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[TI]Pain and Mental Imagery

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[ABSTRACT]ABSTRACT: One of the most promising trends both in the neuroscience of pain and in psychiatric treatments of chronic pain is the focus on mental imagery. My aim is to argue that if we take these findings seriously, we can draw very important and radical philosophical conclusions. I argue that what we pretheoretically take to be pain is partly constituted by sensory stimulation-driven pain processing and partly constituted by mental imagery. This general picture can explain some problematic cases of pain perception, for example, phantom limb pain, and it also has important consequences for some recent philosophical debates about the nature and content of pain.

[AHEAD]I. Introduction

[TEXT]The standard account of pain perception is that it is caused by some form of tissue damage. The tissue is damaged, the pain sensors, commonly referred to as nociceptors, get activated and send a signal to the central nervous system, and the processing of this pain signal gives rise to painful phenomenology. You step on my toe, the nociceptors in my toe send a signal to my brain and the processing of this signal gives rise to the feeling of the pain in my toe.

My aim is to question this account of pain perception and argue that pain perception is at least partly constituted by pain processing that is not triggered by nociceptors. Using the parlance borrowed from neuroscience and psychology, we can say that pain perception is partly constituted by mental imagery (I will say [much] more on why this would count as mental imagery below). And there are cases (e.g., phantom limb pain and the thermal grid illusion) where pain perception is fully constituted by mental imagery (that is, by pain processing that is not triggered by nociceptors).

More and more empirical research has been focusing on the role of mental imagery in both pain perception and pain treatment. My aim is to provide a theoretical/philosophical framework that allows us to engage with this body of research. One of the most promising trends both in the neuroscience of pain and in psychiatric treatments of chronic pain is the focus on mental imagery. Many patients with chronic pain report involuntary mental imagery connected with the pain and some of them also report developing coping mental imagery (Berna et al. 2012; Winterowd et al. 2003; Gosden et al. 2013). Finally, one of the most efficient ways of treating chronic pain is to alter the mental imagery of patients (Fardo et al. 2015; MacIver et al. 2008; Moseley 2004, 2006; Volz et al. 2015; Philips 2011).

Here is one illustrative example. Berna et al. (2011) and Berna et al. (2012) give the case study of a 47-year-old woman with chronic pelvic pain, who had recurrent spontaneous mental imagery of a burning hole at the locus of the pain. She also developed coping imagery of a hot water bottle applied on the locus of the pain, which helped her a great deal. This is not an isolated example (see Fardo et al. [2015]; MacIver et al. [2008]; and Volz et al. [2015] for very similar case studies).

These findings clearly indicate that the concept of mental imagery is one that should be taken very seriously both in understanding pain perception and also in devising ways of treating patients with chronic pain. My aim is to go further and argue that mental imagery, understood in the way psychologists and neuroscientists use this concept, which encompasses certain forms of anticipations and expectations, is a constitutive part of pain perception.

In other words, pain perception is a mixture of sensory stimulation-driven pain processing and mental imagery. In Section II, I say more about this concept of mental imagery and in Section III, I argue that mental imagery plays a constitutive role in pain perception. Finally, I trace the consequences of this view for some recent philosophical debates about the content of pain (Section IV).

[AHEAD]II. Mental Imagery

[TEXT]I need to say more about what I mean by mental imagery in this paper. My aim here is not to capture our everyday concept (partly because I am not sure that there is a coherent everyday concept of mental imagery). It is rather to clarify what psychologists and neuroscientists mean by ‘mental imagery’. I do this because the findings I mentioned in the last section (and the findings I will refer to in what follows) all use this technical, psychological, and neuroscientific concept of mental imagery. So to engage with this empirical literature, we need to be very clear about what this concept entails and what it does not entail (see also Nanay 2015, forthcoming).

What psychologists and neuroscientists mean by mental imagery is early perceptual processing that is not triggered by corresponding sensory stimulation in the relevant sense modality (see Kosslyn et al. 1995a, Kosslyn et al. 1995b; Pearson and Westbrook 2015; Pearson et al. 2015). Here is a representative quote from a recent review article on mental imagery: “We use the term ‘mental imagery’ to refer to representations [. . .] of sensory information without a direct external stimulus” (Pearson et al. 2015). This way of thinking about mental imagery needs some unpacking.

First, mental imagery is not necessarily visual: there is auditory, olfactory, tactile, etc. imagery (see Zatorre and Halpern 2005; Bensafi et al. 2003; Herholz et al. 2012). Second, by sensory stimulation, I mean the activation of the sense organ by an external stimulus. In the visual sense modality, sensory stimulation amounts to the light hitting the retina. Some perceptual processing starts with sensory stimulation. But some other instances of perceptual processing—mental imagery—are not triggered by sensory stimulation (in the same sense modality).

Third, by perceptual processing, I mean processing in the perceptual system. Some parts of the processing of the sensory stimulation are more clearly perceptual than others. To take the visual sense modality as an example (Katzner and Weigelt 2013; Grill-Spector and Malach 2004; Van Essen 2004; Bullier 2004) in humans and nonhuman primates, the main visual pathway connects neural networks in the retina to the primary visual cortex (V1) via the lateral geniculate nucleus (LGN) in the thalamus; outputs from V1 activate other parts of the visual cortex and are also fed forward to a range of extrastriate areas (V2, V3, V4/V8, V3a, V5/MT). The earlier stages of this line of processing are more clearly perceptual than the later ones. And we can safely assume that cortical processing is perceptual processing. If we have such early cortical processing but no corresponding sensory stimulation, we clearly have (visual) mental imagery (see Page et al. [2011]; Slotnick et al. [2005]; but see also Bridge et al. [2012] for caution about how to think of ‘early cortical’ in this context).

Fourth, the concept of correspondence plays a crucial role in this way of thinking about mental imagery. We can have mental imagery even when there is sensory stimulation in the given sense modality if it fails to correspond to the perceptual processing (we can have mental imagery of X while staring at Y). In terms of experimental methodology, correspondence is relatively easy to measure, given the retinotopy of the early visual cortices (and their equivalent in the other sense modalities, see, e.g., Talavage et al. [2004]), which provides a convenient way of gaining evidence about the correspondence or lack thereof of sensory stimulation and perceptual processing. The primary visual cortex (and also many other parts of the visual cortex [see Grill-Spector and Malach (2004) for a summary]) is organized in a way that is similarly structured as the retina—it is retinotopic. So we can assess in a simple and straightforward manner whether the retinotopic perceptual processing in the primary visual cortex corresponds to the activations of the retinal cells. In the case of mental imagery, we get no such correspondence.

Finally, the definition of mental imagery was perceptual processing that is not triggered by corresponding sensory stimulation *in the relevant sense modality*. Perceptual processing that is triggered by corresponding sensory stimulation in *another* sense modality would still count as mental imagery So, we have olfactory mental imagery if *olfactory* perceptual processing that is not triggered by corresponding *olfactory* sensory stimulation. Olfactory mental imagery can be (and is often) triggered by *nonolfactory* (for example, auditory) sensory stimulation. This leads to *multimodal* mental imagery (Nanay forthcoming).

 Some readers will find the concept of mental imagery I outlined here to be different from the concept of mental imagery that is present in philosophical discussion or everyday discourse. The aim of the rest of this section is to point out how this concept may differ from the ways in which philosophers and the folk often use this concept.

Philosophers often try to capture the intuitive concept of conjuring up an image, for example, by closing one’s eyes and visualizing an apple (Richardson 1969; Kind 2001; Currie 1995). Defining mental imagery as perceptual processing not triggered by corresponding sensory stimulation in a given sense modality makes the example of closing one’s eyes and visualizing an apple a special case of mental imagery, but it also highlights the ways in which this example is unrepresentative.

First, philosophers often take mental imagery to be necessarily conscious (Richardson 1969; Kind 2001; Currie 1995). And visualizing an apple does indeed conjure up conscious mental imagery. But mental imagery, the way psychologists and neuroscientists use the term, is not necessarily conscious. We have strong empirical reasons for supposing that mental imagery (that is, perceptual processing that is not triggered by corresponding sensory stimulation in the relevant sense modality) can be unconscious. First, there are subjects (and in fact, surprisingly many of them) who have no conscious experience of mental imagery whatsoever, and at least some of these subjects are still capable of performing tasks that are assumed to require the manipulation of mental imagery—for example, the mental rotation task (Zeman et al. 2007, 2010, 2015). Second, the experimental methodology of neither psychology nor neuroscience treats mental imagery as necessarily conscious (starting with the classic mental rotation experiment of Shepard and Metzler [1971]). Third, we know that perception can be conscious or unconscious (see Kentridge et al. 1999 for a summary). Given that mental imagery, according to the psychological/neuroscientific definition, is one specific form of perceptual processing (that is not triggered by a certain kind of sensory stimulation), it is difficult to see why this form of perceptual processing, unlike sensory stimulation-driven perceptual processing, would be necessarily conscious (see also Church [2008]; Nanay [2010a]; and Phillips [2014] for some philosophical arguments).

Second, visualizing the apple is something you do voluntarily and intentionally. But mental imagery does not have to be voluntary or intentional. One can have flashbacks of some unpleasant scene—this is also mental imagery, but it is not a voluntary or intentional exercise of mental imagery. And some of our mental imagery is of this involuntary and unintentional kind—this is especially clear in the auditory sense modality, as demonstrated by the phenomenon of earworms: tunes that pop into our heads and that we keep on having auditory imagery of, even though we do not want to.

Third, visualizing an apple is not normally accompanied by any feeling of presence. You are not fooled by this mental imagery into thinking that there is actually an apple in front of you so that you could reach out and grab it. But, again, this is not a necessary feature of mental imagery. There is no prima facie reason why mental imagery could not be accompanied by the feeling of presence. In fact, lucid dreaming, which is widely considered to be a form of mental imagery (see Hobbes 1654; Walton 1990; Ichikawa 2009) is very much accompanied by the feeling of presence. The same is true of hallucinations, which is standardly characterized in psychology and psychiatry as a form of mental imagery (see Nanay [2016] for a philosophical summary).

The psychological/neuroscientific concept of mental imagery (that I parse as perceptual processing not triggered by corresponding sensory stimulation) is an extension of the introspective/philosophical concept of mental imagery that focuses on examples like closing our eyes and visualizing an apple. But just how (and how far) we can extend the introspective concept of mental imagery (and where this extension should stop) is something introspection will not tell us—we need perceptual psychology and cognitive neuroscience for that.

[AHEAD]III. Mental Imagery in Pain Perception

[TEXT]Perceptual processing can be triggered by various things. If it is triggered by corresponding sensory stimulation in the given sense modality, we get sensory stimulation-driven perception. If it is not triggered by corresponding sensory stimulation in the given sense modality, we get mental imagery. We have very diverse evidence from neuroscience that even very early sensory cortical processing can happen without being triggered by corresponding sensory stimulation in the relevant sense modality (often because it is triggered by sensory stimulation of another sense modality).[[1]](#endnote-1)

Importantly, in the vast majority of everyday perceptual scenarios, both of these kinds of perceptual processing play an important role. The reason for this is the involvement of perceptual processing (in fact, early cortical processing in the primary visual cortex) that is not triggered by corresponding sensory stimulation in the relevant sense modality in amodal completion. Amodal completion is the representation of those parts of the perceived object that we get no sensory stimulation from. In the case of vision, it is the representation of occluded parts of objects we see: when we see a cat behind a picket fence, our perceptual system represents those parts of the cat that are occluded by the picket fence. In tactile perception, it is the completion of those parts of the objects we touch that are not in direct contact with our hand, for example. We complete those parts amodally.

Amodal completion is, by definition, perceptual processing that is not triggered by corresponding sensory stimulation (the representation of occluded parts of a perceived object) and given that it is an almost omnipresent feature of everyday perception, this makes mental imagery an almost omnipresent feature of everyday perception (and the representation of occluded parts of perceived objects happens already in the primary visual cortex.[[2]](#endnote-2) This claim has echoes of Kant’s “imagination is a necessary constituent of perception itself” (*Critique of Pure Reason*, A120, fn. a; see also Strawson 1974), but the former is a much more specific claim and one that is grounded in empirical research.

So we get a picture of perception where what we pretheoretically take to be perception is really a mixture of sensory stimulation-driven perception and mental imagery. This mixture is not necessarily 50-50%, but mental imagery plays at least some role in the vast majority of everyday perceptual scenarios. My aim is to argue that the same general picture is also applicable to pain perception. What we pretheoretically take to be pain perception is also a mixture between sensory stimulation-driven perception and mental imagery.

What would count as mental imagery in the context of pain perception? As we have seen, mental imagery is perceptual processing that is not triggered by corresponding sensory stimulation in the relevant sense modality. So when it comes to pain it would be cortical pain processing that is not triggered by nociceptors (that is, by the sensory stimulation of the pain receptors on our skin).

Again, take vision. In sensory stimulation-driven perception, the light hits our retina and this triggers perceptual processing (in V1, V2, V4/V8, MT, etc). If there is perceptual processing in these regions that is not triggered by retinal input, we have to talk about mental imagery. Similarly, in sensory stimulation-driven pain perception, the nociceptors are activated and this triggers pain processing in clearly delineated cortical regions (the primary and secondary somatosensory cortices and the anterior cingulate cortex, among others). And if there is pain processing in these regions that is not triggered by nociceptors, we have to talk about mental imagery.[[3]](#endnote-3)

I want to argue for a strong claim: that pain depends *constitutively* on mental imagery. One potential worry about this claim would be to acknowledge the importance of mental imagery as a *causal* influence on pain, but nonetheless deny the *constitutive* dependence claim. Without going into the details of the literature in metaphysics about the difference between causal and constitutive dependence, I have to point out that in any of the mainstream ways of conceiving of this difference (see Ylikoski [2013] for a summary), we conclude that pain depends constitutively and not merely causally on mental imagery.[[4]](#endnote-4)

The view I am arguing for is that pain depends constitutively on both nociceptor-driven pain processing and mental imagery—as it is the mixture of the two. And I need to argue against the claim that mental imagery has a merely causal influence on pain. I will give a reductio argument. Suppose that pain depends on mental imagery merely causally. If this were so, then pain would fully depend constitutively on something else—something other than mental imagery. But what is it that pain is supposed to fully depend on constitutively? Barring dualism, pain is fully constituted by a physical process. And if we exclude mental imagery—non-nociceptor-driven pain processing—the only option that remains would be to claim that nociceptor-driven pain processing is fully constitutive of pain. In other words, the view that follows from the supposition for reductio is that pain is fully constituted by nociceptor-driven pain processing and it depends merely causally on mental imagery. And I will argue that this view is inconsistent with empirical findings about how pain processing works because there are instances of pain where there is no nociceptor-driven pain processing; there is only mental imagery.

 Phantom limb pain has been at the center of philosophical discussions of pain, partly because it seems to demonstrate that we can have pain even if the intentional object of this pain does not exist. But if we consider the phenomenon of phantom limb pain in the general theoretical framework I outlined above, it will very clearly count as mental imagery: the very well-documented activation of somatosensory and anterior cingular cortices are blatantly not triggered by nociceptors (as the relevant nociceptors don’t even exist).

It is crucial to emphasize that this does not mean that phantom pain is any less real than nociceptor-driven pain: I am not doubting the reality of phantom pain at all when I am describing it as mental imagery.[[5]](#endnote-5) We have seen that mental imagery may or may not be conscious. And if conscious, it may or may not be accompanied by the feeling of presence. In the case of phantom limb pain, mental imagery is clearly conscious and it is also clearly accompanied by the feeling of presence.

Let us return to the constitutive claim. We have seen that the view I need to argue against is that pain fully depends constitutively on nociceptor-driven pain processing and it depends merely causally on mental imagery. This view is false in the light of the phantom pain findings. In the case of phantom pain, we have genuine pain, but there is no nociception involved—there is no nociceptor-driven pain processing. So given that pain needs to depend on *something* constitutively and assuming that this ‘something’ is a physical process, the only thing it can depend on constitutively is mental imagery: pain processing not triggered by nociceptors.

The claim I am defending in this paper is that pain is *partly* constituted by mental imagery. But in the phantom limb case, pain is *fully* constituted by mental imagery. There is nothing else it can depend on constitutively.

 And regardless of what criterion we use to keep apart constitutive and causal dependence (Ylikoski 2013), the dependence of pain on mental imagery in the phantom limb case will count as constitutive dependence. If we remove all pain mental imagery (that is, pain processing not triggered by nociceptors) from the world, there would be no phantom pain at all. In a world without mental imagery, there is no phantom limb pain. The condition for constitutive dependence is satisfied.

The general upshot of the argument so far is that pain perception has a nociceptor-driven and a mental imagery component and we have reason to believe that the two interact at various stages of pain processing (Goffaux et al. 2007; Koyama et al. 2005; Atlas and Wager 2012; Ploghaus et al. 2003; Carlino et al. 2014).

And phantom limb pain is not the only instance of pain that is fully constituted by mental imagery. Another example is the thermal grill illusion. This is one of the oldest perceptual illusions involving pain: if the subject touches three bars, the middle one cold and the others warm, she experiences burning pain where the middle bar touches her skin (Craig and Bushnell 1994). This is a clear example of mental imagery in my framework as the activation in S1/S2 is not triggered by nociceptors (in fact, nociceptors are not involved anywhere in the entire process, see Defrin et al. [2002], Marotta et al. [2015]). Nonetheless, the subjects feel pain. Again, mental imagery is not merely partly constitutive of pain (let alone causally involved in pain perception): it is fully constitutive of pain.

Further, Ramachandran’s famous mirror treatment of phantom limb pain is very easily explained in this conceptual framework. Ramachandran successfully treated many cases of phantom limb pain by making the patients place their hands (both the intact hand and the ‘phantom’ hand) in a box, where they saw the movement of the intact hand reflected in a mirror exactly where the ‘phantom’ hand was localized. The subjects were then asked to move the two hands simultaneously and this lead to the alleviation of the phantom limb pain (see Ramachandran et al. [1995], Ramachandran and Rogers-Ramachandran [1996b], and for some more wrinkles, see Ramachandran and Rogers-Ramachandran [1996a]).

 If we accept the theoretical framework I am proposing, Ramachandran’s mirror treatment amounts to an early example of treating pain with the help of mental imagery. As we have seen, phantom limb pain would count as mental imagery: it involves the activation of the somatosensory and anterior cingular cortices without any activity from nociceptors. And what happens in Ramachandran’s mirror experiments could be described in the following manner. The experiments triggered in the subjects visual mental imagery of their phantom limb. And this visual mental imagery is what (causally) modified that mental imagery that is constitutive of the phantom limb pain (see also McIver et al. [2008] and Beaumont et al. [2011] for different ways of using mental imagery in alleviating phantom limb pain).[[6]](#endnote-6)

The conceptual framework I’ve been arguing for, where pain is constituted by a mixture of nociceptor-driven pain processing and mental imagery, gives a unified explanation of the treatment of phantom pain and the more recent clinical procedures of the treatment of pain in general that I started this paper with: they both involve interfering with the mental imagery constituent of pain by manipulating the patient’s other (visual, tactile) mental imagery. This is exactly what happens in the example of the 47-year-old woman with chronic pelvic pain when she conjures up the mental imagery of the hot water bottle: her visual (or tactile) mental imagery influences (causally) the mental imagery constituent of her chronic pain.

But the framework according to which pain is constituted by a mixture of nociceptor-driven pain processing and mental imagery has even more important theoretical virtues in terms of its explanatory unification. It can give a simple and unified explanation for the significant body of evidence from neuroscience that suggests that pain is very much dependent on a number of contextual cues (Carlino et al. 2014; Ploghaus et al. 2003). Philosophers often make a distinction between the sensory and the affective components of pain (see Aydede 2009)—but there is plenty of evidence that both of these depend on contextual cues.

A relatively well-understood case of this context dependence is the effects of placebo and nocebo on pain: placebo alleviates pain and nocebo does the opposite (Benedetti et al. 2005, 2007). More generally, pain very much depends on our expectations (Goffaux et al. 2007; Koyama et al. 2005; Atlas and Wager 2012; see also Peerdeman et al. [2016] for a meta-analysis) and there is more and more data on the neural mechanism of this process (Sawamoto et al. 2000; Keltner et al. 2006; Ploghaus et al. 1999; Jensen et al. 2003). One crucial finding is the involvement of sensory cortical areas (S1/S2), which interact with the processing of pain input very early on in cortical processing, on the expectations of pain (Porro et al. 2002; Wager et al. 2004).

Hence, some expectations and anticipations of pain will count as mental imagery in the psychological/neuroscientific sense of the term as we have clear evidence that some expectations can activate S1/S2 and also these regions without any nociceptors being involved (Sawamoto et al. 2000; Keltner et al. 2006; Ploghaus et al. 1999; Porro et al. 2002; Wager et al. 2004). It is important to emphasize that this does not mean that expectations and anticipations in general will have to be labeled as mental imagery. Many instances of expectations and anticipations will not count as mental imagery—for example, if I make an appointment with my dentist for next month and I am anticipating the pain I will have to endure then, this will not count as an instance of mental imagery as long as the somatosensory and anterior cingulate cortical areas are not directly activated. But we have plenty of evidence that at least some expectations can activate the somatosensory and anterior cingulate cortical areas directly, without the involvement of nociceptors. These instances of expectations will count as mental imagery.[[7]](#endnote-7)

As we have seen, there are many studies that show that these expectations clearly involve early cortical activations (Sawamoto et al. 2000; Keltner et al. 2006; Ploghaus et al. 1999; Porro et al. 2002; Wager et al. 2004). Our expectations about the pain stimulus influence pain intensity as well as pain location and even the presence of pain (Carlino et al. 2014; Ploghaus et al. 2003; see also Peerdeman et al. [2016] for a summary). The general framework I argued for predicts these results: if pain is at least partially constituted by mental imagery, then, provided that some expectations count as mental imagery, we should predict complex and diverse interactions between expectations and pain.

[AHEAD]IV. Philosophical Consequences: Challenges for Imperativism about Pain

[TEXT]I argued that what we pretheoretically consider to be pain is a mixture of nociceptor driven processing and mental imagery. In this last section, I want to trace some of the consequences of this general theoretical picture for some philosophical debates about the nature and content of pain. One big question about pain is about its representational content: what it represents and how it represents whatever it represents.

I will assume that pain is a representational state. This is not a particularly controversial assumption. What would be a controversial assumption would be to claim that the phenomenology of pain could be fully explained in terms of the representational content of pain. But I will not say anything about whether the representational content would fully or partially (or not at all) explain the phenomenology of pain. But if pain states are representational states, then the question is: what kind of representational states are they?

 There are two major proposals here. According to some, the content of pain states is indicative content: it represents some states of affairs (standardly: the tissue damage) in some way. It has a mind-to-world (or belief-like) direction of fit: it ‘describes’ a state of affairs (Tye 1995; Cutter and Tye 2011; Bain 2013). According to others, the content of pain states is imperative content: it does not describe a state of affairs (or does not *merely* describe a state of affairs), but rather prescribes a course of action (standardly, that the agent sees to it that the pain experience is gone). It has a world-to-mind (or desire-like) direction of fit (Klein 2007, 2012], 2015; Martinez 2010, Hall 2008; Klein and Martinez forthcoming).[[8]](#endnote-8) These are the two major proposals, but there are many ways of substantiating both and many versions of both the indicative and the imperative theories of pain (and things are even more complicated as there are also hybrid views that posit imperative content for some components of pain and indicative content for others—see Martinez [2010], Hall [2008], and Bain [2011] for discussion).

 How does the conceptual framework I argued for above help with this debate? I want to argue that it poses some challenges for imperativism, but not for indicativism. I do not think that it provides a knock-down argument against imperativism, but it draws attention to a number of questions imperativism would need to answer.

Very simply stated, if pain has indicative content, there is no problem as mental imagery also has indicative content: it represents some state of affairs in some way. But if pain has imperative content, then we get a tension between the direction of fit of pain (world-to-mind) and the direction of fit of mental imagery (mind-to-world). Imperativists would need to say more about how these two claims could fit together. I will survey four options that are open to imperativists, some more promising than others.

First, imperativists could bite the bullet and insist that nociceptor-driven pain has world-to-mind direction of fit, whereas pain not nociceptor-driven has mind-to-world direction of fit. This move is somewhat problematic for at least two reasons: first, if the difference between perceptual processing that takes place in nociceptor-driven pain processing and in non-nociceptor-driven pain processing (that is, mental imagery) is merely the etiology, that is, that one, but not the other is triggered by nociceptors, then it is difficult to see why the same perceptual processing leads to imperative content when it is triggered by nociceptors and it leads to indicative content when it is not. The second problem is that when nociceptor-driven pain processing and mental imagery are combined, one has world-to-mind direction of fit, whereas the other has mind-to-world direction of fit. We know from a great number of empirical studies that nociceptor-driven pain processing and mental imagery interact at various stages of pain processing (Goffaux et al. 2007; Koyama et al. 2005; Atlas and Wager 2012; Ploghaus et al. 2003; Carlino et al. 2014). But then imperativists would need to give an account of how we can harmonize imperative and indicative content at multiple levels of processing without serious computational overload (for a process—pain perception—that is notorious for being extremely fast [see Ploner et al. 2006]).

The second option for the proponent of imperativism about pain would be to argue that it is the outcome of the mixture of nociceptor-driven pain processing and mental imagery that has imperative content. So mental imagery may have indicative content, but when it is combined with nociceptor-driven pain processing, it acquires imperative content. The problem with this way of proceeding is that sometimes mental imagery is not combined with nociceptor-driven pain processing and it nonetheless leads to genuine pain. In the case of phantom limb pain and the thermal grill illusion, mental imagery is not at all combined with nociceptor-driven pain processing because there is no nociceptor-driven pain processing. We do have fully fledged pain without any nociceptors being involved. So in these cases, assuming that mental imagery has indicative content, pain would also have to have indicative content because it is not at all combined with nociceptor-driven pain processing that would revert its direction of fit.

The third option would be to deny that mental imagery, or at least the form of mental imagery that plays a role in pain perception, has indicative content. Maybe visualizing an apple has indicative content, but the mental imagery that is (constitutively) involved in pain perception has imperative content. This way of thinking about mental imagery in general and mental imagery in pain processing in particular would be somewhat revisionary, but not at all incoherent. However, it needs to be noted that this way of thinking about mental imagery in pain perception (as having world-to-mind direction of fit) would make it more difficult to explain the interaction between visual and tactile mental imagery and the mental imagery that is involved in pain perception (and, as we have seen, this interaction can explain the beneficial effects of [visual and tactile] mental imagery in pain therapy, as in the example of the 47-year-old woman with pelvic pain).

Fourth, we could take both mental imagery and pain to have both indicative and imperative content. So pain would have a double direction of fit and mental imagery would also have double direction of fit: they would then both describe how the world is and prescribe an action (see Millikan 1995; Pacherie 2000; Pacherie 2011; Clark 1997, for the concept of double direction of fit). Ruth Millikan introduced the term ‘Pushmi-Pullyu representations’ for representations that have both directions of fit (Millikan 1995): they represent the way the world is and at the same time prescribe how the world is supposed to be. The sentence ‘Dinner!’, for example, has such double direction of fit: it both describes something (that dinner is ready) and prescribes an action (that one should come to eat dinner). The suggestion in the present context would be that pain would also count as a Pushmi-Pullyu representation: it both describes, say, tissue damage at a certain location and also prescribes an action (of seeing to it that this tissue damage is stopped). And as long as the mental imagery that is involved in pain perception also has such double direction of fit, we have no mismatch between nociceptor-driven pain perception and mental imagery: all pain perception would come out as having double direction of fit. This is a promising option for the imperativist (although not for the ‘pure imperativist’, see Klein [2011, 2015]). But it would also entail a serious modification of the account in response to the challenge posed by the importance of mental imagery in pain perception.

In short, if what we pretheoretically take to be pain perception is really a mixture between nociceptor-driven pain processing and mental imagery, then imperativists about pain would need to say much more about a number of details that are not made explicit in their account. And, as we have seen, indicativism has a straightforward way of accommodating the picture I argued for in this paper, according to which pain is partly constituted by mental imagery.

REFERENCES

Arditi, A.J.D. et al. 1988. “Mental Imagery and Sensory Experience in Congenital Blindness,” *Neuropsychologia* 26: 1–12.

Atlas, L.Y. and T. D. Wager 2012. “How Expectations Shape Pain,” *Neuroscience Letters* 520: 140–48.

Aydede, Murat. (2009). "Is Feeling Pain the Perception of Something?" *The Journal of Philosophy,*106(10): 531-567.

Bain, D. 2011. “The Imperative View of Pain,” *Journal of Consciousness Studies* 18(9–10), 164–85.

———. 2013. “What Makes Pains Unpleasant? *Philosophical Studies* 166, S69–S89.

Beaumont G, C. Mercier, P.E. Michon, F. Malouin, and P.L. Jackson 2011. “Decreasing Phantom Limb Pain through Observation of Action and Imagery: A Case Series,” *Pain Med* 12: 289–99.

Benedetti, F., H.S. Mayberg, T.D. Wager, C.S. Stohler, and J.-K. Zubieta 2005. “Neurobiological Mechanisms of the Placebo Effect,” *Journal of Neuroscience* 25: 10390–402.

Benedetti, F., M. Lanotte, L. Lopiano, and L. Colloca 2007. “When Words Are Painful: Unraveling the Mechanisms of the Nocebo Effect,” *Neuroscience* 147: 260–71.

Bensafi, M. et al. 2003. “Olfactomotor Activity during Imagery Mimics That during Perception,” *Nature Neuroscience* 6:1142–44.

Bergmann, J. et al. 2016. “Smaller Primary Visual Cortex Is Associated with Stronger, but Less Precise Mental Imagery,” *Cerebral Cortex* in press.

Berna, C., I. Tracey and E.A. Holmes 2012. “How a Better Understanding of Spontaneous Mental Imagery Linked to Pain Could Enhance Imagery-Based Therapy in Chronic Pain,” *Journal of Experimental Psychopathology* 3: 258–73.

Berna, C., K. Vincent, J. Moore, I. Tracey, G.M. Goodwin, and E.A. Holmes 2011. “Presence of Mental Imagery Associated with Chronic Pelvic Pain: A Pilot Study,” *Pain Medicine 12*, 1086–93.

Block, N. 2006. “Bodily Sensations As an Obstacle for Representationism,” in M. Aydede, ed., *Pain: New Essays on Its Nature and the Methodology of Its Study*, Cambridge, MA: MIT Press, 137–42.

Bridge, H. et al. 2012. “Vivid Visual Mental Imagery in the Absence of the Primary Visual Cortex,” *Journal of Neurology* 259: 1062–70.

Bullier, J. 2004. “Communications between Cortical Areas of the Visual System,” in L.M. Chalupa and J.S. Werner, eds., *The Visual Neurosciences*, Cambridge, MA: MIT Press.

Calvert, G.A. et al. 1997. “Activation of Auditory Cortex during Silent Lipreading,” *Science* 276: 593–96.

Carlino, E, E. Frisaldi and F. Benedetti 2014. “Pain and the Context,” *Nature Rev. Rheumatol* 10: 348–55.

Church, J. 2008. “The Hidden Image: A Defense of Unconscious Imagining and Its Importance,” *American Imago* 65: 379–404.

Clark, A. 1997. *Being There: Putting Brain, Body and World Together Again*, Cambridge, MA: MIT Press.

Craig, A.D. and M.C. Bushnell 1994. “The Thermal Grill Illusion: Unmasking the Burn of Cold Pain.” *Science* 265: 252–55.

Cui, X. et al. 2007. “Vividness of Mental Imagery: Individual Variability Can Be Measured Objectively,” *Vision Research* 47: 4474–78.

Currie, G. 1995. “Visual Imagery As the Simulation of Vision,” *Mind and Language* 10: 25–44.

Cutter, B. and M. Tye 2011. “Tracking Representationalism and the Painfulness of Pain,” *Philosophical Issues* 21(1): 90–109.

Defrin R, A. Ohry, N. Blumen, and G. Urca 2002. “Sensory Determinants of Thermal Pain,” *Brain* 125: 501–10.

Derbyshire, S.W.G., M.G. Whalley, V.A. Stenger, and D.A. Oakley 2004. “Cerebral Activation during Hypnotically Induced and Imagined Pain,” *NeuroImage* 23: 392–401.

Fardo, F., M. Allen, E-M.E. Jegindo, A. Angrilli, and A. Roepstorff 2015. “Neurocognitive Evidence for Mental Imagery-Driven Hypoalgesic and Hyperalgesic Pain Regulation,” *NeuroImage* 120: 350–61.

Ghazanfar, A. and C.E. Schroeder 2006. “Is Neocortex Essentially Multisensory?” *Trends in Cognitive Sciences* 10: 278–85.

Goffaux, P., W.J. Redmond, P. Rainville, and S. Marchand 2007. “Descending Analgesia—When the Spine Echoes What the Brain Expects,” *Pain* 130: 137–43.

Gosden, T., P.G. Morris, N.B. Ferreira, C. Grady, and D.T. Gillanders 2013. “Mental Imagery in Chronic Pain: Prevalence and Characteristics,” *Eur. J. Pain* 18: 721–28.

Grill-Spector, K. and R. Malach 2004. “The Human Visual Cortex,” *Annual Review of Neuroscience* 27: 649–77.

Hall, R.J. 2008. “If It Itches, Scratch!” *Australasian Journal of Philosophy* 86(4): 525–35.

Hazenberg, S. J., Jongsma, M. L., Koning, A., & van Lier, R. (2014). [Differential familiarity effects in amodal completion: support from behavioral and electrophysiological measurements. *Journal of Experimental Psychology: Human Perception and Performance, 40(2)*, 669-684](http://dx.doi.org/10.1037/a0034689).

Herholz, S.C. et al. 2012) “Neuronal Correlates of Perception, Imagery, and Memory for Familiar Tunes,” *Journal of Cognitive Neuroscience* 24(6): 1382–97.

Hertrich, I. et al. 2011. “Cross-Modal Interactions during Perception of Audiovisual Speech and Nonspeech Signals: An fMRI Study,” *Journal of Cognitive Neuroscience* 23, 221–37.

Hobbes, T. 1654. *De Corpore*, London.

Hoenen, M., K.T. Lubke, and B.M. Pause 2015. “Somatosensory Mu Activity Reflects Imagined Pain Intensity of Others,” *Psychophysiology* 52: 1551–58.

Holmes, E.A. et al. 2010. “Key Steps in Developing a Cognitive Vaccine against Traumatic Flashbacks: Visuospatial Tetris versus Verbal Pub Quiz,” *PLoS ONE* 5, e13706.

Ichikawa, J. 2009. “Dreaming and Imagination,” *Mind and Language* 24: 103–21.

Iurilli, G. et al. 2012. “Sound-Driven Synaptic Inhibition in Primary Visual Cortex,” *Neuron* 73: 814–28.

James, T.W. et al. 2002. “Haptic Study of Three-Dimensional Objects Activates Extrastriate Visual Areas,” *Neuropsychologia* 40: 1706–14.

Jensen, J., A.R. McIntosh, A.P. Crawley, D.J. Mikulis, G. Remington, and S. Kapur 2003. “Direct Activation of the Ventral Striatum in Anticipation of Aversive Stimuli,” *Neuron* 40: 1251–57.

Katzner, S. and S. Weigelt 2013. “Visual Cortical Networks: Of Mice and Men,” *Current Opinion in Neurobiology* 23: 202–206.

Keltner, J.R., A. Furst, C. Fan, R. Redfern, B. Inglis, and H.K. Fields 2006. “Isolating the Modulatory Effect of Expectation on Pain Transmission: An fMRI Study,” *Journal of Neuroscience* 26: 4437–43.

Kentridge, R.W. et al. 1999. “Attention without Awareness in Blindsight,” *Proc. R. Soc. Lon. B* 266: 1805–11.

Kind, A. 2001. “Putting the Image Back to Imagination,” *Philosophy and Phenomenological Research* 62: 85–109.

Klein, C. 2007. “An Imperative Theory of Pain,” *Journal of Philosophy* 104(10): 517–32.

———. 2012. “Imperatives, Phantom Pains, and Hallucination by Presupposition,” *Philosophical Psychology* 25(6): 917–28.

———. 2015. *What the Body Commands: The Imperative Theory of Pain*, Cambridge, MA: MIT Press.

Klein, C., and M. Martínez forthcoming. “Imperativism and Degrees of Pain,” in D. Bain, M. Brady and J. Corns, eds., *The Nature of Pain*.

Komatsu, H. 2006 The neural mechanisms of perceptual filling-in. *Nature Review Neuroscience* 7: 220-231.

Kosslyn, S.M., M. Behrmann, and M. Jeannerod 1995a. “The Cognitive Neuroscience of Mental Imagery,” *Neuropsychologia* 33, 1335–44.

Kosslyn, S.M. et al. 1995b. “Topographical Representations of Mental Images in Primary Visual Cortex,” *Nature* 378: 496–98.

Koyama, T., J.G. McHaffie, P.J. Laurienti, and R.C. Coghill 2005. “The Subjective Experience of Pain: Where Expectations Become Reality,” *PNAS* 102: 12950–55.

Lacey, S. and R. Lawson, eds. 2013. *Multisensory Imagery*, New York: Springer

Lee, T. S. and Nguyen, M. 2001 “Dynamics of subjective contour formation in the early visual cortex”. *Proceedings of the National Academy of Sciences 98*: 1907-1911.

MacIver, K., D.M. Lloyd, S. Kelly, N. Roberts, and T. Nurmikko 2008. “Phantom Limb Pain, Cortical Reorganization and the Therapeutic Effect of Mental Imagery,” *Brain* 131: 2181–91.

Macpherson, F. 2012. “Cognitive Penetration of Colour Experience,” *Philosophy and Phenomenological Research* 84: 24–62.

Marotta, A., E.R. Ferre, and P. Haggard 2015. “Transforming the Thermal Grill Effect by Crossing the Fingers,” *Current Biology* 8: 1069–73.

Martinez, M. 2010. “Imperative Content and the Painfulness of Pain,” *Phenomenology and the Cognitive Sciences* 10: 67–90.

Martuzzi, R. et al. 2007. “Multisensory Interactions within Human Primary Cortices Revealed by BOLD Dynamics,” *Cerebral Cortex* 17: 1672–79.

Millikan, R.G. 1995. “Pushmi-Pullyu Representations,” *Philosophical Perspectives* IX, 185–200.

Moseley, G.L. 2004. “Graded Motor Imagery Is Effective for Long-Standing Complex Regional Pain Syndrome: A Randomised Controlled Trial,” *Pain* 108: 192–98.

———. 2006. “Graded Motor Imagery for Pathologic Pain: A Randomized Controlled Trial,” *Neurology* 67: 2129–34.

Nanay, Bence 2010a. “Perception and Imagination: Amodal Perception as Mental Imagery,” *Philosophical Studies* 150: 239–54.

———. 2010b. “Attention and Perceptual Content,” *Analysis* 70: 263–70.

———. 2015. “Perceptual content and the content of mental imagery,” *Philosophical Studies* 172: 1723-1736.

———. 2016. “Hallucination As Mental Imagery,” *Journal of Consciousness Studies* 23(7–8): 65–81.

———. forthcoming. *Seeing Things You Don’t See*. Oxford: Oxford University Press.

Pacherie, E. 2000. “The Content of Intentions,” *Mind and Language* 15, 400–32.

———. 2011. “Nonconceptual Representations for Action and the Limits of Intentional Control,” *Social Psychology* 42, 67–73.

Page, J.W. et al. 2011. “ERP Evidence of Visualization at Early Stages of Visual Processing,” *Brain and Cognition* *75*(2), 141–46.

Pearson, J. and Westbrook, F. 2015. “Phantom Perception: Voluntary and Involuntary Nonretinal Vision,” *Trends in Cognitive Sciences* 19: 278–284.

Pearson, J. et al. 2015. “Mental Imagery: Functional Mechanisms and Clinical Applications,” *Trends in Cognitive Sciences* 19: 590–602.

Peerdeman, K.J., A.I. van Laarhoven, S.M. Keij, L. Vase, M.M. Rovers, M.L. Peters, and A.W. Evers 2016. “Relieving Patients’ Pain with Expectation Interventions: A Meta-Analysis,” *Pain* 157: 1179–91.

Pekkola, J. et al. 2005. “Primary Auditory Cortex Activation by Visual Speech: An fMRI Study at 3 T,” *NeuroReport* 16: 125–28.

Philips, H.C. 2011. “Imagery and Pain: The Prevalence, Characteristics, and Potency of Imagery Associated with Pain,” *Behav. Cogn. Psychoth.* 39: 523–40.

Phillips, I. 2014. “Lack of Imagination: Individual Differences in Mental Imagery and the Significance of Consciousness,” in J. Kallestrup and M. Sprevak, eds., *New Waves in Philosophy of Mind,* Palgrave Macmillan.

Ploghaus, A., I. Tracey, J.S. Cati, S. Clare, R.S. Menon, P.M. Matthews, and J.N.P. Rawlins 1999. “Dissociating Pain from Its Anticipation in the Human Brain,” *Science* 284: 1979–81.

Ploghaus, A., L. Becerra, C. Borras, and D. Borsook 2003. “Neural Circuitry Underlying Pain Modulation: Expectation, Hypnosis, Placebo,” *Trends in Cognitive Sciences* 7: 197–200.

Ploner, M., J. Gross, L. Timmermann, and A. Schnitzler 2006. “Pain Processing Is Faster Than Tactile Processing in the Human Brain,” *Journal of Neuroscience* 18: 10879–82.

Porro, C.A., P. Baraldi, G. Pagnoni, M. Serafini, P. Facchin, M. Maieron, and P. Nichelli 2002. “Does Anticipation of Pain Affect Cortical Nociceptive Systems?” *J Neurosci* 22: 3206–14.

Ramachandran, V.S. and D. Rogers-Ramachandran 1996a. “Denial of Disabilities in Anosognosia,” *Nature* 382: 501.

———. 1996b. “Synaesthesia in Phantom Limbs Induced with Mirrors,” *Proc. R. Soc. Lond. B* 263, 377–86.

Ramachandran, V.S., D. Rogers-Ramachandran, and S. Cobb 1995. “Touching the Phantom Limb,” *Nature* 377: 489–90.

Richardson, A. 1969. *Mental Imagery*, New York: Springer.

Roseboom, W. et al. 2013. “The Cross-Modal Double Flash Illusion Depends on Featural Similarity between Cross-Modal Inducers,” *Scientific Reports* 3: 3437.

Ryle, G. 1949. *The Concept of Mind*, London: Huchinson.

Sawamoto, N., M. Honda, T. Okada, T. Hanakawa, M. Kanda, H. Fukuyama, J. Konishi, and H. Shibasaki 2000. “Expectation of Pain Enhances Responses to Nonpainful Somatosensory Stimulation in the Anterior Cingulate Cortex and Parietal Operculum/Posterior Insula: An Event-Related fMRI Study,” *Journal of Neuroscience* 20: 7438–45.

Scherzer, T. R. & Ekroll, V. 2015 Partial modal completion under occlusion: What do modal and amodal percepts represent. *Journal of Vision* 15: 1-20.

Sekuler, R. et al. 1997. “Sound Alters Visual Motion Perception,” *Nature* 285: 308.

Shepard, R.N. and J. Metzler 1971. “Mental Rotation of Three-Dimensional Objects,” *Science* 171, 701–703.

Slotnick, S.D. et al. 2005. “Visual Mental Imagery Induces Retinotopically Organized Activation of Early Visual Areas,” *Cerebral Cortex* 15: 1570–83.

Spence, C. and O. Deroy 2013. “Crossmodal Imagery,” in S. Lacey and R. Lawson, eds., *Multisensory Imagery*, New York: Springer, 157–83.

Strawson, P.F. 1974. “Imagination and Perception,” in *Freedom and Resentment*, London: Methuen, 45–65.

Talavage, T.M. et al. 2004. “Tonotopic Organization in Human Auditory Cortex Revealed by Progressions of Frequency Sensitivity,” *Journal of Neurophysiology*91: 1282–96.

Teufel, C. and B. Nanay 2016. “How to (and How Not to) Think about Top-Down Influences on Perception,” *Consciousness and Cognition*,in press.

Tye, M. 1995. *Ten Problems of Consciousness: A Representational Theory of the Phenomenal Mind*, Cambridge: Bradford Books.

Van Essen, D.C. 2004. “Organization of Visual Areas in Macaque and Human Cerebral Cortex,” in *The Visual Neurosciences*, ed. L. Chalupa and J.S. Werner, Cambridge, MA: MIT Press.

Volz, M.S., V. Suarez-Contreras, A.L. Santos Portilla, and F. Fregni 2015. “Mental Imagery-Induced Attention Modulates Pain Perception and Cortical Excitability,” *BMC Neurosci* 16: 15.

Wager T.D., J.K. Rilling, E.E. Smith, A. Sokolik, K.L. Casey, R.J. Davidson, S.M. Kosslyn, R.M. Rose, and J.D. Cohen 2004. “Placebo-Induced Changes in fMRI in the Anticipation and Experience of Pain,” *Science* 303: 1162–67.

Walton, K. 1990. *Mimesis As Make-Believe*, Cambridge, MA: Harvard University Press.

Watkins, S. et al. 2006. “Sound Alters Activity in Human V1 in Association with Illusory Visual Perception,” *NeuroImage* 31: 1247–56.

Winterowd, C., A.T. Beck, and D. Gruener 2003. “Eliciting and Modifying Imagery,” in *Cognitive Therapy with Chronic Pain Patients*, New York: Springer, 183–207.

Ylikovski, P. 2013. “Causal and Constitutive Explanation Compared,” *Erkenntnis* 78: 277–97.

Zangaladze, A. et al. 1999. “Involvement of Visual Cortex in Tactile Discrimination of Orientation,” *Nature* 401: 587–90.

Zatorre, R.J. and Halpern, A.R. 2005. “Mental Concert: Musical Imagery and Auditory Cortex,” *Neuron* 47: 9–12.

Zeman, A. et al. 2007. “‘Blind Imagination’: Brain Activation after Loss of the Mind’s Eye,” *Journal of Neurology Neurosurgery & Psychiatry* 78(2): 209.

———. 2010. “Loss of Imagery Phenomenology with Intact Visuo-Spatial Task Performance: A Case of ‘Blind Imagination’,” *Neuropsychologia* 48: 145–55.

———. 2015. “Lives without Imagery: Congenital Aaphasia,” *Cortex* 73: 378–80.

1. See Hertrich et al. 2011; Pekkola et al. 2005; Zangaladze et al. 1999; Ghazanfar and Schroeder 2006; Martuzzi et al. 2007; Calvert et al. 1997; James et al. 2002; Iurilli et al. 2012; Kilintari et al. 2011. [↑](#endnote-ref-1)
2. See Lee and Nguyen 2001; Komatsu 2006; Scherzer and Ekroll 2015; Hazenberg et al. 2014; Nanay 2010a. [↑](#endnote-ref-2)
3. Some instances of mental imagery are accompanied by the characteristic (painful) phenomenal character. Some other instances (for example, most cases of imagining that one is in pain, see Hoenen et al. 2015, Derbyshire et al. 2004) are not. We can have activation in the primary and secondary somatosensory cortices and the anterior cingulate cortex that is very similar to nociceptor-driven pain processing that nonetheless does not lead to any painful phenomenology. Similarly, in the visual case, one can have activation in the early visual cortices without having the phenomenal feel of visualizing anything. But even if mental imagery is not accompanied by any painful phenomenology, it can still influence the phenomenal character of simultaneous nociceptor-driven pain processing. [↑](#endnote-ref-3)
4. I should clarify that I take both the causal and the constitutive claim to be about the actual world and no some necessary claim about all possible world. I’m sure there are possible worlds where pain works very differently from the way it does in the actual world. I’m not particularly interested in what is going on in those worlds. I am interested in what is going on in the actual world when I have a headache. [↑](#endnote-ref-4)
5. Note that I am not committed to the claim that phantom limb pain is hallucinated pain. Ned Block argued at length that there is no such thing as pain hallucination (Block 2006). And while hallucination will count as a form of mental imagery according to the concept of mental imagery I have been using (as perceptual processing that is not triggered by corresponding sensory stimulation in the relevant sense modality), the form of mental imagery that is involved in pain perception in general and in phantom limb pain in particular may be very different from the form of mental imagery that one may want to label ‘hallucination’. See Nanay (2016) for a discussion of what form of mental imagery hallucination is. [↑](#endnote-ref-5)
6. This mirror-induced mental imagery was not voluntarily triggered. It was not like closing one’s eyes, counting to three and then visualizing an apple. It was triggered involuntarily by the mirror-trick of visual stimulus – the visual stimulus of what appeared to be the visual perception of the phantom limb. So while Ramachandran’s mirror treatment of phantom limb pain is an early instance of treating pain with the help of mental imagery, it amounts to treating pain with the help of not voluntarily conjured up mental imagery (like the experiments in Fardo et al. 2015, MacIver et al. 2008 and Volz et al. 2015), but rather involuntary crossmodally triggered mental imagery. [↑](#endnote-ref-6)
7. Further, hypnosis induced pain will also count as mental imagery as in this sense as it is not triggered by nociceptors, but the very same regions are active as in the case of nociceptor-driven pain processing (Derbyshire et al. 2004). Interestingly, the mental imagery here is conscious: the subjects under hypnosis do have painful phenomenology. [↑](#endnote-ref-7)
8. I use ‘having indicative content’ and ‘having content with mind-to-world direction of fit’ interchangeably (ditto for ‘having imperative content’ and ‘having content with world-to-mind direction of fit’). Also, I bracket some some recent controversies about the usefulness and coherence of this term ‘direction of fit’ in what follows (see Frost 2014). [↑](#endnote-ref-8)