**How Subjects Can Emerge from Neurons**

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*AbstrAct: We pose a foundational problem for those who claim that subjects are ontologically irreducible, but causally reducible (weak emergence). This prob- lem is neuroscience’s notorious binding problem, which concerns how distributed neural areas produce unified mental objects (such as perceptions) and the unified subject that experiences them. Synchrony, synapses, and other mechanisms can- not explain this. We argue that this problem seriously threatens popular claims that mental causality is reducible to neural causality. Weak emergence addition- ally raises evolutionary worries about how we have survived the perils of nature. Our emergent subject hypothesis (ESH) avoids these shortcomings. Here, a sin- gular, unified subject acts back on the neurons it emerges from and binds sensory features into unified mental objects. Serving as the mind’s controlling center, this subject is ontologically and causally irreducible (strong emergence). Our ESH draws on recent experimental evidence, including the motivation of a possible correlate (or “seat”) of the subject, which enhances its testability.*

“Now it is, if I may so speak, an upside-down world if the trivial and low types of reality are simply immune to guidance by higher level types.”

—Charles Hartshorne, *The Logic of Perfection*, p. 226

# Framing the Debate

Searle (“Free Will”), Kim, and many others have claimed that thought, perception, and other forms of mental causality do exist, but are wholly reducible to (or preempted by) physical causality, such as neuronal inter- actions. For example, Searle states that

[t]here is no ontological reductionism in this account, because at no point are we denying that consciousness has an irreducible first- person ontology. But there is a causal reduction. Consciousness has no causal powers beyond the powers of the neuronal (and other neurobiological) structures. (“Free Will” 498)

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This article focuses primarily on a serious problem in this claim that subjects are *ontologically irreducible, but causally reducible* (weak emer- gence). This problem is neuroscience’s notorious binding problem, which concerns how distributed neural areas produce unified mental objects (such as perceptions) and the unified subject that experiences them. For example, how do the quite separate color, shape, and motion neural areas produce unified colored shapes in motion, and how are they perceived by a singular, unified subject? Synchrony, synapses, and other mechanisms cannot explain this.

Weak emergence advocates overlook this persistent problem con- cerning how neural activity binds to form unified mental activity. This shortcoming seriously threatens their claims that mental causality is reduc- ible to neural causality. Weak emergence additionally raises evolutionary worries about how we have survived the perils of nature.

Our emergent subject hypothesis (ESH) avoids these shortcomings. Here, a singular, unified subject acts back on the neurons it emerges from and binds sensory features into unified mental objects. Serving as the mind’s controlling center, this subject is *ontologically and causally irreduc- ible* (strong emergence).

We seat this subject in the brain’s electromagnetic (EM) field, partly because this field interacts with neurons and has continuity across distinct neuronal spaces and neuronal processing times, hence supporting the subject’s capacity to bind separate mental features into unified sensory objects. We do not identify the subject with its underlying neural EM field described by physics. The subject’s existence and causal powers are not reducible to the electrical activities specified by neuroscience—here the subject actually influences neurons in a recurrent, or top-down, manner via the field generated by the neurons. (This field theory is put in testable form in section IV.)

Our ESH draws on recent experimental evidence concerning the anesthetic effects on multimodal sensory binding, the brain’s EM roles in relation to the subject’s multimodal sensory binding, and the brain’s EM roles in relation to the subject’s guiding neuronal activities. In sections III and IV, we lay down this evidence and suggest ways to experimentally test the ESH. After addressing potential objections (in section V), we close by suggesting two possible paths to the irreducible subject from the perspective of current field theory (in section VI), namely nonreductive monist-leaning and dualist-leaning paths. For the former, we utilize the mental realism of Strawson and the process panexperientialism of Griffin.

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For the latter, we utilize the dualist-leaning field theory of Lindahl and Arhem. Breaking away from traditional (or purely analytical) versions of dualism, Lindahl and Arhem mount a sophisticated scientific defense of their theory. It is this appeal to empirical evidence, empirical tests, and the avoidance of empirical problems that distinguishes our ESH from purely analytic approaches to the subject’s strong emergence.

# Weak Emergence: Searle’s Biological Naturalism

Searle advocates a species of weak emergence called biological natu- ralism, whereby “all of our mental phenomena are caused by lower-level neuronal processes in the brain and are themselves realized in the brain as higher-level, or system, features” (*Philosophy* 152). Searle bolsters this view by drawing distinctions between (1) the elements that compose a system, (2) “system features,” and (3) “causally emergent system features” that cannot be deduced or predicted from an analysis of the sheer phys- ical structure of any given element (*Rediscovery* 112). Let us suppose, for example, that we have a neural system (NS) composed of neurons, a, b, c, and so forth. But NS has features that are not the features of a, b, c, and so forth. NS weighs four pounds, but each neuron does not weigh four pounds. The weight of NS is a system feature. Nonetheless, the weight of NS is a system feature that can be deduced from the weight of its indi- vidual neurons. However, there are some features of NS that cannot be deduced from the features of its individual neurons. One of these causally emergent system features is transparency, which cannot be figured out from the sheer physical structure of its underlying hydrogen and oxygen molecules (e.g., weight and shape), nor from its environmental relations. An explanation of transparency must also take into account the causal interactions among its underlying molecules. Similarly, first-person con- sciousness itself cannot be deduced “from the sheer physical structure of the neurons without some additional account of the causal relations between them” (Searle, *Rediscovery* 112). If we cannot deduce transparency from its underlying physical elements, how could we ever deduce the reality of first-person consciousness from its underlying physical elements?

But being committed to an irreducible ontology of consciousness on grounds of its first-person (or subjective) character, Searle maintains, does not entail a commitment to Cartesian substance dualism, where con- sciousness can exist apart from bodies. For mental phenomena might be nothing greater than emergent features of a suitably organized biological system.

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Searle describes two forms of mental emergence. In the weak form, which he accepts, the causal relations that hold among neurons could account for the causal efficacy of consciousness (Searle, *Philosophy* and “Free Will”). In the stronger form, which Searle rejects, consciousness could cause events, including neural ones, that could not be explained by inter-neuronal causal relations: “The naïve idea here is that consciousness gets squirted out by the behavior of the neurons in the brain, but once it has been squirted out, it then has a life of its own” (*Rediscovery* 112). A standard claim here is that current neuroscientific accounts of behav- ior make no reference to consciousness, so strong emergence is unlikely. While this might be credible if neuroscience was close to fully explaining behavior in purely neuronal terms, the current neuroscience of even basic perceptual activities is actually far from complete in this sense. So the explanatory power of current neuroscience offers little support for claims that the highest levels of creative imagination, for example, will ultimately be explained in purely neuronal terms.

## Shortcomings of Weak Emergence

In this section we address weak emergence, where subjects are onto- logically irreducible, but causally reducible, to brains. We argue that weak emergence, such as Searle’s biological naturalism, fails to account for unified sensory objects and the unified subjects who experience them and raises evolutionary worries about how we have survived the perils of nature.

Advocates of weak emergence must face up to the problem of object unity (which involves providing an account of how distributed mental features are bound into a unified object of consciousness). Evidence culled from the visual neurosciences strongly indicates that consciousness of an object’s features relies upon neuronal areas distributed across the visual hierarchy. For example, damage in visual area 4, an area of the ventral system, produces achromatopsia (i.e., color blindness), damage in the inferior temporal lobe produces associative agnosia (i.e., the inability to identify shapes); and damage in visual area 5 produces akinetopsia (i.e., motion blindness) (Crick and Koch). Moreover, specialized neuronal areas have been identified within the dorsal system, which correlate with spatial attention, spatial representation, and the ability to differentiate the spatial parts within an object as well as between objects (Robertson). Recent data also indicate that the processing sites that encode the respective fea- tures of an object operate asynchronously, with temporal gaps as great as

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eighty milliseconds (Zeki, “Disunity” and “Massively”). Thus, what we currently know about the visual system is that it consists of specialized processing sites that operate at different times and spaces (for further empirical details, see LaRock, “Why,” “Disambiguation,” “Intrinsic,” and “Philosophical”; also Mashour and LaRock; Persuh, LaRock, and Berger). These data motivate the following foundational question: if the neurons that respond to an object are distributed in space and time, then how is a single, unified object of consciousness possible?

The foregoing data set poses a foundational challenge to weak emer- gence (of the sort advocated by Searle and others). For, according to weak emergence, all macro-level mental features are caused by and realized in their geographically distinct micro-level neural processes. A color feature is caused by and realized in visual area 4, a motion feature is caused by and realized in visual area 5, a figure feature is caused by and realized in visual area 3, and so forth. By implication, the distinct features of an object are caused by and realized in their respective geographically separate neuro- nal areas, and thus it is not clear how weak emergence could account for object unity (see LaRock, “Disambiguation” and “Cognition”).

Proponents of weak emergence must also confront the problem of subject unity (or the problem of explaining the singularity intrinsic to every conscious experience and how that singularity relates to the unity of consciousness across modalities of the brain). For example, I hear waves crash against rocks (an object of audition) while seeing a star fall from the night sky (an object of vision). I have these two objects as part of my total experience. Thus a further question arises for any theory that purports to offer an explanation of experience, and that is a question about subject unity: how could a distributed account of objects (or features) within and across different modalities of the brain explain subject unity? Notice, neither phenomenal unity nor the bearer of such unity could be identical to distributed physical processes across different sensory cortices and/or their correlated sensory phenomenal features, for that would entail the very problem under discussion.

Without such unity, the world would appear as an unconnected set of features—a phenomenal cacophony—and this would raise a worry about how we have survived the perils of nature. For example, while hearing and seeing a predator, a part of the brain processes information about a predator’s roar and another part processes information about a predator’s location, but there is no brain part that unites a predator’s roar and location. Given weak emergence, these sensory features would remain

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geographically separate and thus one would not know whether the roar is north, south, east, or west; consequently, one would not be able to devise a plan to avoid the owner of that roar. If the roar belongs to a hungry predator, then one would most likely become that predator’s next meal. But evolution does not favor fifth wheels (or that which has no bio- logical function and thus is explanatorily irrelevant). Hence, it is unlikely that consciousness—a feature so central to our lives—would emerge as an irreducible feature and just ride on the fray of neural activity much like froth rides on a wave (Kosslyn and Koenig 433; also LaRock, “Dis- ambiguation”). And any appeal to the principle of transitivity (on Searle’s behalf) or to the principle of the causal closure of the physical world (on Kim’s behalf) will not suffice as a scientifically tenable rebuttal here. For those principles of causation and explanation would be true only if science were in a state of completion—presumably a state that included the con- firmation of those principles. But science is not in a state of completion. So advocates of weak emergence (or supervenience physicalism in Kim’s view) cannot mean that we currently possess a sufficient account of con- sciousness, including its causal powers, entirely in terms of its underlying physical bases (LaRock, “Disambiguation”; Jones, “Mounting”; Hasker; Davies). The foregoing problems, among others (see Lowe), seriously threaten popular claims that mental causality is reducible to neural

causality.

# ESH

Under our ESH, a unified, irreducible subject acts back on the neu- rons it emerges from and functions to integrate mental features across modalities of its brain.

## Subject Unity and ESH

In our ESH, phenomenal features do not float freely; they belong to (or inhere in) a subject. Thus, whenever a brain correlates with phe- nomenal features, it also correlates with a subject for the binding (or integration) of those features (see LaRock, “Disambiguation” and “Cog- nition”). Analytic philosophers, who posit a subject (or self ) to account for such unity, are not alone on this score. For example, British neurosci- entist Semir Zeki (“Disunity” and “Massively”) argues that because the functional architecture of the brain essentially involves distinct tempo- ral hierarchies—in virtue of processing an object’s features at different times—the subject, rather than the brain, is the only feasible ontological

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ground of a single unified consciousness. Similarly, Sir John Eccles, the Nobel prize-winning neuroscientist, argued for a similar view several decades ago: “[T]he experienced unity comes, not from a neurophys- iological synthesis, but from the proposed integrating character of the self ” (Eccles and Popper 362). Eccles proposed that the self (or subject) functions to select and integrate information pieces from different mod- ules in the liaison area of the dominant hemisphere. Unlike Eccles, we are willing to grant that attention mechanisms function to select sensory information pieces from geographically separate areas of the brain (see section V). But we still agree with Eccles (and, by logical extension, with Zeki) that the subject (or self ) plays a fundamental role of binding (e.g., cross-modal binding). At the same time, we must delve a bit deeper into the scientific underpinnings of integration. Hence, we go beyond the usual, purely analytic, formulations of strong emergence by suggesting the testability of our ESH with respect to cross-modal sensory unity in light of recent advances in neuroanesthesia. Under our ESH, the subject is crucial to multimodal sensory feature binding.

## Anesthesia and ESH: Toward Testability

Presumably a subject is closely linked to the neurochemistry of its brain. Certain anesthetic agents are thought to induce unconsciousness by impacting key neuronal hubs in the dorsolateral and prefrontal areas. We lean toward the possibility that what is being rendered unconscious is the subject—the “executive center” of cross-modal binding—instead of the brain to which the subject relates. This distinguishes our ESH from certain traditional views that link the subject to consciousness at all times (e.g., Descartes). Under our hypothesis, a subject is capable of possessing both conscious and unconscious properties.

For example, Warnaby and colleagues at Oxford University recently demonstrated that propofol anesthesia consistently suppressed a specific part of the dorsolateral insula cortex after loss of behavioral responsive- ness1 and that suppressing the dorsal anterior insula cortex leads to a breakdown of frontoparietal feedback. From these findings, Warnaby and colleagues hypothesize that the dorsal anterior insula cortex might function as a cortical gate for the subject of consciousness with respect to multimodal sensory processing.

How do the findings of Warnaby and colleagues relate to our ESH? If the cortical gate is closed (e.g., due to anesthetic suppression), the subject cannot access diverse sensory information states and their related

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phenomenal features and thus cannot bind those states and their related phenomenal features into a unified object of consciousness. In sum, when you suppress the dorsal anterior insula cortex (and perhaps other critical neuronal hubs), you suppress the subject’s function to bind sensory-based phenomenal features across modalities of its brain.2

The foregoing experimental data suggest a way in which to test our ESH, which distinguishes it from the usual, purely analytical, theories of the subject’s strong emergence. Even so, further progress is needed to explain *how* subjects can emerge from neurons. In section IV, we address this issue and provide further details of the testability of our ESH.

# How Subjects Can Emerge via Electromagnetic Fields

The argument above is that the subject is not reducible to the brain but emerges from the brain, binds phenomenal features across cortical areas, and possesses causal powers to influence the neurons from which it emerges. But questions remain. How can a subject that is not reducible to the brain causally influence the brain? Also, how can a singular, physically irreducible subject emerge from billions of distributed processes? Simply replying that the subject encompasses a space greater than its underlying neuronal correlates may seem platitudinous and nonempirical. We need a proximal seat of the subject (hopefully at fundamental levels) that allays such worries.

We will seat this subject in the brain’s electromagnetic (EM) field, partly because this field interacts with neurons and has continuity across distinct neuronal spaces and neuronal processing times, hence supporting the subject’s capacity to bind separate mental features into unified sensory objects. This field theory is put in testable form below.

## Seating Subjects in Fields

EM field theories of mind arose from renowned thinkers like Kohler, Libet, and Eccles and Popper. They proliferated because they draw on considerable experimental evidence, withstand past criticisms, and help to avoid neuroscience’s serious problems concerning mental unity and sensory qualia (see Jones, “Electromagnetic”).

Our own field theory of mind seats subjects in neuroelectrical activity (i.e., in neuronal electricity and the electromagnetic field it generates). Here the term “seat” will specify an intimate yet nonreductive relation- ship in four ways. (1) The subject is proximally related to the brain’s EM field, which reaches locally along its circuitries—rather than reaching

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globally across the brain, which raises various problems. (2) The subject’s existence and causal powers are not reducible to the electrical activities specified by neuroscience—here the subject actually influences neurons in a recurrent, or top-down, manner via the field generated by the neurons.

1. The subject performs cross-modal binding operations from the field instead of from discrete neurons or separate brain areas. (4) Grounding the subject in the brain’s EM field may enable us to explain in testable ways how different sensory qualia arise, while avoiding serious problems that standard neuroscience faces with qualia.

The details of some possible metaphysical positions concerning how subjects are seated in neuroelectrical activity are spelled out in the final section below. But before entering metaphysical meditations, we begin by examining some foundational evidence for our approach to field theory.

* 1. The subject is proximally related to the brain’s EM field, which reaches locally along its circuitries and has certain theoretical advantages over global field theories. For example, locally activated electroencephalo- grams (which trace local fields versus global fields across the brain) track conscious perception better than other known methods (Koch et al.). This supports our field theory, in which perceptions depend on strong, localized fields in sensory areas. These local fields reach along the dif- fuse ion currents around neural circuits. They can even extend between nearby circuits. Incidentally, these local fields can avoid problems raised by global field theories concerning sensory qualia and external fields. The latter inevitably faces vagueness worries about the boundary conditions of conscious perception and thus would not be theoretically equipped to identify the precise neural correlates of conscious perception (for further empirical details, see Jones, “Electromagnetic”).
  2. Under our ESH, the subject influences neurons in a recurrent (top-down) manner via the field generated by neurons. That is, fields are not impotent by-products (epiphenomena) of neurons, as often thought. Instead, fields actually act back on the neurons that generated them, as field theories have long claimed. This fits recent mounting evidence (e.g., Anastassiou and Koch) that neural EM fields do in fact act back on neurons in ways that help shift the focus of attention and guide brain activity. So seating the subject in neural fields may further show how subjects can influence their brains by exerting a top-down causal influ- ence on neurons during recurrent processing (for empirical details on the subject’s top-down causal role during recurrent processing, see LaRock, “Disambiguation”; Jones, “Mounting”).

**Quanta:** Neurons Unexpectedly Encode Information in the Timing of Their Firing A temporal pattern of activity observed in human brains may explain how we can learn so quickly. Author: renken 2021

**Here’s latest binding acct in origl form of DCSD 2020:** Neuroscience’s unresolved binding problem concerns how distributed neural areas create unified mental objects (perceptions, thoughts, etc.) and the unified subject that experiences them. This binding isn’t explicable by neural mechanisms such as synapses, synchrony, or attention.

To start with, “there is no single cortical area to which all other cortical areas report exclusively, either in the visual or in any other system” (Zeki, 1993, p. 296; also Zeki 2003, 2015). More recent studies still find no evidence that a single, central brain circuit binds cortical activity into unified, coordinated experience (XX 2019). This isn’t surprising, given the combinatorial capacity limitations of brain circuits (Crick & Koch 2003; Engel 2003; XX 2007a; Singer 1999, 2007; von der Malsburg 1999; Zeki 2003, 2015b).

Specifically, visual processing uses separate, parallel circuits for color and shape, which raises the binding problem of how they combine to form complete images. Ascending color and shape circuits have few, if any, synapses for linking their cells to create colored shapes (Zeki 2003). Arguably, Zeki overlooks how feedbacks from higher cortex into lower cortical maps might indirectly bind color and shape (e.g., Kawato, 1997). But to encode detailed images, feedbacks would have to systematically connect shape and color features point by point all across lower cortex, which hardly seems plausible.

As already argued, neuroscience has problems explaining how different circuits bind together to produce unified experience. NCSD can explain binding in terms of EM fields. The brain’s EM field interacts with neurons and has continuity across separate neuronal spaces and neuronal processing times, hence supporting the subject’s binding operations. We’ll look now at evidence that fields can avoid two kinds of object binding problem.

(1) Neuroscience has a difficult time explaining mental unity in terms of the convergence of processing upon a single cortical area. For “there is no single cortical area to which all other cortical areas report exclusively, either in the visual or in any other system” (Zeki, 1993, p. 296; also Zeki 2003, 2015). More recent studies still find no evidence that a single, central brain circuit binds cortical activity into unified, coordinated experience (XX 2019). Again, this isn’t surprising, given the combinatorial capacity limitations of brain circuits (Crick & Koch 2003; Engel 2003; XX 2007a; Singer 1999, 2007; von der Malsburg 1999; Zeki 2003, 2015b)).

Such evidence may seem to support Daniel Dennett’s insistence that there’s “no central Headquarters” where all processing comes together, but just “multiple channels in which specialist circuits try, in parallel pandemoniums, to do their various things....” (Dennett 1991, p. 257-258). This view would preclude binding altogether. But Anne Treisman’s (2003) research on false bindings (binding properties from the wrong objects) has provided one of many lines of compelling evidence that cognition does rely on binding. A further problem for Dennett here is that he continually conflates consciousness and attention. There’s now strong evidence that the two are distinct (e.g., Koch and Naotsugu Tsuchiya, ‘Attention and Consciousness: Two Distinct Brain Processes,’ Trends in Cognitive Sciences, Vol. 11 (2006): 16-22).

So, if binding is real and convergent processing can’t explain it, what can? Although the brain doesn’t have a single, central circuitry to bind all its experience together, the brain does have a single EM field that reaches along its circuitries. This strong, local field reaches across discrete neurons and separate brain areas in a continuous form (for quanta in strong fields form a probability cloud of continuously high energy). Even where circuits don’t connect synaptically, the neural field can unify them so long as their ion currents and field make contact. This continuity supports the cross-modal binding of percepts, emotions, and thoughts that we attribute to the subject. These diverse modes of experience are ultimately unified by and inherent in the subject. There’s growing evidence that oscillating fields play roles in unifying perception, attention, etc., as already noted.

This argument that fields bind experience doesn’t deny that there are various processing hubs in brains that could help unify experience. For example, the dorsolateral prefrontal cortex helps control attention and working memory (see §III above). But as just noted, there’s no evidence that it (or any other structure) serves as a single, central brain circuitry that binds all experiences together. Nor do these high-level hubs explain how unity arises in lower-levels activity, such as between color and shape circuits, which are both spatially and temporally dispersed. Similarly, these high-level hubs don’t account for the unity of preattentive experience (for example, as we scan a crowd to find a friend, most of the scene is preattentive at any one time). So, it’s unclear how brain circuitries alone can account for overall mental unity. The point is that fields can help deal with this problem.

(2) Neuroscience also has a difficult time explaining mental unity in terms of binding by synchrony. As already argued, the brain’s color and motion pathways lack systematic synaptic connections in both space and time (Zeki, 2003, 2015). The pathways’ temporal gaps are as great as 80 milliseconds. So it’s unclear how these pathways alone can bind to form singular images of colored objects in motion.

Field theories can avoid this problem, for the brain’s EM field can reach across pathways where they’re adjacent (as in some cortical maps) to pool shape and color elements together in images. Here synchrony plays an indirect role by sometimes fortifying neuronal fields, that is, by making the peaks and troughs in field oscillations align. As noted above, there is much evidence that synchronized EM fields of various frequencies play roles in perception, attention, working memory, etc. But it’s evidently the fields’ strengths, not their synchronies, that do the binding.

This approach explains why unified consciousness is lacking in synchronous activities during anesthesia, seizures, etc. Here, hypersynchronous firing separated by long pauses wholly disrupts and jumbles sensory awareness in neural fields. More generally, these fields explain what other mechanisms often failed to — why unified consciousness has been found only in neural systems and why it extends from simple preattentive percepts to the complex thoughts.

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* 1. We propose that the brain’s EM field interacts with neurons and has continuity across separate neuronal spaces and neuronal processing times, hence supporting the subject’s cross-modal binding operations. An advantage of this proposal is that it can avoid serious problems in neuro- science’s standard binding theories, which try to explain mental unity in terms of a single cortical area or neuronal synchrony. To start with, Zeki (along with many other neuroscientists) points out that “there is no single cortical area to which all other cortical areas report exclusively, either in the visual or in any other system” (*Vision* 296, “Disunity,” and “Massively”). But, as just suggested, the brain does have an EM field that reaches locally along its circuitries. This strong, local field reaches across dis- crete neurons and separate brain areas in a continuous form. Quanta in strong fields do form a probability cloud of continuously high energy. This continuity supports the cross-modal binding of percepts, emotions, and thoughts that we attribute to the subject. These diverse modes of experience are ultimately unified by, and inhere in, the subject (recall

section III above).

Seating the subject in the brain’s EM field helps avoid a second prob- lem in neuroscience’s binding theories. The brain’s color and motion pathways lack systematic synaptic connections in both space and time (Zeki, “Disunity” and “Massively”). The pathways’ temporal gaps are as great as eighty milliseconds. So it is unclear how the pathways alone can bind to form singular images of colored objects in motion. Field theories can avoid this problem, for the brain’s EM field can reach across pathways to pool this distributed information at micro-levels, hence supporting the subject’s binding operations at macro-levels.

In one standard approach, synchronized firing by neurons binds them into a conscious unity. The difficulty here is that perceptual binding occurs without synchrony in many studies, and synchrony is enhanced during certain anesthesia and seizure events, though such events lack consciousness (Koch et al.; LaRock, “Hard Problems”). To avoid these problems, our approach can argue that the brain’s EM field reaches across (and connects) neurons and that synchrony just plays an indirect role by fortifying neuronal fields—by making the peaks and troughs in field oscillations align. In our approach, when the subject is knocked out by anesthesia or seizure, you disrupt the field, which in turn leads to a break- down of functional connectivity between the crucial neuronal hubs that correlate with consciousness (also see the section “Anesthesia and ESH” above).

Elabortn: It might be replied that field strength isn’t enough by itself to account for unified consciousness, for strong, synchronized fields occur during seizures (for example), but consciousness is absent. But NPT still relies solely on field strength to unify consciousness. The lack of this unfied consciousness in seizures is explained as follows. These “electric storms,” disrupt the oscillating electrical fields localized along circuits that run between brain areas. Such circuits normally help to carry out information processing between areas and to sculpt the focus of attention, select the content of working memory, and conduct the operations of imagination and other cognitive activities (Bastos et al., 2018; Ezzyat et al., 2018; Kay et al., 2020). When the electrical activity of circuits is disrupted by seizures, connections and coordinations between brain areas break down. The EM fields that unify consciousness are shattered.

“During unconsciousness, disrupted connectivity in the brain and greater modularity are creating an environment that is inhospitable to the kind of efficient information transfer that is required for consciousness.” Timescales of Intrinsic BOLD Signal Dynamics and Functional Connectivity in Pharmacologic and Neuropathologic States of Unconsciousness. Zirui Huang, Xiaolin Liu, George A. Mashour and Anthony G. Hudetz. Journal of Neuroscience 28 February 2018, 38 (9) 2304-2317.

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In another standard approach to binding, focal attention binds dif- ferent perceptual features into a unified, conscious object—as when we suddenly spot a familiar face while scanning a crowd. The difficulty is that binding can occur without attention. In experiments by Treisman, subjects reported false bindings of color and shape as their attention was diverted. But these subjects have still performed the function of binding, albeit of a false binding sort (for details, see LaRock, “Disambiguation”). Field theory can help to explain this experimental result by arguing that fields play a supportive role of binding colors and shapes by connecting neurons even at preattentive levels in visual pathways. Relying on Lamme, field theory can add that recurrent signals into the lower cortex, accompa- nied by stronger firing, can fortify fields there and help to connect neurons that underlie raw colors and shapes. (For more evidence of preattentive awareness, see Tsuchiya and Koch.)3

* 1. Grounding the subject in the brain’s EM field may enable us to explain in testable ways how different sensory qualia arise without two serious problems standard neuroscience faces here. The first problem is that neuroscientists often attribute qualia to special circuits (labeled lines) with their own detectors and processing areas. This processing is enhanced by comparisons of detector outputs to resolve ambiguities about which sensory stimuli are present. But these operations of stimuli detections and signal integrations are so similar in the various sense modes that it is unclear how processing circuits actually differ enough to account for stark differences in their qualia. The second problem is that neuroscien- tists often attribute qualia to sensory processing that culminates in highly integrated cortical levels where attention operates. But this conflicts with evidence that colors and shapes can bind at preattentive levels in the lower cortex (see Lamme above).

To avoid the first problem above, our approach can draw on rapidly growing evidence that different sensory qualia correlate with intense, localized electrical activity in different sensory-detector cells. These cells reside at all levels of sensory circuitries, not just attentive levels, avoiding the second problem above. The electrical activity occurs in the cells’ mem- branes, specifically, in their ion-channel proteins and G-protein-coupled receptors (GPCRs).

An example of these qualia-protein correlations is that temperatures correlate with unique ion channels, including TRPM8 for cold, TRPV3 for warm, and TRPV1 for hot (Wang and Siemens). Also, sweet tastes correlate with the unique GPCR complex of T1R2 and T1R3, savory

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correlates with the complex T1R1 and T1R3 (Zhao et al.), and bitter cor- relates with the large GPCR family TAS2R (GeneCards). Additionally, the primary colors correlate with OPN1MW, OPN1LW, and OPN1SW, which are GPCRs of the opsin class (GeneCards). There are far too many correlations across the various sense modalities to cover here. Such correla- tions arguably apply also between emotional qualia and limbic hormonal receptors (Pert and Snyder).

If all our different qualia ultimately do correlate with different electrically active proteins in detector cells, this would support our elec- trochemical correlational approach to qualia over problematic existing theories of how different qualia arise. This makes our approach testable.

# Objections to ESH and Replies

Daniel Dennett would insist that there is “no central Headquarters” where all processing comes together. Instead, there are just “multiple chan- nels in which specialist circuits try, in parallel pandemoniums, to do their various things” (Dennett 257–58). So the very idea of binding—in which a single, irreducible subject functions to bind features across modalities of its brain as our ESH posits—must be misguided.

Therefore, it would be helpful if one could provide some additional evidence to support the claim that visual (and perhaps other modes of) consciousness usually involves processes of binding. We think that our ability to produce false bindings (i.e., binding features from the wrong objects) argues in favor of the view that we do carry out processes of bind- ing. For example, Anne Treisman’s experimental research on false bindings has provided compelling evidence in a way that coheres with our ESH. In one experimental setup, subjects were shown two colored letters at the same time: a green T and a red O. The experimenters found that when the focus of attention was prevented by means of a brief presentation of the letters, subjects would experience false bindings: the subjects reported seeing “a red T when a green T and a red O” were presented at the same time (Treisman 99). Consequently, red, rather than green, was bound to the shape of T and the result was an experience of false bindings. What is interesting is that these subjects have still carried out processes of binding, albeit of a false binding sort.

A further inference that can be drawn from the above data set is that attention and consciousness are not the same, since consciousness arises even when attention is prevented. This would challenge recent attempts to identify consciousness with attention, a tendency that Dennett, at times,

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manifests when advocating his theoretical preferences about the (purely) functional character of consciousness (see Koch and Tsuchiya).

Promissory materialists may raise another objection. There may be no need for a subject to bind experiences, for eventually neuroscience will reveal a convergence zone in the brain, a central neuronal place where a subject’s thoughts, images, pains, phenomenal features—mental con- tents in general—come together as a unity. But even if we supposed (or stipulated) that there were a convergence zone in the brain, such as the claustrum (or even the dorsal anterior insula cortex and/or frontoparietal areas), that convergence zone would be composed of (finer) parts and thus the binding problem would likely surface once again.4 Therefore, a convergence zone in the brain is an unlikely candidate of binding.

Having addressed some potential objections to our ESH, we close by suggesting two possible ways to the irreducible subject from the perspec- tive of current field theory.

# Epilogue: Possible Ways to the Irreducible Subject

Field theory currently offers two possible ways of explaining how sub- jects can exist irreducibly and possess powers beyond physical laws. Recent field theories that are either dualist-leaning or nonreductive monist- leaning can draw on the evidence and explanations above (in points one to four of section IV) for correlations between EM/electrochemical activities and the subject’s unified perceptual, emotional, and other experiences. Both theories can also draw on the evidence above for the interaction of such experience with brain circuits. These theories can do these things without the costs of either traditional dualism or reductionism. In the closing paragraphs, we briefly explore these possible theories.

* 1. Traditional dualists argue that subjects exist nonphysically. This faces the problem of how radically different subjects and brains can inter- act. But Lindahl and Arhem mount a sophisticated defense of more recent dualist-leaning field theories—from Kohler, Libet, Eccles, and Popper— that do not seem vulnerable to this traditional dualist worry. They argue that the subjective mind is nonphysical and irreducible to brain events yet still interacts with the brain’s action-potential patterns via the mediation of the brain’s EM field. This can fit claims above that emergent subjects are seated in the brain’s EM field and have a causal and unifying presence in relation to their brains.

Lindahl and Arhem develop evolutionary arguments against causal reductionism that reinforce those in section II above. They also defend

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dualist interactionism by, for example, drawing on Popper’s view of De Broglie’s pilot waves. Empty pilot waves are not linked to particles and do not carry energy. In some views, they can interfere with nonempty, energy-carrying waves. Nonenergetic processes may thus influence ener- getic processes such as membrane potentials poised at firing thresholds. This could explain how autonomous subjects that are incorporeal, none- nergetic, and not directly observable could—via EM fields—have a causal presence in brains and influence physical operations there. Their theory thus closely aligns with our ESH.

* 1. Alternatively, a nonreductive monist field theory could draw on realist ideas that we access our experiences directly but perceive matter indirectly by instruments, reflected light, eyes, and so forth. So, we cannot know matter’s underlying reality beyond its sensory appearances. Authors from Russell onward have further argued that we cannot know what brain matter is really like beyond perceptions of it. For all we know, the under- lying reality of the brain could be the mind.5 Galen Strawson adds that all matter-energy could be conscious in this way. While it may be unusual to treat all matter and fields as correlating with consciousness, Strawson shows that it avoids perennial mind-body problems. A comparable view, briefly discussed below, appears in the process panexperientialism of Griffin.

These are now well-established positions. They do *not reduce* conscious activities to the observable activities of neuroscience (which creates an explanatory gap). Instead, the conscious subject is the *underlying reality* of neural activities beyond neuroscience’s descriptions of them. This coheres with a nonreductive monist field theory in which the mind, the under- lying reality of the brain, gives rise to a subject whose causal powers are autonomous of physics (Jones, “Mounting”; Hartshorne6). For when we weigh moral feelings, or even choose which foods taste best, these qualia comparisons are determined by the conscious, underlying reality of our neural fields, not by principles of electrodynamics (counter to superve- nience physicalism).

This nonreductive monist field approach could support a process panexperientialism in which experience is fundamental and ubiquitous in processes (see Griffin). Here, fields could unify the micro-experiences in neuronal processes to form a single macro-experience of a colored shape. This process approach may choose to treat experience as ubiquitous while treating consciousness as the higher-level, subjective, volitional form of experience. Other nonreductive monist field theories may choose to treat experience and consciousness as synonyms.

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This overall conception of nonreductive monist field theory, like Lindahl and Arhem’s dualist-leaning field theory, backs core claims of our ESH—that the subject performs cross-modal binding and interacts with its brain via its EM field—yet exists irreducibly and is autonomous of physical laws.7

# Notes

1. While loss of behavioral responsiveness is currently the only objective mea- sure that neuroscientists use to infer the loss of consciousness, we acknowledge and have published elsewhere that loss of behavioral responsiveness per se does not necessarily entail unconsciousness. In rare cases (approximately one to two out of a thousand), confirmed by broad studies in Europe and America, loss of behavioral responsiveness has been achieved, and yet consciousness is still present without any objective indices. For empirical details, see Mashour and LaRock; LaRock, “Philosophical.”
2. For further empirical details on anesthesia and the subject’s strong emer- gence, see LaRock, “Hard Problems.”
3. Binding in consciousness arguably occurs at this intermediate level, since the lower-level processing is too piecemeal, and higher-level processing is too abstract (see Prinz, “Intermediate”; LaRock, “Disambiguation”). This fits the data surrounding the “viewer-center” (or point of view) intrinsic to experi- ence and its explanatory relevance to questions about survival in real-time scenarios. That object recognition is dependent on the viewer-center of the subject also explains why visual agnosics can see objects without recognizing them. The subject, seated in the EM field, appears to be engaged in some crucial biological way at this intermediate level of neuronal organization during perception.
4. Incidentally, there are, in fact, multiple competing theories about the function of the claustrum. Some theorists hypothesize that the claustrum functions as a synchrony detector and others a salience detector. The latter has important evolutionary benefits: if one can detect the presence of a lion through its characteristic roar, then one can deliberate over competing action plans to avoid it. This salience capacity is categorical by nature and hence is linked to our capacity to recognize objects on the basis of salient cues. See Smythies et al.; Remedios et al.
5. This conception of the fundamental ontology of mind does not originate in British philosophy but has rather ancient philosophical roots (see Hartshorne).
6. Similarly, Charles Hartshorne, a pioneer of the process philosophy movement, argued for “psychical monism,” which maintains that “mind is primordial” (211). It is monism without materialism.

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