as well. Merleau-Ponty describes a very different *Gestalt* of experienced time from Buzsáki's (or William James's). It is not the present instant as a figure against the background of past and future. Instead, the personal, present but future-directed, initiating aspect of ourselves, as nature naturing, is the "figure" against the background of the "impersonal" facts of the past and present, and assumptions about future surroundings. Excerpts from one of Merleau-Ponty's most notoriously dense passages follow. If this passage is recognized as simply articulating experiences that are so basic, so pre-linguistic, that we never usually articulate them even to ourselves, it makes surprisingly clear sense:

But the present . . . is the zone in which being and consciousness coincide. . . Time is 'the affecting of self by self'; what exerts the effect is time as a thrust and a passing towards a future: what is affected is time as an unfolded series of presents: the affecting agent and affected recipient are one, because the thrust of time is nothing but the transition from one

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<sup>46</sup> Schopenhauer anticipated this thought a century earlier, using the metaphor of eye anatomy:

But the I or the ego is the dark point in consciousness, just as on the retina the precise point of entry of the optic nerve is blind, and the brain itself is wholly insensible, the body of the sun is dark, and the eye sees everything except itself. Our faculty of knowledge is directed entirely *outwards* in according with the fact that it is the product of a brain-function that has arisen for the purpose of mere self-maintenance, and hence of the search for nourishment and the seizing of prey. (*The World as Will and Representation*, Vol. II, 1966)

<sup>47</sup> Schopenhauer's whole philosophy turns on a similar distinction. Rather than the traditional mind-body dualism, he suggests that we experience the "outside" world and our own bodies *and* most of our thoughts and "inner life" via the indirect Kantian structure of "representations." However, he claims that we each also have direct access to what he considers the underlying initiating force of all of us, the universal "will," which each of us can recognize as a deeper identity within ourselves than our own individual selves are. We each experience ourselves simultaneously as both "will" and "representation." And thus he circumvents Kant's claim that we can never know true reality beyond our own categories of thinking, by responding that we cannot "know" it in these terms simply because we experience it *too* directly for the categories of everyday knowledge to apply. But this unusually direct knowledge of the cosmic will *is* mediated by one's bodily experience: "the knowledge I have of my will, although an immediate knowledge, cannot be separated from that of my body. I know my will not as a whole, not as a unity, not completely according to its nature, but only in its individual acts, and hence in time . . ." (WWR I, p. 101), even though he then insists that, on a metaphysical level, time as we know it does not exist. One could argue that in *some* respects Merleau-Ponty resembles a naturalized Schopenhauer, a Schopenhauer who has eschewed metaphysical claims, and is instead arguing that these metaphysical descriptions are in fact valuable insights into how our mammalian "lived bodies" experience living.

present to another. . . the explosion or dehiscence of the present towards a future is the archetype of the *relationship of self to self*. . . [Our temporality] is the basis both of our activity or individuality, and our passivity or generality – that inner weakness which prevents us from ever achieving the density of an absolute individual. We are not in some incomprehensible way an activity joined to a passivity, an automatism surmounted by a will, a perception surmounted by a judgement [referring to Kant's theory here, sic], but wholly active and wholly passive, because we are the upsurge of time. (pp. 424-428)

If we were to come up with a metaphor of this *Gestalt* of experienced time, it would not be a *line*, but an *intersection*. One axis could represent the more impersonal background of the past: one's personal history, physiology, sedimented habits and tendencies of thought, the world at large with social and natural rules governing what to expect, and so on; we constantly add to this background through our perception. This is the "affected" aspect of time, "time as an unfolded series of presents." (We might think of it as extending laterally from ourselves.) The other axis, crossing the first, could represent our various and overlapping and concentric goals and "projects" into the future, ultimately grounded in the fact that we evolved to be motile creatures. This is the "affecting" aspect of time, "time as a thrust and a passing towards a future."<sup>48</sup> (We might think of this as extending from behind to in front of ourselves.) We can imagine that the metaphorical intersection would "move" forward as time progresses, as we imagine the standard metaphor of linear time doing. However, the lateral axis (representing the past, the impersonal "given" world) marking the moment of the present would be more than a marker. It would be a reminder that also represented the cumulative brain states that we had experienced up to that moment, along with the predispositions, expectations, habits, etc., that we had gained from them. And the anterior-posterior axis would not be the standard metaphor of *abstract* bidirectional clock time, but would face towards the future, representing our future-oriented motility and purposiveness. Some predictions would exist as imagined possibilities in the impersonal background. Others would be associated with our own desires, goals, and motions. Others, such as the implicit prediction involved in accompanying other musicians, or in dancing together, seem to be an unusual version of this intersection with such constant anticipation and adaptation that Grastyán's circuit of motion and sensory feedback would not have discrete cycles but would constitute an ongoing dialogue. But in any case, *the "friction" between the two metaphorical axes reflects our sense of time passing.*<sup>49</sup>

Distinguishing these two metaphorical axes also helps us clarify the metaphors of time described by George Lakoff and Mark Johnson. Lakoff and Johnson assume that most people experience time metaphorically as a line from behind going through and in front of them, which is the position that psychologist Connirae Andreas and her colleagues describe as "in time." But Andreas has encountered about as many clients who experience time as extending instead from their left out towards their right. This position, interestingly, is associated with a more detached, reflective attitude. For instance, people who experience time primarily in this way will tend to experience memories from a "dissociated" third-person point of view; they will imagine seeing themselves in the memory. Andreas and her colleagues refer to this as the "through time" position. (People who tend to experience time as a back-to-front line, instead, will tend to experience memories as they lived them, from their own "associated" point of view. This particular position seems to enhance

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<sup>48</sup> This may be why the abstract notion of time as a fourth dimension of space just does not make sense to many people. Our brains are simply not constructed so that we could experience time as at all analogous to any dimension of space – we *do not* "occupy" it in the way that we do space. (Of course, we are not here addressing objective time, clock time, but only subjective time. The physics of time is another topic entirely, and against some other philosophers, I am skeptical whether our subjective experiences of time can give us any insight into that.)

<sup>49</sup> Philosopher Candice Shelby (personal communication, August 21, 2009) notes that children learn the notions of time durations from having to wait. The "tension" between one's own goals and the rest of the world's facts can be a metaphor for the tension of impatience as well!

spontaneity, being "in" the moment. However, it is less beneficial for scheduling than the left-to-right metaphor for time.)

Now, Lakoff and Johnson have found two different kinds of metaphors of the passing of time. In some cases, we think of ourselves as stationary observers facing a sequence of events moving towards us. Hence we speak of "The time will *come* when . . . The time has long since *gone* when you could mail a letter for three cents. The time for action has arrived. . . The summer just *zoomed by*."<sup>50</sup>

In other cases, we think of ourselves as *moving* observers, travelling through different locations, each of which is the present when we are there. Thus, we talk in terms of "trouble *down the road*. . . What will be the *length* of his visit . . . We are *coming up on* Christmas . . . We *passed* the deadline" (ibid., p. 146). Lakoff and Johnson point out that these two different metaphors are actually extremely similar; "they are *figure-ground reversals* of one another" (p. 149). What is key in each metaphor is not which aspect is imagined as moving in relation to which other aspect. What is key, they write, is the *duality* of two aspects moving in relation to each other. And I would emphasize that we each participate in *both* aspects. Consciousness seems irreducible from the interaction between our capacity for motion and our purposiveness, on the one hand, and our memories, habits of motion and thought, and "impersonal" physical limitations, on the other hand. (Where does perception fit in? It is an essential part of the circuit of motion and perception, and it is translated and sedimented into the "given" background world. It is what allows movement to be put into the context of the moving organism and its surroundings.)

Now, I would suggest that among westerners the "stationary observer" metaphor is typical of people who predominantly experience time in what Andreas refers to as the "through time" position. Perhaps we think in terms of ourselves as stationary in a moving time when we are identifying more with the receptive, reflective, detached *natura naturata* aspect of ourselves. And we experience ourselves a moving through a sequence of stationary events when we are identifying more with the active, future-oriented *natura naturans* aspect.

The metaphor of a 90 degree intersection of two axes is of course arbitrary, as are, ultimately, the metaphors of timelines. The notion of a feedback circuit is also an abstract metaphor. Perhaps others might prefer the metaphor of an airplane, whose thrust results in air flow which functions not only as drag, but also as lift. Or perhaps others can create more compelling metaphors. The main idea that I hope to convey is the complexity and temporality of even the briefest moment of consciousness as we experience it, and that this first-person account *may* reflect, to a surprising degree, the third-person accounts of brain activity by Buzsáki and Llinás.

We should also note one important implication of Merleau-Ponty's approach to experienced time, which is consistent with Buzsáki's and Llinás's hypotheses. Non-human mammals (and perhaps other vertebrates to varying degrees) would appear to have the same basic experience of time as we humans do, in virtue of their being motile, perceiving creatures, of their having a very similar brain and nervous system to ours. They may not have abstract concepts of "day," "year," etc.. They may not even have an abstract sense of "the future Binky," which would allow them, for example, deliberately to delay some kinds of gratification for long periods. Yet they do clearly have some sense of the future, in that they have purposes and they desire outcomes.<sup>51</sup> And this may impact our approach to animal welfare.

### **Applications of This Model of Subjective Time Experience**

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<sup>50</sup> Lakoff and Johnson, p. 143, their italics.

<sup>51</sup> My plump tortoiseshell tabby Dr. Phibes is understandably food-oriented, since she was a skeletal six-week-old kitten when she was found in a busy street. When her food bowl *begins* to get low, with only a few days' worth of kibble left, she starts leading me to it, sitting expectantly, and staring at me. The lower I let it get, the more insistent she becomes. She isn't satisfied with merely having enough food every day; she wants a good reliable survivalist hoard. Dr. Phibes is no genius even by cat standards, but she does clearly have a vivid sense of the near future, in terms of a few days.

The “common sense” conceptual model of experienced time, the standard “linear duration,” is based on the older notion of consciousness as a passive, perceiving thinker – Descartes’ *cogito* cognitively apprehends the passage of moments as if they were box cars in a train.

The suggested alternative model, developed from Merleau-Ponty, allows for *motility* and growing memory as well as perception – the motility that Buzsáki and Llinás have worked so hard to convince us is the ultimate basis of consciousness and thus of who we are. And it allows the aspect of perception to be distinguished from the impetus of motility. By so doing, it permits a more fine-grained description of the experience of temporal *distortions*, which have frequently been ill served by standard accounts such as “cognitive deficits in apprehending the rate of time passage.” It offers help only in forming descriptions, not explanations, of course. Nonetheless, more accurate descriptions may help prompt new hypotheses and studies.

Time famously seems to speed up during pleasant and engaging times, when we are interacting fully with our surroundings. It seems to slow down when one is feeling thwarted or bored or overwhelmed by, or disconnected from one’s surroundings. According to the intersection metaphor, this would be described as one of the two axes dominating the other. I am curious as to whether the normal “speed-up” of time during engagement with surroundings or a task might correlate with particular brainwave frequencies and areas, such as the intriguing hippocampal theta waves which fascinated Grastyán, or with activation of the dopamine circuits arising from the mid-brain nuclei, associated by Jaak Panksepp with what he terms SEEKING behavior in animals.<sup>52</sup>

In two unusual cases, the intersection seems to disappear. In the euphoric state of “flow,” when one’s capacities are perfectly matched to a task so that one is absorbed in it, people report *either* extreme speeding up of time, *or* a dramatic slowing of time, while maintaining a sense of dynamism.<sup>53</sup> Apparently the sense of oneself as future-oriented and motile is expanded to incorporate many aspects that are normally experienced as “given” background, as “drag” on the “thrust,” so to speak. Other background data simply drop out of perception, so that the usual feeling of a *controlled* change is lost. Only the change is felt.

In the case of severe emotional or physical shock, the whole perceptual *Gestalt* temporarily collapses. Soldiers in battle or survivors of a crash may find themselves fixating on finding a shoe. Here, the temporal *Gestalt* seems to collapse along with the perceptual field’s structure. Perhaps this state could be better understood in terms of Llinás’s idea of emotions as premotor FAPs, and qualia as sensory FAPs. Just as a sudden shock may evaporate a motile FAP (e.g. a harpist playing a difficult piece has it blown out of her head by a dropped tea tray or by the sudden realization that she has locked her keys in her car), a shock may also disrupt the normal patterns of emotional, cognitive, and perceptual expectation and concentration that we normally have the luxury of taking for granted.

Frederick Melges, professor of psychiatry at Duke University until shortly before his death, studied correlations of various psychopathologies with various distortions of experienced time, especially in regard to how the patients viewed their futures.<sup>54</sup> He notes that patients with clinical depression reported time to slow its pace dramatically and painfully, using such descriptions as “walking in molasses.” They frequently had *no* sense of a future, though a normal sense of the past. When their semi-conscious “time lines” are elicited, they will report the sense of a “line” for the past, but not for the future; the “time line” will be truncated. The metaphor of subjective time as an intersection allows us to examine this with more detail. It is not that they have a cognitive deficit with regard to apprehending future clock time, but that there is a dysfunction of *agency* or

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<sup>52</sup> Jaak Panksepp, *Affective Neuroscience: The Foundations of Human and Animal Emotions* (Oxford University Press), 1998, quoted by Temple Grandin.

<sup>53</sup> Mihaly Csikszentmihalyi and Isabella Selega Csikszentmihalyi, Eds., *Optimal Experience: Psychological Studies of Flow in Consciousness*, 1988.

<sup>54</sup> Frederick Melges, *Time and the Inner Future: A Temporal Approach to Psychiatric Disorders* 1982. In a similar vein, psychologist Suchoon S. Mo has explored some reversals of temporal functioning in psychosis, with schizophrenic claims of pre-cognition hypothesized to originate in a reversal of the “about” posture, normally directed to future events, with the “from” and “about” posture, normally directed to past events. “Time Reversal in Human Cognition: Search for a Temporal Theory of Insanity,” 1990.

*purposiveness or initiative* of some kind. I am curious whether Grastyán's version of the usual circuit, motility causing perceptual feedback, might be reversed or fragmented in these cases, or in similar cases of learned helplessness. The standard model of *normal* stimulus-and-response, in other words, might actually turn out to be a good description of a *pathological* state of learned passivity.

For people in physical pain, time also seems to drag. Normally, the pain itself may be the *perceived* figure, the focus of the whole perceptual or sensorimotor field, but the larger temporal *Gestalt* is intact, and functions as it does in frustration. But in severe cases, an unusual temporal distortion seems to happen. Two friends who suffer from migraines have independently described this experience in similar terms: "I can't get past the moment," "It's as if the moment will never end." It is as though the axis of the given impersonal world is almost suppressing the other, future-oriented axis. Might the cingulate cortex be involved somewhere in such time distortions?

Schizophrenics, Melges writes, seem to progress through four stages of fragmentation of time experience, beginning with the present seeming to lengthen, possibly from incipient fragmentation; through difficulty in sequential thinking – due not only to intellectual difficulties but to some unusual disturbance of "purpose"; through the past, present, and future becoming discontinuous, and the self feeling unfamiliar; to the fragmented sense of time collapsing so that the individual can no longer distinguish them. This has been very poorly understood by the "cognitive deficit in gauging temporal progression and sequencing" approach. However, the notion that future-directedness is associated with purposiveness and motility may open up new possibilities for exploring how structural and physiological brain problems might underlie the tragic experiences of these individuals.

Buzsáki discusses alpha wave frequencies being boosted by both Yoga and Zen meditation, as well as by technologically mediated neurofeedback. Some mystics have reported experiences of timelessness, in which the individual seems to become immersed in the Nature naturing axis without any externally-direct "project," so that the individual seems to have been transcended, and the sense of purposiveness is reflected back on itself, as it were, rather than receiving the usual perceptual feedback. Their brainwave frequencies during these experiences would be fascinating to explore.

## Conclusion

Buzsáki and Llinás are developing new converging approaches to the mammalian brain based on brain functioning, including consciousness, as involving brainwave oscillations, and thus as inherently temporal. Both begin with research connecting electrical brain activity with motility, and extend this connection beyond motility to consciousness, and perception, as well. Both also argue that motility is the foundation of consciousness, giving evolutionary and embryonic/fetal developmental evidence.

Both are developing new conceptual models of what philosophers would call the "self," consciousness, or subjectivity: models which include not only perception and awareness – as traditional philosophical models do – but also agency and initiative, which only a few "counter-tradition" philosophers have done. Thus, Llinás hypothesizes that emotions and sensations can be thought of as analogs to motility in that all might be Fixed Action Patterns. And thus Buzsáki develops and defends Grastyán's reversal of the usual reflex circuit, so that our brains act on our bodies to produce movement, and our perceptions follow as feedback.

What I am calling the counter-tradition of Heraclitus, Spinoza, Schopenhauer, Nietzsche, and Merleau-Ponty is a valuable resource for Buzsáki and Llinás in this enterprise. These thinkers, due to their anticipation of aspects of Buzsáki's and Llinás's work, can help them rebut the objections of writers such as Chalmers, define the legitimate and illegitimate roles of psychological introspection, re-categorize humanity as the most complicated mammal rather than a qualitatively different kind of entity, articulate subjective human experience as both receptive and active and thus as irreducibly complicated, elaborate the ways in which humans as well as other mammals are, fundamentally, sources of *agency* and inhabitants of *change*, and form a new simple conceptual model of experienced time which allows for more fine-grained and accurate descriptions of experienced distortions of time, both pathological and healthy, which might lead to new hypotheses and studies.

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