Synthese (2023) 201:10
https://doi.org/10.1007/s11229-022-04015-z

ORIGINAL RESEARCH

Quantum computation and the untenability of a "No fundamental mentality" constraint on physicalism

Christopher Devlin Brown[1]

Received: 31 August 2021 / Accepted: 14 December 2022 / Published online: 26 December 2022

Abstract
Though there is yet no consensus on the right way to understand 'physicalism', most philosophers agree that, regardless of whatever else is required, physicalism cannot be true if there exists fundamental mentality. I will follow Jessica Wilson (Philosophical Studies 131:61–99, 2006) in calling this the 'No Fundamental Mentality' (NFM) constraint on physicalism. Unfortunately for those who wish to constrain physicalism in this way, NFM admits of a counterexample: an artificially intelligent quantum computer which employs quantum properties as part of its cognitive operations. If one of these quantum properties serves a proper functional role in the artificial intelligence, then that property counts as a mental under the physicalism-friendly theory of mentality called "realizer functionalism", which says that a lower-order property is mental if it satisfies an appropriate higher-order functional description. Further, if this quantum property is both fundamental and mental, then NFM must rule that it is not physical. Yet the existence of such an artificially intelligent quantum computer, which possesses mental properties solely in virtue of the functional roles those properties play, is surely consistent with the truth of physicalism. This ought to motivate NFM proponents to reformulate their view.

Keywords Physicalism · No fundamental mentality · Via negativa · Quantum computation · Fundamentality · Realizer functionalism

Physicalism is the popular metaphysical view that there is nothing over and above the physical. Despite its popularity, physicalism has two definitional issues: (i) 'nothing over and above' is underspecified, and might be cashed out as one or another distinct sort of metaphysical dependence relationship; and (ii) it is unclear what 'physical' means. My concern is the latter issue.

✉ Christopher Devlin Brown
christopher.devlin.brown@gmail.com

[1] Xiamen University, Xiamen, China

Perhaps the most obvious way to understand ‘physical’ says that the term refers to the posits of physics (see Hellman & Thompson, 1975; Smart, 1978; Hellman, 1985; Poland, 1994; Melnyk, 1997, 2002; Stoljar, 2001). Unfortunately, this way of understanding ‘physical’ faces Hempel’s (1949, 1969) well known objection: if ‘physical’ refers to the posits of current physics, then physicalism is trivially false, since current physics is incomplete and there are things outside its scope. Alternatively, if ‘physical’ refers to the posits of future physics, then physicalism is hopelessly unclear—since the content of physics may change a great deal before we have finished inquiry—or it is trivially true, if by ‘future physics’ we mean ‘complete physics’. The last option is especially problematic, since it allows anything which exists to count as physical. This would mean that paradigmatic nonphysical things, such as gods and ghosts, are consistent with the truth of physicalism, if they exist.

Though there is yet no consensus on the right way to understand ‘physical’, most philosophers agree that, regardless of whatever else is required, something cannot be physical if it is fundamentally mental.[1] Following Jessica Wilson (2006), I will call this the ‘No Fundamental Mentality’ (henceforth ‘NFM’) constraint on physicalism. Fundamental mentality is mentality which metaphysically depends on nothing else—it is mentality at the bottom of nature, so to speak. The existence of such fundamental mentality suffices to make physicalism false, under this common view.[2] Standard examples of entities which possess fundamental mentality are Cartesian souls and God. Some take the absence of fundamental mentality as both necessary and sufficient for being physical—these are via *negativa* physicalists (Levine, 2001, Montero, 2005, Montero & Papineau, 2005, Papinueau & Spurrett, 1999, Smith, 1993, Worley, 2006)—while others add it as a necessary, but not sufficient, condition on ‘physical’—see Crook and Gillett (2001) and Wilson (2006).

A number of issues have been identified with NFM, but these criticisms tend to rely on contentious metaphysical assumptions. Specifically, NFM wrongly rules that physicalism is false in certain classes of metaphysically possible worlds. These are, respectively, (i) worlds without a fundamental level, which decompose into an infinite regress of functionally-characterizable mental properties (Brown, 2017a), and (ii) priority monist worlds in which the whole of nature is a mental system which possesses functionally-characterizable mentality (Brown, 2020). For the sake of space, I will not elaborate on the details of these worlds, especially since the argument here does not rely on any such unusual metaphysical possibilities.

---

[1] Notable exceptions are Galen Strawson (2003), who thinks that physicalism is identical to panpsychism; Noam Chomsky (1995), who thinks that physicalism is trivially true; Daniel Stoljar (2001) who thinks that exemplars of physical objects might turn out to have fundamental mentality, and that these exemplary physical objects define what is physical; and Janice Dowell (2006), who thinks that ideal physical theory is consistent with the existence of fundamental mentality.

[2] I will use “fundamentally mental” and “fundamental mentality” interchangeably. Further, I will assume that if something is both fundamental and mental, then it is fundamentally mental (or, equivalently, that it is an instance of fundamental mentality). However, when Wilson (2006, p. 68) says that fundamentally mental entities are “such as to individually possess or bestow mentality”, she perhaps has stricter requirements for determining whether something counts as fundamentally mental. Regardless, the problem case I will discuss is an instance of a property individually bestowing mentality, so it ought to satisfy Wilson’s (perhaps) stricter requirements.

I believe that there is a counterexample to NFM which is not just metaphysically possible, but nomologically possible. In fact, I suspect that this counterexample may become actual at some time in the foreseeable future. The counterexample is this: an artificially intelligent (henceforth 'AI') quantum computer which employs quantum properties as part of its cognitive operations. If one of these quantum properties serves a proper functional role in the AI, then that property counts as a mental property under the physicalism-friendly theory of mentality called 'realizer functionalism', which says that a lower-order physical property is identical to a mental property for a particular population if the lower-order physical property satisfies an appropriate higher-order functional description in all members of that population.[3][4] Realizer functionalism is 'physicalism-friendly' since it is widely accepted to be consistent with physicalism: realizer functionalist mental properties can exist without making physicalism false. Further, if this quantum property is both fundamental and mental, then NFM must rule that it is not physical. Yet the existence of such an AI quantum computer is surely consistent with the truth of physicalism.

This can be put as a premise-numbered argument against NFM:

(1) If some property plays a well defined functional role in a mental system, then it is a realizer functionalist mental property
(2) It is nomologically possible for a fundamental property to play a well defined functional role in an artificially intelligent quantum computer
(3) The existence of such a realizer functionalist mental property is consistent with the truth of physicalism
(4) An artificially intelligent quantum computer could be a mental system
(5) Therefore, the existence of fundamental mental properties is consistent with the truth of physicalism

The conclusion is just the negation of NFM, which (remember) says that fundamental mentality is inconsistent with the truth of physicalism. As I pointed out, this argument is more troubling than other criticisms that NFM faces, since it says that there could be physically acceptable fundamental mentality *in the actual world*. Thus, even if one were to restrict physicalism to a thesis about what could be the case in the actual world—that is, a thesis about what is nomologically possible—NFM makes the wrong ruling.

---

[3] Dorsey (2011) and Zhong (2016) raise a similar issue for NFM, both claiming that it is conceivable that fundamental entities which seem physically acceptable could be mental entities. The argument presented in this paper can be seen as an attempt at fleshing out their claim, to show how such physically acceptable fundamental mentality might be instantiated in the actual world.

[4] Note the requirement that realizer functionalism must relativize mental properties to populations, such that a mental property M is identical with whatever realizer property P *in population N* plays the M role in all members of N (thanks to an anonymous referee for pushing me on this). Relativization to a population type must be done to avoid the problem that multiple first-order properties might satisfy a functional description, which would have failure of identification as a consequence if a mental property is specified as *the* realizer of some functional description. However, there are multiple plausible ways to go about doing the requisite relativization—specifically, one can relativize to a species, or relativize to a smaller population type (perhaps even to a population type which contingently has a sole member). For the present argument, it is not important what sort of population mental properties are relativized to.

1 Distinguishing role realizers from their proper parts

‘Well defined functional role’ in the first premise requires a bit of explanation. This is supposed to differentiate properties which play full-blooded functional roles from properties which are somehow involved in the realization of a functional role property, but which are not themselves mental properties. For instance, the properties of the parts of an individual neuron (e.g. that calcium is in such-and-such a location) are not mental properties, even though they might play some part in realizing mentality.

A well defined functional role property is defined relative to a folk or scientific psychological theory, such that the functional role can be fully understood in terms of generalized causal relations to other posits of the theory. For instance, we have a folk psychological theory of pain. In this theory, the term ‘pain’ refers to a property which is caused by damage to innervated tissue, causes thoughts like ‘ouch, that hurt’, and leads to pain avoidance behavior (this can be translated into a Ramsey sentence, which replaces the posits of the theory with existentially bound variables). Anything which is causally related to the various posits of the folk theory in this way is an instance of pain.

Again, note that this argument applies only to realizer functionalism, and not to role functionalism. Realizer functionalism identifies mental properties with the realizers of higher-order functional properties (see McLaughlin, 2006), whereas role functionalism identifies mental properties with the higher-order functional properties (see Witmer, 2003). The biggest difference between these two views is that role functionalism allows for multiple realizability of one and the same mental property by different types of realizers (like neurons or computer chips), whereas realizer functionalism is really a type-identity theory, and disallows multiple realizability of the same mental property by different realizers.[5] Realizer functionalism is widely recognized as a view which is consistent with physicalism. If the existence of some property is inconsistent with physicalism, it must be for a reason beyond the fact that the property satisfies a higher-order functional role description.

Regarding the plausibility of the first premise, this is a basic assumption for all realizer functionalists. They agree that if some property plays the right functional role in a mental system, then it is a mental property. As I pointed out, not *every* part of a

---

[5] Note that nothing in my argument requires multiple realizability of mental properties. NFM rules that physicalism is false if there exists any fundamental mentality, regardless of whether that mentality is multiply realizable or not. Under realizer functionalism, mental properties are identified with the first-order realizers of functional role descriptions, and so are not multiply realizable, since this view is ultimately a sort of identity theory. For example, suppose that human pain = neural property N, martian pain = alien goo property M, and computer pain = silicon property S. Since $N \neq M \neq S$, it follows that the realizers in these cases are non-identical, so human pain cannot be possessed by computers or Martians, even though the functional description of human, Martian and computer pain might be identical. It may seem that realizer functionalism requires or allows multiple realizability because this view has us apply the same functionalist criteria across the board in order to determine mentality ascription, e.g. whether property P is pain or a pain-like mental property depends on whether P is caused by e.g. body damage and causes pain-appropriate-thoughts and avoidance behavior. It does not follow from the view that satisfaction of an appropriate functional description suffices for mentality ascription that all satisfiers are the same mental property—in fact, this is exactly what realizer functionalism denies. That said, it is nonetheless the case that mental properties fall under a common functionally-defined genus under realizer functionalism, even though they are non-identical mental properties.

mental system will count as a mental property, but I have already provided an account for distinguishing mental from non-mental properties under functionalism generally.

2 How mentality-relevant functional roles might be realized by a quantum computer

The second premise says that a fundamental property can play a well defined functional role in an artificially intelligent quantum computer. This premise assumes that quantum properties are fundamental—the odd and unique features of the quantum level are less important to this argument than the relatively more mundane fact that quantum properties depend on no lower-level properties. Nonetheless, to see how a fundamental quantum property might play a well defined role in a quantum computer, we can look to the present state of research into quantum computation, and extrapolate possible future technological developments which might be applied to an AI. At present, quantum computers operate by employing quantum circuits, which execute functions by manipulating basic units of quantum information (called "qubits") via basic logical transformations (called "quantum gates"). The main thing that distinguishes qubits from the bits of classical computers is that bits can exist in only one of two states (0 or 1), whereas qubits exist in a superposition, with 0 and 1 as only two of the possible states in a two-dimensional Hilbert space.[6]

Though 0 and 1 are the only possible *measurable* states of a qubit—due to collapse from a superposition upon measurement—it can store "hidden" information which is manipulable through quantum gates. Beyond the quantitative difference of being able to fit more computational hardware in a smaller space, this hidden and manipulable information is primarily what distinguishes quantum computers from classical computers, allowing qubits to potentially store more information than classical bits.

Qubits are represented as vectors in Dirac notation as $|\Phi\rangle$, with Φ representing either a 1 or 0 if the qubit is collapsed out of superposition—measured qubits are always measured as $|0\rangle$ or $|1\rangle$. If the qubit is in superposition—which is the state a qubit is in before measurement, which means that the qubit is simultaneously in both states $|0\rangle$ and $|1\rangle$—then $|\Phi\rangle$ is connected to a probability vector which attaches $|0\rangle$ and $|1\rangle$ to coefficients α and β respectively. These are complex numbers—i.e. they are numbers which can be in imaginary number space and thus can (when appropriate) be represented using the unit i, which is the square root of -1—and which represent probability amplitudes. The formalism is as follows: $|\Phi\rangle = \alpha\ |0\rangle + \beta\ |1\rangle$, which is equivalent to the matrix $\begin{bmatrix} \alpha \\ \beta \end{bmatrix}$. Further, it must be the case that $|\alpha|^2 + |\beta|^2 = 1$. If the qubit has a 50% chance of collapsing to either $|0\rangle$ or $|1\rangle$ upon measurement, then one option (of four) for the values of α and β are $\alpha = 1/\sqrt{2}$ and $\beta = 1/\sqrt{2}$ (which each become $1/2$ when squared, and of course add up to 1). Note that the probability amplitude for a qubit need not be 50%.

---

[6] Technically, qubits can be represented as positions on a three-dimensional Bloch sphere (which requires the use of imaginary numbers to accurately represent), but as I understand it the third dimension is largely irrelevant for quantum computational purposes.

Qubits in state $|0\rangle$ are represented by the matrix $\begin{bmatrix} 1 \\ 0 \end{bmatrix}$, and qubits in state $|1\rangle$ are represented by the matrix $\begin{bmatrix} 0 \\ 1 \end{bmatrix}$. These can be thought of as positions on a unit circle, with $\begin{bmatrix} 1 \\ 0 \end{bmatrix}$ as the north pole position, $\begin{bmatrix} 0 \\ 1 \end{bmatrix}$ as the east pole position, and $\begin{bmatrix} 1/\sqrt{2} \\ 1/\sqrt{2} \end{bmatrix}$ as the northeast position at a 45° angle from the center of the circle. Note that making any of the coefficients in these matrices negative affects the vector's phase and position on the unit circle—and thus is relevant to logical transformations applied to these matrices—but does not change the probability of collapsing to $|0\rangle$ or $|1\rangle$, since the square of a negative is always positive. Applying a logic gate to a qubit transforms the qubit in a way that predictably moves the qubit's position around the unit circle. For instance, the Hadamard gate transforms a qubit which is in state $|0\rangle$ or $|1\rangle$ into a state in superposition with a matrix representation of $\begin{bmatrix} 1/\sqrt{2} \\ 1/\sqrt{2} \end{bmatrix}$ or $\begin{bmatrix} 1/\sqrt{2} \\ -1/\sqrt{2} \end{bmatrix}$ respectively; i.e. into a vector with a 50% probability of collapsing to $|0\rangle$ or $|1\rangle$. It does the inverse to a qubit which is in exactly-equal superposition, transforming it into a $|0\rangle$ or $|1\rangle$ (without measuring the qubit). Due to the fundamental laws of physics, all quantum logic gates must be reversible functions, which means that if you know the output and know the logic gate which was applied, you can determine the input (unlike some classical gates, e.g. set-to-1 which takes any input bit and transforms it to a 1).

These gates are implemented using machinery which causes the qubit to change spin or polarization without measuring—and thereby collapsing—the qubit. I won't get into the specific mathematical details of how quantum logic gates work, but they all ultimately rely on multiplying the tensor product of input qubits by one or another specific matrix (though quantum funniness arises from entanglement, which I will address shortly). There are various ways of implementing quantum circuits, as demonstrated experimentally with e.g. condensed matter systems. Though technical hurdles remain, it has been demonstrated that such systems can execute at least some functions.

Since quantum computers are *computers*, this premise assumes that at least some mental functional roles are computational, i.e. that they essentially involve the implementation of algorithms which execute functions via logical transformations on symbols. Though this is a widespread view in cognitive science, it is not universally held to be correct. For instance, some think that human cognition necessarily involves embodied processes—which are processes which essentially depend on interrelationships between environment (including a person's bodily and behavioral environment) and the core cognitive system (i.e. the brain)—and that such embodied processes are not reducible to any computational processes (see Varela et al., 1991; Chemero, 2009).

Even if it is true that human cognition is embodied, this does not negatively affect my second premise, since this premise does not require that every part of the mind is computational. Rather, it suffices that at least one functional role in a mental system can be given a correct computational description. This can be the case even if the system as a whole involves processes which are not computable. For instance, perhaps the early visual processing that occurs in a human is computational, and this computation generates an output which figures in a process which is not entirely computational. A quantum computer AI could likewise be embodied, so long as the computer system (which constitutes the core computational part of the cognitive system) is correctly coupled to an environment (which, again, can be a body or a way of behaving). This allows some mental predicates to correctly refer to computational parts of the system, even though the whole system is not completely computational (see Rupert, 2009 and Clark, 2014 for similar suggestions).

Notice what is *not* required for this premise to succeed: quantum computers need not be "hypercomputers", which are theoretical computers capable of computing non-Turing-computable functions (i.e. functions which are not computable on a classic Turing machine, as described by Turing, 1936); nor must quantum computers be in principle any more efficient (in a technical sense of "efficient") than classical computers, which would be the case if a quantum computer could compute functions on a logarithmic timescale which can only be computed on an exponential timescale when using a classical computer. It is enough that a quantum computer can compute some mentality-relevant function *at all*, which is likely the case given that (i) we have a proof from Feynman (1982) that quantum computers are physically possible (as well as subsequent experimental validation), (ii) at least some mentality-relevant functions are Turing-computable, and (iii) quantum computers are in-principle capable of computing any Turing-computable function (proven by Deutsch, 1989).

Given that quantum computers which are universal Turing machines are nomologically possible, one might wonder about the second claim, that some mentality-relevant functions are Turing-computable. A "mentality-relevant" function is a function that, if implemented, would realize a functionally characterized mental property. Penrose (1989) has argued that the brain employs functions which are not Turing-computable.[7] If this position were correct, would it undercut my argument? No: Penrose thinks that the mind is not Turing-computable because he thinks that the brain directly employs quantum properties in its operations. Well, surely a quantum computer could employ similar properties to compute non-Turing-computable functions. So even if there are no mentality-relevant functions which are not Turing-computable, it still seems that a quantum computer would be able to compute those mentality-relevant functions.

Even granting all this, there is still room to push against the second premise. There are two additional reasons one might be skeptical: (i) one might think that quantum properties are not fundamental, or (ii) one might think that quantum properties are too simple to play well defined functional roles of the requisite sort. I will address each of these objections in turn.

Are quantum properties fundamental? Frankly, I have no idea. Some views in physics, such as string theory, posit even-more-fundamental properties underlying the properties of better-established subatomic theories. However, it seems fairly reasonable to suppose that quantum mechanical properties or properties that are very similar to them are fundamental—there are some physicists who have suggested something like this, e.g. Hawking (1981). Regardless, however deep the fundamental level lies,

---

[7] Note that this view is almost certainly false: nearly all of cognitive science is predicated on the assumption that some (or, more likely, *all*) mentality-relevant functions are Turing-computable. Progress in cognitive science has largely been based on accurately modeling cognitive processes as Turing-computable functions, e.g. Marr's (1982) work on vision.

it seems a plausible supposition that we might (in principle, anyway) exploit the properties at that level to perform computations. And this is all that my argument requires. The alternative to this is that there is no fundamental level—there are other physicists who think this, e.g. Bohm (1957)—and thus no fundamental properties to be exploited by a quantum computer. As noted above, I (Brown, 2017a) have previously offered an alternative critique of NFM which applies to worlds which have no fundamental properties.

The second objection says that the properties which realize well defined functional roles in human beings are extremely complex neural properties, and that no fundamental property has the requisite complexity to satisfy such a functional description. Consider that a typical human brain is composed of about one hundred billion neurons. For all we know, the neural realizer for the property of *being in pain* may involve millions, or even billions, of neurons. It seems implausible that e.g. the charge of a single electron could be used in a quantum computer to realize an analogous functional role. Does this mean that this premise is not viable?

No: quantum computers we are currently endeavoring to build can use a surprisingly small number of fundamental properties in order to accomplish powerful computational tasks (see Shor, 1994). This is because these computers exploit features of quantum properties which are non-existent at the level of classical physics, such as quantum superposition and entanglement.[8] These quantum mechanical properties allow computational shortcuts which are unavailable to computers utilizing only classical physics, and likewise unavailable to our hot, wet, messy human brains, which almost certainly do not employ quantum mechanical properties directly (see Tegmark, 2000; Jumper & Scholes, 2014). So, it is a mistake to underestimate how much computational work quantum mechanical properties can perform as compared to properties which only have classical features.

It is also a mistake to overestimate how much sophistication is required to minimally implement a mental property of some sort. Though the realizers of human mental properties may generally be extremely complex, not all realizers of mental properties need to be so. Consider a simple roundworm, which has exactly thirty two neurons. This organism senses and responds to its environment, and has a simple brain. It seems fairly reasonable to attribute mental properties of some sort to the roundworm, despite the simplicity of its nervous system. Given the robust computational power of quantum mechanical properties, and the low level of sophistication which may be minimally required to realize some simple mental properties, it follows that this objection—that quantum properties cannot serve well defined functional roles—seems to fail.

All this said, one might wonder how exactly a quantum computer could allow for realization of mentality-relevant functional roles which are not realizable by classical computers, and might not be impressed with my appeal to the demonstrable power of experimental quantum computers. Allow me to further substantiate this premise. Let's start by imagining a classical computer with two switches, either of which can be in state 1 or state 0. There are four possible states this two-switch system can be

---

[8] Again, this does not require that quantum computers are hypercomputers, nor that they are able to compute functions in logarithmic time that are only computable by classical computers in exponential time. All that is required is that quantum computers are measurably more powerful than classical computers, which has now been well-demonstrated experimentally (see Arute et al., 2019).

in: 11, 10, 01, or 00. We can apply logic gates to this system which operate just as corresponding logical connectives function, such that e.g. an AND gate outputs 1 from a two-bit system in the 11 state, and outputs 0 from a two-bit system in any other state.

Now, instead imagine a quantum system containing quantum-entangled entities—the electrons in phosphorus atoms, perhaps, as are used in some actual quantum computation experiments—which represent qubits of information. This is in contrast with the classical entities—electricity-conducting switches, in the previous example—which represent bits of information. There are two important differences between the classical computational system and the quantum computational system: (i) the state of a quantum entity which is entangled with other quantum entities depends on the states of those other entangled quantum entities (and vise versa), and (ii) quantum entities exist in a superposition until measured, such that e.g. an electron in superposition is not in either a determinate spin up state nor a spin down state.

The upshot of this is that we cannot simply describe an entangled two-qubit quantum system in superposition as being either in state $|11\rangle$, $|10\rangle$, $|01\rangle$ or $|00\rangle$. Instead, coefficients representing probability amplitudes must additionally be used to describe the system, as I described earlier in this section. Again: qubits in superposition can be represented in matrices to which quantum logic gates can be applied. Quantum logic gates are also represented as matrices, and application of a logic gate consists of matrix multiplication and tensor multiplication (the latter of which is used to combine multiple quantum vectors into a single matrix).

However, entanglement complicates things. Suppose that there are two entangled qubits in the system. We generally apply tensor multiplication $\begin{bmatrix}\alpha\\ \beta\end{bmatrix} \otimes \begin{bmatrix}\gamma\\ \delta\end{bmatrix}$ to get the tensor product matrix of $\begin{bmatrix}\alpha\gamma\\ \beta\delta\\ \beta\gamma\\ \beta\delta\end{bmatrix}$, and this matrix can generally be factored into the starting matrixes. Not so, though, for entangled qubits. Suppose that the matrix for these entangled qubits is $\begin{bmatrix}1/\sqrt{2}\\ 0\\ 0\\ 1/\sqrt{2}\end{bmatrix}$. There is no way to factor out this matrix to the inputs of tensor multiplication. This is because we would need all of the following equations to be true: $\alpha\gamma = 1/\sqrt{2}$, $\alpha\delta = 0$, $\beta\gamma = 0$, and $\beta\delta = 1/\sqrt{2}$. Yet if $\alpha\delta = 0$ and $\beta\gamma = 0$ are true, then at least two of α, β, γ, or δ must be equal to 0, and this cannot be the case if $\alpha\gamma$ and $\beta\delta$ are both equal to non-zero. Entangling qubits is fairly non-mysterious from a mathematical perspective, requiring only two quantum logic gates to execute (the Hadamard gate and the CNOT gate, which are both crucial gates for quantum computations).

This has an important consequence in the context of my argument: if qubits are entangled, the full product state must be represented. If *n* qubits are entangled, the vector must have a size of 2^n stored in memory. This number quickly becomes enormous as more qubits are added, which explains why quantum computers can store vastly more information than classical computers. Further, note that there are some operations which demonstrably require far fewer steps to compute on a quantum computer than on a classical computer (though getting into the mathematical explanation would take me too far off topic). For instance, it only requires one query step for a quantum computer to determine whether some unknown function is constant (such that the output is the same regardless of input) or variable, whereas it takes at minimum two queries for a classical computer. Something like this principle underlies the famous Shor's (1994) algorithm, which can be used to find the prime factors of arbitrarily large numbers. Shor's algorithm works astronomically faster than the best prime factorization algorithms that can run on classical computers.

The above description of quantum computers requires that *groups of entangled quantum entities* store information in any quantum computer which involves more than one qubit. This is something which allows quantum computers to be so powerful compared to classical computers—as qubits are added, there is a massive exponential rise in informational capacity. It seems likely that a 50 qubit system could store enough information such that it could represent a mentality-relevant functional state, e.g. the state of being caused by bodily damage and causing some pain-thoughts and avoidance behavior. However, you may recall that my argument requires that *fundamental entities* are capable of realizing mentality-relevant functional descriptions. Since only *groups* of fundamental entities could plausibly store enough information to realize mentality-relevant functional roles, and it seems that a group of entities is not fundamental—since a group is not mereologically simple—there seems to be an issue with my argument.

However, several philosophers have urged that entangled properties are fundamental properties, even though they are properties of groups of entities. For instance, Schaffer (2010) says that entangled properties are fundamental, and uses this assumption as a basis for arguing that the properties of a whole quantum-entangled cosmos would be fundamental rather than the properties of the cosmos' parts. Ney (2008) and Rosenberg (2015), among others, have suggested that entangled properties are strongly emergent, which plausibly means that they are fundamental.[9] As I see it, the best argument for this view is that the properties of the individual elements in a quantum entangled system cannot be specified without specifying the properties of the whole system. As Schaffer (2010) puts it: "an entangled system is one whose state vector is not factorizable into tensor products of the state vectors of its components". Under the assumption that this reasoning is right, then even if an orchestrated collection of entangled quantum entities is required to realize a mentality-relevant functional role, it is plausible that the entangled properties of these entities ought to count as fundamental.

---

[9] I admit that it is difficult to understand what 'strong emergence' means. Wilson (2011) defines 'strong emergence' as occurring when a high-level property has causal powers which are not a proper subset of the causal powers of its subvenience base, but this excludes epiphenomenal properties from possibly being strongly emergent, which seems wrong. I prefer to understand 'strong emergence' relative to different modal constraints: if the existence of some high-level property is nomologically necessary but not metaphysically necessary, then that property is strongly emergent. Though this articulation faces problems if all properties possess their nomological profiles with metaphysical necessity, as under necessitarianism (see Bird, 2005). Regardless of exactly how to cash out 'strong emergence', I take it that it is plausible that (i) strongly emergent properties are fundamental in some important sense, and (ii) entangled properties are strongly emergent.

3 The in-principle compatibility of a quantum computer AI and physicalism

The third premise—that the existence of a quantum computer AI which employs fundamental quantum properties in its cognitive operations is consistent with the truth of physicalism—is nearly unassailable, I believe. If it were to turn out—contrary to our best evidence—that human brains normally employ quantum mechanical properties in their operations, surely no one would hereby declare that physicalism has been proven false. And it would be similarly absurd for someone to declare that we have proven physicalism false by constructing a quantum computer AI of the sort described here.

However, perhaps a proponent of the NFM constraint on physicalism might stop at this point and say: “while the fundamental mental properties of a quantum computer may *seem* physically acceptable, it turns out that the existence of any such fundamentally mental property—functionally defined or otherwise—suffices to render physicalism false. After all, ‘physical’ just *means* ‘not composed of anything with fundamental mentality’”. I find this response both implausible and question begging. Allow me to explain.

Notice that the quantum computers in question do not require mentality to be metaphysically special in any way. Their mentality entirely depends upon the fact that the AI quantum computer is a functionally-characterized machine of the right sort. No magic mind dust or ghost in the machine is necessary. Since the mentality in question is an instance of realizer functionalist mentality, and realizer functionalism is a theory which is widely accepted as consistent with physicalism, it would be very strange for quantum computers to be excepted as physically unacceptable.

The only reason I see that one might hold that quantum computer AI is physically unacceptable is an unwavering commitment to NFM. But of course, this is exactly what I am trying to prove false, so using NFM to deny premise three looks to me to be question-begging. The mentality in this case seems physically acceptable, despite the fact that it is realized by fundamental properties.

Alternatively, a proponent of NFM might take my example to show that physicalism is inconsistent with realizer functionalism generally. Though the existence of an AI quantum computer would not show that physicalism is false in our world, this response says that the computer’s mental properties must be identical to non-fundamental functional or informational properties, rather than identical to the lower-order role-realizers of those higher-order properties. As with the other objection to this premise, I find this move implausible. Realizer functionalism is accepted by nearly everyone as a view which is consistent with physicalism—in my eyes, it is the most viable version of identity theory. If realizer functionalism allows for some fundamental properties to be mental, this is not a problem with realizer functionalism’s physicalist credentials, but rather with NFM.

4 The plausibility of mind-endowed machines

Finally, the last premise says that an artificially intelligent quantum computer could be a mental system. I take it that this is a necessary consequence of realizer functionalism, assuming that the AI has a cognitive architecture which is sufficiently robust. However, it is logically coherent to be a physicalist who is a human-centric chauvinist about mentality attribution, perhaps appealing to the arguments of Block (1978) or Searle (1980). I have no response to this view beyond pointing out that it seems unreasonable to deny attribution of mentality to beings who exhibit certain sorts of complex behavior (e.g. the capacity to engage in meaningful conversation) and who are internally organized in ways that are functionally analogous to the way a human brain is organized.

The complete denial of mentality to any possible AI is not a common view, even for identity theorists. More common is to say that we cannot know if an AI would possess subjective experience—as in Block (2002)—or that no near-term computer system would be sophisticated enough to possess mentality—as in McLaughlin and Rose (forthcoming). Neither of these stances are sufficient to defeat my argument. The quantum computer AI invoked in my argument can be as sophisticated as is required for possession of mentality. Further, even if it were true that an AI could not possess subjective experience—which, again, is not a common view for physicalists—this does not prevent the AI from possessing *some sort* of mentality, e.g. intentional or volitional mentality. And the realization of physically acceptable fundamental mentality *of any sort* suffices to prove the untenability of NFM.

5 Dependent mentality

An anonymous referee has suggested the following objection: the mental property in the above-described scenario of *being in pain* seems to metaphysically depend on other properties such as e.g. *being caused by body damage* and *being the cause of pain thoughts and avoidance behavior*. Notice that if the appropriate relata were to not exist, then—under realizer functionalism—it seems that pain would fail to be instantiated. This does not seem to be just a causal sort of dependence, since it is not just that functionally-characterized pain is merely a causal consequence of body damage and so on, but that pain cannot possibly exist if body damage and so on does not exist. Yet if the property of *being in pain* metaphysically depends on other properties for existence, then it is not a fundamental property—and so the scenario I describe in this paper would not constitute a challenge to NFM.

However, also notice that realizer functionalism is an identity theory. Under this view, mental properties are identified with appropriate realizers of functional descriptions. If the functional description of *having pain-appropriate causes and effects* is satisfied by a quantum property, then realizer functionalism says that this quantum property is a pain property. Suppose that the quantum property in question is the property of *evolving according to the Schrödinger equation*, which is the equation which we use to describe the wave function in quantum mechanics. This is plausibly a fundamental property.

Unfortunately, we now face a contradiction: it cannot be the case that mental property M is non-fundamental, quantum property Q is fundamental, and Q=M. This is because if Q and M are identical, then they must share all higher-order properties, including the property of *being fundamental/non-fundamental*. As I see it, there are three routes toward resolving this contradiction: (i) reject realizer functionalism, (ii) deny that Q is fundamental, or (iii) deny that M is non-fundamental. Of these three options, (iii) looks to me to be the most palatable. Allow me to explain.

I think we ought not reject realizer functionalism simply on the grounds that it seems to yield a contradiction in this case, since the view is independently attractive, and the contradiction can be resolved without rejecting this theory. Realizer functionalism is attractive because it avoids a serious issue with mental causation which arises for non-reductive physicalist accounts of the mind—specifically, Kim's (1993) causal exclusion argument that identifying mental properties with higher-order realized properties leads to problematic overcausation of effects by distinct causes—while also allowing us to apply functionalist criteria for mentality ascription. Of course, philosophical discussion about the causal exclusion argument is ongoing, with some parties (e.g. Bennett, 2008) arguing that there are ways for non-reductive physicalists to avoid the problem, and others (e.g. Brown, 2019) arguing that these routes do not work. Regardless of the state of this debate, it seems to me that an attractive reductionist account of the mind ought not be thrown out because of the present case involving quantum computation, if it can be avoided.[10]

The second option—denying that the quantum property Q in this case is fundamental—strikes me as a non-starter. Notice that the only difference between Q in this case and a similar quantum Q* in a case which does not involve mentality is that Q has mentality-relevant causal relata, whereas Q* lacks those causal relata. It is highly contentious that causal relata alone could ever determine whether a property is fundamental or not—unless the property in question is somehow grounded in those causal relata—and in this case it seems especially unlikely that the mere fact that Q has mentality-relevant causal relata could render Q non-fundamental. I admit that there may be independent reasons for suspicion that quantum properties are fundamental, but those other reasons are irrelevant to the issue described here.

Finally, there is the option of denying that M is non-fundamental. How can this be, if M existentially depends on other properties? Well, this response requires saying that—despite appearances—M does not depend on other properties. Under this response, mentality-relevant causal relata might explain why Q and M are identical, but neither M nor Q would metaphysically depend on those causal relata.

I believe that this response can be given more credibility by attending to another case in which an identity claim can plausibly be explained, but the explanation does not metaphysically ground the identity. Consider the identity claim that water is identical to H2O. This identity claim can be given an explanation—perhaps involving how our folk concept of *water* fixed the concept to stuff with such-and-such perceptible properties, and then we later discovered that the stuff which we fixed our *water* concept to is composed of H2O molecules—but the explanandum (the proposition 'water =

---

[10] I would not say the same thing about not throwing out NFM because of a strange case concerning quantum computation, since NFM explicitly concerns fundamental mentality, whereas issues with fundamental mentality are obviously peripheral to realizer functionalism.

H_2O’) does not depend on the explanans (the causal story about how the relevant terms were fixed to referents).[11] In this case, our concept was fixed to a first-order substance via a folk description, but the folk description (the stuff that falls from the sky and which we drink and so on) does not pick out the essential nature of water.

Further, notice that the problem raised in this section is not a problem for realizer functionalism only when it applies to fundamental entities, but rather a general issue for the view. Suppose that the realizer for some functional role in a human being is a neural property N. N is caused by earlier neural properties, and causes later neural properties, but N does not seem to metaphysically depend on those earlier and later neural properties (or their associated functional characterizations), since N could plausibly exist even if the actual causal relata to N were to not exist. Yet, under realizer functionalism, the mental property M of *being in pain*—just as in the quantum computation example—appears to metaphysically depend on appropriate causal relata. Though this neural case does not concern fundamentality, it does generate a similar contradiction as discussed above, since the identity of N and M requires that they have all the same higher-order properties, including having the same metaphysical dependence base. So, at minimum, this is not a special issue for the quantum computation example I describe, but rather an issue for realizer functionalism generally.

I admit that this is tricky. Nonetheless, I maintain that the most reasonable way to resolve the apparent contradiction raised by this objection is by allowing that mental properties posited by realizer functionalism have all and only the higher-order properties of the realizer, including the property of being fundamental. This resolves the contradiction while maintaining the viability of realizer functionalism. For those who are skeptical of my solution, I grant that the following conditional can be appended to my argument: ‘if realizer functionalism is viable, then there could exist a physically acceptable instance of fundamental mentality’.

6 Alternatives to the ‘No Fundamental Mentality’ criterion

If I am right, then I have shown how a physically acceptable sort of fundamental mentality could be realized in the actual world. This is a serious problem for the straightforward NFM constraint on physicalism, since this constraint stipulates that such a property cannot be physical. Could the NFM constraint be modified so as to avoid this outcome? I suspect the answer is ‘yes’, and this can be done by specifying what sorts of mentality are physically acceptable and unacceptable. As far as I know, there are two people who have articulated such refined versions of NFM. One is Justin

---

[11] There is a substantive question lurking here about whether our mental concepts are rigid designators—such that they refer to the same referents in all worlds in which those concepts refer—or non-rigid designators—such that the same concept refers to different referents in different possible worlds. Lewis (1980) develops a version of realizer functionalism under which mental concepts are non-rigid, but I take it that nothing bars realizer functionalists from deeming mental concepts to be rigid. The issues with rigidity and realizer functionalism are difficult. I would like to avoid taking a stance on the rigidity/non-rigidity of mental concepts under realizer functionalism, since I believe that my argument is viable either way. However, note that a host of complexities and potential problems arise if mental terms are taken to be non-rigid, and that it is perhaps more natural for realizer functionalism to deem mental terms as rigid rather than non-rigid designators.

Tiehen (2016), who argues that physicalism requires role or realizer functionalism. In my eyes, this is far too strong: physicalism additionally seems consistent with non-functionalist versions of identity-theory, and perhaps with a number of other views as well, like Russellian physicalism (e.g. Brown, 2017b; Montero, 2010; Stoljar, 2001).

The other person to articulate an alternative to flatfooted NFM is Torin Alter (2022), who suggests that physicalists ought to say that physicalism is inconsistent with the existence of non-structural mentality. Instead of a No Fundamental Mentality principle, Alter substitutes a 'No Non-structural Mentality' principle (NNM). Mentality is structural if it fully depends on or is constituted by only structural or dynamical properties. It seems that most functionally characterizable mentality—e.g. the mentality of neural systems—is structural in this sense. I think Alter offers an interesting suggestion, but the example described in this paper (with one additional supposition) constitutes a unique challenge to this view.

Notice that Russellian physicalism explicitly denies the NNM principle, and identifies phenomenal properties with categorical properties (i.e. non-structural and non-dynamical properties). Alter is unconcerned that his articulation of physicalism is inconsistent with Russellian physicalism, since he considers Russellian physicalism to be a deviant sort of physicalism, and as such he feels that it is acceptable to exclude this view from the house of physicalism proper. It seems to me that there are two features of Russellian physicalism which render it deviant: as I said, the view requires an explicit principle which states that phenomenal properties are categorical, as well as a principle which states that phenomenal properties depend on or are constituted by fundamental categorical properties.

These features of Russellian physicalism constitute the contentious features of the view. A far less contentious, but somewhat related, view is that the fundamental entities of the universe are categorical. This is the view of Lewis and others who say that the relations described by physics must have non-relation-defined relata. As Stephen Hawking (1988) puts it, there must be something to "breathe fire into the equations of physics".

It seems very plausible that "categoricalism" about fundamental entities—that fundamental entities are ultimately categorical—is consistent with physicalism. Now reconsider my quantum-computation-based counterexample to NFM. In this example, a fundamental quantum entity has a mental property. Under the assumption that the fundamental level of nature is composed of categorical properties, it would follow that there is a fundamental categorical property which is a mental property: a categorical property would be the role-filler for a mentality-denoting functional description.

In this situation, Alter's NNM principle would be false. Yet—as with NFM—it seems that this should not necessarily render physicalism false, since it is plausible that categoricalism is consistent with physicalism. Thus, the quantum computer example described in this paper constitutes a reason to reject both NFM and NNM, under the assumption that physicalism does not require non-categoricalism about the fundamental level.[12]

---

[12] Perhaps Alter could reject my argument in Sect. 5, and hold that even if categoricalism is true, the case I describe—of quantum mechanical realizer functionalist mentality—is one in which fundamental mental properties partially metaphysically depend on function-appropriate structural/dynamical relations.

7 Conclusion

The argument I have presented shows that NFM as typically articulated leads to the wrong ruling on whether physicalism is true *even in nomologically possible scenarios*. However, while NFM is ultimately not a viable articulation of physicalism, the motivating idea behind the view is reasonable: that physicalism is inconsistent with the existence of metaphysically special mentality. I suspect that there exists a way to describe the difference between physically-acceptable and physically-unacceptable mentality, but the difference cannot ultimately come down to whether that mentality is fundamental or not. A more sophisticated articulation is required to properly capture the spirit of physicalism.

Declarations

Conflict of interest There are no conflicts of interest nor sources of funding to report for this paper.

References

Alter, T. (2022). Physicalism without fundamentality. *Erkenntnis*, *87*(4):1975-1986.
Arute, F., Arya, K., Babbush, R., et al. (2019). Quantum supremacy using a programmable superconducting processor. *Nature, 574*, 505–510.
Bennett, K. (2008). Exclusion again. In J. Hohwy & J. Kallestrup (Eds.), *Being reduced: New essays on reduction, explanation, and causation* (pp. 280–307). Oxford University Press.
Bird, A. (2005). Laws and essences. *Ratio, 18*, 437–461.
Block, N. (1978). Troubles with functionalism. *Minnesota Studies in the Philosophy of Science, 9*, 261–325.
Block, N. (2002). The harder problem of consciousness. *Journal of Philosophy, 99*(8), 391–425.
Bohm, D. (1957). *Causality and chance in modern physics*. Routledge and Kegan Paul.
Brown, C. D. (2017a). Minds within minds: An infinite descent of mentality in a physical world. *Erkenntnis, 82*(6), 1339–1350.
Brown, C. D. (2017b). A properly physical Russellian physicalism. *Journal of Consciousness Studies, 24*(11–12), 31–50.
Brown, C. D. (2019). Exclusion endures: How compatibilism allows dualists to bypass the causal closure argument. *Analysis, 79*(4), 587–594.
Brown, C. D. (2020). Fundamental mentality in a physical world. *Synthese, 199*(1–2), 2841–2860.
Chalmers, D. J. (1996). The conscious mind: In search of a fundamental theory. Oxford University Press.
Chemero, A. (2009). *Radical embodied cognitive science*. MIT Press.
Chomsky, N. (1995). Language and nature. *Mind, 104*(413), 1–61.
Clark, A. (2014). *Mindware: An introduction to the philosophy of cognitive science*. Oxford University Press.
Crook, S., & Gillett, C. (2001). Why physics alone cannot define the 'physical': Materialism, metaphysics, and the formulation of physicalism. *Canadian Journal of Philosophy, 31*, 333–360.
Deutsch, D. (1989). Quantum computational networks. *Proceedings of the Royal Society of London A, 425*, 73–90.

Footnote 12 continued
However, even if it is true that the realizer mental properties under realizer functionalism partially metaphysically depend on structural/dynamical properties, this does not save Alter's view. This is because many dualists also claim that non-physical mental properties partially depend on realization of appropriate functional properties—for instance Chalmers' (1996) psychophysical law dualism. Perhaps a view such as psychophysical law dualism can be distinguished from realizer functionalism on the grounds that psychophysical law dualism requires mentality-specific psychophysical laws. However, such a project would go beyond characterizing the non-physical as merely non-structural/non-dynamical mentality, and so Alter's NNM principle would still be insufficient.

Dorsey, J. (2011). On the supposed limits of physicalist theories of mind. *Philosophical Studies, 155*(2), 207–225.

Dowell, J. (2006). The physical: Empirical, not metaphysical. *Philosophical Studies, 131*(1), 25–60.

Feynman, R. (1982). Simulating physics with computers. *International Journal of Theoretical Physics, 21*, 467–488.

Hawking, S. (1981). Is the end of physics in sight? *Physics Bulletin, 32*, 15.

Hellman, G. (1985). Determination and logical truth. *Journal of Philosophy, 82*, 607–616.

Hellman, G., & Thompson, F. (1975). Physicalism: Ontology, determination, and reduction. *Journal of Philosophy, 72*, 551–564.

Hempel, C. (1949). The logical analysis of psychology. In H. Feigl & W. Sellars (Eds.), *Readings in Philosophical Analysis* (pp. 373–384). Appleton-Century-Crofts.

Hempel, C. (1969). Reduction ontological and linguistic facets. In S. Morgenbesser (Ed.), *Philosophy, science, and method: Essays in honor of Ernest Nagel.* Martin's Press.

Jumper, C., & Scholes, G. (2014). Life—Warm, wet and noisy?. Comment on "Consciousness in the universe: A review of the 'Orch OR' theory" by Hameroff and Penrose. *Physics of Life Reviews, 11*(1), 85–86. https://doi.org/10.1016/j.plrev.2013.10.008

Kim, J. (1993). *Supervenience and mind: Selected philosophical essays*. Cambridge University Press.

Levine, J. (2001). *Purple haze*. Oxford University Press.

Lewis, D. (1980). Mad pain and Martian pain. In N. Block (Ed.), *Readings in the Philosophy of Psychology* (pp. 216–222). Harvard University Press.

Marr, D. (1982). *Vison*. W. H. Freeman.

McLaughlin, B.; Rose, D. (forthcoming). On the Matter of Robot Minds. Oxford Studies in Experimental Philosophy.

McLaughlin, B. (2006). Is role-functionalism committed to epiphenomenalism? *Journal of Consciousness Studies, 13*(1–2), 39–66.

Melnyk, A. (1997). How to keep the 'physical' in physicalism. *Journal of Philosophy*, *94*(12), 622–637.

Melnyk, A. (2002). Physicalism. In S. P. Stich & T. A. Warfield (Eds.), *Philosophy and Phenomenological Research* (pp. 573–587). Blackwell.

Montero, B. (2005). What is the physical? In A. Beckemann (Ed.), *The Oxford handbook of philosophy of mind.* Oxford University Press.

Montero, B. (2010). A Russellian response to the structural argument against physicalism. *Journal of Consciousness Studies, 17*(3–4), 3–4.

Montero, B., & Papineau, D. (2005). A defense of the via negativa argument for physicalism. *Analysis, 65*, 233–237.

Ney, A. (2008). Physicalism as an attitude. *Philosophical Studies, 138*(1), 1–15.

Papineau, D., & Spurrett, D. (1999). A note on the completeness of "Physics." *Analysis, 59*(1), 25–29.

Penrose, R. (1989). *The emperor's new mind*. Oxford University Press.

Poland, J. (1994). *Physicalism, the philosophical foundations*. Oxford University Press.

Rosenberg, G. (2015). Causality and the combination problem. In T. Alter & Y. Nagasawa (Eds.), *Consciousness in the physical world: Perspectives on Russellian monism* (pp. 224–245). Oxford University Press.

Rupert, R. (2009). *Cognitive systems and the extended mind*. Oxford University Press.

Schaffer, J. (2010). Monism: The priority of the whole. *Philosophical Review*, *119*(1), 31–76.

Searle, J. (1980). Minds, brains, and programs. *Behavioral and Brain Sciences, 3*(3), 417–457.

Shor, P. (1994). Algorithms for quantum computation: Discrete logarithms and factoring. *Proceedings 35th Annual Symposium on Foundations of Computer Science*. IEEE Comput. Soc. Press: 124–134.

Smart, J. J. C. (1978). The content of physicalism. *Philosophical Quarterly, 28*(October), 339–341.

Smith, A. D. (1993). Non-reductive physicalism? In H. M. Robinson (Ed.), *Objections to Physicalism.* Oxford University Press.

Stoljar, D. (2001). Two conceptions of the physical. *Philosophy and Phenomenological Research, 62*(2), 253–281.

Strawson, G. (2003). Real materialism. In L. M. Antony (Ed.), *Chomsky and His Critics* (pp. 49–88). Blackwell.

Tegmark, M. (2000). The importance of quantum decoherence in brain processes. *Physics Review, E61*, 4194–4206. https://doi.org/10.1103/PhysRevE.61.4194

Tiehen, J. (2016). Physicalism requires functionalism: A new formulation and defense of the via negativa. *Philosophy and Phenomenological Research, 93*(1), 3–24.

Turing, A. (1936). On computable numbers, with an application to the Entscheidungsproblem. Proceedings of the London Mathematical Society. Second Series, s2–42: 230–65.

Varela, F., Thompson, E., & Rosch, E. (1991). *The embodied mind: Cognitive science and human experience*. MIT Press.

Wilson, J. (2006). On characterizing the physical. *Philosophical Studies, 131*(1), 61–99.

Wilson, J. (2011). Non-reductive realization and the powers-based subset strategy. *The Monist (issue on Powers), 94*(1), 121–154.

Witmer, D. G. (2003). Functionalism and causal exclusion. *Pacific Philosophical Quarterly, 84*(2), 198–215.

Worley, S. (2006). Physicalism and the via negativa. *Philosophical Studies, 131*(1), 101–126.

Zhong, L. (2016). Physicalism, psychism, and phenomenalism. *Journal of Philosophy, 113*(11), 572–590.