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How To Make Mind–Brain Relations Clear

Abstract: *A clear, simple mind–body solution is suggested here. Neuroscience is finding growing evidence of neurochemical correlates to memory, perception and emotion. This supports mind-as-brain views over mind-as-computer views. Admittedly, the former can't intelligibly reduce privately experienced pain, fear, etc. to publicly observed neurochemistry. Yet ideas in Strawson, Stoljar, etc. can be reworked to treat pain as what certain neurochemical activity is like* <u>*beyond*</u> *observed appearances. This bridges the gulf between pains and brains, for (unlike reductions) it intelligibly explains why hidden, private pains accompany pain-detector activity (instead of this activity being nonconscious). By contrast, mind-as-computer views are obscure. They connect radically disparate entities — private pains, abstract computations and neural hardwares — through puzzling reductions and multiple realizations. The mind-as-brain view may thus offer a clear, simple solution to the mind–body problem that explains current experimental evidence without perennial metaphysical obscurities (reductionism, multiple realization, dualism, etc.). It may make mind–body relations clear.*

1. Mind–Brain Obscurity

Minds are characterized by their consciousness (privately experienced inner life) and intelligence (problem-solving abilities). The traditional mind–body problem basically concerns how this consciousness is related to our bodies. They seem intimately related,

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yet deep perplexities have arisen from construing this relation as identity, causality, supervenience, etc. The various theories have long been deadlocked, for each is hard to decisively refute and all harbour deep obscurities that keep them from being wholly accepted. But this essay tries to show how the obscurities underlying this deadlock may all be avoided (the argument is fully summarized in §6 and §10).

These obscurities will just be briefly described, since they're so familiar. One is reductionism. Most reductionists explain consciousness in more fundamental terms of the brain's information processing or chemical hardware. This yields computationalism and mind–brain identity, respectively. It's often replied that private experience radically differs from the abstract relations of information processing, and the observable structures and dynamics of chemical activity. There's an explanatory gulf here, for while neuroscience can explain many quantifiable brain activities, it can't explain why conscious qualities (qualia) such as pain accompany these activities. Such criticisms have existed for centuries from Leibniz (1714) to Levine (1983). They don't refute reductionism, for we can't know if reality reflects our metaphysical reasoning. Yet they do show reductionism's obscurity. This obscurity is hardly alleviated by reductionist claims that pain is just naive 'folk' psychology that science can ignore. This treats pains merely as constructs to explain behaviour — yet the real reason most people think pain exists is that they feel it.

Idealism reverses the reduction of minds to bodies above by claiming that bodies just exist in minds. This derives from theological claims that bodies just exist in God's mind — and from empiricist scepticism about bodies existing beyond our perceptions of them. Idealists are obscure about what causes us to perceive an outer world that isn't really out there. Empiricism can't explain this, for it sticks to perceptions, and while we have an overall perception of the world, we can't go beyond it to perceive its causes. Alternatively, how God's mind (or the absolute) creates the world is deeply obscure. The mind-to-body and body-to-mind reductions above are both hard to refute. But it's widely felt that their claims about identity obscure the differences between subjective, private minds and objective, public bodies.

Traditional dualism respects these differences by treating bodies as physical substances and minds as nonphysical substances. While it's just as irrefutable as its religious roots, dualism is obscure about how causality works. Causality can be unclear in physics too — but by contrast dualism is wholly obscure, including on such basic issues as the mechanics governing mind–body energy transfers. To fend off critics, dualists often adopt Humean causality — but it's obscure too. Dualist spinoffs such as aspect dualism and neutral monism just shift such issues to deeper levels, for they posit underlying entities whose inner operations and relationships to bodies and minds are obscure. Dualist ideas of causality, along with reductive ideas of identity, are the oldest sources of obscurity about minds.

Today's nonreductive physicalism tends to assume that mental activity can be realized in different brains in different ways (multiple realization), and that it can be autonomous of physics. In this physicalism, all substances are physical, unlike in traditional dualism. Yet, as just noted, these substances have emergent mental properties irreducible to the physical, unlike traditional reductions of minds to neurochemistry. Nonreductive physicalism replaces reductive claims like 'all pains are c-fibres firing' (type identity) with looser claims that pain is multiply realized in some physical event or another (token identity). Pain is distinct from, yet dependent on these events (supervenience).

But multiple realization is metaphysically obscure, and it has become empirically dubious since the rise of molecular neuroscience (see §3). Token identity and supervenience also have various obscurities (§5). Nonreductive physicalism is ultimately stuck with the same fundamental dilemma facing the traditional dualism and reductionism it tries to replace. If pain is physical, how does it exist in space–time? If it's nonphysical, how does its causality with brains work? Nonreductive physicalism offers no clear way out of either puzzle — it just *compounds* them to create the most deeply obscure theory of all.

Reductionists and nonreductionists offer replies to the charges above. Some have already been noted. But their views are still widely seen as obscure, and their mutual debates are still deadlocked. So instead of pursuing these familiar issues further, we'll now turn to how these perennial obscurities underlying this deadlock might be altogether avoided. In this effort, we'll start where Holman (2008) leaves off. He notes that due to this impasse between traditional theories, realist views that distinguish reality from appearances are now gaining in popularity as ways to break this impasse.

Realist forms of physicalism claim that matter has a conscious nature that physically underlies its perceivable nature in physics. This will be called 'realist physicalism' below. It might avoid obscure dualist and nonreductionist divisions between mind and brain by instead treating minds as brain matter. It might avoid obscure reductions of minds to the perceivable brain matter of neuroscience by instead treating minds as brain matter behind sensory appearances.

But this view raises its own obscurity about how brains create minds (with privacy, unity and qualia) in this hidden reality. To avoid this obscurity, clear, simple assumptions will be made on how brains work in reality. This 'clear physicalism' isn't verifiable, yet it may be justified, for it may offer a clear, simple mind–body solution that avoids all the deep metaphysical obscurity underlying the mind–body deadlock.

2. Realist Physicalism

A pervasive idea in neuroscience's history ever since the atomists has been that the world acts on our sensory mechanisms to create our perceptions. Locke (*Essay*: §2) inferred on empiricist grounds that since we just perceive this material world indirectly via sensory organs, we 'know not what' its underlying 'substance' is like. Russell (1927) noted that physics describes this matter (down to its simplest particles) in extrinsic, relational terms of perceivable interactions. But physics is silent on brain matter's intrinsic, underlying nature — so for all we know, it's real nature may involve consciousness (Russell's theory of mind is nicely traced in Lockwood, 1981 and 1989, pp. 149–171).

Realist physicalism goes a step further by treating this underlying consciousness as physical. For example, Herbert Feigl tied realism to mind–brain identity theory. His identity claim was that 'private states known by direct acquaintance' are 'identifiable with the referents of certain neurophysiological terms' (1958, p. 448). His realist claim was that these terms don't refer to perceptions of grey matter (pp. 464ff.), but to what reflects light into our eyes to cause these perceptions of grey matter (pp. 452–454). So we have 'double knowledge' of minds by direct acquaintance and scientific description (pp. 446ff.). Since minds aren't reduced to perceivable brains, but instead reside in brains behind perceptual appearances, there's 'no longer an unbridgeable gulf' between them (p. 448). Dempsey (2004) points out that we've overlooked this virtue in Feigl's identity theory.

Arguably, then, Feigl avoids the perennial reductionist and dualist obscurities above. But skeptics reply that Feigl can't access what lies behind appearances, so he can't know its nature, including whether it's even in space–time (Tonneau, 2004). So arguably, Feigl can't fathom how brains, or mind–brain identity, really work. Given his silence here, and his lack of physical accounts for how minds get their privacy, unity, etc., sceptics might say that his double-knowledge view hasn't bridged the mind–brain gulf, nor even avoided dualism. Arguably, he's still stuck with the perennial obscurities above.

Grover Maxwell (1978: pp. 392–396) refined Feigl's position. Maxwell noted that all anti-physicalist arguments based on mind–brain gulfs assume that (1) science shows us the brain's nature, (2) introspection shows us the mind's nature, and (3) both show that minds and brains are too different to be identical. He added that reductionists wrongly defend physicalism by rejecting (2), yet realists rightly defend physicalism by rejecting (1) on grounds that science doesn't reveal the intrinsic nature of brain events, so they could conceivably be conscious (again, 'intrinsic' refers to matter's real nature, underlying its perceivable interactions).

But while realist physicalism may be conceivable, its basic obscurity above remains. Realism and physicalism conflict in that realists 'know not what' is behind appearances — for all they know, it could be a nonphysical realm or an absolute spirit. So realists can no more justify being physicalist than dualist or idealist. Realist physicalism is obscure about the *justification* for its physicalism.

Daniel Stoljar (2001a, b) has resurrected Maxwell's strategy, and rigorously deployed it against anti-physicalists like Jackson and Chalmers. Jackson (1982) said that if Mary learns all about colour vision from neuroscience, yet only actually experiences colours later, then at that time she gets new knowledge that is outside physical science and is thus nonphysical. In reply, Stoljar distinguishes *two senses of 'physical'* in terms of (1) physics and its dispositional accounts of objects, and (2) the intrinsic nature of these objects underlying their observable dispositions (2001a: §2). At this intrinsic level, Mary's brain can conceivably experience colour in physical ways. Stoljar differs from Maxwell in that colour isn't identical to physical events, but supervenes on them.

Stoljar shows that minds are conceivably physical. Yet he's unclear on how minds are physical, for the intrinsic creates them in hidden ways. This prevents scientific accounts of minds (2001a: §5, b: §V). But if we can't clearly explain how the mind's characteristic privacy, unity or qualia are physically created (in either sense of 'physical'), then arguably we can't clearly bridge the explanatory gulf, nor clearly rule out dualism. Sceptics may thus say that instead of avoiding the perennial obscurities above, Stoljar just adds new obscurities involving the intrinsic.

Galen Strawson also rejects reductionist beliefs that physics fully knows the physical. Once again, the physical has an unknowable, intrinsic nature. It somehow 'involves' experience, he says. But he isn't sure whether this is physicalism or aspect dualism (2006: §1–2). So, again, the perennial obscurities above aren't avoided. But emergence is forcefully repudiated (§3). Its advocates admit that it's obscure. They just assume as a brute, inexplicable fact that experience pops into existence from certain organizations of matter. But Strawson stresses how *deeply* obscure this is. Life emerged in virtue of self-replicating abilities in molecules. But this 'in-virtue of' relation is lacking between the nonexperiential and experiential. This emergence is like magic where all is possible. Strawson instead adopts panexperientialism, where some form of experience pervades nature down to its simplest level (cf. Feigl, 1970).

To summarize, realist physicalism argues that matter has a conscious nature that physically underlies its perceivable nature in physics. This suggests ways of avoiding the perennial dualist and reductionist obscurities that deadlock mind–brain theory. But it raises its own obscurities. It isn't clear about what brains are like beyond our perception of them, and how they physically create the mind's privacy, unity or qualia. This makes it unclear how the explanatory gulf is bridged and how dualism is avoided. It takes physicalism in obscure, mystical directions that preclude scientific accounts of consciousness. (Apologies to Gregg Rosenberg, 2004, and other non-physicalist realists for not covering their important works. Hopefully this will be rectified in the future.)

3. Clear Physicalism

Let's now turn to a new version of realist physicalism that tries to avoid its obscurities. Unlike previous versions, it makes clear, simple assumptions about what is behind appearances (i.e., behind what the outer senses show). Although unverifiable, these physicalist assumptions may be justified if they avoid the deep obscurities in realist physicalism and other mind–body theories.[1] This view will thus be optimistically called 'clear physicalism'.

The assumptions are in the following three initial principles. (1) All that exists is matter–energy in space–time. (2) In brains, consciousness is the underlying substance that some matter–energy consists of beyond appearences. (3) As this physical substance, consciousness

[1] Radical empiricists may treat these assumptions about hidden reality as unverifiable nonsense. But clear physicalism can make the two following responses. (1) Kant was also wary of metaphysical claims, yet in his view they can have schematic, analogical meanings, and they can assume regulative roles for making events intelligible (*CPuR* a141, b706-710). These don't yield insights into reality, but just rules for coherent thinking (e.g., treating humans as if they have egos makes psychology intelligible). Clear physicalism could play a similar role in making minds intelligible to neuroscience. (2) Alternatively, clear physicalism could just reject radical empiricism as outdated. For some of its many flaws, see §1 and note 3.

occupies space and exerts force in brains. These principles may be slightly revised later, if it seems likely that consciousness exists outside brains.

This view relies on Feigl's identity theory, Strawson's critique of emergence, and Stoljar's analysis of what 'physical' means. But it replaces their idea of 'intrinsic nature' with the idea of 'substance'. Consciousness is a substance in three standard senses. First, it's the stuff that some brain activities consist of down to fundamental levels. Second, it underlies their appearances. Third, as we'll later see, its fundamental nature gives it an independent existence (contrary to popular claims that it's a property dependent on neural organization).

The key point is that treating consciousness as a *physical substance* is what enables clear physicalism to avoid perennial mind–body obscurities. Let's start with realist physicalism's obscurities. Clear physicalism avoids realist physicalism's obscurity about what reality is like behind appearances. Realist physicalism gives no justification for treating this hidden reality as physical instead of nonphysical. But clear physicalism establishes in principle (1) above that only physical substances exist, and it justifies this as the first step in avoiding perennial mind–body obscurities.

Realist physicalism is also obscure about what brains are like in this hidden reality. Their nature is mysterious and somehow involves consciousness. By contrast, principles (2) and (3) above are clear that brains are physical substances which partly *consist of* consciousness that occupies space and exerts forces in brain circuits. For example, pain is what certain electrochemical activities wholly consist of in firing nociceptors (see §7–8 for evidence about which activity is conscious). We're directly aware of this pain via the inner 'sense', which shows what this activity is really like. But pain is hidden from the outer senses (which just show appearances). They just indirectly detect pain by, for example, the forces it exerts on EEG electrodes. Again, this doesn't conflict with physics, for physics is silent on what particles are like apart from observable interactions.

Clear physicalism's view that consciousness is an electrochemical substance also seems to avoid realist physicalism's obscurity about how brains create the mind's *qualia, privacy and unity.* Clear physicalism makes electrochemistry relevant to explaining qualia (§7–8), while realist physicalism puts qualia beyond science. As we'll see, this electrochemical activity reaches continuously along brain circuits, so it can be unified into a conscious whole. This unity makes qualia private, for these circuits don't run between brains, so brains can't share qualia.

Clear physicalism's view that qualia are underlying substances seems to avoid the obscurities not just in realist physicalism, but also in theories of mind generally. It will be argued (in §4–5) that this approach avoids all reductionist and nonreductionist obscurities by treating qualia as physical substances, yet without reducing them to neuroscience's observable brain events. By contrast, realist physicalism is too unclear about minds and brains to clearly avoid these standard reductionist and nonreductionist obscuities.

This initial account of clear physicalism can't be completed without contrasting it to functionalism. Functionalism rejects that pain is a specific electrochemical activity in all animals. Instead pain is just its functional role of detecting and reacting to injury, which includes neural computations. It's realized in *multiple* brain activities across species, like a software run on multiple hardwares.

But since the rise of molecular neuroscience, multiple realization has been seriously challenged. For example, there's now evidence of chemical and cellular bases across species to long-term memory consolidation, and perhaps even working memory and focal attention (Bickle, 2003, chapters 2, 4). Also, evidence for neural correlates of qualia now seems to favour chemical over functional correlates (see §8 below). Citing their own evidence, functionalists often say that mental tasks are performed by multiple brain structures due to neural plasticity (in learning, injury, etc.). However, this plasticity is actually governed by common molecular mechanisms across individuals and species (Bickle, 2006).

Functionalism is also metaphysically obscure. As just noted, it reduces pain to a function that is realized in multiple hardwares. Yet functions are just abstract input/output relations, so how is pain reducible to them? Also, how is this abstract function 'realized' in brains? It's unclear here how abstract functions can affect brains or become embodied in brains. This reflects the old problem of universals.[2] Realization can be tied to supervenience or token identity, but all are equally puzzling (see §5). Treating pain as electrochemical energy in brain circuits seems clearer and simpler — and more empirically plausible (see §8).

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[2] Universals are general ideas (e.g., redness) exemplified in particular things (wines, etc.). Multiple realization may involve realism about universals, with pain functions being universals that exist apart from us while being embodied in us and affecting us. But it has never been clear how universals do such things. Nominalism and conceptualism are historical alternatives to this realism, yet they aren't viable here.

4. Avoiding Reductionist Obscurity

It was claimed above that clear physicalism can avoid all reductionist and nonreductionist obscurity by treating consciousness as the underlying substance which some brain activity consists of behind appearances. As promised, we'll now look at this in more detail.

To start with, this approach may avoid reductionism's obscure efforts to explain consciousness in more fundamental terms of the perceivable brain activities of neuroscience. In clear physicalism, consciousness is instead a substance underlying this perceivable activity. Also, consciousness is fundamental in itself, for it's the substance this activity consists of fundamentally. Reductionism's *explanatory gulf* also seems to be avoided, for in this approach brains can quite plausibly possess all the key characteristics of consciousness, namely, its qualia, unity and privacy.

First, in clear physicalism, brains can possess *qualia* in plausible ways. Reductions of qualia to perceivable brain activities fail to explain why we can't perceive people's actual sensations of colour, pain, etc. in their soggy grey matter. But clear physicalism can quite plausibly treat these qualia as substances underlying this perceivable grey matter, for both the qualia and the underlying substances are hidden. This seems to bridge the explanatory gulf, for it plausibly explains what reductionism fails to, namely, why certain brain activities are accompanied by qualia, instead of being nonconscious.

In this physicalism, brains can also possess *unified* experience (e.g., emotion and perception together) in plausible ways. As an electrochemical substance in active brain circuits, consciousness reaches continuously along these circuits. So it can be fully unified across scores of brain areas and billions of neurons (see §7).

In this physicalism, brains can also possess *private* experiences in plausible ways. My pain is private because other people can't access it with either their outer or inner senses. First, my pain is inaccessible to others via their outer senses since pain is an underlying substance in my brain behind appearances. So others just perceive my grey matter, not my pain. Second, as just noted, my experience is unified by being an electrochemical substance along my brain circuits. This underpins my inner sense by giving me direct access to experiences in my own brain. Yet these circuits don't run between brains, so my experience stays private.

So, in this physicalism, brains can plausibly possess the characteristics of consciousness. Conversely, consciousness can plausibly possess the characteristics of brains. Physics is silent about what underlies matter's observable dispositions, so consciousness could plausibly underlie brain matter's dispositions — it could occupy space and do work in brain circuits. In these converse ways, clear physicalism seems to bridge the explanatory gulf.

Treating consciousness as a physical substance also avoids idealist forms of reductionism. Their claim that the world just exists in the mind is obscure about why we see a world, when it isn't really out there. By contrast, in clear physicalism the world isn't in the mind, instead the mind is in the world (it's in brains).[3]

5. Avoiding Nonreductionist Obscurity

Clear physicalism's view that consciousness is an electrochemical substance also seems to avoid dualism's obscure nonphysical entities and causes. Pain and fear, for example, are simply electrochemical energy at work inside brains.

Realist physicalism makes roughly analogous claims. But its relatively obscure claims are often seen as a disguised dualism of perspectives, in which (for example) my nonphysical fear is perceivable by scientists as physical activity in my brain (see §2 and Chalmers, 1996, p. 136). By contrast, in clear physicalism both my fear and scientists' perceptions of it are quite clearly physical activities in our different brains (see §3–4). Here the different perspectives of private/public, subjective/objective, etc. just derive from our different brains having *direct or indirect* access to my fear. My limbic circuitry directly experiences my fear, yet the scientists' sensory circuits can only indirectly detect my fear via brain scans. What makes my fear private and subjective isn't that it's hidden away in a nonphysical mind, but that scientists can only detect it indirectly in the physical world in ways that leave its real nature hidden.

Treating experiences as neural substances may thus offer a clearer, simpler foundation to neuroscience than traditional dualism. It also seems clearer and simpler than more recent nonreductionism based on multiple realization, token identity, supervenience and emergence. Each is obscure.

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[3] Clear physicalism's view that minds exert forces that cause perceivable brain events is a form of causal realism, where causes are real powers underlying perceivable events. This avoids a further obscurity in idealism, namely, Hume's reduction of causality to mere correlations in perceivable events (like electricity and magnetism). Hume fails to explain where the correlations come from, for correlations are just abstract relations that can't move events. Causal realism avoids this obscurity by treating causes as real powers underlying correlations.

First, multiple realization doesn't avoid ancient obscurities about how individuals embody universals or abstract properties (§3). Second, token identity is no clearer than traditional type identity on how pains can be identical to grey matter. Also, if token pains are pains felt by specific subjects at specific times, this implies that they're instances of an obscure 'type pain' not felt by these subjects at these times (Guttenplan, 2000). Third, supervenience merely posits a bare dependence relation, without explaining how it arises. Also, it can yield obscure causality involving overdetermination and telekinesis (Kim, 1996). Fourth, emergence involves experience popping into existence from brain organization in inexplicable, brute ways (§2). By contrast, in clear physicalism experience isn't a property with all these puzzling, convoluted relations to brains — it's simply a substance that some brain activity consists of down to fundamental levels.

Nonreductive physicalism's overriding problem is that it's stuck in the same basic dilemma as the traditional dualism and reductionism it tries to replace. If pain is physical, how does it exist in space–time? If it's nonphysical, how does its causality with brains work? Nonreductive physicalism gives no clear way out here. It just compounds the dilemma with entangled, confusing ideas of its own. By contrast, clear physicalism offers a simple way out of this dilemma by clearly explaining how pain can exist in space–time (§3–4).

Clear physicalism's view that consciousness is a neural substance may be where physicalism leads to when stripped of past obscurities, both reductive and nonreductive. This unorthodox nonreductive physicalism may offer the clearest, simplest way for physics to deal with minds.

6. Summary of §1–5

The mind–body problem is concerned with how brains are related to the mind's consciousness (private experience). The problem is that all existing theories are deeply obscure. This essay suggests a clear, simple solution to the mind–body problem that avoids these perennial obscurities. One obscurity is dualism's nonphysical minds, for nonphysical causality is puzzling. Reducing minds to brains raises another obscurity, due to the radical gulf between private experience and publicly observed brains.

Stoljar and Strawson are a first step here. They argue that while private experience differs from observable brains, it can still be what brains are physically like beyond what we observe of them (beyond the appearances created by our outer senses). This 'realist physicalism' may seem to avoid the obscurities above, for it treats experience as physical, yet without reducing it to observable brain events. But these authors don't actually bridge the mind–brain gulf, for they're unclear on what brains are like behind appearances and how they create minds. Nor do they justify treating this hidden reality as physical.

Realist physicalism can arguably clear up its obscurity and fully bridge this gulf by adopting some clear, simple assumptions about what brains are like behind appearances. The *justification* for these assumptions is that they may avoid all the perennial obscurities underlying the mind–brain problem. The initial assumptions of this 'clear physicalism' are that everything behind appearances is matter–energy in space–time, and that our consciousness is the physical *substance* which certain brain events consist of beyond appearances (these principles may be slightly revised later, if it seems likely that consciousness exists outside brains).

Consciousness is a substance here in three standard senses: it's what certain electrochemical events in brains consist of fundamentally, it underlies their appearances, and it exists independently since it's fundamental. This counters popular claims that consciousness is a property, not a substance. Yet it aligns with physics, for physics describes fundamental particles by their interactions. It's silent on what particles are like beyond these observable interactions. So for all we know, beyond perception some particles in brains consist of consciousness that occupies space and exerts forces. While this consciousness is hidden from the outer senses, it's detected indirectly by these forces (via EEGs, etc.).

So, in this view, pains are physical substances that certain brain events consist of beyond our perception of them. This is what enables clear physicalism to avoid the obscurities in other views. It seems to avoid dualism's obscure nonphysical pain. Pain is instead an electrochemical substance that occupies space and exerts forces in brains. What makes pain private here isn't that it's hidden away in nonphysical minds, but instead that it's detectable just indirectly in the physical world in ways that leave its real nature hidden. This also seems to avoid reductionism's obscure efforts to explain pain in more fundamental terms of perceivable brain activity. Instead pain is a substance underlying this perceivable activity. Also, pain is fundamental in itself, for it's what some brain activity fundamentally consists of. This explains without reductionist obscurity why pain accompanies brain activity. Clear physicalism also seems to avoid the reductionist obscurity in idealism's claim that the world only exists in the mind. This is obscure about why we see a world when it isn't really out there. In clear physicalism the world instead exists outside minds.

Clear physicalism also seems to avoid realist physicalism's obscurity about what brains are really like and how they create minds with *qualia, privacy and unity.* To start with, treating pain, fear and other conscious qualities (qualia) as electrochemical substances can help explain exactly how brains create them. The mind's unity is explained by these conscious electrochemical substances reaching continually along brain circuits as a conscious whole. This makes minds private, for circuits don't reach between brains, so brains can't access each other. The mind's qualia are also private since they're underlying substances hidden from public view. Clear physicalism bridges the mind–brain gulf here not just by showing how brains can possess the mind's qualia, unity and privacy in these ways, but also (conversely) by showing how minds can possess features of brain activity such as occupying space and exerting forces.

Functionalists reject any such claims that pain is a specific electrochemical activity. Instead it's a mental function for detecting and reacting to injury. This involves sensory processing, and it's realized in *multiple* hardwares. But since the rise of molecular neuroscience, multiple realization has become empirically dubious. It's also metaphysically dubious, for functions are just abstract input/output relations, so identifying them with pains is obscure. It's also unclear how functions are 'realized' in brains, for this involves ancient obscurities about how things embody abstractions and universals. It also involves the obscurities in related nonreductive-physicalist notions like token identity and supervenience.

Clear physicalism avoids these obscurities. Pain isn't an abstract relation, nor a property obscurely 'realized' in brains. It's just a substance in brains. This is nonreductive physicalism based on mind–brain identity theory instead of multiple realization (where even computers can have minds). This is arguably where physicalism leads to when stripped of its past obscurities, both reductive and nonreductive. It may offer a clear, simple mind–body solution.

7. Explaining the Mind's Unity and Privacy

It has just been argued (in §1–6) that clear physicalism avoids the perennial metaphysical obscurities about minds by treating consciousness as a neural substance. But, as repeatedly noted, those arguments draw on the more empirical arguments now before us (§7–10). We'll now look at flaws in computational neuroscience concerning the mind's *unity, privacy, qualia and causality*. In each case, it will be argued that the mind's consciousness is correctly seen not as computations or information, but as a *neural substance* (a fundamental substance reaching continually through brain circuits). Here the mind's intelligence involves computational circuitry, but its consciousness is in the electricity powering this circuitry.

We'll begin with the mind's *unity*, which includes the binding of diverse sensory activities into perceptions, and their combination with memories, thoughts and emotions into overall experiences. Neuroscience explains this unity in various ways, including processing connections (e.g., Sperry, 1966), synchronized firing (e.g., Crick & Koch, 1990) and attention (Crick & Koch, 2003). But each has well-established problems (Larock, 2006). In vision, for example, few (if any) processing connections exist between the colour and figural-motion pathways (Zeki, 2003). Nor does their binding require attention, for binding occurs even if attention is prevented (Treisman, 2003). Nor do the pathways fire synchronously (Hardcastle, 1996). Synchrony doesn't occur even with stationary stimuli (Tovee & Rolls, 1992). Also, it's a global event no neurons can oversee (McFadden, 2002) so it isn't even detectable while encoding images.

Clear physicalism favours another view of binding that avoids these troubles by attributing minds and their unity to electromagnetic fields in brains. These field theories of mind are proliferating because they avoid the troubles above (McFadden, 2002), and because qualia exhibit correlations with field activity (Pockett, 2000). Also, fields resemble sensory images in that both arguably arise from discrete neurons as continuous wholes spread across space (Libet, 1994).

Fields are the only substances that can reach continually along brain circuits to unify minds, as clear physicalism requires. Its claim (in §3–6) that brain activity is conscious down to fundamental particles ultimately requires that conscious fields of energy transfers bind these isolated, minimally conscious particles into unified, fully conscious minds. Clear physicalism is thus a *neuroelectrical* theory of mind, while the computationalist views above treat minds as mere information.

This seems to explain the mind's unity without computationalism's troubles above.[4] It also avoids troubles in realist physicalism. Feigl (1970) and Strawson (2006) ultimately say that treating brains as

[4] This field view avoids computationalism's problems with binding. For example, it avoids the problem above that colour and shape pathways aren't connected. While they aren't connected in cortical hypercolumns, they're still adjacent there, so localized fields can readily bind these pathways together.

conscious down to fundamental levels implies that everything is likely conscious (panexperientialism). Clear physicalism ultimately agrees.[5] Yet Feigl and Strawson don't explain how simple, isolated micro-experiences in particles bind into our complex, unified macro-experiences (e.g., sensory images). Nor do they explain why individuals are just aware of their own brain's experience, but not of experiences in the world at large, nor of a putative world mind. This is the combination problem. It's widely seen as panexperientialism's central difficulty.

Clear physicalism tries to avoid these problems by explaining the mind's unity electrically. To start with, highly active brain circuits generate an *intense* electromagnetic field that is *continuous* from neuron to neuron and instant to instant. This is due to the circuits' ion currents, which circulate rapidly and continuously through neuronal membrane channels. This field strongly unifies the consciousness of particles in these currents and channels. By contrast, resting circuits lack these intense currents and fields.[6]

It's the sheer intensity of this *highly localized* field right inside (and right near) these currents that strongly unifies their consciousness. But fields of this intensity don't reach between brains, so experience isn't unified between brains. Nor do any kinds of energy fields with this intensity pervade the entire world, so there's *no world mind* aware of everything (instead the world's micro-experiences quite often remain isolated in separate molecules). Only in brains does experience attain the unity and intelligence of minds.

This view has two virtues. First, it closely fits evidence (from Tononi & Edelman, 2000) that highly active, highly connected brain circuits are what make us fully conscious.[7] Second, it explains mental

[5] In clear physicalism, fundamental particles are simple substances that exchange energy, so if one consists of consciousness then all likely do. Because consciousness is the fundamental, underlying substance everything wholly consists of, it's not a mere property dependent on brains. It's physical because it occupies space and exerts forces that the outer senses indirectly detect.

[6] Inside highly active brain circuits, field quanta form a probability cloud of continually high energy. But when fields weaken, quanta are more sparse and discrete, and the field's continuity weakens.

[7] There's evidence that highly active, highly connected neural circuitries make us fully conscious: (1) Evidently, *highly active* circuits are fully conscious, while weakly active circuits are just weakly conscious or even subliminal. For example, pain intensity covaries with the number and frequency of neurons firing in pain pathways. Also, MEG studies show that during binocular rivalry, electrical activity is 50–85% higher in fully conscious visual processing than subliminal processing (Tononi & Edelman, 2000). In higher cognition, EEG studies show that as subjects look for numerical patterns, increasing stages of concentration match jumps in neural field strength (Michel, 1999). Admittedly, epileptic

unity without realist physicalism's combination problem, and without the problems in computationalism and traditional field theory.[8]

Computational neuroscience has troubles explaining not just the mind's unity, but also its *privacy*. Ramachandran (1998), Tononi & Edelman (2000) and other neuroscientists attribute this privacy to the lack of neural connections between brains (though they don't clearly explain consciousness). Clear physicalism partly agrees. Treating minds as neuroelectrical helps explain their privacy since it confines each mind to a single brain's circuitry. This explains why I can only access my own mind with my inner sense. But to explain why other people can't access my mind with their outer senses, clear physicalism argues that minds are what neuroelectricity is like beyond what these outer senses show. This explains the necessary character of the mind's privacy that some philosophers stress, but neuroscientists overlook.

Since clear physicalism ultimately adopts panexperientialism, its initial principles (§3) should be refined as follows. (1) Beyond appearances, all that exists is matter–energy in space–time. (2) Its fundamental particles consist of consciousness that occupies space and

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seizures, anaesthetized brains, and NREM sleep have high activity without apparent consciousness. But they fire in pauses and bursts that fragment the temporal unity of experience (from instant to instant) which was noted in the text. (2) Evidently, *highly connected* circuitries are wholly conscious, while poorly connected ones aren't. Sensory awareness involves highly connected thalamocortical areas, and its unity suffers if these circuits are cut (Sperry, 1966). Also, the conscious control centre of the prefrontal cortex is the best connected brain area, and it too suffers from disconnection syndromes (Goldberg, 2001). Less conscious areas like the cerebellum or basal ganglia seem to rely instead on insulated, parallel circuits (Tononi & Edelman, 2000). Yet full consciousness arguably isn't from the sheer magnitude of connections, but from how they assemble overall images, feelings, etc. from subliminal micro-experiences (see note 9).

[8] Clear physicalism may avoid the problems in traditional field theories of mind, such as Kohler and Wallach (1944), Libet (1994), Popper *et al.* (1993), Lindahl & Arhem (1994), Pockett (2000), John (2001) and McFadden (2002). In clear physicalism, matter and fields consist of consciousness. Strong, *local fields* are thus far more conscious in brains than weak, *global fields*. Global fields are popular in traditional field theories. But local fields offer ways to avoid traditional field theory's difficulties (listed in Lashley *et al.*, 1951; Sperry, 1952; Pockett, 2000). In support of this claim, I can just give brief synopses here of four of my overall arguments. (1) If global fields unify consciousness, we'd be aware of the external fields that reach into our brains from (e.g.) power lines. But this difficulty disappears if our consciousness is instead unified by intense, local fields in our brain's electrical currents. Inside these currents, the external fields are negligible relative to the currents' own intense fields. (2) Evidence that just highly active circuits are fully conscious indicates that experience isn't from all brain and field activity globally, but is instead localized in intense activity. (3) Global fields are distorted relative to visual images, so images can't be global fields. Encoding images in global fields is problematic too, we'll see. Indeed, all theories of images have serious flaws. But these disappear if images reside in local fields inside sensory circuits (see note 9 for details). (4) Lashley and Sperry attacked field theory by showing that animals can do visual tasks with obstacles put in their cortex to (reputedly) disrupt global fields. Yet if images reside inside circuits, these obstacles wouldn't globally disrupt vision, but just create local blind spots.

exerts forces. (3) Inside neural circuitry, these isolated micro-experiences are unified by intense electrical activity into fully conscious minds. (4) So beyond appearances, isolated micro-experiences are the substance all matter–energy consists of, and unified minds are neuroelectricity.

8. Explaining the Mind's Qualia

So clear physicalism's view that pain is an electrochemical substance behind appearances seems to avoid problems in computational neuroscience concerning the mind's unity and privacy. It may also avoid neuroscience's problems with the mind's qualia.

Computationalist accounts of qualia gained ascendency in the 1970s due to Putnam's multiple-realization argument. His targets were traditional mind–brain identity theories like Feigl's, which identified qualia with brain events, but without establishing neurochemical correlates of qualia. Putnam (1967) replied that most likely (1) pain doesn't have the same neurochemical correlate in all species across evolutionary history, (2) pain does have a functional/computational correlate that involves detecting and reacting to tissue damage, (3) so pain is a mental function realizable in multiple hardwares. But Putnam's claims now seem dubious. Evidence now seems to instead favour mind–brain identity theory, especially clear physicalism's electrochemical approach to qualia.

To start with, Putnam's second claim — that pain has a *functional correlate* involving tissue damage — is dubious. Pain can arise without tissue damage just by stimulating pain pathways. Also, the processing of pain and other sensory qualia is very similar. It involves cross-checking inputs from several kinds of peripheral detectors to reduce ambiguity. So computationalism doesn't explain why qualia are processed so similarly yet experienced so differently. Arguably qualia come from more global processing circuits that fire synchronously to bind together (e.g., Tononi & Edelman, 2000). Yet synchrony is problematic too. Computationalism also has problems explaining how to get from all this abstract, coded chatter to concrete colours, pains, etc. spread pictorially across inner space (§3).

Clear physicalism avoids these problems because it doesn't treat images as codes. Furthermore, unlike computationalism, it can intelligibly explain the *substantial, pictorial* nature of images by treating them as electrochemical activities spread across neural maps behind appearances.[9]

Putnam's first claim — that pain lacks a *neurochemical correlate* — is also dubious. It's well known that specialized cells in pain pathways detect painful stimuli. There's now growing evidence from across animal species that what makes each type of detector cell so specialized for a specific stimulus is that *ion channels* of a very specific type are spread over the cell's membrane. As that stimulus appears, gates in these electrical channels open, and ion currents rush through to the oppositely charged interior of the cell, initiating an electrochemical impulse in the sensory pathway.

In fact, as we'll now see, ion channels seem to correlate with *emotional* as well as *sensory* qualities. This evidence is widely overlooked by theories of the neural correlates of consciousness. The point isn't that this evidence is decisive (for we don't fully know the channel chemistry or degrees of consciousness at all levels of qualia pathways, a point driven home by Mancuso, 2009, for example). The point is just that this evidence is better than the evidence for computationalism. While processing circuitries are far too similar to account for different qualia, the circuitries' electrochemistry is more promising (even though electrochemical research has so far focused mainly on peripheral levels, at least in sensory systems). This repudiates Putnam's claim that neurochemical correlates of pain are unlikely. It supports clear physicalism's claim that qualia are electrochemical.

Let's start with the evidence that ion channels correlate with *emotional qualia*. It's now well known that brain areas linked to emotion and motivation (the limbic cortex, amygdala, hippocampus, etc.) are rich in receptors for hormones. They detect specific hormones using highly specialized ion channels. Examples of these hormones are sex steroids, opiates that produce feelings of euphoria, and peptides that

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[9] In clear physicalism, images reside in the electricity and fields in sensory circuits. For example, detectors in visual area V1 map onto the retina point by point. Each contains densely packed cells that create a conscious 'star' if artificially stimulated. Vertical and horizontal circuits could seamlessly connect such detectors into smooth, continuous images without the distortions or graininess in neural maps (this parallels Koch, 2004, by building visual details from local coalitions of neurons). These connections would seamlessly bind detector arrays from different hemispheres and maps to build increasingly coherent images, an example being the callosal connections along V1's midline. The images colours and shapes are hidden behind appearances in this fabric of neural impulses (which explains why pictorial images can't be seen in brains). Neuronal computations in these circuits construct these representations, while electrical activity makes them conscious. Images are thus conscious in themselves, so they don't need any 'spectator in the brain' to become conscious. This modification of traditional field theory may start to explain what all other views fail to — how visual images get their *substantial, pictorial* forms as colours spread across inner space (§10).

mediate hunger and thirst drives. Some hormones exist in both invertebrates and vertebrates (e.g., opiates). Others occur more in higher vertebrates (e.g., hormones mediating pair bonding). Since the discovery of the opiate receptor (Pert & Snyder, 1973), dozens of other receptors have been discovered. Yet it isn't yet known whether a specific ion channel correlates tightly enough with each feeling to be its molecular substrate (though correlations already seem tight with angiotensin receptors and thirst).

Let's turn now to the evidence that ion channels correlate with *sensory qualia*. We've already seen how qualia intensity correlates with the frequency of ion-channel currents (note 7). But the point now is that there are many cases of specific channels being used in detecting specific sensory qualities. This research is more recent than that dealing with emotions, so more details are called for:

(1) The hair cells in cochlea detect sound frequencies. These frequencies vary with the kinds of molecular subunits in the cells' K^+ voltage-gated (KV) channels (Ramanathan *et al.*, 1999; Adamson *et al.*, 2002). KV channels are ubiquitous, but variations in their subunits (and their combinations) create a *distinctive electrophysiological signature* for each kind of hair cell (i.e., for each sound frequency). Many of these traits are conserved across species as varied as rodents, chickens and turtles (Beisel *et al.*, 2007).

(2) Vertebrates and invertebrates use cells with transient-receptor potential (TRP) channels for thermodetection. Each type of channel uses specific subunits to detect different ranges of painful temperature (e.g., Basu and Pramod, 2005).

(3) Gustatory qualities are detected by mammals (and even zebra fish, drosophila, etc.) through further TRP channels, and through G-protein coupled receptors (GPCRs). (GPCRs lack channels, themselves, yet they still activate channels and exhibit extensive electrochemical interactions). For example, TRP channels with PKD2L1 subunits detect sour tastes. GPCRs with T1R2 subunits detect sweet tastes, while those with T1R1 detect savory, and those with T2SR detect bitter (e.g., Oike *et al.*, 2007).[10]

These correlations of ion channels with qualia support clear physicalism's claim that qualia are electrochemical. Returning the

[10] These correlations seem to withstand the following apparent exceptions. (1) TRPV1 detects not just burns, but also capsaicin (in hot peppers), and it's involved in inflammatory diseases. Yet all these still correlate with burning sensations. (2) T1R2s exist in taste buds and intestines. Both can still correlate with sweetness sensations, but only the taste buds connect into our brains and contribute to our minds. (3) T1R3s also exist in sweetness detectors. Yet T1R3s may have similar molecular structures to T1R2s (see note 11). So this needn't threaten the correlations of T1R2s with sweetness sensations.

favour, clear physicalism helps explain what the bare correlations don't, namely, how channels can create the qualia they correlate with.[11] Here clear physicalism says that micro-experiences are the substance that brain activities consist of, and (as already noted) very intense fields unify them into macro-experiences. Now, these fields are intensest in ion currents and ion channels. So it's here that fields best unify micro-experiences into full-fledged macro-experiences of pain, fear, etc. Ion currents, and the channel molecules they electrically interact with, consist of these qualia behind appearances.[12]

In conclusion, clear physicalism seems to better fit current empirical evidence about qualia's neural correlates than functionalism does. It also avoids functionalism's deeply obscure metaphysics. In the end, it acknowledges that neural computations construct mental representations of the world in processing circuitries — but it adds that what makes them into conscious images is their electricity.

9. Explaining the Mind's Causality

So clear physicalism's view that qualia are neural substances behind appearances seems to avoid troubles in neuroscience concerning the

[11] Arguably, clear physicalism doesn't fully bridge the explanatory gap here because it does not ultimately explain why (for example) T1R2s detect sweetness while T2SRs detect bitterness. It may not explain this any more than physics explains why quarks have different charges. But this hardly makes clear physicalism or physics unintelligible. There's no unbridgeable intelligibility gulf between mind and brain here, as in claims that minds reduce to brains (§4) or consciousness emerges from nonconsciousness (§2).

[12] In clear physicalism, qualia are the substances of electrochemical activities in sensory pathways. We experience qualia when fields in the pathways unify the micro-experiences in ion currents and in the channel atoms they electrically interact with. Here are two examples of how this could work. (1) Different qualia could ultimately be the substances of different fundamental particles, such as the quarks and bosons in atomic nuclei. While these particles aren't numerous enough to account for all qualia, many qualia just come from combining more basic qualia (e.g., three primary colours create the entire colour wheel). Similarly, some of these basic qualia may actually come from combining even more basic qualia, which are few in number and reside in fundamental particles. For example, all the taste and odour qualia we experience may come from several qualia that are more basic. Emotional qualia also cluster into families, and these exhibit oppositions like love/hate and joy/sadness that resemble the polarities in particles. (2) As a fallback position, instead of different particles in electrochemical activity consisting of different qualia (as above), differences in the overall energy level of this activity could consist of different qualia. That is, differences in qualia would be 'tuned' by differences in the total energy of the quanta and atoms in this electrochemical activity (arguably, while qualia could emerge here, consciousness wouldn't, for it's what this energy consists of fundamentally). In both options above, our qualia would form just in the strongest parts of fields (§8) in this electrochemical activity, i.e., close to where ion currents electrically interact with each channel (otherwise different qualia could blend together across the brain). The upshot is that qualia depend on molecular structure — the same atoms could form different qualia in different channels.

mind's unity, privacy and qualia. The same applies to the mind's causality. Computationalism renders causality and other mind–brain relations obscure because it treats qualia as information processing. It's unclear how such abstract, formal input/output relations are 'realized' in brains, and how they can have any causal powers or any causal relations with brains (§3, §5, cf. Kim, 1996). Clear physicalism avoids all this by treating qualia as underlying substances of brain activity that exert forces in brains. This gives qualia real causal powers in brains. It leaves clear physicalism with the following two options concerning mental causality.

(1) Arguably, while qualia are the real, underlying nature of observable brain activity, they will prove to be *irrelevant* to explaining brain activity, for this activity will turn out to fully follow the laws of physics (cf. Chalmers, 1996).

(2) Alternatively, qualia could introduce dynamics to brains that go beyond physics and make qualia *relevant* to explaining brain activity (this claim that consciousness has emergent causal powers shouldn't be confused with obscure claims in §2 that consciousness, itself, emerges).

In option (1) brains fully follow the laws of physics just like stomachs do, so underlying conscious events are irrelevant to explaining brain activity. But option (2) replies that brains don't fully follow the laws of physics when they make qualitative decisions about, for example, which foods taste best. In such cases, a conscious electromagnetic field runs through sensory circuits into memory and executive mechanisms, where it helps trigger motor responses. This creates a *unified consciousness* in which these mechanisms can consciously compare different tastes together and intuitively choose which are best.

Because these choices are based on *comparing conscious qualities*, they exhibit new qualitative dynamics that go beyond the laws of physics. Because they're *private activities* they're inaccessible to physics. These qualitative dynamics make qualia relevant to explaining brain activity. So volition doesn't work here just on physio-chemical principles, but also on their powerful synergies with psychological and cultural principles (Jones, 1995). Note that this suggests interesting replies to manipulation arguments against free will's compatibility with determinism.

Yet option (2) sticks close to physics. Minds are nowhere near as autonomous of physics as in the nonreductive causality of dualism, functionalism or traditional nonreductive physicalism. Instead thought is a shifting field of electrical activity detectable by brain scanners. It stays strongly rooted in the neural mechanisms it powers and consciously drives.

But the overriding point is that both of these options in clear physicalism treat the mind's consciousness as an underlying electro-chemical substance with causal powers in brains. This is what arguably enables clear physicalism to avoid the difficulties with minds and their causality that have long beset other theories — both reductive and nonreductive.

10. Summary of §7–9

We saw in §1–6 how perennial metaphysical obscurity about minds seems to be avoided by treating consciousness as a neural substance behind appearances. At least some brain activities consist of it, and it reaches continually along brain circuits to form unified minds. In §7–9 we turned to how this may also avoid recent empirically based problems in computational neuroscience concerning the mind's *unity, privacy, qualia and causality.*

To start with, this computationalist (mind-as-computer) approach explains the mind's *unity* via processing connections, synchrony and attention. Each has serious problems. Clear physicalism avoids them. In its view, some brain activity fundamentally consists of consciousness. This may ultimately imply that fundamental particles (and their fields) are conscious not just in brains, but universally. Yet brains are still special, for in their active circuitry, the micro-experiences of particles are *unified* into fully conscious minds by fields. Electromagnetic fields in brains can unify these micro-experiences precisely because fields are *conscious, continuous substances* joining discrete particles.

Yet this unity doesn't occur all across the brain, but only right inside highly active circuits. Only here are fields *intense and continuous* from cell to cell and instant to instant. This aligns well with experimental evidence that only highly active, highly connected neural circuits are fully conscious. This field intensity is lacking in fields that reach between brains. So while experience is unified into an isolated mind in each brain, experience isn't unified into a group mind between brains. Nor are any fields intense enough across the world to support a world mind. (These various points also fit our evidence about minds.) This makes our minds *private*. Minds are also private because their experiences are substances hidden from public view behind appearances. Computationalism can't fully explain this privacy.

So clear physicalism's account of the mind's unity and privacy seems to fit current evidence while avoiding computationalism's flaws. The same applies to the mind's *qualia*. There's growing experimental evidence (overlooked by philosophers) that sensory and emotional qualia (pain, joy, etc.) correlate with very specific electrical channels in neural detectors. Clear physicalism's neuroelectrical view of minds tightly fits this evidence, for it's precisely at these channels that currents and fields are *most intense* and thus most able to unify micro-experiences into full-fledged feelings of pain, joy, etc.

This experimental evidence counters computationalist claims that qualia aren't specific electrochemical activities, but instead computations realized in multiple hardwares. Computationalism is also undercut by its problems in explaining how brains encode qualia, and how these *abstract codes* become the *substantial, pictorial images* we experience across inner space. By contrast, clear physicalism can intelligibly explain this pictorial nature of images by treating images as electrochemical. That is, electrical circuits can unify conscious detectors in neural maps into seamless, distortion-free pictorial images that are hidden in brains behind appearances. Claims that pictorial images don't exist in brains may thus be wrong.

So treating consciousness as an electrochemical substance seems to explain the mind's unity, privacy and qualia in ways that fit current evidence while avoiding computationalism's flaws. The same applies to the mind's *causality.* Computationalism renders causation obscure because it treats qualia as information processing. It's unclear how such abstract input/output relations can be 'realized' in brains, and have any causal powers or any causal relations with brains.

Clear physicalism avoids this obscurity by treating qualia as electrochemical substances that underlie observable brain activity and do work in brains. This causality can take the two following forms. (1) If brain activity is explained fully by physics, then qualia are irrelevant to explaining this activity. (2) Yet if qualia exhibit dynamics beyond physics, then they're relevant to explaining brain activity. For example, judging which pies are tastiest involves evaluating private taste qualia — and this arguably introduces some qualitative dynamics to thought outside physics.

All this is arguably where physicalism must go to avoid its past problems, namely, computationalism's problems with the mind's qualia, unity, etc; mind–brain identity theory's problems with multiple-realization arguments, reductions, and pictorial images in brains; realist physicalism's problematic claims about reality and its combination problem; and nonreductive physicalism's problems with multiple realization, supervenience, etc. So clear physicalism may offer the best way for physical science to deal with minds. It just fills in what physics is silent about, namely, what brain matter is like behind perceptions of it.

References

Adamson, C. *et al.* (2002), 'Firing features and potassium channel content of murine spiral ganglion neurons vary with cochlear location', *Journal of Comparative Neurology*, **447** (4), pp. 331–50.

Basu, S. & Pramod, S. (2005), 'Immunological role of neuronal receptor vanilloid receptor 1 expressed on dendritic cells', *Proceedings of the National Academy of Sciences USA*, **102** (14), pp. 5120–5125.

Beisel, K. *et al.* (2007), 'Diversity of Ca2+-activated K+ channel transcripts in inner ear hair cells', *Gene*, **15**, 386 (1-2), pp. 11–23.

Bickle, J. (2003), *Philosophy and Neuroscience* (Dordrecht: Kluwer Academic Publishers).

Bickle, J. (2006), 'Multiple Realizability', *Stanford Encyclopedia of Philosophy*, ed. Edward N. Zalta, http://plato.stanford.edu.

Chalmers, D. (1996), *The Conscious Mind* (Oxford: Oxford University Press).

Crick, F. & Koch, C. (1990), 'Towards a neurobiological theory of consciousness', *Seminars in the Neurosciences*, **2**, pp. 263–275.

Crick, F. & Koch, C. (2003), 'A framework for consciousness', *Nature Neuroscience*, **6**, pp. 116–119.

Dempsey, L. (2004), 'Conscious experience, reduction and identity: many explanatory gaps, one solution', *Philosophical Psychology*, **17** (2), pp. 225–245.

Feigl, H. (1958), 'The "Mental" and the "Physical"', *Minnesota Studies in the Philosophy of Science*, **II**, pp. 370–497.

Feigl, H. (1970), 'Mind–body, not a pseudo-problem', in: *The Mind–Brain Identity Theory*, ed. C. Borst (London: Macmillan).

Goldberg, E. (2001), *The Executive Brain* (Oxford: Oxford University Press).

Guttenplan, S. (2000), *Mind's Landscape* (Oxford: Blackwell).

Hardcastle, V. (1996), 'The binding problem and neurobiological oscillations', in: *Toward a Science of Consciousness*, ed. S. Hameroff (Cambridge, MA: MIT Press).

Holman, E. (2008), 'Panpsychism, physicalism, neutral monism and the Russellian theory of mind', *Journal of Consciousness Studies*, **15** (5), pp. 48–67.

Jackson, F. (1982), 'Epiphenomenal qualia', *Philosophical Quarterly*, **32**, pp. 127–136.

John, E. (2001), 'A field theory of consciousness', *Consciousness & Cognition*, **10**, pp. 184–213.

Jones, M. (1995), 'Inadequacies in current theories of imagination', *Southern Journal of Philosophy*, **33** (3), pp. 313–333.

Kant, I. (1787/1965), *Critique of Pure Reason*, ed. N. Kemp-Smith (New York: St. Martin's Press).

Kim, J. (1996), *Philosophy of Mind* (Boulder, CO: Westview Press).

Koch, C. (2004), *The Quest for Consciousness* (Englewood, CO: Roberts & Company).

Kohler, W. & Wallach, H. (1944), 'Figural after-effects', *Proceedings of the American Philosophical Society*, **88**, pp. 269–357.

Larock, E. (2006), 'Why neural synchrony fails to explain the unity of visual consciousness', *Behavior and Philosophy*, **34**, pp. 39–58.

Lashley, K. *et al.* (1951), 'An examination of the electrical field theory of cerebral integration', *Psychological Review*, **58**, pp. 123–136.

Leibniz, G. (1714/1973), *Monadology*, in: *Philosophical Writings*, ed. G. Parkinson (London: Dent and Sons).

Levine, J. (1983), 'Materialism and qualia: the explanatory gap', *Pacific Philosophical Quarterly*, **64**, pp. 354–61.

Libet, B. (1994), 'A testable field theory of mind–brain interaction', *Journal of Consciousness Studies*, **1**, pp. 119–126.

Lindahl, B. & Arhem, P. (1994), 'Mind as a force field', *Journal of Theoretical Biology*, **171**, pp. 111–122.

Locke, J. (1690/1971), *An Essay Concerning Human Understanding*, ed. A. Woozley (New York: Harper/Collins).

Lockwood, M. (1981), 'What *was* Russell's neutral monism?', *Midwest Studies in Philosophy*, **vi**, pp. 143–158.

Lockwood, M. (1989), *Mind, Brain & the Quantum* (Oxford: Blackwell).

Mancuso, K. *et al.* (2009), 'Gene therapy for red-green colour blindness in adult primates', *Nature*, **461**, pp. 784–788.

Maxwell, G. (1978), 'Rigid designators and mind–brain identity', *Minnesota Studies in the Philosophy of Science*, **9**, pp. 365–405.

McFadden, J. (2002), 'The conscious electromagnetic information field theory', *Journal of Consciousness Studies*, **9** (8), pp. 45–60.

Michel, C. (1999), 'Spatiotemporal dynamics of human cognition', *News in Physiological Sciences*, **14**, pp. 206–14.

Oike, H. *et al.* (2007), 'Characterization of ligands for fish taste receptors', *Journal of Neuroscience*, **27** (21), pp. 5584–5592.

Pert, C. & Synder, S. (1973), 'Opiate receptor: demonstration in nervous tissue', *Science*, **179** (77), pp. 1011–1014.

Pockett, S. (2000), *The Nature of Consciousness: a Hypothesis* (New York: Writers Club Press).

Popper, K. *et al.* (1993), 'A discussion of the mind-brain problem', *Theoretical Medicine*, **14**, pp. 167–180.

Putnam, H. (1967), 'Psychological predicates', republished in (1975), *Mind, Language & Reality*, volume 2 (Cambridge: Cambridge University Press).

Ramachandran, V. (1998), *Phantoms in the Brain* (New York: Quill).

Ramanathan, K. *et al.* (1999), 'A molecular mechanism for electrical tuning of cochlear hair cells', *Science*, **8**, 283 (5399), pp. 215–217.

Rosenberg, G. (2004), *A Place for Consciousness* (Oxford: Oxford University Press).

Russell, B. (1927), *The Analysis of Matter* (London: Kegan Paul).

Sperry, R. (1952), 'Neurology and the mind–brain problem', *American Scientist*, **40**, pp. 291–312.

Sperry, R. (1966), 'Brain bisection and consciousness', in: *Brain and Conscious Experience*, ed. J. Eccles (Berlin: Springer Verlag).

Stoljar, D. (2001a), 'Two conceptions of the physical', *Philosophy and Phenomenological Research*, **LXII** (2), pp. 253–281.

Stoljar, D. (2001b), 'The conceivability argument and two conceptions of the physical', *Philosophical Perspectives*, **15**, *Metaphysics 2001*, ed. J. Tomberlin, pp. 393–413.

Strawson, G. (2006), 'Realistic monism', *Journal of Consciousness Studies*, **13** (10–11), pp. 3–31.

Tonneau, F. (2004), 'Consciousness outside the head', *Behavior and Philosophy*, **32**, pp. 97–123.
Tononi, G. & Edelman, G. (2000), *A Universe of Consciousness* (New York: Basic Books).
Tovee, M. & Rolls, E. (1992), 'The functional nature of neuronal oscillations', *Trends in Neurosciences*, **15**, pp. 387–388.
Treisman, A. (2003), 'Consciousness and perceptual binding', in: *The Unity of Consciousness: Binding, Integration, and Dissociation*, ed. A. Cleeremans (Oxford: Oxford University Press).
Zeki, S. (2003), 'The disunity of consciousness', *Trends in Cognitive Neuroscience*, **7** (5), pp. 214–218.

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