Representationalism and the Hard Problem of Consciousness

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Introduction

In the first section of this paper I define and motivate a weak and a strong form of representationalism (intentionalism). In the second section, I define and motivate a thesis that is endorsed by all content externalist theories of conscious experience. In the third section, I argue that these two theses, when conjoined with internalism about phenomenology, form an inconsistent triad, though the inconsistency is less obvious than is generally assumed. In the fourth section, I consider possible approaches to intentionality against the background of rejecting content externalism for qualitative states, and argue that such approaches are no better off than traditional functionalist accounts of consciousness. I conclude that if internalism about phenomenology is true, representationalism provides no special advantage in solving the hard problem of consciousness.

Representationalism

In order to understand representationalism, consider the nature of sensory perception: our experiences give us access to the world. If I am deciding what to wear today, I might look out the window. If it is sunny and warm, I may decide wear shorts. If it is raining, perhaps I decide to wear a jacket. But sense perception is not merely a source of belief and action. When we perceive, we enjoy phenomenally rich experiences. There is something it is like to see and hear the rain – something qualitative that mere belief lacks. Moreover, perceptual experiences attest to
the world. If Sally hallucinates a pink elephant and thereby comes to believe there is a pink elephant before her, her experience is partly to blame. Perceptual experiences represent the world as being a certain way; what they represent is their content.¹

Yet phenomenal character and representational content are apparently distinct. The former consists in the *something it is like* to be in a particular state, while the latter consists in the *aboutness* of a particular state. Moreover, it appears that phenomenal character and representational content can come apart: some mental states, such as beliefs, may represent the world and yet have no phenomenal character while others, such as pains, are robustly phenomenal while having no obvious representational content.

Despite these differences, there is reason to suppose that there is a significant relationship between the phenomenal and representational aspects of perceptual experience. For example, the phenomenal character of an experience is a guide to its representational content: if what it is like for me changes, then how things seem to me also changes.² It is in virtue of enjoying a perceptual experience that one knows about the things it represents. In addition, there are theoretical advantages in treating phenomenal character and representational content in relation to one another. Representation is a mysterious phenomenon, but we have some idea how to approach it. For example, many think that an individual's history and environment are relevant in determining the contents of her mental states. Consciousness, on the other hand, appears intractable. Explaining how the phenomenal character of experience is grounded in the merely physical appears to be a truly hard problem. No set of ordinary physical properties seems adequate to the qualitative character of subjective experience. Given this, any relationship

¹ Byrne 2009, Pautz 2010, and Siegel 2010a and 2010b defend the view that all experiences have contents.
² See Byrne 2001.
between intentionality and consciousness should help illuminate the hard problem of consciousness.

One might hold that the relation between content and character is a determination (i.e., supervenience) relation. If the content of a perceptual experience determines its phenomenal character, then a change in phenomenal character entails a change in content. Moreover, this relationship entails that that a given content is sufficient for a given phenomenal character, thus providing a sufficient condition for conscious experience. Call this thesis ‘representationalism’: it says that if two perceptual states have the same content, they have the same phenomenal character. 3

This initial representationalist thesis should be refined along two dimensions. First, in quantifying over all perceptual experiences, it is too broad. Take for example the phenomenon of blindsight: a cognitive disorder in which subjects report partial or total blindness yet exhibit robust visual recognitional capacities which allow them to 'guess' the object before them with a high degree of accuracy. 4

Understood straightforwardly, the perceptual states of blindsighted subjects have content but no phenomenal character. Assuming further that the contents of blindsight states can also be the contents of qualitative states (in, say, another subject), the representationalist thesis is falsified. The possibility of unconscious perceptual states allows that two perceptual states have the same content and distinct phenomenal character.

In light of this, we can restrict representationalism to qualitative perceptual experiences. Thus amended it states that if two qualitative perceptual experiences have the same content, they

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3 I do not argue for representationalism here. Rather, I proceed by assuming a weak form of representationalism. A useful overview of arguments in favor of representationalism may be found in Byrne 2001.

4 See Weiskrantz 1986.
have the same phenomenal character. It may appear *ad hoc* to simply exclude problematic cases in this manner, and one might worry that doing so jettisons the explanatory power of the thesis. It is thus incumbent on the representationalist to make a principled distinction between the contents of qualitative and those of non-qualitative perceptual experiences. Given that unconscious perceptual experiences occur under only very particular circumstances, perhaps such an account can be given.

The second clarification cuts the opposite way. By only ranging over qualitative perceptual experiences, the representationalist thesis is too narrow. The thesis cannot provide traction on the hard problem of consciousness if it does not range over all conscious experiences. It ought to assign every conscious experience some intentional content. Such states include sensational states such as pains and nausea, and emotional states and desires, as well as all other states with phenomenal character such as phosphenes.

Given these restrictions we may revise the supervenience representationalist thesis:

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(SR) \text{ If two qualitative states have the same content, they have the same phenomenal character.}
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5 For such an account see Tye 1995.

6 We might rephrase the representationalist thesis as 'if two perceptual experiences of type Q have the same content, they have the same phenomenal character', where perceptual experiences of type Q are those on the qualitative side of this distinction. For simplicity, however, we will use the former characterization.

7 See Byrne 2001 and Kind 2007 for arguments to this effect.
There is also a stronger form of this thesis which entails both SR and its converse, that if two states have the same phenomenal character they also have the same content. On this stronger, biconditional form of representationalism, content and phenomenal character covary exactly:

(BR) Two qualitative states have the same content iff they have the same phenomenal character.\(^8\)

Notice that while both SR and BR establish a theoretically useful relationship between consciousness and intentionality, neither account for nor explain the former in terms of the latter. Both a supervenience and a biconditional relation between content and phenomenal character leaves open the precise relationship between the two. For example, the phenomenal character of an experience might simply consist in its intentional content, or the two might be metaphysically distinct and merely covary. Representationalism as such is merely a starting point for further theorizing about the nature of consciousness. It must combine with other theories – specifically theories of content - to offer an account of conscious experience.

I argue below that given a compelling principle about phenomenal character, the most explanatory theories of content are incompatible with both forms of representationism. To show this I argue that such theories are incompatible with even the weakest form of representationalism, SR. (When I use ‘representationalism’ in this paper, I mean SR unless

otherwise noted.) Once I establish that the most explanatory theories of content are incompatible with SR, I consider whether other theories of intentionality will yield an explanatory account of consciousness when combined with either SR or BR. Ultimately, I argue that they do not.

**Content Externalism**

One advantage of representationalism is that it can apply the progress philosophers have made on intentionality to the hard problem of consciousness. Suppose some set of content-fixing properties suffices for a qualitative mental state to have a given content. According to SR, the content of a qualitative state suffices for it to have a particular phenomenal character. Since sufficiency is transitive, those content-fixing properties suffice for that state to have that phenomenal character. In this manner, representationalism allows for a theory of consciousness. Notice, however, that such a theory is possible only if we already understand something about content-fixing properties.

Fortunately, many think we do understand something about content-fixing properties, at least for many types of representation. For example, the experiences of two otherwise identical subjects might be accurate of different properties in virtue of differences in the subjects' respective environments, causal interactions, and histories.9

Consider a case of the visual experiences of colors: imagine two near intrinsically identical subjects – Claire and Emily – in color-inverted environments. Claire and Emily are almost perfect microphysical duplicates, each living in environments where the properties that

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cause their color experiences are inverted relative to their twin's. To a single person travelling between them, the colors of strawberries and bananas in Emily's environment appear to be, respectively, the colors of limes and eggplants in Claire's environment, and vice versa.

However, unbeknownst to both Claire and Emily, their sensory inputs are also inverted relative to one another. When Claire sees a strawberry from Claire’s environment, she enters a state identical to the one Emily enters when Emily sees a strawberry from Emily’s environment. Despite living in inverted environments, the causal effects on their cognitive systems is re-inverted. Thus Claire and Emily behave and interact with their respective environments in exactly the same ways, while interacting with different properties.

Do Claire and Emily both perceive the colors of objects veridically? Both get along perfectly well in their respective environments and identify colors just as reliably as the other. Nothing privileges one of the environments as correct. Absent a reason to think otherwise, it seems reasonable to hold that each perceive the colors around them veridically.

To see this more clearly, suppose we take Emily out of her environment, surgically invert her sensory inputs to match Claire’s, and put Emily in Claire's environment. Emily is now an exact duplicate of Claire. Upon awaking in Claire's environment, Emily notices nothing. Everything seems just as it has always been. Nevertheless, the world around her is radically different. Does Emily's experience represent the world accurately? It does not seem so. At least upon awakening, Emily misperceives the colors of the objects around her. After all, the world differs radically from her normal environment and it is only because she underwent surgery that it appears the same.
When both are in Claire's environment, Emily and Claire are intrinsically identical. Yet their respective mental states are accurate of different objects. If this is right, then Claire and Emily's respective histories affect the objects about which their experiences are accurate.

Because vision is the most clearly representational sort of qualitative experience (and hence the sort of experience about which representationalism is most clearly true), I will for the most part consider visual experiences. Specifically, I will abstract away from other properties represented in visual experience and focus mostly on color experiences. Accordingly, when I speak of two experiences being phenomenally identical I mean this with respect to the colors represented (for simplicity we can assume that all other properties represented are the same).

Inversion cases like Emily and Claire appear possible for a wide range of sensory properties. Pineapples could taste to some individuals as radishes taste to us. Itchiness might feel to you as pain feels to me. Warmth might feel to a human as coldness feels to a martian. Some have argued that experiences of co-called 'primary' properties – such as visual and tactile experiences of shape – can vary independently of the properties normally causing such experiences (though this would not, strictly speaking, be a case of inversion). Since inversion scenarios appear possible for properties other than colors, the conclusions here should apply to them as well. If they do not, however, the argument in this paper would remain valid.

One approach to intentionality accepts that Claire and Emily's experiences are both veridical and holds that the difference between them is a difference in content-determining properties. According to such theories, Emily's experience represents the properties from her own environment. Upon waking in Claire's environment, Emily's experience incorrectly

10 Thompson 2010
represents Claire's environment to have those very same properties. Thus Claire and Emily's experiences are accurate under different conditions because they have different contents.

According to such theories, content-fixing properties are relations to certain states of affairs and Claire and Emily's experiences differ with respect to content-fixing properties. On such a view, some content-fixing properties are external to a state in the sense that they might differ or be absent in cases of intrinsic duplicates of that state (if, for example, the intrinsic duplicate were in a different environment). By contrast, internal properties are those necessarily shared by intrinsic duplicates. Call such theories of content 'externalist'. We can characterize them provisionally as follows: for a given qualitative state with content p, an intrinsic duplicate of that state might not have p.

Note that this characterization is consistent with the possibility that while not all intrinsic duplicates of a state have content p, p is the only possible content such states can have. Surely this is false. When Claire and Emily both look at a particular object, it is not the case that one of their experiences simply fails to have content. Nor is this how we would describe cases more generally. There is no one set of external properties that fix exclusively the content of a given state.11 In light of this modification, we can more accurately characterize content externalism for qualitative states as follows:

(CE) Two intrinsically identical qualitative states can have different contents.

11 Though of course intrinsic duplicates cannot have just any contents. For example, a perceptual state cannot have a belief content. Plausibly, the range of contents that intrinsic duplicates can have all fall under the same or similar mental kind.
One advantage of content externalist theories is that they provide a naturalistic explanation of intentionality by allowing that some ordinary external relations fix contents. Accordingly, most versions of externalism hold that content-fixing properties are causal, teleological, functional, or social relations to states of affairs in the world.

Causal externalist theories of intentionality, for example, often hold that a state $S$ represents $p$ iff $S$ is normally tokened by the fact that $p$. Emily's strawberry-experiences represent the strawberries from Emily's environment because those experiences are normally caused by strawberries from her environment. Teleological externalist theories claim that $S$ represents $p$ iff, when under normal conditions $S$ operates where and how it was designed, $S$ is tokened iff $p$. Emily's strawberry-experiences represent strawberries from her environment because, when Emily's cognitive system operates under normal conditions in the environment in which it evolved, she has strawberry-experiences when and only when there is a strawberry from her environment before her. Functional externalist theories invoke states' wide functional roles, such as indicating that $p$ to the subject. Social externalist theories invoke facts about a subject's social and linguistic community to fix the contents of her mental states. The case of Claire and Emily was given in terms of a causal externalist theory, but similar cases can be given for

12 I follow Chalmers 2004 in characterizing reductive accounts.


alternative externalist theories (though for teleological theories such cases may require inversion between humans and martians17).

While these theories differ with respect to which properties determine content, all agree that such properties are a combination of naturalistic external relations and some basic internal properties.18 By giving an account of intentionality in terms of naturalistic properties, these theories attempt to reduce intentionality to such properties. Call all theories which attempt to reduce intentionality to some naturalistically acceptable properties 'reductive'. Since this paper is concerned with theories of intentionality and consciousness, we can say that a property is naturalistically acceptable just in case it is not itself reduced to intentional or phenomenal properties.

Combining a reductive theory of intentionality with representationalism yields a reductive theory of consciousness. Content externalist theories are reductive, and when conjoined with representationalism, they provide a highly explanatory naturalistic theory of consciousness.19

**Physical Inversion**

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17 See Tye 2002 for such a theory.

18 Content externalist theories hold that a state must meet some minimal internal requirements in order to have content. However, nothing in this paper turns on such internal properties, so in this paper I'll speak mostly of external properties determining content.

19 Note that content externalism as defined here applies only to qualitative states. This paper is neither about semantic content externalism nor belief content externalism (assuming beliefs have no phenomenal character).
Many have worried that externalist theories of intentionality, together with a compelling principle concerning phenomenal character, are incompatible with representationalism. To understand the worry, consider the following characteristic of conscious experience. When sensory-inverted Claire and Emily, in their respective environments, are each shown a banana from her respective environment, both enter the same physical state. The bananas themselves are physically very different, but each affects its viewer in the same way.

How should we describe the phenomenal character of Claire and Emily’s experiences? It seems clear that though different properties cause their experiences, what it is like for them to enjoy those experiences does not differ. The phenomenal characters of their experiences are the same, precisely because the two states are physically identical. Generalizing from this, let us suppose that whenever two states are intrinsically identical, what it is like to be in them is the same. That is, the phenomenal character of a particular mental state is determined by properties internal to that state. Call this phenomenal internalism:

\[(PI)\] If two qualitative states are intrinsically identical, they have the same phenomenal character.20

Many think that representationalism, content externalism, and phenomenal internalism are incompatible.21 If so, then content externalism and phenomenal internalism should entail the negation of representationalism. That is to say, CE and PI should entail the following:

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20 I ignore here the possibility of zombies and of inverted qualia in physical duplicates (a different, much stronger form of inversion).
(-SR) It is metaphysically possible that two qualitative states have the same content and different phenomenal character.

Consider what kinds of states have distinct phenomenal characters: by the contrapositive of PI, if two states have distinct phenomenal character, they are intrinsically distinct. But given that qualitative mental states can be realized in various physical states, intrinsic distinctness is not sufficient for phenomenal distinctness. Martians, though physically distinct from humans, may also see colors and feel nauseous.

In accordance with PI, we may say that two states are phenomenally distinct when some intrinsic duplicates of those states are themselves phenomenally distinct. For example, a single subject's experiences of a lime and of a strawberry may have distinct phenomenal characters. Therefore, all states in all subjects that are intrinsically identical to those two states also have distinct phenomenal characters. If a martian's experience of a lime is qualitatively identical to a human's experience of a lime, then the martian's experience of a lime and the human's experience of a strawberry are phenomenally distinct. The same holds for other qualitative states. Because a single subject's pain experiences and itchy experiences differ in phenomenal character, so will the intrinsic duplicates of those states across all subjects. -SR entails that at least one such pair of states have the same content.

21 See Block 1990, Shoemaker 1991
CE and PI straightforwardly entail that two states can share phenomenal character and differ in content. However, it is one thing for two phenomenally identical states to differ in content; it is another for two phenomenally distinct states to have the same content. As a supervenience relation, representationalism allows a given character to be realized in multiple contents and hence is compatible with the former. To contradict representationalism, CE and PI must entail the latter. But such a case is not obvious with respect to Claire and Emily. When input-inverted and shown a strawberry from Emily's environment, it is not clear that Claire and Emily's respective experiences have the same content. After all, Claire would act quite differently than Emily upon seeing it!

However, another case in the vicinity can provide evidence for ~SR. Take Jack and Jill, two otherwise identical individuals whose sensory inputs are inverted relative to one another but who, unlike Claire and Emily, have always lived in the same environment. Both Jack and Jill go at green lights and stop at red ones. If we show them a yellow ball, both apply to it the term 'yellow'. Absent a reason to believe otherwise, let us assume that Jack and Jill are functionally identical.

Nevertheless, each enters a different state upon seeing a given object. The state Jack enters upon seeing a yellow ball is the state Jill enters upon seeing an otherwise identical purple ball, and vice versa. Since what it is like for Jack to see a yellow ball is not what it is like for him to see a purple ball, these two experiences are phenomenally distinct. Since Jack's experience of a purple ball is intrinsically (and hence phenomenally) identical to Jill's experience of a yellow ball, Jack and Jill's respective experiences of a yellow ball are phenomenally distinct.
Do Jack and Jill perceive the colors of objects in their environment veridically? It seems that they do, and that they do for the very same reasons that were raised in Claire and Emily’s case. Assuming that Jack and Jill are functionally identical, there is nothing about Jack's experience of a purple ball that is tied to purple balls in a way that Jill's experience of a purple ball is not. Neither experience is privileged over the other with respect to accuracy. Jack and Jill's phenomenally distinct experiences are equally good candidates for being accurate of purple balls. There appears to be no reason why either should misperceive the color purple, or any color for that matter.

Content externalist theories attribute the same content to Jack and Jill's respective experiences of a purple ball. To see why, notice that holding CE while denying this (i.e. while denying ~SR) entails a restricted view of the role of external properties, where each state has, in virtue of its intrinsic state, a proprietary range of possible contents. Recall that one advantage of content externalism is its ability to explain, via external properties, why a given mental state has the content it does. But if content externalists deny ~SR, their denial raises a question: why does a given mental state have this range of possible contents and not some others? On such a view, internal rather than external properties explain why a given state has the content it does. Accepting CE and PI but denying ~SR fails to explain via external properties why mental states have the contents they do, since having a certain content is explanatorily grounded in having a certain internal property. For these reasons, content externalism should accept that two phenomenally distinct states may have the same content.

22 At least each version of content externalism would on a version of this case adapted to that theory's account of content-fixing properties. For example, on Tye's particular theory.
Against the background of the general goals for a theory of content, representationalism, phenomenal internalism, and content externalism (for qualitative mental states) are incompatible. While content externalism allows content to vary across intrinsic duplicates, phenomenal internalism does not allow phenomenal character to so vary, and thus content and phenomenal character vary independent of one another, contra representationalism.

**Content Internalism**

To resolve this conflict, philosophers reject one or more of these three theses. For the rest of this paper I will deny content externalism and see what approaches to content are consistent with representationalism and phenomenal internalism. Ultimately, I will argue that no theory of intentionality is in a better position to explain consciousness than were traditional theories of consciousness prior to representationalism.

Above, I examined briefly two reasons for accepting representationalism. I also motivated phenomenal internalism by considering the case of Claire and Emily. The intuitive plausibility of phenomenal internalism can be further motivated by considering another case of exact duplicates in identical environments. Suppose Sarah and Jane are two identical subjects in the same environment. The properties they interact with, and the states they enter, are the same. Moreover, suppose that they have always been this way, in the same environment with the same history. Neither has ever been inverted relative to the other in any respect. Is what it is like for

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them to see a banana the same? Surely it is. And this is just what the content externalist would expect in such a case.

Now suppose instead that Sarah and Jane, though currently exact duplicates in identical environments, previously lived in inverted environments and interacted with distinct properties (though as with Claire and Emily these inverted environments had the same effects on each). Should we say that what it is like for Sarah and Jane now is different because in the past they interacted with different properties? It does not appear so. Sarah and Jane are intrinsically identical at the time of evaluation.

We can run the same case for other externalist theories of intentionality as well. No matter Sarah and Jane’s social, functional, or teleological history, their being in a given physical state appears to suffice for their being in a given phenomenal state. Their respective pasts have no residual effects on the phenomenal character of their experiences. This is one intuitive motivation for phenomenal internalism.

If we assume that representationalism and phenomenal internalism are true, then content externalism is false and it is not possible for two intrinsically identical states to differ in content. That is to say, content internalism must be true:

(CI) If two states are intrinsically identical, they have the same content.
According to CI, a state's content is determined by properties internal to that state. CI entails that all intrinsically identical states have the same content-fixing properties.

Recall that one advantage of content externalism is its ability to reduce intentionality to naturalistic properties and relations. If one could combine CE with representationalism, one could apply CE to the hard problem of consciousness. If one could further offer a reductive version of CE (most versions of CE are reductive), then one could offer a reductive theory of consciousness. But as seen above, if phenomenal internalism is true then CE cannot be combined with representationalism in this way.

However, content externalism is just one way of offering a reductive theory of intentionality. It is also possible to have reductive internalist theories of intentionality, on which naturalistic properties internal to a given state fix the contents of that state. If one could combine CI with representationalism, one could apply CI to the hard problem of consciousness. If one could further offer a reductive version of CI, then one could offer a reductive theory of consciousness.

We already saw that representationalism and phenomenal internalism entail CI. An internalist account of intentionality specifies internal properties necessary and sufficient for a given content. If we combine this with the supervenience relation SR, these properties are also sufficient - though not necessary - for that state to have a given phenomenal character. (They aren’t necessary since SR, as a supervenience relation, allows phenomenal character to be realized by multiple contents.) If we then combine a reductive internalist account with SR, the resulting theory would state naturalistic internal properties that are sufficient, though not

24 See Block 1986 for an internalist theory of intentionality.
necessary, for a state to have a given phenomenal character. Such an account might provide an internal specification of brain states that give rise to a given phenomenal character.

But if this is all that a reductive version of CI in conjunction with SR yields, their combination is somewhat trivial. This combination states that some internal properties, when instantiated, give rise to some particular mental state. That is, it states a supervenience relation from brain states to mental states: given these internal properties, one has these mental properties. But this is already entailed by phenomenal internalism: internal duplicates are phenomenal duplicates. Neither of these theses say anything about the nature of those mental properties, only that they are determined by some internal properties. It is an important thesis. For example, phenomenal externalists deny mind-brain supervenience by holding that phenomenal character partially supervenes on properties outside the skull. But it states nothing over and above phenomenal internalism. A reductive version of CI in combination with SR yields no unique approach to the hard problem.

However, the conjunction of CI with the stronger biconditional thesis BR would provide a more substantive account of consciousness. The problem with the conjunction of CI and SR was they it provides merely sufficient conditions for conscious states. A full account of consciousness provides both necessary and sufficient conditions, which CI and BR conjoined can provide. To see how, suppose it is true both that a state has a certain character iff it has some particular content (BR) and that a state has that content iff it has some internal properties (some content internalist account). Then it is true that a state has a given phenomenal character iff it has some particular internal properties. As a biconditional, BR in conjunction with CI provide both necessary and sufficient conditions for a state to have a given phenomenal character. In short, their combination delivers a biconditional relation between content-fixing properties and
phenomenal character, satisfying one of the advantages of representationalism with which we began.

We now have two theses which together yield a theoretically useful biconditional relationship between content-fixing properties and phenomenal character. To deliver a reductive account of consciousness, we need further a reductive internalist theory of intentionality, one which provides naturalistic properties that are necessary and sufficient for a given content. Given BR, such properties are also necessary and sufficient for a given phenomenal character. So, to deliver a reductive account of consciousness, we must find internal naturalistic properties that are necessary and sufficient for phenomenal character. But notice that this is exactly the same task as traditional functionalist theories of consciousness! Those theories set out to find some naturalistic internal properties that subvene all conscious states of a particular type. By combining CI and BR, the task of finding a reductive internalist theory of intentionality just is the task of finding a functionalist account of consciousness. To give a reductive account of consciousness via representationalism, one must already have resolved classic debates in philosophy of mind. Representationalism offers no better an approach to the hard problem of consciousness than classic accounts of consciousness.

**Conclusion**

Representationalism purports to offer a novel solution to the hard problem of consciousness when combined with a naturalistic theory of intentionality. However, given that phenomenal states are determined by internal properties of mental states, even the weakest form of representationalism cannot be combined with externalist theories of intentionality. Moreover,
though internalist theories of intentionality are compatible with representationalism, they fail to offer a reductive theory of consciousness. If content internalism is combined with a weak form of representationalism, the resulting thesis fails to substantively advance over mere phenomenal internalism. If content internalism is combined with a stronger form of representationalism, the resulting theory is in no better place to solve the hard problem of consciousness than classic functionalist theories. If phenomenal consciousness is determined by internal states of the brain, representationalism fails to offer a new approach to the hard problem of consciousness.
Bibliography


