The version of record of this manuscript has been published and is available in Philosophical Explorations (April 2, 2021), see https://doi.org/10.1080/13869795.2021.1908575

What should the sensorimotor enactivist say about dreams?

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October 8, 2020

Abstract

Dreams provide a compelling problem for sensorimotor enactivists like Alva Noë: they seem to replicate our perceptual experiences without sensorimotor interaction with distal sensory stimuli. Noë has responded by saying that dreams actually fail to replicate perceptual experiences in virtue of their lack of detail and stability. Noë's opponents have replied by pointing out that some dreams are richly detailed and stable, and that instability and a lack of detail in dreams can anyway be explained in terms of the underlying neural activity. In this paper I develop how the sensorimotor enactivist should respond: dreams fail to replicate perceptual experiences because they are exhausted by what shows up at a given moment in phenomenal consciousness, while perceptual experiences go beyond this to include everything accessible via sensorimotor exploration. This difference permeates all levels of experience, so that dreams can't even replicate perceptual experiences of simple shapes and colors. Further, unlike detail and stability, there are not obvious neural explanations of this phenomenal difference.

1 Introduction

Right now I'm looking at a pencil I'm holding. It's a classic-style wood-barrel pencil painted a dull yellow. As I do so I (as we might variously put it) *experience* the pencil, or am *phenomenally conscious* or *phenomenally aware* of it.

Here is the standard view of this experience, endorsed widely in philosophy, neuroscience, and psychology (e.g. Crick and Koch 1995; Prinz 2000; Dretske 2003; Clark 2012). My experience is a *representation*, specifically a token representational state. *What* I experience—the pencil itself, along with some of its parts and properties—is what's represented by this state. The state itself is either a state of some part of my brain, including the areas responsible for processing sensory input from the pencil, or supervenes on (and gets its content from) such a brain state. I'll call this view 'neural representationalism', although I don't mean to attach to it the commitment that all phenomenal properties are representational properties.

Drawing on previous work (e.g. Gibson 1979; Varela et al. 1991), Alva Noë, with collaborators, has put forward an alternative, dubbed 'sensorimotor enactivism' (O'Regan and Noë 2001; Noë 2004; O'Regan 2011). According to him, my experience is a *revealing* of the pencil which emerges out of the way in which I engage the pencil through my senses. Specifically, what I experience (again: the pencil along with some of its parts and properties) are the distal sensory stimuli accessible to me through my (implicit) grasp of how my own movement and the movement of those stimuli will affect how things are for me from within my private first-person point-of-view, i.e. will affect my "phenomenal consciousness". For example, I know that if I rotate the pencil 180° in my hand I'll see its back side, and I have certain expectations about how the shape the pencil projects onto my retina will change as I move relative to it. Because my current experience is a revealing of the pencil I'm holding which emerges out of my sensorimotor interaction with it, the experience (according to Noë) metaphysically depends on this interaction.[1]

A compelling response against Noë is that our perceptual experiences, like my current experience of my pencil, are *replicable* in dreams (e.g. Prinz 2006; Clark 2012; Rosen 2018a). If perceptual experiences are a revealing of distal sensory stimuli emerging out of (and so metaphysically dependent on) our skilled sensorimotor interaction with them, how could they be replicated while we're asleep? When I (as it's natural to say) "dream a pencil" or "see

[1]By 'sensorimotor interaction' (or sometimes: 'sensorimotor exploration') I mean physical actions directed at a distal sensory stimulus mediated by a subject's implicit grasp of how movement affects their phenomenal consciousness. Shifting my focus from my pencil's tip to its eraser in order to bring the eraser into better view is a sensorimotor interaction, and so is turning the pencil to see its backside, running my thumb over its barrel to feel its surface, and moving my head to see how the 2D projection of the pencil in my field of view changes in order to ascertain the pencil's 3D shape.

a pencil in a dream", for example, I'm not actually holding, and looking at, any pencil.

Noë's response to this objection is that dreams don't, in fact, replicate perceptual experiences. He notes (2004, 214) that, unlike perceptual experiences, "Dream sequences tend to be poor in detail, and what detail there is tends to vary unstably across scenes." He suggests that dreams lack this detail-richness and stability precisely because they *are* driven purely by neural activity. In normal waking perception, we experience a detail-rich and stable world not because the brain constructs a detail-rich and stable model, but instead because our sensorimotor exploration simply reveals a detail-rich and stable world to us.

Andy Clark (2012) and Melanie Rosen (2018a) have raised two problems for this response. First, a detail-rich and stable neural model being constructed during (and metaphysically grounding) perceptual experiences is consistent with dreaming being detail-sparse and unstable. Perhaps the brain will only build a stable and detail-rich world model under the constraints of sensory input from a detail-rich and stable world. Second, while dreams may *typically* be detail-sparse and unstable, introspective reports suggest that at least some lucid dreams and false awakenings are detail-rich and stable.

In this paper I develop how the sensorimotor enactivist should respond to this challenge from dreams. First, the issue isn't that perceptual experiences reveal *a lot* of "details", i.e. a lot of parts and properties, of distal sensory stimuli, but instead that perceptual experiences are *complete*. They reveal *all* the details accessible through sensorimotor exploration, including details not immediately available in phenomenal consciousness. Dreams, in contrast, are *incomplete* in the sense that what one (phenomenally seems to) experience is exhausted by what shows up in phenomenal consciousness in any given moment. This difference makes it so that *what it's like* to dream things—whether a complex scene or simple colors or shapes—is different from *what it's like* to perceptually experience them. The difference also fits with the predictions of sensorimotor enactivism and obviates any immediate challenge from dreams to the idea that perceptual experiences depend metaphysically on sensorimotor interaction with distal sensory stimuli.

This response has a major advantage over Noë's simpler proposal. As Clark suggests (2012, 763–766), there are fairly straightforward, plausible stories the neural representationalist might tell to explain a discrepancy in detail and stability. If the aspects of perceptual experiences not repeatable

in a dream can be (and are) explained in terms of neural differences, then the sensorimotor enactivist hasn't really escaped the challenge. After all, what they need is some unrepeatable aspect that's due to sensorimotor interaction with distal sensory stimuli. I shall argue that while the matter is, in the end, just an open empirical question, there is no obvious way for the neural representationalist to explain why perceptual experiences but not dreams are complete. In particular, Clark's favored approach seems to entail (by his own indirect admission) that if perceptual experiences are complete, then dreams should be so as well.

The rest of this paper goes as follows. Section 2 articulates the claim that dreams can replicate waking perceptual experiences and explains why it's problematic for sensorimotor enactivists. Section 3 sets out Noë's response that dreams do not replicate waking perceptual experiences, because they lack detail and stability, and why this response fails. Section 4 lays out my proposal for a better response: dreams fail to replicate waking experiences because they are incomplete. Section 5 explains why dreams don't even replicate simple waking experiences of colors and shapes, which would still have been a problem for the sensorimotor enactivist. Finally, section 6 examines whether there's a neural explanation for the incompleteness of dreams, and argues that actually, it's neural representationalist accounts which struggle to explain this incompleteness.

A point of clarification: as neural representationalists note (e.g. Clark 2012, 767), perceptual experiences "reveal" the world to us on their view as well. While many neuroscientists and psychologists still endorse an indirect realism according to which what we experience are private inner sensibilia (often dubbed 'percepts', 'qualia', or 'sense data'), the neural representationalists among philosophers are almost entirely direct realists who hold that we experience distal sensory stimuli themselves. They hold that *what* we experience is what's represented by sensory neural activity, which is the external world itself (Dretske 2003). While sensorimotor enactivists (e.g. Noë 2007, 471; Ward 2012, 735) and their relationalist allies (e.g. Fish 2009, 22–23) sometimes say representationalist views entail indirect realism, I'm happy to concede that this is false. What's importantly different between the two views is the nature of this revealing: for the neural representationalist, it's a kind of representation; for the sensorimotor enactivist, it's a way of relating to distal sensory stimuli. Thus, sensorimotor enactivism is a form of *relationalism* (e.g. Campbell 2002; Martin 2004) about perceptual experience (Noë 2007, 465).

2 The problem raised by dreams

When neural representationalists say dreams can replicate perceptual experiences, what exactly do they mean? It's difficult to precisify this claim without begging the question or using conceptual framing the sensorimotor enactivist would reject, but consider again the perceptual experience I'm now enjoying as I look at the pencil I'm holding. The neural representationalist wants to say that I could have a dream in which I *seem* to look at my hand and *seem* to see (i.e., seem to perceptually experience) a qualitatively identical pencil. The term 'seem' here refers to phenomenal seemings. To put their claim another way, during a dream things could be for me, from within my private first-person point-of-view, just like they would be for me were I actually looking at, and experiencing, a real pencil with all the properties of the one I'm holding. That is, *what it's like* for me, in a dream, could be just like *what it's like* for me now as I look at my pencil.

Note that, as I'm using the term, a *perceptual experience* is a token event in which some distal sensory stimulus shows up in a subject's phenomenal consciousness (i.e., in their private first-person point-of-view). Perceptual experiences, being *particulars*, cannot be repeated at all, let alone in dreams. But they do have aspects which can be repeated. The neural representationalist claims that the phenomenal character of perceptual experiences can be repeated in a dream.

Using my example, the claim would be that the phenomenal character of my current perceptual experience of my pencil could be repeated exactly and exhaustively, save for any phenomenal character accruing thanks to the identity of my pencil. For simplicity, and because both Noë and his opponents share it, I will assume that no phenomenal character accrues thanks to the identity of a perceptually experienced object.[2] Hence, the claim is that the phenomenal character of my current perceptual experience of my pencil could

[2]Some relationalists (e.g. Campbell 2002; Fish 2009) claim that perceived objects are constituent parts of the phenomenal character of the experiences in which they are perceived, implying that swapping one object for a qualitatively identical twin will necessarily change phenomenal character (see Mehta 2014; French and Gomes 2019). While Noë thinks that perceived objects are constituent parts of the perceptual experiences in which they are perceived (see Noë 2007, 465), he doesn't generally talk as if these constituent objects affect phenomenal character. He says (2007, 464) "What makes it the case that our experience has the [phenomenal] character it does are the regularities governing our manner of interaction with ... objects." These regularities concern an object's properties, not its particularity (i.e., its identity).

be exactly and exhaustively repeated in a dream.

Why is this replicability claim (if true) problematic for sensorimotor enactivists? Noë emphasizes (2007) that (according to his view) the "physical substrates", the "underlying realizations or mechanisms" (p. 458), of perceptual experiences are skilled sensorimotor explorations of distal sensory stimuli. Noë is clear (2007, 457) that he means perceptual experiences are not merely *causally*, but *constitutively*, dependent on skilled senoriomotor interaction with a distal sensory stimulus; this interaction is *metaphysically necessary* for the perceptual experience it produces.[3] In (2004; 2007), Noë uses the term 'experience' to refer to repeatable phenomenal states, i.e. to what I would call the phenomenal character of an experience. Hence, his claim is that the physical substrates of phenomenal character (of perceptual experiences) extend beyond the head to our skilled sensorimotor exploration (see also Degenaar and O'Regan 2017, 393). But if my actual senorimotor interaction with my pencil is metaphysically necessary for the phenomenal character of my current experience, how could that phenomenal character be repeated in a dream? After all, I could have a dream (so the claim goes) with phenomenal character that matched the phenomenal character of my current experience exactly and exhaustively, even though, while asleep, I'm not actually looking at my (or any) pencil.[4] Hence, dreams are a problem for sensorimotor enactivists because they seem to involve the reproduction of phenomenal character from waking perceptual experiences without the sensorimotor interaction the enactivist says is necessary for that phenomenal character.

This statement of the problem implicitly presumes that dreams are "envatted", but some dreams do involve interaction with distal sensory stimuli. As Jennifer Windt notes (2018), both distal and bodily sensory stimuli are often incorporated into dreams. For example, you might hear the sound of your alarm from within your dream before it wakes you up. Windt provides a number of rich examples of how proprioceptive and tactile feedback from

[3]Despite this talk of *constitutive* dependence, Noë (2016) says that perceptual experiences are not identical to, and don't reduce to, skilled sensorimotor interactions. So presumably he takes them to emerge out of, or supervene on, these interactions. It's not clear how to square all of Noë's claims.

[4]There are representationalist views which similarly make phenomenal character dependent on what's outside the head (e.g. Dretske 2003), but don't face any challenge from dreams because the extraneural substrate posited on these views (a history of causal interaction with sensory stimuli) is still realized while dreaming (Block 2005, 264).

the sleeping body are often incorporated into, and even drive, dream experiences. According to Windt, these bodily experiences in dreams are actually *perceptual*, albeit illusory, experiences of the sleeping body. This wrinkle won't help the sensorimotor enactivist in the case at hand, since there's no reason to suppose that *everything* experienced in a dream is an incorporated stimulus, and since there's nothing strange in supposing that I could dream a yellow pencil like the one I'm holding without some actual yellow pencil being around to (somehow) stimulate my visual and tactile receptors. Further, it's not clear the kind of interaction involved in stimulus-incorporating dreams counts as the kind of interaction posited as metaphysically necessary by Noë.[5] So, the problem stands whether or not we assume dreams are fully "envatted".

Note that I'll use (as just above) colloquial phrases like 'dream a yellow pencil' as shorthand for longer locutions about phenomenal character. For example, to "dream a yellow pencil" is just to have a dream in which it phenomenally seems to you that you are experiencing a yellow pencil. This construal avoids controversial talk of the *content* of experiences and the vexing issue of assigning intentional objects to experiences of what doesn't exist or isn't there. My talk of experiencing or doing something "in a dream", or talk of dreamed items, will likewise be shorthand for longer phrases about how things phenomenally seem.

3 Noë's response: Detail and stability

Noë has a ready response to this problem (see Noë 2004, 213–15, 2006, 431, 2007, 470–72). He denies that dreams really can replicate normal waking perceptual experiences.[6] He says (2004, 210, 218) that while sensorimotor interaction is metaphysically necessary for experiences with exactly the phenomenal character enjoyed while perceiving distal sensory stimuli, neural activity in the brain can be (metaphysically) sufficient for some experience (and hence for some phenomenal states). The idea, roughly, is that while I could have a dream in which *what it's like* for me is similar to *what it's*

[5] Perhaps it's then a challenge for the sensorimotor enactivist to explain how we could have perceptual experiences from within dreams, but this challenge would be distinct from the one we're addressing.

[6] Noë is not the first to make this claim. John Austin (1962, 42) famously wrote that "we all know that dreams are *throughout un*like waking experiences".

like for me now as I look at my pencil, the dream would not match this phenomenal character exactly and exhaustively. The difference, he says, is that the replicating dream will lack the detail and stability of the perceptual experience.[7]

Noë offers this response in a few brief passages, without elaboration. He says:

> ... there *are* reasons to believe that differences exist between dream visual experiences and non-dream visual experiences. The biggest difference, phenomenologically speaking, has to do with detail and stability. Dream sequences tend to be poor in detail, and what detail there is tends to vary unstably across scenes. Perhaps this is explained by the fact that, as a neuroscientific matter, the brain is not very good at storing detailed representations of scenes. In normal perception, there is no need to store detail, since the world is available to serve as a repository of information about itself. This suggests a hypothesis: Dream states are unstable and poor in detail precisely because dream states, unlike normal, non-dream perceptual states, *are* produced by neural activity alone. Actual perceptual consciousness is anchored by the fact that we interact with, refer to, and have access to the environment. The stability of the environment is what gives our experiences their familiar stability. (Noë 2004, 214, endnote omitted)

The same idea is later articulated in (Noë 2007, 472). As Noë says (2004, 22), he is here following J. Kevin O'Regan (1992) and Rodney Brooks (1991) in thinking that, during normal perception, there is no need for the brain to construct a rich representation of the environment. Instead, the world is just *there*, available to be picked up or detected through our senses. This sensory pickup is facilitated by neural processing employing representations, but what we perceive, i.e. what we experience, is not just what these representations represent (see also Noë and Thompson 2004).

[7] Noë also suggests (2007, 472) that perhaps dreams *can* replicate perceptual experiences, but only because of previous sensorimotor interaction with the environment while awake. The problem, as I explain below, is that Noë's account entails that phenomenal character depends on sensorimotor interaction with the things *currently* being experienced. Past interactions don't help.

For now, set aside how the mechanics of this explanation mesh with the broader sensorimotor enactivist view. Noë's suggestion that dreams are detail-sparse and unstable, and thus do not reproduce the phenomenal character of normal waking perceptual experiences, is intriguing. Noë does not elaborate on what exactly he means, aside from pointing to the common phenomena of dreamed text being difficult to read (Noë 2006, 431). Being unable to read, in a dream, the text on a sign or piece of paper is probably familiar to you, but is also noted in the scientific literature (e.g. LaBerge and DeGracia 2000, 293). In a similar way, difficulty understanding the speech of others in dreams is sometimes reported (ibid).[8] Focusing on details in general is something that's reported to be difficult in dreams (Nir and Tononi 2010, 97). These phenomena fit with Noë's suggestion: you don't notice the difficulty of reading text, parsing speech, or distinguishing fine (visual) details in dreams until you actually try (and fail) to pickup the relevant details through the use of your senses. So the activity (sensorimotor exploration) which would reveal these details to you during normal perception fails to reveal them when you try it in a dream.

Aside from the difficulty of reading text, dreams are often bizarre, narratively weird, or unstable in ways that should be familiar. To give a few examples, dream reports show that, in dreams, the background might fade in and out, experienced features like colors or shapes might transform before your eyes, the scene might suddenly shift, or you might experience impossible confluences like an object that's at once two colors (Hobson et al. 2000, 799; LaBerge and DeGracia 2000, 287, 291; Nir and Tononi 2010, 90). In addition, dream reports often indicate (as Noë suggests) a lack of detail. For example, some dreams are missing color (Schwitzgebel 2003; Schwartz and Maquet 2002, 29). One study suggests that when prompted to spontaneously judge the detail of experiences, on average subjects rate their dreams as less detailed than normal waking perceptual experiences (Kahan and LaBerge 2011, 506). My own dreams often are missing details; for example, dreamed objects may lack common parts (like a pencil without an eraser) or unrealistically appear to be a single solid color without gradations in hue, saturation, or brightness due to lighting artifacts and surface defects.

So, Noë's suggestion that dreams lack the detail and stability of waking perceptual experiences fits nicely much of the empirical evidence on *what it's like* to dream. The problem is that there is substantial interpersonal

[8]Following Windt (2013), I assume that dream reports are reliable.

and intrapersonal variation between dreams (Windt 2010, 296). So while some dreams may be detail-sparse and unstable, others may be detail-rich and stable. For example, lucid dreamers report wide variation in detail and vividness, ranging from some dreams being more sparse and dull than waking experience to others having surreal levels of detail (LaBerge and DeGracia 2000, 285). Rosen (2018b) has pointed out that while many dream reports include bizarre elements which distinguish them from waking perceptual experiences, others are mundane and seem to approximate waking perceptual experiences. Specifically in response to Noë's suggestion that dreams are detail-sparse and unstable, Rosen (2018a, 304) has argued that some lucid dreams and false awakenings are cases of richly detailed, stable dreams (see also Prinz 2006, 17). These dreams are so detail-rich and stable that they (at least for a short time) either fool us into thinking we are awake (false awakenings) or are reported to be good approximations of waking perceptual experiences (some lucid dreams).

My own dream reports suggest that special examples like false-awakenings and the dreams of practiced lucid dreamers are not necessary for examples of these more realistic dreams. In a recent dream (recorded upon waking, December 20, 2019) I found myself walking up a small hill in a park towards some buildings. I was picking up trash along the way. At the top, by the buildings, I talked to three people. First a man, in his twenties, asked for help. He was locked out of his car. Next a couple with a dog asked me if I could recommend something in the area for them to do. My recollection on waking was that the dream was extraordinarily realistic in the extent to which it reproduced *what it's like* to perceptually experience. I saw the people and places in the dream in good detail. In the dream I didn't notice missing or morphing parts or properties. The dreamed people looked, on the whole, normal.[9]

As both Rosen (2018a, 310) and Windt (2018, 2581) point out, it doesn't matter if dreams are *typically* detail-sparse and unstable. It will be problematic for the senorimotor enactivist if *some* dreams (even if rarely) can repeat

[9]On reflection, the dream was probably more incomplete than this report suggests. I recall that the trash I picked up included styrofoam bowls which were missing their right halves, as if they had been cleanly cut. While I was aware of what was being said, I didn't actually auditorily experience most of it; instead, I simply somehow just knew what was being said. Experience of my own body was lacking as well. As I walked I didn't feel my body or any sense of exertion. At no point did I visually see (say) my arms and hands, or my nose, either.

the phenomenal character of (some) normal waking perceptual experiences exactly and exhaustively. It may seem, at this point, like an easy step for the neural representationalist: surely, given the evidence, it's (physically, and so also metaphysically) possible for me to have a detail-rich and stable dream in which *what it's like* for me is just like *what it's like* for me now as I look at my pencil.

4 The contribution of sensorimotor interaction: Completeness

There is a response available to the sensorimotor enactivist. They can point out that while some dreams have *a lot* of detail and are *relatively* stable over short timescales, they aren't *complete* in the way normal waking perceptual experiences are complete. As I now look at my pencil, I don't just see and feel *a lot* of detail. I see and feel *every* perceptible detail: that is, I see and feel every part and property of the pencil which is accessible through sensorimotor exploration.

To explain this notion of completeness, it's helpful to take a closer look at the contours of Noë's view (see especially Noë 2004, 49–73). Consider again my current perceptual experience of my pencil. I am phenomenally aware of the pencil I'm holding, along with some of its parts and properties. For example, my experience includes the color and shape of the pencil barrel. This is interesting, as although the barrel is a single solid color (a dull yellow), there is a sense in which all that's visible to me are a variety of "apparent" colors. A shadow crosses the barrel through the middle and glare from an overhead light streaks down the barrel, both causing discontinuities in how the barrel color appears. These artifacts aside, the lightening in the room matters as well; the barrel's color would appear different if I went outside into natural light. Similarly, although the barrel is a 3D hexagonal cylinder, in some sense all I "see" are the apparent 2D shapes the barrel projects through my visual field and onto my retina. In addition, this shape has parts, such as its back surface and the bit under my thumb, which are occluded from my view.

So how do I come to experience the full 3D shape and real color of my pencil's barrel? Noë says that my experience of this shape and color emerge from my implicit understanding of the relationship between movement and

the "apparent" shapes and colors. I know, for example, how to bring the occluded parts of the barrel into view by moving my thumb and rotating the pencil. I know how lighting and shadows affect the appearance of color. I know how the 2D projections of a 3D hexagonal cylinder change as my perspective on the cylinder changes. As I look over my pencil, my grasp of these sensorimotor dependencies (as Noë calls them) allows me to experience the pencil barrel's full shape and real color.

Note that, in some sense, I never have the pencil barrel's shape and color in phenomenal consciousness all at once (Noë 2004, 56). My perceptual experience of these two properties is not complete at any one moment. This is very important for Noë's view. He says that perceptual experiences are not like snapshots or pictures, which have (and present) their content all at once. Still, I experience the full shape and real color of the pencil barrel despite (at best) only ever having in phenomenal consciousness at any one moment an incomplete array of 2D projections and "apparent" colors. Actually, Noë even rejects that we have these projections or "apparent" colors in consciousness all at once, but it will help discussion for now to set aside this (important) part of his view.

So in what sense do I *experience* the full shape and real color? I experience them, according to Noë, in the sense that they are *accessible* to me (Noë 2004, 63, 67, 2006, 422). Although these properties are not right now themselves fully in my phenomenal consciousness, my phenomenal consciousness still nonetheless *reveals* (Hellie 2014, 244), or *discloses* (Johnston 2006, 282), them to me through my skillful looking and touching. Now the idea I want to press, which is mostly there already in Noë's work, is that we can turn this proposal around. Specifically, what my skillful looking and touching reveal to me is simply whatever parts and properties of my pencil are accessible based on the sensitivity of my sensory systems and my grasp of the related sensorimotor dependencies. For example, I perceptually experience my pencil's 3D shape, despite only "seeing" 2D projections and not "seeing" its backside or the part occluded by my thumb, because this shape and its missing pieces are accessible to me. The upshot is that, as I now look at my pencil, I experience *all* of its parts and properties which are detectable through sensorimotor exploration.

Thus, my current perceptual experience is *complete* in the sense that it involves experience not only of my pencil, but also of all of my pencil's parts and properties which are accessible through sensorimotor exploration. If I want to know if a specific part or property of the pencil is one of these

accessible ones, I simply have to *look and feel* (and smell and taste). If I find the part or property, it is one of these accessible bits (and hence part of my complete experience). Not every part and property of the pencil is accessible to me. For example, no matter how much I look and feel I can't discern the inside of the pencil (without breaking it), I can't see scratches in the paint too fine for my visual system to discriminate, and I can't tell that my pencil doesn't produce a magnetic field. Still, there is a seemingly limitless array of parts and properties which I can access. If I take seriously the task of inspecting the pencil, I find that I can sit here looking it over for minutes at a time while still discovering new parts and properties: e.g., new scratches, new textures, new small patches of color, imperfections in the wood and paint, and dents in the metal ferrule. To emphasize an important point again, it doesn't matter that these parts and properties aren't all "in" my experience at any moment (say, at the start of my exploration); my experience is not a "snapshot" of the world, given all at once, at any given moment.

Now, the phenomenal character of my current perceptual experience depends on this completeness. The accessibility of all this detail is a part of *what it's like* now for me to look over my pencil, even if, at any one moment, I don't actually take in all that detail. For example, there is a phenomenal difference between merely seeing the 2D projection of a 3D shape and seeing that 2D projection as part of an accessible full 3D shape. *What it's like* for me now to perceptually experience my pencil would be quite different if this phenomenal character were exhausted by whatever parts and properties of my pencil are directly, in the moment, in my phenomenal consciousness. That I experience the pencil's full 3D shape, *along with all of its other accessible parts and properties*, affects my experience's phenomenal character.

What the sensorimotor enactivist should say is not that dreams fail to be detail-rich and stable, but instead that dreams fail to be complete in this way. Granting that some dreams may be stable and involve *a lot* of detail, even at the start it's implausible that dreams are ever complete. For example, as I (in my park dream) talked to the people at the top of the hill, I may not have noticed (in the moment) any missing details, but I certainly did not, in the dream, experience *every* part and property which would have been accessible to me had I been actually interacting with, and perceiving, real people. In the dream, I did not phenomenally seem to see features of their clothing which fell out of my focus of attention but which, had I shifted attention, could have been brought into my phenomenal consciousness. Returning to the pencil example, if dream experiences are always incomplete, then it's not

possible for me to have a dream in which *what it's like* for me is exactly and exhaustively like *what it's like* for me now as I look at my pencil.

The neural representationalist might raise the following objection. In what sense are dreams incomplete? The notion of completeness (they may press) is only well-defined for perceptual experiences because there is an objective object being experienced against which we can compare the experience. For example, were I to not experience my pencil's eraser, we could say that my experience is incomplete only because the pencil I'm looking at in fact has an eraser that's accessible through sensorimotor exploration. But if I fail to experience the eraser of a dreamed pencil, on what basis do we say that my dream experience is incomplete, i.e. is missing a detail which "should" be there? Perhaps I'm not having an incomplete dream experience of a normal pencil, but a complete dream experience of a weird incomplete pencil.

In reply, there is a way to define the incompleteness of dreams which gets at the intuitive issue while avoiding the technical problems arising due to the fact that, in dreams, we (phenomenally seem to) experience what's not there or doesn't exist. Here is the idea. In dreams, what you experience is exhausted by what's in your phenomenal consciousness at a moment. For example, as I talked to those people in my park dream, at any one moment I took in a rich visual presentation of them. But it did not phenomenally seem to me that there was more, hidden just outside my immediate phenomenal consciousness but available through the right gaze shifts or other modes of sensorimotor exploration. In contrast, as I now look at my pencil's eraser, it phenomenally seems to me that there is more to view—that, for example, a gaze shift down to my left will bring into focus the pencil's tip. Similarly, the apparent colors that immediately appear to me, as I now look at my pencil, phenomenally seem to be merely the present appearance of some more objective color which I could explore by changing the lighting or viewing angle.

It's precisely this sense in which dreams are incomplete: they are exhausted by what shows up, at any given moment, in phenomenal consciousness. Normal perceptual experiences are complete in the sense that they include not only whatever shows up in the moment in phenomenal consciousness, but also what's accessible to you through sensorimotor exploration. As framed above, perceptual experiences are complete in the sense that they include *every* part and property of distal sensory stimuli accessible through sensorimotor exploration.

The sensorimotor enactivist has an explanation for the incompleteness of dreams. They will say that, while dreaming, it doesn't phenomenally seem like there is more to access because there isn't more to access. As I look at my pencil now, it phenomenally seems to me that there is a slew of parts and properties just outside my momentary view precisely because there are in fact these parts and properties, and they are accessible or revealed through the right skillful movements. In contrast, how things phenomenally seem to me in a dream depends on (just to take the most obvious answer) how they are represented as being, in the moment, by my brain.

As noted, Noë emphasizes that perceptual experiences are not like snapshots. But he does not merely mean that, while some things are presented all at once in experience (e.g., "apparent" colors), others (e.g., objective colors) are not. He says that *all* perceptual experience content is "virtual", meaning that it's content we access through sensorimotor exploration (Noë 2004, 50, 63, 67, 215). He talks (2004, 135) about how perceptual experiences are "fractal", in the sense that whenever we think we've isolated some small or simple part of the experience which we can take in at a glance, all at once, we find that that part too is a field to be explored with parts to be accessed. Noë denies that *anything* we perceptually experience shows up, all at once, in phenomenal consciousness. When perceiving, my phenomenal consciousness at any one moment is always empty. For every object, part, or property we perceptually experience, that thing is experienced as accessible, and never fully in view. So, for example, we don't even take in, at once, "apparent" colors and 2D shape projections, as experience of these too is "fractal". If Noë is right, then dream experience is fundamentally different from perceptual experience, even at the level of phenomenological description, as the one is exhausted wholly by "snapshots" while the other doesn't even have a snapshot-like component.[10]

[10]Noë says (2007, 471) that "... dream experiences, whatever their nature, are not of the same basic kind as perceptual experiences. Phenomenologically, perceiving is for us an encounter with situations and things; it is not, for us, an encounter with mental images or some other kind of interior data of sense." My proposal is a way to understand these brief remarks. The completeness of perceptual experiences and the incompleteness of dreams explains *why* the one phenomenally presents itself as an encounter with the world and the other phenomenally presents itself as an encounter with mental images.

5 A reply: Color and shape experience

The neural representationalist might respond as follows. We can consider not just the overall phenomenal character of my current perceptual experience, but that phenomenal character which accrues thanks to my experience of my pencil barrel's color and shape. There is *something it's like* for me to visually perceptually experience an object with this color (dull yellow) and shape (hexagonal cylinder). Even if the overall phenomenal character of my current perceptual experience can't be reproduced in a dream because any dream of a pencil would be incomplete, surely these two specific aspects can be reproduced. As Jesse Prinz says (2006, 17) in reply to Noë, "The experiences of color and shapes in dreams are often just like those in waking life." Surely (the claim goes) I can have a dream in which I phenomenally seem to experience a dull-yellow hexagonal cylinder. Isn't that just as problematic for the sensorimotor enactivist?

It's worth pausing to address this question. Noë never explains why his view entails that actual sensorimotor interaction with distal sensory stimuli is metaphysically necessary for the phenomenal states instantiated during perceptual experiences. Noë often even hedges on whether his view even really entails neural phenomenal externalism at all (e.g., see Noë 2006). Still, there is a way to make the connection. This way entails that even phenomenal character, accruing thanks to perceptual experience of colors and shapes, depends metaphysically on sensorimotor interaction with instances of those colors and shapes. Consider my current perceptual experience of my pencil barrel's color and shape. Part of the phenomenal character of this experience consists in the character of these properties themselves; that is, *what it's like* for me to experience this color and shape is in part just what the color and shape themselves are like.[11] So as I perceptually experience the dull yellow color and hexagonal cylindrical shape of my pencil, those (external, physical) properties get into the phenomenal character of my experience. Crucially, according to the sensorimotor enactivist, my perceptual experience only includes these properties because my sensorimotor

[11] This idea is from G.E. Moore's famous off-hand remarks on transparency (Moore 1903) and is adopted by both some neural representationalists (e.g. Dretske 2003, 67) and relationalists (e.g. Fish 2009, 10). The idea is that, when we try to describe *what it's like* to experience a stimulus, all we're able to do is describe the stimulus itself. Noë's explanation of phenomenal character in terms of objective stimuli features suggests that he endorses this idea (Noë 2004, 82–86, 123).

exploration of their instances in the pencil makes them accessible to me. So their contribution to the phenomenal character of my perceptual experience depends (metaphysically) on this sensorimotor interaction.

Is Prinz right that I could have a dream in which it phenomenally seemed to me exactly and exhaustively like it phenomenally seems to me as I experience the dull yellow color and hexagonal cylindrical shape of my pencil? No. My perceptual experiences of my pencil barrel's color and shape are themselves complete, and this completeness matters for their phenomenal character. Since this completeness cannot be duplicated in a (even detail-rich and stable) dream, the phenomenal character can't be duplicated (exactly and exhaustively) either.

Take my perceptual experience of my pencil barrel's shape. This shape consists of a near-limitless number of surface patches, edge segments, contour lines, and connecting angles. All these components are accessible to me through my sensorimotor exploration of the pencil. As I bring the pencil closer to my eyes I see new bits of the surface, new contour lines, and new edge segments that weren't in my phenomenal consciousness before. If this slew of detail were not available to me, then *what it's like* to experience the barrel's shape would be quite different.

My dream experiences of shapes do not seem to be complete in this way. In a dream I may phenomenally seem to visually experience a hexagonal cylinder "in sharp detail", but by this I mean that it (phenomenally) seems to me, in a glance, that I clearly take in the defining edges, outlines, and contours of the shape. You could have a dream which (phenomenally seemed to) reproduce the content of, say, a sophisticated drawing of a hexagonal cylinder, but this would not be to reproduce the full, complete "content" of my perceptual experience of the barrel's shape. As noted above, in my dream I wouldn't even have the (phenomenal) sense that there is detail missing from my (seeming) experience of the shape, detail that goes beyond what's immediately in my phenomenal consciousness.

Color experience goes the same way. I do not take in the dull yellow of my pencil barrel in a glance. The color appears different depending on how light hits it and my angle of viewing. The color itself has different properties, such as hue, saturation, and brightness, which I can bring into or let drop out of my phenomenal consciousness through changes in my attention. The color thus has many aspects (e.g., how it looks under this light, from that angle, attending to its hue or saturation) which I can access depending on how I look at it. While in a dream it may phenomenally seem that I'm

experiencing a color that appears just like the dull yellow of my pencil barrel *when viewed under one set of conditions*, my dream experience of this color will lack the rich phenomenal character which accrues thanks to the accessibility (during normal perception) of the dull yellow's appearance under all the other conditions.

What *is* it like to dream colors and shapes? Plausibly, dreams merely (phenomenally seem to) present one with some array of "apparent" shapes and colors. These dreamed "apparent" shapes and colors can be taken in at a glance and aren't open to further sensorimotor exploration which might reveal them to be merely perspectival or contextual aspects of richer objective shapes and colors.

Are there *any* aspects of the phenomenal character of my current perceptual experience which can be reproduced, exactly and exhaustively, in a dream? Is there any part or property of my pencil such that it can phenomenally seem to me, in a dream, exactly and exhaustively how it phenomenally seems to me now as I perceptually experience that part or property? If you think (against Noë) that there's some snapshot-like aspect to my current perceptual experience existing at each moment I'm looking at my pencil—perhaps consisting of an array of 2D projections and "apparent" colors—then any phenomenal character accruing thanks to these "snaphots" could likely be reproduced in a dream. But the reproduction in dreams of the phenomenal character accruing thanks to perceptual "snapshots" (if there are such things) wouldn't be a problem for the sensorimotor enactivist. These snaphots wouldn't be dependent on sensorimotor exploration, and so the sensorimotor enactivist has no reason to think that any phenomenal character accruing from them depends on interaction with distal sensory stimuli.

What the neural representationalist needs to show is that there's a part or property of some stimulus which is revealed in normal perceptual experience *through sensorimotor exploration* such that, in a dream, it can phenomenally seem to us exactly and exhaustively like it phenomenally seems when we perceptually experience that part or property. But the parts and properties which are revealed to us through sensorimotor exploration are precisely the ones which *can't* be taken in at a glance. They are ones with near-limitless aspects which our sensorimotor exploration makes accessible. Dreams will fail to reproduce the phenomenal character which accrues thanks to the perceptual experience of these parts and properties precisely because the dream will lack the completeness of the perceptual experience.

6 Representationalist explanations of incompleteness

The above proposal loses much of its interest if there is a neural explanation for why dreams are incomplete while perceptual experiences are complete. In fact, if this phenomenal difference is one that's explained by differences in the neural activity underlying dreams and perceptual experiences, then it's no help to the sensorimotor enactivist. What they need is a phenomenal difference that's due to sensorimotor interaction.

Could there be a neural explanation for the incompleteness of dreams? While asleep, neural activity is often suppressed in both the primary visual cortex and post-visual prefrontal cortex, while neural activity between these two sites (along with activity in post-visual hippocampal regions) remains high. These active areas include the inferior temporal cortex, fusiform gyrus, and dorsal lateral occipital cortex, along with their projections in the parahippocampal gyrus and hippocampus (Braun et al. 1998, 93; Schwartz and Maquet 2002, 23; Nielsen and Stenstrom 2005, 1286; Nir and Tononi 2010, 89). These areas are known to be closely associated with visual perceptual experiences.

Adding to these findings are newer results from multivariate pattern analysis, aka "neural decoding". This technique translates brain imaging scans (e.g., from fMRI) into high-dimensional vectors and trains machine learning algorithms to classify these vectors by experience content, thereby "decoding" the brain scan. For example, one of these decoders could be trained to pick out fMRI scans taken while a subject is looking at some particular object, such as a house or a cat. The main result of interest here come from Tomoyasu Horikawa and Yukiyasu Kamitani, whose lab in a series of experiments has shown that the same decoders trained on wakeful subjects looking at stimuli can be used successfully to decode dreams (Horikawa et al. 2013; Horikawa and Kamitani 2017b).[12] While neural decoding put to this purpose demands caution (see Ritchie et al. 2017), Horikawa and Kamitani take their results to show that the neural representations deployed during normal wakeful perception are redeployed while dreaming.

[12] Braun et al. (1998, 91), recording during REM sleep, found depressed activity in the primary visual cortex, while Horikawa and Kamitani (2017b, 3), recording during sleep-onset (NREM sleep), were able to decode dreams from this area. Presumably the area is more active at sleep-onset.

The neural representationalist will suggest any incompleteness in a dream is due to a corresponding incompleteness in the redeployed representation. It's plausible that at least some missing details can be explained by differences in neural activity. For example, perhaps achromatic dreamed objects are explained by an activity decrease in the brain regions associated with color experience, the lingual and fusiform gyri (Schwartz and Maquet 2002, 29). It is known that lesions in areas associated with color perception result in a loss of color in dreams (Nir and Tononi 2010, 91). Studies of wakeful visual imagery show correlation between activity in early visual areas like the primary visual cortex and the imagination of fine detail (Brogaard and Gatzia 2017), so perhaps lower levels of activation in these areas explain some missing details in dreams. Similarly, it's often suggested that dreams are detail-sparse and unstable because the brain will only produce detail-rich, stable representations under the constraints of external sensory input (Nir and Tononi 2010, 97; Clark 2012, 765; Rosen 2018a, 300–301).

This can be, at best, a speculative suggestion. It's an open empirical question whether the relative completeness vs incompleteness of perceptual and dream experiences can be explained by a difference neural activity. More importantly, the incompleteness of dreams isn't merely a matter of missing details, but also has to do with how those details are completed in perceptual experiences. Is there a neural explanation of why, as I now look at my pencil, I phenomenally seem to be presented with every part and property accessible through sensorimotor exploration, while my dreams of pencils phenomenally seem to be exhausted by what immediately shows up in my phenomenal consciousness?

I want to conclude by suggesting that the most natural way for neural representationalists to explain why, during waking perception, we experience more than we take in at a glance, entails that there's no neural explanation for why dreams are exhausted by what immediately shows up in phenomenal consciousness. To make this argument it's helpful to start with Andy Clark's work (2012) on predictive processing and how he applies it to dreams and perception of perspective-independent features. According to predictive processing accounts (e.g. Clark 2013; Hobson and Friston 2014; Windt 2018), experiences, both during waking perception and while dreaming, are generated by the brain's attempts to build models which predict incoming sensory signals. What we experience is whatever these models represent.

Now, Clark (2012) is sensitive to Noë's point that we often perceptually experience more than is given via any momentary sensory input, including

the cases we've been discussing, such as seeing the full 3D shapes of objects. Clark says that what we experience *during normal waking perception* is what's represented by hierarchical models constructed in our sensory systems' attempts to predict (or match) input from sensory receptors. According to Clark (2012, 762), what explains why we experience more than what's in view during a single glance is that the models at the higher levels are abstract enough so that they disregard perspectival features of what they are trying to predict. If the system wants to be able to guess the new sensory input it will receive when it views a stimulus from a new angle or when the stimulus itself moves, it's helpful to model the stimulus in a way that's independent of perspective and captures properties like its 3D shape and real color. For example, if activity in the lower levels of our visual neural networks represent the 2D projections on our retina, predicting this lower activity is helped by having activity in higher levels which represents the full 3D shape projecting those 2D shapes. Thus, I now perceptually experience my pencil barrel's full 3D shape and real color despite not viewing them all at once because some level of my visual processing represents these properties.

That's how Clark explains how and why waking perceptual experience goes beyond what's given in momentary sensory input. To explain dreams, Clark (2012, 764–65) notes that a system capable of generating the models needed to predict receptor input can run (and generate those models) without the constraint of that input. So, for example, while sleeping, these same hierarchical predictive neural networks can run offline, generating activity and representational models even without any sensory input (i.e., constraints on those models). According to Clark, dreams result from this detached operation of our predictive sensory systems.

Now here is the problem for Clark's view. Assume our predictive sensory systems are running offline while asleep. Presumably it's not just the lower levels of the system that are running. The higher levels, which attempt to match the activity of the lower levels, are presumably running as well. It's these levels which contain the perspective-independent representations which Clark says explain how waking perceptual experience goes beyond momentary sensory input. But in that case, Clark's view predicts that dreams, like waking perception, will also involve experience that goes beyond what's given in phenomenal consciousness at any moment. Thus, the explanatory pieces provided by Clark don't add up in a way which could account for why waking perceptual experience, but not dream experience, goes beyond what's in phenomenal consciousness at any moment.

Note that the lack of sensory input (sensory constraints) during dreams should not matter. As Clark suggests (2012, 765), it's plausible that sensory input is required for our predictive sensory systems to construct a detail-rich, stable model of the world. But there's no reason to suppose that such input is required for these systems to produce models of the same basic kind as they do during waking perception: e.g., models of objective 3D shapes. If the high levels of the system (which kick-off the whole cascade) generate perspective-independent models during perception, they would likewise do so while dreaming, even if those models are now detail-sparse and unstable. A neural model can be detail-sparse and unstable, while still being perspective-independent, thus giving rise to detail-sparse and unstable experiences which seem to outstrip what's presented in phenomenal consciousness at a moment. The point is that while Clark and other neural representationalists might be able to explain why dreams are detail-sparse and unstable by appealing to the lack of sensory input during dreams, this appeal will not explain why dreams have a wholly "snapshot" phenomenology which fails to give the feeling of objects and properties beyond what's momentarily presented in phenomenal consciousness.

The problem just outlined is not tied to Clark's appeal to predictive processing. The natural way for the neural representationalist to explain why waking perceptual experience phenomenally seems to involve more than we view in a glance is to appeal to perspective-independent representations in sensory processing (whether or not we assume those representations are generated for the purpose of predicting lower-level input). These perspective-independent representations are thought to be encoded in higher areas of visual processing (Cichy et al. 2016; Horikawa and Kamitani 2017a,b). But these high-level processing areas (as noted above) are active during dreams. If this activity explains experience during dreams, it's reasonable to assume that the same *kind* of representations (perspective-independent ones) are being produced. If so, we wouldn't expect dreams to be exhausted by what we view in a glance.

7 Conclusion

This paper started with the challenge, oft-noted in the literature (Prinz 2006; Clark 2012; Rosen 2018a), that sensorimotor enactivism is incompatible with the common observation that waking perceptual phenomenology is repro-

duced while dreaming. Alva Noë (2004; 2006; 2007) has suggested that in fact waking perceptual phenomenology is not reproduced while dreaming, owing to the lack of details in, and instability of, dreams. Researchers sympathetic to neural representationalism (e.g. Rosen 2018a) have pointed out that some dreams are detail-rich and stable, and that there are potential neural explanations for the typical lack of detail and stability (Clark 2012). Here I have proposed an alternative: dreams fail to reproduce the phenomenology of waking perceptual experiences because they are incomplete. Specifically, when dreaming, what we experience is exhausted by what's presented in phenomenal consciousness at any given moment. While this might amount to a highly detailed and stable dream scene, it's not like waking perceptual experience, which goes beyond what's momentarily presented in phenomenal consciousness and includes *every* accessible part and property of distal stimuli. Further, while no exhaustive argument has been presented, and the matter is an empirical one to be tested, the natural representationalist explanations for how we experience more than we take in at a glance cause problems for explaining the "snapshot" phenomenology of dreaming. Explanations, like Clark's (2012), wrongly imply that dream experience should also go beyond what's momentarily presented in phenomenal consciousness.

Acknowledgements

This papers owes much to an anonymous referee (or referees) at this journal, who gave multiple detailed sets of helpful comments, the first of which lead to substantial revisions. These comments helped me both clarify my ideas and better situate them with respect to Noë's work. Earlier drafts of this paper were read by Mark Fortney and Mohan Matthen, who both gave helpful feedback. An earlier draft of this paper was also presented at *Dreams, Hallucinations and Imagination*, a workshop by the Centre for the Study of Perceptual Experience at the University of Glasgow (February 23–24, 2019). Thanks to the participants and organizers of this workshop, especially Melanie Rosen, for their helpful feedback.

Keywords

Dream phenomenology, Sensorimotor enactivism, Presence, Neural internalism

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References

Austin, J. L. (1962). *Sense and Sensibilia*. Oxford University Press. Reconstructed by G. J. Warnock from the Manuscript Notes.

Block, N. (2005). Alva noë: Action in perception. *Journal of Philosophy 102*(5), 259–272.

Braun, A. R., T. J. Balkin, N. J. Wesensten, F. Gwadry, R. E. Carson, M. Varga, P. Baldwin, G. Belenky, and P. Herscovitch (1998). Dissociated pattern of activity in visual cortices and their projections during human rapid eye movement sleep. *Science 2*, 91–95.

Brogaard, B. and D. E. Gatzia (2017). Unconscious imagination and the mental imagery debate. *Frontiers in Psychology 8*(799), 1–14.

Brooks, R. (1991). Intelligence without representation. *Artificial Intelligence 47*, 139–59.

Campbell, J. (2002). *Reference and Consciousness*. Oxford: Oxford University Press.

Cichy, R. M., A. Khosla, D. Pantazis, A. Torralba, and A. Oliva (2016). Comparison of deep neural networks to spatio-temporal cortical dynamics of human visual object recognition reveals hierarchical correspondence. *Scientific Reports 6*(27755), 1–13.

Clark, A. (2012). Dreaming the whole cat: Generative models, predictive processing, and the enactivist conception of perceptual experience. *Mind 121*(483), 753–771.

Clark, A. (2013). Whatever next? predictive brains, situated agents, and the future of cognitive science. *Behavioral and Brain Sciences 36*(3), 181–253.

Crick, F. and C. Koch (1995). Are we aware of neural activity in primary visual cortex? *Nature 375*, 121–23.

Degenaar, J. and J. K. O'Regan (2017). Sensorimotor theory and enactivism. *Topoi 36*, 393–407.

Dretske, F. (2003). Experience as representation. *Philosophical Issues 13*(1), 67–82.

Fish, W. (2009). *Perception, Hallucination, and Illusion*. Oxford: Oxford University Press.

French, C. and A. Gomes (2019). How naïve realism can explain both the particularity *and* the generality of experience. *The Philosophical Quarterly 69*(274), 41–63.

Gibson, J. J. (1986/1979). *The Ecological Approach to Visual Perception*. Hillsdale: Lawrence Erlbaum.

Hellie, B. (2014). Love in the time of cholera. In B. Brogaard (Ed.), *Does Perception Have Content?*, pp. 241–261. Oxford: Oxford University Press.

Hobson, J. A. and K. J. Friston (2014). Consciousness, dreams, and inference: The cartesian theatre revisited. *Journal of Consciousness Studies 21*(1-2), 6–32.

Hobson, J. A., E. F. Pace-Schott, and R. Strickgold (2000). Dreaming and the brain: Toward a cognitive neuroscience of conscious states. *Behavioral and Brain Sciences 23*(6), 793–842.

Horikawa, T. and Y. Kamitani (2017a). Generic decoding of seen and imagined objects using hierarchical visual features. *Nature Communications 8*(15037), 1–15.

Horikawa, T. and Y. Kamitani (2017b). Hierarchical neural representation of dreamed objects revealed by brain decoding with deep neural network features. *Frontiers in Computational Neuroscience 11*(4), 1–11.

Horikawa, T., M. Tamaki, Y. Miyawaki, and Y. Kamitani (2013). Neural decoding of visual imagery during sleep. *Science 340*, 639–642.

Johnston, M. (2006). Better than mere knowledge? the function of sensory awareness. In T. Szabo Gendler and J. Hawthorne (Eds.), *Perceptual Experience*, pp. 260–290. Oxford University Press.

Kahan, T. L. and S. LaBerge (2011). Dreaming and waking: Similarities and differences revisited. *Consciousness and Cognition 20*, 494–514.

LaBerge, S. and D. J. DeGracia (2000). Varities of lucid dreaming experience. In R. Kunzendorf and B. Wallace (Eds.), *Individual Differences in Conscious Experience*, pp. 269–307. John Benjamins.

Martin, M. G. F. (2004). The limits of self-awareness. *Philosophical Studies 120*(1-3), 37–89.

Mehta, N. (2014). The limited role of particulars in phenomenal experience. *The Journal of Philosophy 111*(6), 311–331.

Moore, G. E. (1903). The refutation of idealism. *Mind 12*(48), 433–453.

Nielsen, T. A. and P. Stenstrom (2005). What are the memory sources of dreaming? *Nature 437*(7063), 1286–1289.

Nir, Y. and G. Tononi (2010). Dreaming and the brain: from phenomenology to neurophysiology. *Trends in Cognitive Sciences 14*(2), 88–100.

Noë, A. (2004). *Action in Perception*. Cambridge: The MIT Press.

Noë, A. (2006). Experience without the head. In T. Szabo Gendler and J. Hawthorne (Eds.), *Perceptual Experience*, pp. 411–433. Oxford University Press.

Noë, A. (2007). Magic realism and the limits of intelligibility: What makes us conscious. *Philosophical Perspectives 21*, 457–474.

Noë, A. (2016). Sensations and situations: A sensorimotor integrationist approach. *Journal of Consciousness Studies 23*(5–6), 66–79.

Noë, A. and E. Thompson (2004). Are there neural correlates of consciousness? *Journal of Consciousness Studies 11*, 3–28.

O'Regan, J. K. (1992). Solving the "real" mysteries of visual perception: The world as an outside memory. *Canadian Journal of Psychology 46*(3), 461–488.

O'Regan, J. K. (2011). *Why Red Doesn't Sound Like a Bell: Understanding the Feel of Consciousness*. Oxford: Oxford University Press.

O'Regan, J. K. and A. Noë (2001). A sensorimotor account of vision and visual consciousness. *Behavioral and Brain Sciences 24*(5), 939–1031.

Prinz, J. (2000). A neurofunctional theory of visual consciousness. *Consciousness and Cognition 9*(2), 243–259.

Prinz, J. (2006). Putting the brakes on enactive perception. *PSYCHE 12*(1), 1–19.

Ritchie, J. B., D. M. Kaplan, and C. Klein (2017). Decoding the brain: Neural representation and the limits of multivariate pattern analysis in cognitive neuroscience. *The British Journal for the Philosophy of Science axx023*, 1–27.

Rosen, M. (2018a). Enactive or inactive? cranially envatted dream experience and the extended conscious mind. *Philosophical Explorations 21*(2), 295–318.

Rosen, M. (2018b). How bizarre? a pluralist approach to dream content. *Consciousness and Cognition 62*, 148–162.

Schwartz, S. and P. Maquet (2002). Sleep imaging and the neuropsychological assessment of dreams. *TRENDS in Cognitive Sciences 6*(1), 23–30.

Schwitzgebel, E. (2003). Do people still report dreaming in black and white? an attempt to replicate a questionnaire from 1942. *Perceptual and Motor Skills 96*, 25–29.

Varela, F. J., E. Rosch, and E. Thompson (1991). *The Embodied Mind: Cognitive Science and Human Experience*. The MIT Press.

Ward, D. (2012). Enjoying the spread: Conscious externalism reconsidered. *Mind 121*(483), 731–751.

Windt, J. M. (2010). The immersive spatiotemporal hallucination model of dreaming. *Phenomenology and the Cognitive Sciences 9*, 295–316.

Windt, J. M. (2013). Reporting dream experience: Why (not) to be skeptical about dream reports. *Frontiers in Human Neuroscience 7*(708), 1–15.

Windt, J. M. (2018). Predictive brains, dreaming selves, sleeping bodies: How the analysis of dream movement can inform a theory of self- and world-simulation in dreams. *Synthese 195*, 2577–2625.