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A Whiteheadian Innervation of the Soma: A New Vision for the Peripheral Nervous System

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Abstract: This essay draws attention to two problems in neuroscience's set of assumptions. These self-defeating assumptions include: 1) the assumption that what the nervous system, especially the brain, does is synthesize experience, while also assuming philosophical realism, and 2) the problem of biological signal transduction. In the latter, neuroscientists and philosophers of biology have left unaddressed the issue that the signal differences between the inside and outside of the organismic boundary are of distinct ontological types; and yet no concern has been expressed regarding how it is possible that an organism's inner states could reflect the experiential content flowing from outside of the organism's boundary. To resolve this problem, I propose that the process philosophy of Whitehead be implemented to adjust our understanding of what body is and how the peripheral nervous system draws in experience through the senses. Some discussion will surround the enteric nervous system, regarding the evolutionary past of organisms, the thought that enteric nervous system probably played the role of the brain in our evolutionary ancestors, and how Whitehead's philosophy of organism can help bring some understanding to this anti-Cartesian idea.

Keywords: Whitehead, nervous system, process philosophy, cognition, neuroscience, metaphysics, panpsychism, panexperientialism

In the theory and philosophy extending from the time of Galen, the supremacy of the brain as seat of cognition and consciousness has been on the rise. Perhaps the final anointing of this supremacy came when Descartes (1641/2017, p. 18) introduced *res cogitans*, and then put it in strict localized interaction with the brain. The centrality of the brain's role in consciousness and cognition appears almost fixed in the times of modern neuroscience and cognitive studies. Some challenges to the centrality of goings-on in the cranium have arisen, but there has yet to be head-on challenge presenting a framework that seeks to substantially contradict the contemporary commonsense assumption,

namely, as far as consciousness and cognitive activity is concerned it is all in the head.

The following article begins with an illustration that the central philosophical tenets of the mechano-reductionistic theoretical framework of brain and cognitive sciences are grounded in contradictions. I will proceed from there, explaining how considerably more sense and consistency can be brought to understanding the consciousness as processes, though in radically different terms than those of the analytically-minded approach to brain science. The cost of this consistency comes with the humility of accepting limitations to

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the interpretation of contemporary science, and this cost may be termed “mystery.” The admission of this mystery comes by way of implementing the ontological and metaphysical framework of Alfred North Whitehead to the peripheral nervous system (PNS), which forces us to remove emphases on the centrality of the brain by lifting the tyranny of the eye. By the end of this article, the previous clause will be made clear, as we dispose of the erroneous presupposition that the realm of visual contents necessarily and exhaustively catalogs all that is.

Motivation

There are two distinct arguments that arise out of assumptions made by contemporary sciences of the brain and cognition, which, in themselves, seem to destroy the entire interpretive framework of theoretical science. I will call these: (a) the argument from hallucination; (b) the argument from cellular signal transduction. In addition to these two arguments this article will find its motivation in a discussion regarding the death of mechanistic philosophy, which has almost entirely gone under the radar possibly because of scientists and analytic philosophers continuing their post-wake mornings hundreds of years later.

It doesn't seem to have clicked for most scientists and contemporary philosophers that the aspect of synthesis within the framework of modern understandings of what the brain does falls victim to a congenital illness. This congenital illness is that which has been inherited from Kant's transcendental idealism. First, an examination of the contemporary neuroscientific perspective will assist in establishing the prevailing mindset, and then the connection to Kant's synthetic approach will appear more readily. I have chosen Anil Seth, professor of Cognitive and

Computational Neuroscience at the University of Sussex, to represent the popular interpretation of what the brain is and does. In an interview, he characterized the popular view as follows: “In the story I'm going to tell you, our conscious experiences of the world around us, and of ourselves within it, are kinds of controlled hallucinations that happen with, through and because of our living bodies” (Seth and Raz, 2018) Any kind of inner synthesis of experience is going to beg the question, inquiring into the nature of that experience's connection to what is external. As soon as one commits to this manner of thinking, there is an immediate schism to the generation of “inner states” and whatever might be objectively external to that state. Kant's transcendental framework admits no discernible way to connect the noumenal realm to the phenomenal realm with explicit detail, except to stipulate that the ground phenomenal experience is grounded in things-in-themselves that make up the noumenal realm (Stang, 2016). Detailing Kant's framework, where passively given raw data of experience have categories imposed upon the collective sense content through the imagination in time and resulting in a transcendental unity of apperception, leaves one open to whether there is any need for an external ground to the “resultant” objects of perception (Rosenberg, 2005). With a little examination, it is clear that our everyday use of the word “hallucination” entails a baseline for reference: we know what it is like to not hallucinate, which provides a point of comparison for when our conscious experience includes items that might not be there. It is, indeed, a natural step to say that if all experience is synthesized, then it is a hallucination, because the implication is that there is no way to corroborate that the synthesized contents of experience really reflect anything external to that experience. This is one of a number of reasons why Kant (1787/1997, p. 112)

correctly saw the need to distinguish contents of perception from the underlying real things that give rise to them, and it is also why, even if stated more for shock value, Seth is correct in characterizing the modern neuroscientific view as a sort of hallucination. The difference between the two characterizations is that the neuroscientific view believes that the contents of the mind conform to the objects in the world, whereas objects conform to the mind for Kant (Segall, 2019, p. 94)

If the modern neuroscientific view is that the world that I have access to is constructed,

then I have to question what in my consciousness reflects what is outside while also not taking for granted that there is an outside. There are trees and also brains, which is strangely self-contradictory. For it is perceptual information about brains, through an interpretative filter of what the brain does (i.e., constructs experience), that first gives rise to the thinking that one has no grounds to believe that there is a brain to begin with. The rationale follows a cycle that self-refutes as follows:

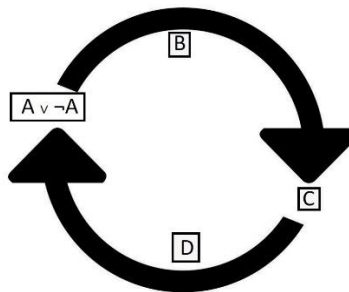


Figure 1: The hallucination narrative cycle.

- A) Phenomenal experience naively indicates that there are brains.
- B) Phenomenal experience indicates brain processes.
- C) Brain processes are interpreted to construct experience.
- D) The contents of experience cannot be verified to exist independent of synthesis, thus we have no ground to affirm contents of A, and no real reason to think A is the case.

The neuroscientific interpretation implicitly rests upon a strange assumption that naïve realism is the case, and that whatever one experiences must, by virtue of being experienced, be real. This is strange in the sense that philosophy has battered the view from pillar to post, as one might see the collective progression of philosophy and science as a move away from naively accepting the contents of experience, refining the concepts of naïve experience, reformulating metaphysics, and using these to develop empirical methodological research programs. The assumption, which is very likely and completely outside the conscious acknowledgement of scientists, is particularly strange in its inclusion here

because as Seth (Seth and Raz, 2018) says, experience is constructed in the neuroscientific view. Experience cannot be both a fabrication of internal processes and the product of what is immediately drawn in by the internal-external sensory interface of the organism. Therefore, neuroscience seems to implement a D* condition in the above cycle, which states something along the lines of “but while we can’t be sure that the first order contents of A have a positive ontological status, naïve realism affords these contents ontological affirmation.” I see no possible means of rational generosity that would remove this contradiction. However, matters get worse from here for modern interpretation of the brain sciences.

Quite possibly, the problem of cellular signal transduction has gone completely unnoticed in the philosophy of science and in the empirical interpretation of neuroscience. Signal transduction is the “transformation of sensory stimulus energy into a cellular signal, such as a receptor potential” (Bear et al., 2016). Since one of the focuses of this article is to challenge the tyranny of the eye, so to speak, I will adduce phototransduction in rods within the eye as the example. In fact,

1. Electromagnetic waves incident upon the rhodopsin (photopigment).
2. Retinal in the opsin absorbs the electromagnetic energy.
3. The absorption means molecular changes in the retinal within the opsin, inducing “activation.”
4. Transducin (the relevant G-protein) is stimulated.
5. Phodiesterase (PDE), the effector enzyme, is activated.
6. PDE activity reduces the cGMP level.
7. Na⁺ channels close and the cell is hyperpolarized (Bear et al., 2016, pp. 312-315)

From here, the signals pass through direct and indirect pathways to the bipolar cells and eventually into the central visual system. While these physiological steps may not seem to say much about the general theory of neuroscience, I contend very much to the contrary, as there is a tremendously important disjunction present, as theorized by biology, between the inner organism and that which is external. The philosophical problem is that what is outside of the organism is not what is inside of the organism. The question I pose is: How is it possible for cognitive processes to take what is at the internal periphery of the organism, and extract from the subsequent concatenation of physical phenomena a remotely accurate model of the external world? Simply put in declarative form: what is outside is not what is inside, and so the neuroscientist cannot claim that the outside world has anything to do with the inner world. In fact, these internal signals are not what is outside, so one arrives at a similar complication as pointed out in figure 1.

cones work similarly, and the argument that follows could just as easily have included Merkel disks instead of photoreceptor cells. The process of signal transduction can be stated with varying levels of complexity, but some of these details are cropped for purposes of emphasizing salient features of the process that are relevant to the present discussion. The step-by-step process of signal transduction in photoreceptor cells, called rods, is as follows:

Namely, that the eye is trusted in giving us accurate information about the world, and then the interpretation of those phenomenal goings-on tell us that there is a schism that undermines the flow of reliable information into the organism. If the final upshot of all of these processes, conscious experience, cannot determine that there is a world behind its veil of perception, then the experiencer is not justified in claiming that there is an external world.

The general conclusion of the above arguments is that they are out of touch with reality, and empirical science cannot pretend to knowledge if it undermines the mode of access it has to reality. The resolution proposed later in this article when looking at the PNS, will be to ground the interpretation of neuroscience in a philosophical framework that is realistic, and which affirms that the organism is in touch with its environment through philosophically realist means.

The interpretive component in both of the foregoing arguments against the modern neuroscientific understandings – and we may as well, with some reservation, include contemporary biology – are problematic in their mechanistic assumptions. The history of physics includes a rarely cited problem, so rarely cited that it doesn't really have a proper name, sometimes called the boundary problem in mechanics, the contact problem, or the argument against collisions. The key to all of mechanical philosophy, as in the Descartes' philosophy (Gaukroger, 2010, p. 5), was that two disjoint things made of the same substance, in this case matter, could influence the motions of one another through contact. The problem is really nothing more than the simple quandary of how it is possible for two objects, like to iron balls, to come into contact. If one gives the question the appropriate moment's pause, it seems that contact might occur at infinitesimal points, but the issue with this is that the meaning of infinitesimal points being in contact doesn't lend itself to sensible physical interpretation (Hagar, 2014, pp. 14-19). At the instant of first contact, it appears that mathematical conceptions of accumulation points, after the concepts of Real Analysis, does not make for intelligible physical behavior.

For my part, I think the historical commentary on mechanistic thinking is almost fully laid out by Noam Chomsky in his 1992 lecture in Spain, at the University of Girona. In that lecture he said that the idea of Cartesian dualism didn't survive the century, but many mistakenly think that the Cartesian notion of mind or, as Ryle referred to it, the notion of the "ghost" was done away with it. Quite to the contrary, the problem of contact in mechanistic philosophy was dealt with by Newton, and it would be that Newton's work "exorcised" the machine, not the ghosts, but that rather it would be ghosts all the way down after that (Chomsky, 1992). I say

"almost" above, as the replacement of action at a distance was partial, being that the conception of gravity as distal agent of influence was only a partial overturning of problem of contact; and it would be, as Chomsky says, ghosts all the way down, once the idea of electrical fields would come into their own. This is the reason that, historically, the exorcism of the machine went unnoticed: the exorcism was done piecemeal beginning with the universal law of gravitation, and then being completed with the works in electrical fields and the general notion of the atom as comprised of these fields. Chomsky doesn't mention the importance of these latter notions in completing the exorcism, but he does note that the exorcism was taken somewhat more seriously later.

In fact, I would actually say that the disjunction between science and philosophy that grew out of the early 20th century where, as Goldman (2006) notes, scientists differentiated and separated themselves from philosophers only to begin doing their own philosophy without knowledge of proper philosophical training, which ultimately contributed to the strong reemergence of mechanical philosophical assumptions. For instance, advancements in science in the 17th and 18th centuries looked far less mechanistic, where Galvani (Pera, 1986/1992, p. xix) argued for the existence of "animal electricity" Driesch (1905/1914, p. 14) argued on behalf of a vitalism in biology, and romantic thinker Hans Christian Ørsted (Gillesberg, 2009, p. 27) discovered the holistic nature of electricity and magnetism. Therefore, the split between philosophy and science resulted in scientists not knowing of the exorcism and previous problems in philosophy or the history of science. They began taking up naïve realist views and, perhaps, fully recommitted to mechanical philosophy.

That's why contemporary discussion ridiculing the ghost in the machine is completely off track. In my opinion, it's just missing the point in what happened. What did not survive is the theory of the machine – contact mechanics was thrown out. I'm being somewhat anachronistic when I say that the 17th century exorcised mechanical philosophy. It did, in principle, but it didn't yet do it, in fact. One consequence of eliminating the machine is that we have gotten rid of any notion of body, physical, or material. There is no longer any notion of a material world. Remember, Descartes could be a dualist because he had a notion of body, not a very clear notion, but at least a general notion, given by the fact that a body is *res extensa*, an extended sort of thing (Descartes, 1641/2017, p. 13), "Body" is defined by mechanical philosophy, by contact mechanics, that's body, as in the case of the universal law of gravitation, as it requires action at a distance. Now, Newton (Smith, 2007) showed that's not the way a body works; therefore, we have no conception of body. In fact, there's just the world, whatever it is. Unless someone comes up with a new notion of the physical, talking about physicalism, materialism, eliminative materialism, or the mind-body problem, is meaningless. If you have no notion of material, there can be no problem of reducing things to the material; and there is no notion of material (Chomsky, 1992). Chomsky (1992) goes on to say that the entire field, presumably the field of all cognitive and brain sciences, is composed of discussion that he says is not merely wrong but downright meaningless. There may be no item more crucial than this point about whether there can be any such notion of "material" or "mechanism" without contact, as every initiate of neuroscience reads textbooks laden with the words "mechanical," "mechanism," and "matter." For example, "ACh (acetylcholine) and all the molecular

machinery associated with it are collectively called the cholinergic system" (Bear et al., 2016, p. 145). The training literature for these brain-oriented disciplines is rife with these references, which are meaningless.

This now serves as the segue into the primary purpose of this article, which is to implement a philosophical framework for neuroscience to make sensible commentary on the nature of consciousness. To do this I will explore how the metaphysical and ontological aspects of Whitehead's speculative philosophy alters the interpretive understanding of what the brain does, and neuroscience, more generally.

Enter the Philosophy of Organism

In the motivation, two preeminent points rise above all others: a) the need for philosophical realism to justify and certify that internal states reflect the external world; b) to address the exorcism of mechanistic philosophy and the concept of matter. In purview of these items needing correcting, it is not arbitrary that an examination of Whitehead's philosophy has been called forth to rectify the ailing scientific interpretation. Recent developments in the philosophy of mind, regarding the PNS, further supports the choice of Whitehead's philosophy, as will be discussed shortly. Whitehead's philosophy of organism does away with substance, and it provides a return to realism. Whitehead achieves a return to realism by regarding all bits of existence as being the same in their type, as in each atomic bit being like others in metaphysical kind, which we can refer to for simplicity either as "actual occasions" or "drops of experience" (Whitehead, 1929/1985, p. 18). Within Whitehead's ontology, there is also very deliberate room made for a pluralism of perspectives, such as viewing the world as waves, which, like the process metaphysics that allows for drops of

experience to merge and coneresce, one can understand how waves might superimpose. In the way that multiple waves can enter into superposition in a given location, so can actual occasions. Unlike waves, actual occasions do not pass through one another unaltered, but participate in a process of becoming. This is the first insight.

The argument regarding cellular signal transduction instantiates a divide between the inside and outside of the organism, such that what is outside and coming toward the organism's periphery must be considered fundamentally different from what is immediately inside the cellular boundary. In other words, the only concept in common between the outside of the organism and the inside is energy, but that is the only commonality. It is doubtful that a completely disjoint inner world might be able to connect meaningfully to the outer world in a way that the information or experience on the different sides of the boundary are somehow the same, but in different forms. The signals outside are thermally radiative, electromagnetic, or mechanical waves, whereas the signals inside are propagations of potential difference along membranes of neurons.² To reiterate, if not entirely dismissed outright on the grounds of the disjunction induced by signal transduction. At the very least, the neuroscientific view is left in a logically

inconsistent anti-realist position where it has undermined the very features of perception (i.e., seeing stuff going on in the brain) that first gave rise to the scientific field's understanding. Understanding experience as hallucinatory, in that experience is constructed, seems to obviate the apparent function of neural sensory pathways: of what service is a set of sensory systems to an organism if these pathways do not accurately reflect what is outside of the organism? The newly gained insight of Whitehead's philosophy of organism allows an interpretive view that does away with this problem entirely. That is, the "signals," to be crude, are of the same ontological type inside the organism as they were outside, namely, actual occasions. The many conerescing contents of these complex, interdependent drops of experience might mean that the contents of experience, as they enter into the organism, are not quite what they were outside of the organism. But the type of goings-on outside are the same inside, and thus we have a fully satisfactory realism that justifies that what is being experienced by the organism is largely consistent with what is going on outside of it. With some of the preliminary points addressed, regarding how the problems in the motivation will be addressed with Whitehead's sophisticated and radical philosophy of organism, I need to address advances in the philosophy of mind

² Even in the plurality of ways in which one may look at the movement of electrical qualities in the nervous system, there is emphasis on the difference between what is inside the organismic boundary and what is outside. Whether one takes the view that the propagation of action potential is the consequence of ionic solutions vacillating and oscillating across membranes of a single neuron or as if electrons were flowing in direct-current-like conditions, both have pragmatically acceptable claims to the reality of what is happening (Allen, 2013). One need only consider the Volta-Galvani debate to see the more primitive version of this argumentation (see Marcello Pera's *The Ambiguous Frog: The Galvani-Volta*

Controversy on Animal Electricity) and reflect upon this with the matured American Pragmatic thought of Baas C. van Fraassen's *The Scientific Image*. From this, the various ways, as a collection, in which we can look at what is happening inside of the organism is certainly in no obvious way what is happening outside of the organism; and from the phenomenological vantage point, there is no guarantee that what one is receiving on their "television screen" is what is happening in front of the "camera" or sensors, outside the organism. However, thanks to Whitehead, we are not left to talk of a noumenal realm, as Kant's solution to the problems of early modern philosophy led him.

involving the PNS. Once that is complete, a deeper discussion of a Whiteheadian innervation (and invigoration) will be possible.

The Growing Importance of the Peripheral Nervous System to the Philosophy of Mind

The Peripheral Mind by István Aranyosi deserves a great deal of attention for its powerful and original approach to understanding consciousness. Aranyosi's approach is one that, if not fully grokked in its subtleties, may be difficult to distinguish from embodied mind. He frames his view differently, so as to interpret "the mind as truly distributed over the body... I would rather call my approach 'enminded body' than 'embodied mind'" (Aranyosi, 2013, p. xi). The impetus of Aranyosi's thinking on this subject derives from his personal experiences of cancer treatment that caused him to lose the use of his limbs, as if his mind no longer extended to these peripheral domains of his body – only later to regain control, having them re-enminded, so to speak. There is a certain sense that, upon losing access to his limbs, Aranyosi's inner/outer boundary, or his subject/object boundary, moved in such a way that his mind lost ground: "The mind-world boundary seems to have moved from the skin/environment junction to the innervated/denervated junction within the body. So, part of the body has become external to the mind, or 'deminded'" (Aranyosi, 2013, p. 10). Interestingly, when one typically thinks about the skin as being the interface between the organism and the environment, the idea of this boundary moving fails to be a consideration. That is one point that lends so much originality and power to Aranyosi's book.

In addition to the original contributions of the book Aranyosi adduces, from across the philosophy of mind literature, some compelling points about the distributional aspect of experiential states.

"[S]ensory states, like pain, are not accounted for by a definite place in the brain, but as a continuous interaction among the peripheral nerve fibers, the spinal cord, and several areas of the brain. This means that a neuroscientific account of these states will involve large areas of both the CNS and the PNS, and that the state itself is therefore most naturally understood as a distributional property of the nervous system, where what is distributed is electrical activity" (Aranyosi, 2013, pp. 14-15).

There are two tacit thoughts feeding into this on that Aranyosi (2013) is expressing. The first is that neuroscience and its philosophical interpreters appear to interpret very nearly unanimously that there is no single location where all of the neuronal signals or action potentials are flowing. There isn't a place where "it all comes together" (Dennett, 1991, p. 107). If there is no central control room or experiencing room – Cartesian Theatre, as Dennett puts it – where all of the individuated signals combine and arrive as if to be represented in a unified experience, then it is unclear that there is another way to talk about experience other than in a distributed sense. "Distributed sense," rather than a localized place where "it all comes together," suggests that experience is smeared out across, at least, the central nervous system (CNS). That begs the question of what is different about the neurons in CNS and PNS? If philosophers of mind and neuroscience, or the neuroscientists themselves, can't distinguish the neurons then the periphery of the body, as with the

PNS, deserves some focus and mention when it comes to where experience is.

The second tacit thought is the peculiarity in the philosophy of mind literature in discussing c-fibers as being identical to pain, in that c-fiber firing is what pain is. Authors, beginning with Puccetti (1977), have pointed out that c-fibers are not themselves a part of either the dorsal column-medial lemniscus pathway or the lateral corticospinal tract. In other words, “they do not themselves project any higher [than the receptor cells on the spinal cord], and thus are not brain states when stimulated” (Puccetti, 1977, p. 303). The peculiarity is that philosophers have placed so much stock in a Cartesian way of thinking, in which the mind is housed by the cranial cavity, and yet one of the first opportunities philosophers take to discuss how the biological “wires” and “hardware” are the mental states results in a faux pas of placing the mental state outside of the brain. While this is a peculiarity on the part of identity theorists and adherents of functionalism, Aranyosi doesn’t take this move as a true faux pas: “[T]he real irony is that... they were basically right [that] pain is C fiber firing and anything else that involves the PNS’s activity within pain states! They were right for the wrong reasons” (Aranyosi, 2013, p. 41). The intuition of placing mental states beyond the skull, though not the intention of philosophers of mind, coincides well with the thinking that experience is distributed. With no reason to limit the distribution to CNS, the PNS can be taken as also possessing mental states. The emendation I will make is that the PNS and the entire nervous system *channels* experience, acting as a conduit for experiences in a Whiteheadian metaphysical framework.

As much as *The Peripheral Mind* is a boon for the views taken in this paper, there is

arguably even more support for a Whiteheadian understanding of the PNS from the shortcomings of Aranyosi’s book. While taking a much more empirical approach, noting relevant, well-known facts of neuroscience, the book lacks some amount of substance in that it doesn’t answer basic questions about the conclusions drawn throughout. One such issue that I would like to address is when Aranyosi says, “The fiber can be considered conscious in the sense of its activity being constitutive of a conscious state, say, a sensory state. What ‘conscious’ means at that level is, of course, nothing but being active or firing in a certain way, the way depending on what global conscious state it is a part of” (Aranyosi, 2013, p. 50). Problematic is why firing and being active takes the fiber from an unconscious state to a conscious state. The direction of the book is noble and, I think, right-headed, as it accounts for empirical, analytic, and phenomenological considerations; however, I perceive the weakness in the cited stretch of text is a problem of metaphysics. The Peripheral Mind Hypothesis (PMH), as he calls it, is not sufficiently undergirded with a metaphysical framework. Such a metaphysical framework should satisfactorily answer ontological questions, such as why a fiber is conscious when it is active and not when it isn’t. The apparently arbitrary claims don’t stop there. A logical extension of the privileged status of firing nerve fibers is that Aranyosi sets the neuromuscular junctions (NMJs) as sites that separate what can be conscious from what is never conscious, (i.e., muscle and whatever else is on the NMJ that is not, itself, part of the PNS). From this, one should detect that Aranyosi avoids moving into the realm of panpsychism by arbitrarily capping his arguments prematurely with stipulations. Drawn to their conclusion, the arguments could go a few different ways, depending on the metaphysics one takes up. For instance,

one might say that the nerve fibers, in a way, take on a constitutive role in consciousness whenever they fire, because there is already a property in their raw “material” nature, namely, a mind-like or mind-constituting property, as in some varieties of substance neutral monism (Stubenberg, 2016).

The transition in discussion to a proverbial Whiteheadian innervation can be made by noting, specifically, what Aranyosi’s struggle seems to be. As a project, *The Peripheral Mind* (Aranyosi, 2013) seems to rest upon the naive materialistic metaphysics of neuroscience, which, as discussed in the motivation for this paper, is not a tenable assumption or set of assumptions. More broadly, the materialistic line of thought is probably a major contributing factor for categories difficulties in philosophy of science, such as those generated by the notion of natural kinds. In fact, that can be seen in *The Peripheral Mind*, where the author never discusses the content of the nervous system at a level lower than that of “fibers” or “wires.” Thinking about the nervous system in terms exclusively for the sake of excitatory post-synaptic potentials and inhibitory post-synaptic potentials raises the individual neuron to a privileged status without considering the roles and relevance of intercellular and extracellular fluids – the soup of cations and anions (K^+ , Na^+ , Cl^- , and Ca^{2+}) with charged gradients qua “societies of electronic occasions,” as Whitehead would say (Whitehead, 1929/1985, p. 91). This thinking also fails to consider the consciousness/unconsciousness status of glial cells or components comprising the neuron itself. Are voltage-gated ions and metabotropic receptors conscious? What about when the fiber, the neuron, is undergoing an action potential? If one considers the physical process occurring during depolarization and the firing of the action potential, there actually is no one state

that is the “firing” of the neuron, but it is, instead, the series of events. It is far easier and more natural to think about the flows of ions across membranes and the movement of electric potential in the neuron, all, as flows and events. For this reason and more, I think the best answer to the above-asked questions is to formulate the answers in a way that makes consciousness a constitutive property of the world, and to make the focus of the discussion events, not objects or things in a piecemeal, disconnected sense. Whitehead’s metaphysics is supremely suited for this task.

The consequences of applying Whitehead’s process metaphysics and ontology to the understanding of the human organism are in stark contrast to attempts to understand the human organism from within a materialist framework. Neuroscience extends its machine-speak by extending the use of language to axons, referring to them as wires in many cases, but almost invariably referring to them in such a way as to imply that they are carrying signals, integrating signals in excitatory and inhibitory ways, and even processing signals in ways that are similar to binary computational processes (Churchland, 1986, pp. 210-211; Bear et al., 2016, pp. 132-140). The conditional assumption that gives rise to this perspective is one that supports the tyranny of the eye: if it can be seen, it is real, and if it cannot be detected by the eye, it is not real. In other words, the eye has exhaustive access to reality, whether that means direct or indirect access. This conditional assumption is peculiar for its radical contradiction with Seth’s hallucination characterization and the problematic nature of signal transduction (Raven et al., 2005/2014, p. 168). One might restate the conditional assumption with maximal irony, in the following sort of way: hallucinations exhaustively indicate what exists and what does not. If drawn out to its fullest logical extent, a self-referential truth

paradox will arise. The speculative process philosophy, in connecting the inside and outside of the organism, making the periphery of the organism no boundary at all, leaves room for interpretations as to how one should think about what's going on, if an organism is not merely an electro-chemical soup with signals floating around in it. The interpretation I offer here is one that moves away from the hubris of the tyranny of the eye, to a humbler conception, specifically, a conception that admits that we cannot see all of what is going on in the nervous system.

The intent here is not to deny what we see in neurophysiology. That there are things appearing as signal transmission between neurons with propagations down axons, seems beyond doubt. However, rather than electrons carrying information down a wire, it is more sensible to think of these visible phenomena as tracers for what is happening. The reasoning behind thinking these action potentials – or even the recognized smaller contents of cells, such as the cations, anions, and alpha helix components of ion channels – are merely tracers is that Whitehead tells us that actual occasions are not fully analyzable, but that they can be analyzed in parts through modes. “The philosophy of organism is a cell-theory of actuality. Each ultimate unit of fact is a cell-complex, not analysable into components with equivalent completeness of actuality” (Whitehead, 1929/1986, p. 219). Therefore, I propose that the way one views the influx of data from the nervous system be such that the flows of information be seen as flows of experience. On that score, the PNS and CNS can be thought of as a conduit of channels that directs experience around various pathways. Even this explication is not correct in the fullest sense. The view is still a bit materialistic and mechanical, thinking of experience as a fluid moving a round pipes. Just as the electromagnetic field “leaks” out of the pipe, that is the wire, so, too, we should

consider the nervous systems as guides for drops of experience, but that not all of which remain on the beaten path. With this caveat in mind for qualification of my subsequent manner of speaking, we can briefly discuss the role of the brain.

The swirlings of experience along the paths of the neuron somas and down the axons, across the synapses of the PNS, CNS, and the brain can only be clearly understood if one takes the view that the point of the flows is to gain a unified large-scale consciousness within the organism. Due to the complexity and nuances of the interchange of processes in the PNS with what happens in the brain, it is beyond the scope of this article to discuss the brain's role, specifically. More relevant is the role of negative prehensions at the peripheries of the organism, which will ultimately serve as a prelude to what the brain is and does. Of central importance, however, one should take stock of the fact that the type of content giving rise to each region of the body, in terms of giving rise to the structure and state of the body in time, is the same. That is, the PNS draws in actual occasions, and all of what we characterize as the contents of the cranium are, likewise, an ensemble of actual occasions. While actual occasions qualitatively differ in the PNS and brain, ontologically speaking, they are metaphysically the same type of thing; just as oxygen and nitrogen, in the materialist metaphysics, are of the same type (i.e., matter), while differing in ontological quality.

If we look at the human body, as well as organisms from earlier ancestral lines that are still extant, there is some indication that neurophysiology at the periphery is quite different, especially in terms of sense organs, and it is even clear that organismic to various forms of sense data arose in succession. For instance, the sudden wide-ranging eruption

of vision, as a mode of perception, in the Cambrian explosion was a significant event in the organismic evolutionary trajectory (Trestman, 2013). I argue that we can understand this more readily in the realist terms of Whitehead's conception of negative prehensions in the PNS and the specialized sensory pathways. Taking philosophical realism seriously, in simpler lifeforms, one would not expect an organism to draw in a complex holism of experience through its periphery, (i.e., organismic boundary) and utilize it comprehensively to perceive the environment. Rather, one would expect simpler data influx, which then could be used in a simplistic way to maintain its survival and successfully procreate. In Whitehead's categorial scheme, chapter two of *Process and Reality*, it includes a conception that describes what happens not only in any sense organ, but what can occur in any actual occasion: negative prehension – an elimination of feeling, which “holds its datum as inoperative in the progressive concrescence of prehensions constituting the unity of the subject (Whitehead, 1929/1986, pp. 23-24). Instead of viewing nociceptors, for example, as engaging in signal transduction resulting in pain signals from the domain of the skin, one can eliminate logical contradictions by viewing this process as entailing negative prehensions: with an overwhelming totality of feeling existing on the outer boundary of the organism, negative prehensions permit in a limited amount of what is available in the incoming drops of experience. Rather than the inundation of an infinitude, negative prehension allows for a simpler, more manageable influx of feeling. On this view, that simpler organisms are even without brains should not be very surprising. If what an organism is doing is channeling inward a small qualitative swathe of what is available in the environment, then more complex organisms, possessing more varieties of sensory experience, would need a

means to swirl around the “routes of experience,” whereby nerves serve as swirling paths to mix and combine experience. In fact, this is a remixing of what is already present in the external world, just beyond the horizon of the organism. Here, we arrive at a radically new evolutionary purpose for what the brain does in giving rise to consciousness. However special the brain is in the human body, for example, it is not quite as unique as the uninitiated might think. Let us look deeper into the PNS.

The enteric division (which I will refer to as “ENS” for enteric nervous system) of the autonomic nervous system (ANS), a division of the PNS, has two parts: the myenteric and submucous plexuses. They serve as the lining and source of innervation of the esophagus, stomach, intestines, pancreas, and gall bladder. This division is often referred to as the “little brain” by the mechanistically-minded neuroscientists (Bear et al., 2016, p. 535). Referring to this portion of the ANS as a brain used to be only due to the great independence with which it operates and the hundred million plus neurons contained therein. This observation turns out to have a deeper connection to the human evolutionary history. Researchers in the field of neuroscience have found compelling evidence to suggest that not only was the ENS probably in existence prior to the development of the cranially encased brain, which may have found its first neurons stem from what is now the colon, but the global operation of earlier evolutionary ancestors, for whatever global direction there was within the organism, seems to have been handled by the organism's gut (Furness and Stebbing, 2017; Spencer et al., 2018). Two decades before these researches elevated the status of the ENS, Michael D. Gershon, M.D. had taken up the thesis seriously, as his interest in the neurotransmitter 5-HT/serotonin, led him to focus on the gut, the

producer of over 95 % of the body's serotonin (Gershon, 1999, p. xii). While Gershon's work largely figures into the treatment of disease, directly, such as in addressing the poltergeist-like bowel and gut diseases, there is tremendous philosophical value in considering the ENS as a second brain that has self-managing functions and which takes on moods, emotional dispositions, and which may even be said to have instincts all its own.³

What this gut-as-brain thinking does philosophically is challenge any left-over Cartesian thinking remaining in neuroscience and philosophy of mind. To Chalmers and Clark's (2012) thinking that cognition "ain't all in the head," these neuroscientific researchers affirm the folk psychology of 18th and 19th centuries as if to say: yes, we knew this all along, but the knowledge of the feelings in our guts were persuaded by the reasons in our skulls (p. 1). By leaning their thought heavily upon phenomenology, Clark and Chalmers have generated and developed the conception of an extended mind, but the idea of embodied knowledge is not widely accepted among philosophers, and it isn't even accepted by Aranyosi in his philosophy on the PNS. The natural inclination to reject thinking about the ENS as a brain, even though it may have been the executive before there was one housed in a skull, is that one might find it difficult to accept that the gut has knowledge. In Part III, "Mind Embodied"

in *The Peripheral Mind*, Aranyosi resists many of the conclusions argued for by embodied minded, despite the fact that he's presenting a kind of "enminded body" approach; and one of these conclusions he dismisses is knowledge in the PNS. Aranyosi's mantra seems to be that all aspects of cognition are constitutive in the presence of some higher order manifestation: PNS firing, for example, is constitutive of a global awareness. Thus, I think he would say that a nerve cell firing is conscious in the body, in concert with those other constitutive firings, though not *in vitro*. The problem appears to be one of method. Analytically-minded philosophy views the world as building upwards from parts, and so this is a preeminent feature of Aranyosi's thought. It precludes the gut from having knowledge, primarily, because there isn't a sensible way to discuss abstract knowledge in the ENS – not that there is one for the cerebral cortex! The aspect of construction in Aranyosi's PMH is clear when one appreciates that he views the sense organs and PNS as one would roots of a tree, and where the roots draw in water the sense organs and PNS play a necessary and unique role in how the organism experiences the world.⁴ "[A] precise recreation of the experience of the external world will have to involve the peripheral reconstruction of a body, with all its relevant components, not only neural but hormonal and anatomical" (Aranyosi, 2013, p. 24). This thinking shines with brilliance as

³ I'll leave it for a future endeavor to examine the literature of feelings in relation to the gut – an idea that has fallen out of favor in the 20th century. Sufficient for this discussion is that there is an empirical and evolutionary reason for thinking this way, as well as a pragmatic reason, in that this way of thinking yields to medical application and a methodological research program for further inquiry. However, the reader's mind should, *tout de suite*, go back to the 18th and 19th century, when dispositional and emotional sense were lent to the gut; and to the history of philosophical thought, which afforded

deeper significance to the quality of digestion as it relates to the whole person.

⁴ I admit the shortcoming of this analogy in a number of respects. What tree roots draw in are the same as what is within the tree roots; and this is Whiteheadian, not what Aranyosi wants to say. As an aside, the tree root is an excellent representation of the nervous system as a Whiteheadian "nervous system ecology," similar to what Allan Combs (2011) communicates through a Lynn Margulis quote about the true nature of nerves in Ch. 3 of *The Radiance of Being*.

Aranyosi meets the question of, “What is it like to be a bat?,” with, “What is it like to be this bat versus that bat?” The philosophy developed is laudable, but the shortcoming in this is that it leaves no room for the gut to possess knowledge.⁵ Whitehead’s philosophy of organism allows for the “constitutive” element that Aranyosi’s PMH explicitly needs, without committing to any notion of a constructed experience. This is made possible through concrescence, prehension (especially, the idea of negative prehension), and the specific metaphysical makeup of the world, namely, actual occasions. This framework replaces our modern mechanical materialistic view of what happens at the organism’s boundary, so as to draw in the drops of experience, the actual occasions. All cells – each being societies of actual occasions – in various ways, will serve as portals or inward flows of experience through prehension. Philosophers and scientists tend to think of the sensory organ pathways (e.g., the auditory pathway) as carrying the only elements of experience, but with the shift to Whitehead’s philosophy, drops of experience are prehended along the entire outer manifold and envelop of the organism. The focus by philosophers and scientists on sense organs is entirely because of the relatively systematic fashion in which these pathways can access information, but the benefit and stability of drawing in a limited swathe of experience to be analyzed systematically comes at the cost of negative prehension. These pathways cut out some experience, allowing in more uniformly mode-specific varieties of what we

commonly mean by “sense experience” – each pathway drawing in its own specific feeling (e.g., aspects of vision). To put it squarely for the newcomer to Whitehead’s philosophy, “With the purpose of obtaining a one-substance cosmology, ‘prehensions’ are a generalization from Descartes’ mental ‘cogitations,’ and from Locke’s ‘ideas,’ to express the most concrete mode of analysis applicable to every grade of individual actuality” (Whitehead, 1929/1985, p. 19).⁶ Organisms are finite beings, and so the capacity to make sense of the whole drops of experience not entering through the sense organs, usually go without much conscious awareness; however, sometimes they mysteriously rise to the point of salient consciousness even if not fully understandable. For the parts of the sensory world that we have come to know from the supposed “five senses” we tend to give all the credit, but one should not cede to the tyranny of the eye, so to speak, assuming that the finite sense modalities of our human experience is exhaustive. Whitehead’s speculative philosophy suggests it is not exhaustive. Moreover, there is a seeming endless run of documented experience through various intellectual disciplines or in personal accounts wherein the experiences are mystical, whether that means they are not reproducible or are inexplicable in terms of our common modes of sense. The history of literature is peppered with unusual human experiences that are consistent with experience that is not derived from sense organs.⁷ One example comes in a passage of Joseph Conrad’s *The Heart of Darkness*:

⁵ It is worth taking the moment to remind ourselves that the framework in which experience is constructed fails, and this was addressed as one of the motivations of this paper in the opening salvo.

⁶ I include this particular bit, as it shows the metaphysical solution to the question posed by William James regarding how things outside of the organism might pass into the organism, considering, for example, a red cube outside of the organism is

extended and read, whereas the cube inside the organism’s boundary is neither actually red nor actually a cube (James, p. 487). There is no extended, red-colored thing inside the organism’s boundary, though it is red and extended in the mind.

⁷ Whitehead’s lingo does cover this conception formally with the terminology of “presentational immediacy” (Whitehead, 1929/1985, p. 121). I have consciously pulled back a bit on the Whiteheadian

“The fact is I was completely unnerved by a sheer blank fright, pure abstract terror, unconnected with any distinct shape of physical danger. What made this emotion so overpowering was – how shall I define it? – the moral shock I received, as if something altogether monstrous, intolerable to thought and odious to the soul, had been thrust upon me unexpectedly. This lasted of course the merest fraction of a second...” (Conrad, 1902, pp. 107-108)

The experience was not anchored in sensory modalities, which is why it was a “blank fright” and a “pure abstract terror.”⁸ Within the ambit of Whitehead’s philosophy, the experience is quite intelligible, since one *can* have experiences that are not so directly contingent upon the data coming in from sense organs. Another example is Mrs. Gradgrind in Dicken’s *Hard Times*, when Mrs. Gradgrind experiences a pain that is in the room (Dickens, 1854/2001).

Revisiting the ENS with a mind toward Whitehead’s philosophy of organism, the idea of gut feelings and experiences, especially somatic experiences, that do not seem to hinge on sensory organ input. Instead of electrical signals pulsing around the body, we can think in terms of the feelings or drops of experience (or actual occasions) swirling about the organism, mostly, but not exclusively, in the PNS – and the PNS is a

vocabulary, seeking a “middle way,” choosing to employ only those bits of verbiage that are unavoidable for the discussions of the philosophy of organism in this paper.

⁸ To reduce the concern that we are merely speaking from a vapid point of fiction, Whitehead provides more concrete experiences that are not grounded in presentational immediacy. One example of particular power is causation or causal connection, which one

series of conduits and canals channeling drops of experience, ushering them to other parts of the organism. In so thinking, we arrive back at a common understanding of how experiences or feelings are processed “in the gut,” such as in Nietzsche’s reference to this in his *On the Genealogy of Morals*: “If someone cannot cope with his ‘psychic sufferings,’ this does *not* stem from his psyche, to speak crudely; more probably from his stomach...A strong and well-formed man digests his experiences (including deeds and misdeeds) as he digests his meals, even when he has hard lumps to swallow” (Nietzsche, 1887/2013, p. 95). The common experience of gut feelings, whether about immediate dangers or the experiences of love or in moral consideration, lends to the decentralization of cognition leading it away from the throne of its former glory, spreading it around the body more democratically.

Concluding Remarks

The problems for philosophy of mind and neuroscience presented here, namely, the problem of signal transduction and the problem of where to go after the exorcism of mechanistic philosophy, I have suggested a resolution through by implementing Whitehead’s philosophy of organism. While the current scientific take, viewing the nervous system as merely electrical in nature, Whitehead’s metaphysical view of “substance” is one that dismisses with the mechanistic, materialistic world. It opts for a world of events, drops of experience, which can combine in the constitutive fashion that

might either deny like Hume, as it seemed to be a kind of “pure abstract terror” to Hume. The point is that not all of what exists in our world is given in presentational immediacy, despite there being very strong evidence for it. And the evidence of feelings that arise, not appended to sense organ data, are indicative of things in the world as shown in fictional literature.

Aranyosi (2013) discusses. This also eliminates the problem of signal transduction, because the kind of thing on the outside of the organism is the kind of thing that exists on the inside of the organismic boundary: actual occasions/drops of experience/feelings. The analyzed content of each incoming actual occasion may be different and sense organs of an organism may draw in a specific type of feeling through negative prehension, but it remains the case that these modes are drawing from the same kind of ontological and metaphysical entity,

actual occasions, which we do just as well to think of as drops of experience. The process and reality of the nervous system, then, is one of actual occasions producing a swirling buzz along the neuronal conduits. The body is furnished throughout with experience, provided by the rise of new actual occasions from other constantly concreting and satisfying occasions. In this Whiteheadian innervation, the living organism is brought to life with the satisfaction of feeling, which is situated in a realist ontology devoid of debilitating internal inconsistencies.

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