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MENTAL IMAGERY

PHILOSOPHY, PSYCHOLOGY, NEUROSCIENCE

BENCE NANAY

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Foreword

Here is a story the French photographer Henri Cartier-Bresson liked to tell: during the Second World War, he was hiding in a shed in the middle of the nondescript German countryside surrounded by a mountain range. He spent weeks there, fearing for his life. Then one day he visualized the ocean behind the mountain range. And this completely transformed his experience. Not only his experience of the mountain range, but also of his general situation and of himself.[1] Mental imagery does have a huge influence on the way we perceive, and on our mental life in general.

This book is about mental imagery and the important work it does in our mental life. It plays a crucial role in the vast majority of our perceptual episodes. It also helps us understand many of the most puzzling features of perception (like the way it is influenced in a top-down manner and the way different sense modalities interact). But mental imagery also plays a very important role in emotions, action execution, and even in our desires. In sum, there are very few mental phenomena that mental imagery doesn't show up in—in some way or other. The hope is that if we understand what mental imagery is, how it works and how it is related to other mental phenomena, we can make real progress on a number of important questions about the mind.

I wrote this book for an interdisciplinary audience. As it aims to combine philosophy, psychology, and neuroscience to understand mental imagery, I have not presupposed any prior knowledge in any of these disciplines. As a result, readers with no background in any of these disciplines can also follow the arguments.

The book has many short chapters, organized into five parts. Part I is about mental imagery, whereas the rest of the book is about the role it plays in perception (Part II), multimodal perception (Part III), cognition (Part IV), and action (Part V). The chapters are (almost) all self-standing, so the reader can jump around freely, but it probably makes sense to read Part I first.

A lot has been written about imagination in the philosophy of mind and beyond. Mental imagery is a much more basic (and also conceptually less problematic) concept than imagination. Nonetheless, much less attention has

[1] I heard the story from Marine Franck, Cartier-Bresson's widow in 2004 in Locarno.

been devoted to mental imagery. The aim of this book is to fill this gap and put mental imagery at the forefront of our thinking about the mind.

David Hume memorably said that "the memory, senses, and understanding are, [. . .], all of them founded on the imagination."[2] My aim is to convince the reader that "the memory, senses, and understanding are, all of them founded" on mental imagery.

I started working on the topic of mental imagery in the Fall of 2006, when, fresh out of PhD, I gave my first graduate seminar at Syracuse University. And mental imagery has been the primary focus of my research in the last eight years or so. As a result, it is difficult to enumerate all those who helped me to think through these issues and also the venues where I presented the material of the book, but I'll try it anyway.

I gave talks that were directly related to mental imagery at various conferences of the American Philosophical Association (one Eastern, one Pacific, two Central) as well as the University of Manchester, the University of British Columbia, Simon Fraser University, University of Geneva, various conferences of the American Society of Aesthetics, University of Cardiff, University of Sheffield (twice), University of Porto, University of Warwick, various conferences and talks at Ruhr Universität Bochum, University of Bergen, Berlin School of Mind and Brain (twice), various conferences of the Association of the Scientific Study of Consciousness, University of Leeds, Institut Jean Nicod, Courtauld Institute, University of East Anglia, University of Urbino, University of Milan (twice), University of Exeter, University of Oslo, Barnard College, University of Salzburg (twice), University of Aix/Marseilles, Oxford University (twice), Southern Society of Philosophy and Psychology, University of North Carolina, Chapel Hill, Hebrew University, Jerusalem, Kirschberg Symposium, University of Southampton, University of Nijmegen, University of Toronto, University of Ghent, University of Torino, NYU Abu Dhabi, Bilkent University, various online talks during the COVID-19 pandemic, Washington University, Saint Louis, University of Kent, Humboldt Universität, Berlin, University of Kraków, University of Bristol, City University of New York, Universita Svizzera Italiana, LMU Munich, University of Lisbon.

Some versions of the arguments I presented in this book were published in the following journals: *Philosophical Transactions of the Royal Society B*, *Cognition*, *Cortex*, *Philosophical Studies*, *Pacific Philosophical Quarterly*, *Analysis*, *Journal of the American Society of Aesthetics*, *Ergo*, *Synthese*,

[2] Hume: *Treatise of Human Nature* 1.4.7.3–4. I want to leave open the possibility that what Hume meant by "imagination" is in fact closer to what I mean by "mental imagery."

Multisensory Research, *Thought*, *Perception*, *i-Perception*, *Consciousness and Cognition*, *The Monist*, *Frontiers in Psychology*, *Mind & Language*, *Journal of Consciousness Studies*, as well as in various edited volumes.

There is no way I can enumerate everyone who gave excellent feedback to some of the material in this book, but I am especially grateful to those who read and commented on either the entire book or almost the entire book: Dustin Stokes, Neil Van Leeuwen, Jake Quilty-Dunn, Robert Briscoe, Dominic Gregory, Amy Kind, Peter Langland-Hassan, Santiago Echeverri, Geraldo Viera, Alma Barner, Adam Bradley, Bras Saad, Laura Silva, Jason Leddington, Nicolas Porot, Peter Fazekas, Carlota Serrahima, Brandon Ashby, Sarah Arnaud, Kris Goffin, Francesco Marchi, Stephen Gadsby, Alex Kerr, Oli Odoffin, Amanda Evans, Anna Ichino, Alex Geddes, Lu Teng, Manolo Martinez, Denis Buehler, Anya Farennikova, Jonathan Cohen, Mohan Matthen, Thomas Raleigh, Kevin Lande, Nick Wiltsher, Chris McCarroll, Dan Williams, Margot Strohminger, Craig French, Maarten Steenhagen, Patrick Butlin, Jacob Berger, Dan Cavedon-Taylor, Chiara Brozzo, Laura Gow, Andrea Blomkvist, Julian Bacharach, Jeremy Pober, Andrea Rivadulla, Grace Helton, as well as an anonymous referee for Oxford University Press.

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PART I

MENTAL IMAGERY

1
Mental Imagery in Psychology and Neuroscience

Close your eyes and visualize an apple. Got it? This is an example of mental imagery. It would be tempting to use this example to anchor the reader's intuitive understanding of mental imagery instead of spending some time trying to figure out how we should understand mental imagery. William James famously started his discussion of attention with the sentence: "Everyone knows what attention is" (James 1890, p. 403). So it would be tempting to start this book by saying that "Everyone knows what mental imagery is" and just leave it at that.

This strategy would be extremely problematic for a number of reasons. The most important of these is that there are very significant and well-documented differences between individuals when it comes to mental imagery: some people do not experience mental imagery at all—I will say a lot more about the philosophical significance of this in Chapter 3. Some others have very vivid mental imagery. So trusting that we all know intuitively what mental imagery is, is just lazy.

"Mental imagery" is a technical term. The concept of mental imagery was first consistently used in the, then very new, discipline of empirical psychology at the end of the nineteenth century by psychologists like Francis Galton, Wilhelm Wundt, or Edward Titchener (Galton 1880; Titchener 1909; Wundt 1912).

Technical terms are supposed to be used in a way that maximizes theoretical usefulness. In this case, theoretical usefulness means that we should use "mental imagery" in a way that would help us to explain how the mind works. My aim is to use a vast amount of empirical data in order to understand age-old and deep philosophical issues. But in order to do so, we need to start with the empirical sciences. So how do the empirical sciences of the mind use the concept of mental imagery?

My starting point is the definition used in a review article on mental imagery in the leading journal *Trends in Cognitive Sciences*: "We use the term 'mental imagery' to refer to representations […] of sensory information

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without a direct external stimulus" (Pearson et al. 2015, p. 590).[1] This definition aims to capture how the concept of mental imagery is used in a number of empirical disciplines, including psychiatry, neuroscience, and psychology. It is also consistent with some famous characterizations of mental imagery; for example, the one by the all-star team of Stephen Kosslyn, Marlene Behrmann, and Marc Jeannerod, who write that:

> Visual mental imagery is "seeing" in the absence of the appropriate immediate sensory input, auditory mental imagery is "hearing" in the absence of the immediate sensory input, and so on. Imagery is distinct from perception, which is the registration of physically present stimuli.
>
> (Kosslyn et al. 1995a, p. 1335)

It is not entirely clear what those scare-quotes mean around the word "seeing" and "hearing" (we'll come to that). But one thing to note already is that mental imagery, in spite of the connotations of the word "image," is not necessarily visual: mental imagery can be auditory, olfactory, and tactile as well: it can happen in all sense modalities, not just in vision.

Another influential, albeit somewhat picturesque, characterization of mental imagery comes from the pioneer of mental imagery research, Roger Shepard:

> The relation of a mental image to its corresponding object is in some ways analogous to the relation of a lock to a key. [. . .] the lock can be externally operated only by its corresponding key [. . .] It may also be possible to operate the lock, at least partially, by direct manipulation of its mechanism from the inside, in the absence of its external key. (Shepard 1978, p. 130)

I am not entirely sure how much experience Shepard had with locks (as picking a lock would also involve external intervention), but the spirit of this characterization is clear: mental imagery lacks external input. I will follow the usage of the concept of mental imagery in the empirical sciences and define mental imagery as *perceptual representation that is not directly triggered by sensory input*.[2] This definition needs some unpacking.

[1] The part of the definition I edited out is "and the accompanying experience." I will come back to why this is a fair omission (and also in line with the consensus in psychology and neuroscience) in Chapter 4.

[2] I should add that there is no crystal-clear consensus in the empirical literature on the exact definition of mental imagery. However, the Pearson et al. definition that I appropriate (with some minor

By sensory input or sensory stimulation I mean the activation of the sense organ by external stimuli Sensory stimulation is an event. So, in the visual sense modality, sensory stimulation amounts to the light hitting the receptors in the retina. Some perceptual processing starts with sensory stimulation. But not all. Some perceptual processing is not directly triggered by sensory stimulation.

By triggering a perceptual representation, I mean a simple causal process: our perceptual system can get activated by the event of sensory stimulation (for example, by the light hitting our retina). But it can also get activated in the absence of sensory stimulation. It needs to be emphasized that even on those occasions when it is sensory stimulation that directly triggers perceptual representations, the sensory input gets elaborated and embellished in the course of this perceptual processing—but what triggers this processing and what gets elaborated and embellished is the sensory stimulation. In the case of mental imagery, this perceptual processing (already very early cortical processing, see, for example, Slotnick et al. 2005) is not directly triggered by sensory stimulation, so whatever gets elaborated and embellished is not the sensory stimulation.

By perceptual representation, I mean a representation in the perceptual system. Some of our perceptual representations are triggered directly by sensory input—this amounts to perception, or, as I will say, to "sensory stimulation-driven perception." And some others are not triggered directly by sensory input—this amounts to mental imagery. Note that I am making a distinction between perception and perceptual representation. Perceptual representation is representation involved in perceptual processing, which is just processing in the perceptual system. Perceptual representations get activated when we perceive. But they also get activated when we have mental imagery. Perceptual representation that is triggered directly by sensory input is sensory stimulation-driven perception. Perceptual representation that is not triggered directly by sensory input is mental imagery.

I characterized, and will continue to characterize, mental imagery as perceptual representation not directly triggered by sensory input. But some may complain that, strictly speaking, representations are not the kind of things that get to be triggered by sensory input. Perceptual processing is the kind of thing that may or may not be triggered by sensory input. And perceptual

changes) is as representative as it gets. Some empirical researchers work with a narrower conception (where some additional constraint of being top-down generated or being conscious is added). I will address the plausibility of such constraints in Chapters 3, 4, and 5.

representation is the representation used in perceptual processing. I am perfectly happy with this way of formulating mental imagery as perceptual representation that is used in perceptual processing that is not directly triggered by sensory input. But for the sake of simplicity, I will continue to talk about perceptual representations not directly triggered by sensory input. I also think that my characterization of mental imagery is equivalent to saying that mental imagery is perceptual processing not directly triggered by sensory input, as long as we take this perceptual processing to be representational processing. I will use these two ways of characterizing mental imagery (perceptual representation not directly triggered by sensory input and perceptual processing not directly triggered by sensory input) interchangeably, as the perceptual representation in question is the representation used in perceptual processing and as the perceptual processing is representational. Either way, these perceptual representations that are not directly triggered by sensory input are bona fide representations that higher-level processes (perceptual and non-perceptual ones) can use and process further. I will say more about the kind of representations that constitute mental imagery in Chapter 6.

But defining perceptual representation in terms of perceptual processing, and defining perceptual processing in terms of the perceptual system, leaves open how we should think about the perceptual system. Some parts of the processing of sensory stimulation are more clearly perceptual than others. Take the visual sense modality as an example—I will use mainly visual examples in the next couple of chapters before turning to the importance of the complex interaction between the sense modalities. 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 (like the secondary visual cortex (V2), V4/V8, V5/middle temporal area (MT), and so on) (Bullier 2004; Grill-Spector and Malach 2004; Van Essen 2004; Katzner and Weigelt 2013).

While there may be some debates about whether some later stages of this line of processing would count as perceptual, we can safely assume that early cortical processing (that is, the earliest stages of processing following the input) counts as perceptual processing.[3] Throughout the book, I will take early cortical processing as sufficient for perceptual processing and most of

[3] It is important to emphasize that perceptual processing here is understood functionally and not neuroanatomically. Given the enormous neural plasticity of the mind, activation of the primary visual cortex is neither necessary nor sufficient for visual imagery (see, for example, Bridge et al. 2012). Even if there is no activation in the primary visual cortex, but there is activation of some other early visual

the examples I will talk about involve early cortical processing. But I want to leave open the possibility that non-early perceptual processing that is not directly triggered by sensory input would also count as mental imagery.

Finally, the concept of directness in my definition of mental imagery may need some further clarification (and the same goes for the concept of "appropriate immediate sensory input" (Kosslyn et al. 1995a, p. 1335; see also Shepard and Metzler 1971) that has also been used to specify what mental imagery lacks). The perceptual processing is triggered *directly* by sensory input if it is triggered without the mediation of representations involved in some top-down or lateral (perceptual or extra-perceptual) processes.

If the perceptual representation is triggered by something non-perceptual (as in the case of closing our eyes and visualizing), it is not triggered directly by the sensory input.

If the perceptual representation in the visual sense modality is triggered by sensory input in the auditory sense modality (as in the case of the involuntary visual imagery of your face when I hear your voice on the phone with my eyes closed), the visual processing is triggered indirectly. It is triggered with the mediation of some kind of auditory representation—I will call this form of mental imagery "multimodal mental imagery," see Chapter 13. A direct trigger here would be visual input, but there is no visual input in this case. The auditory input leads to an auditory representation and this auditory representation laterally triggers the visual representation. This process is mediated by the auditory representation. Hence, it is not direct. It counts as mental imagery.

And if the visual representation of the center of the visual field is triggered by input in the periphery of the visual field (say, because the center of the visual field is occluded by an empty white piece of paper), then the visual processing at the center of the visual field is, again, triggered indirectly, that is, in a way mediated by the visual representation in the periphery (see Chapter 8). A direct trigger would have to be sensory input at the center of the visual field, but there is no such direct trigger in this case. The visual input in the periphery leads to the visual representation of the contours in the periphery. These visual representations trigger, laterally, the visual representation of the contours at the middle of the visual field. This process is mediated by the visual representation in the periphery. Hence, it is not direct. It counts as mental imagery.

cortical areas (for example, of MT/V5+ in the case of imagery of a moving object, we can still conclude that there is visual imagery; see Kaas et al. 2010). See Chapter 14 for further details on this.

All these three different examples of perceptual processing count as mental imagery as the perceptual processing is not triggered directly by the sensory input. Thus, all of these count as mental imagery.

The directness or indirectness of the causal link between sensory input and perceptual processing plays a crucial role in the definition of mental imagery, so here is a quick and dirty way of keeping direct and indirect causal links apart in this context. In all sense modalities, we have a fairly clear idea of the hierarchy of processing. We have seen that, for example in the visual sense modality, information from the retina is processed in the lateral geniculate nucleus, then in the primary visual cortex (V1), the secondary visual cortex (V2), and then V4/V8, V5/MT. If the processing of a feature in, say, the primary visual cortex is triggered in an entirely bottom-up manner, this is not mental imagery. If it is triggered in a top-down manner or laterally, it is mental imagery. Lateral triggering can happen from a different sense modality (say, audition) or from the same sense modality (when the V1 processing of a feature at the middle of the visual field is triggered by the V1 processing of other features on the left- and right-hand side of the visual field). It is important that while we get mental imagery when the perceptual processing is triggered laterally this way, we do not get mental imagery if the perceptual processing of the input is merely influenced or modified laterally as in this case, the perceptual processing is still directly triggered by the sensory input.

We can also get mixed perception/imagery cases. For example, if seeing the purple paper makes me visualize a purple dinosaur, this perceptual representation may be directly triggered by the sensory input with respect to color, but not in any other respects. In this case, we see the color purple, but have mental imagery of the dinosaur. As we shall see in Chapter 9, these mixed cases are very important in everyday perception.

In some of my earlier writings on mental imagery, I characterized mental imagery as perceptual processing not triggered by corresponding sensory input. While there is an obvious difference between these two ways of thinking about mental imagery (in one it is the lack of directness, in the other it is the lack of correspondence that sets mental imagery apart), I take the two definitions to be co-extensive for the vast majority of cases. The official definition of perceptual representation not directly triggered by sensory input is more general and that is why I am sticking with it, but thinking of mental imagery as perceptual representation that lacks correspondence with the sensory input can be helpful in some contexts.

In the case of shape perception, for example, correspondence is easy enough to measure, given the retinotopy of the primary visual cortex. Correspondence here is simple spatial correspondence. The sensory stimulation is a fairly straightforward event: light hitting my retina in a certain pattern. And what is supposed to correspond to (or fail to correspond to) this pattern of sensory stimulation is the patterns in early cortical perceptual processing. In the visual sense modality, this would be the retinotopic primary visual cortex. 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 structurally homomorphic to the retina—it is retinotopic. If you are looking at a triangle, there is roughly a triangle-patterned activation of direction-sensitive neurons in your primary visual cortex. 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.

The retinotopy of the early visual cortices (and their equivalent in the other sense modalities, see, for example, Talavage et al. 2004) makes spatial correspondence an extremely convenient way of gaining evidence about whether a given perceptual representation is mental imagery or not. For many kinds of stimuli (for example, shape), if there is no spatial correspondence between the processing in the visual cortices and the input, then the former could not have been triggered directly by the latter. Direct triggering would mean retinotopic triggering and this would guarantee spatial correspondence. But, of course, we can get such correspondence even if the processing in the visual cortices is not triggered by the input directly (for example, if there is a correspondence by accident without any causal link between the corresponding features). And with stimuli other than very simple shapes, the concept of correspondence is not entirely clear (or not easily measurable).

For all these reasons, I use the presence or absence of a direct causal link between input and perceptual processing as the mark of mental imagery, while acknowledging that the presence or lack of correspondence can be used diagnostically. The same goes for temporal correspondence (again, something easy to measure by assessing whether the activation of the early cortices follows the sensory stimulation quickly enough), a topic I will come back to in Chapter 12.

The definition of mental imagery as perceptual processing that is not directly triggered by sensory input is noncommittal about a number of different points. It is silent on whether this perceptual processing is conscious or not, voluntary or not, and so on—I will return to these distinctions in Chapters 3 and 4.

But I want to emphasize, even here, a crucial point that this definition of mental imagery is neutral about. The definition of mental imagery as perceptual processing that is not directly triggered by sensory input is an entirely negative definition. It does not tell us what it is that the perceptual processing of a certain feature is directly triggered by. If it is triggered, albeit indirectly, by sensory input in the same sense modality, this still counts as mental imagery, because the direct causal link is missing (mental imagery of this kind will play an important role in Chapter 8). If it is triggered laterally, by another sense modality, it counts as multimodal mental imagery (see Chapter 13). Finally, if the perceptual processing is triggered directly by higher-level mechanisms (not necessarily cognitive processes or beliefs or knowledge, but mechanisms that are higher up than early perceptual processing in the perceptual hierarchy, see Chapter 11 for details), we also get mental imagery (this is what happens when you close your eyes and visualize an apple).

One helpful metaphor used by neuroscientists is that of an "active blackboard" (Girard et al. 2001; Bullier 2001, 2004; Sterzer et al. 2006; Roelfsema and de Lange 2016). The general idea is that the early visual cortices (and especially V1) function as a blackboard. Various processes can write on this blackboard. Sensory—that is, retinal—stimulation automatically leaves traces on this blackboard, and does so in a retinotopic manner. To simplify a bit, what is on the retina is copied onto the blackboard.

When the retina is copied onto the blackboard, it is sensory stimulation-driven perception. When any other mental process draws on the blackboard, it is mental imagery. Some of these mental processes are determined by the sensory stimulation that shows up on other parts of the blackboard. Some are determined by perceptual processing in a different sense modality. And in some other cases the drawing is done by mechanisms further up in visual processing (Mechelli et al. 2004; Dentico et al. 2014).

This is a very helpful metaphor, but it should be added that this is only one aspect of what happens in visual cortical areas (see Chapter 5 for more nuances about the layers of the early visual cortices on this). Nonetheless, the psychological/neuroscientific definition of mental imagery as perceptual processing that is not directly triggered by sensory input can be understood as those processes that add to the already existing (retinally drawn) drawing on the blackboard of early cortical areas.

The question I will address in the next chapter is what this concept has to do with our everyday concept of mental imagery (if there is such a think).

2
Mental Imagery in Philosophy

The concept of mental imagery is not devoid of colorful connotations: it brings to mind imagination, little images, pictures appearing before the "mind's eyes," and so on. This is especially confusing as mental imagery is a technical term and, as we have seen, we should use it in a way that is maximally theoretically useful. Hence, in order to arrive at a workable conception of mental imagery, we should carefully remove these unwanted connotations of the concept—a task not entirely trivial, given that throughout the history of philosophy people have often used terms like "imagination," "visualizing," "seeing in the mind's eye," or "images" interchangeably.

It is not my aim here to give a comprehensive history of the concept of mental imagery in the history of philosophy—I'm sure this would be an interesting project, but it is not my project. It would be an interesting project because the technical term of mental imagery was not systematically used until the end of the nineteenth century, and throughout the history of philosophy people often used the term "imagination" to refer to what we now would describe as mental imagery. Thomas Hobbes, for example, talked about "retaining an image of the seen thing," which comes very close to at least a subcategory of the current use of mental imagery in psychology and neuroscience, but he referred to this mental phenomenon as imagination (Hobbes 1651, chapter 2). More generally, both the (British) empiricists and the (German) idealists used the term "imagination" at least sometimes in the sense that would be captured by the concept of mental imagery nowadays (see Yolton 1996 for a summary). If we want to understand the evolution of philosophical thinking about mental imagery, we would need to go through all the historical texts about imagination and separate out references to voluntary acts (imagination proper) from references to perceptual representations that are not triggered directly by sensory input (mental imagery). Again, this is not something I intend to do here.

Mental imagery has been surprisingly ostracized in the last few decades of philosophical thinking about the mind.[1] It is not clear why this is—maybe it

[1] There are, of course, important exceptions (Richardson 1969; Currie 1995a; Kind 2001). A less-obvious one is David Kaplan's use of "images" in his way of characterizing "vivid names," a crucial aspect of understanding propositional representation (see Kaplan 1968, esp. p. 411).

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is one of the side-effects of the "linguistic turn" of analytic philosophy. If we are trying to understand how the mind works by focusing on language, then mental imagery (a non-linguistic mental representation par excellence) is likely to fall by the wayside.

I want to focus on two approaches that were both highly influential and also particularly helpful for showing that the philosophical concept of mental imagery is not too far removed from the one I zeroed in on in Chapter 1.

Here is a famous and classic definition from more than half a century ago:

> Mental imagery refers to all those quasi-sensory or quasi-perceptual experiences [. . .] which exist for us in the absence of those stimulus conditions that are known to produce their genuine sensory or perceptual counterparts, and which may be expected to have different consequences from their sensory or perceptual counterparts. (Richardson 1969, pp. 2–3)

Although I'm not sure that what Richardson means by stimulus condition is the same as what I mean by sensory stimulation (the former seems to be a state and something external, the latter is an event and happens to our sense organ), it seems that the general gist of Richardson's definition is not that far away from the way psychologists and neuroscientists think about mental imagery—with one exception. Richardson talks about "quasi-sensory or quasi-perceptual experiences."

So mental imagery, according to Richardson, is by definition conscious (as experiences are supposed to be conscious mental states). And many other philosophers agree (see, for example, Thompson 2007). Here is Peter Kung's definition, which is just one example of what I take to be the standard way of characterizing mental imagery in philosophy: "a sight or 'picture' in your mind's eye, a sound in your mind's ear" (Kung 2010, p. 622). This way of thinking about mental imagery seems to imply that mental imagery is necessarily conscious.

In contrast, if we understand mental imagery the way it is used in psychology and neuroscience, there is no such restriction. If you have perceptual processing that is not directly triggered by sensory input, you have mental imagery, regardless of whether this perceptual processing is conscious. I will say (much) more on unconscious mental imagery in Chapter 4.

Further, it is notoriously unclear how one should interpret the phrase "quasi-perceptual" in this context. Gregory Currie's definition is a helpful development in this respect:

> Episodes of mental imagery are occasions on which the visual system is driven off-line, disconnected from its normal sensory inputs and experiential outputs. (Currie 1995a, p. 26)

Currie cashes out the "quasi-perceptual" nature of mental imagery in terms of a common mechanism: visual imagery and visual perception both use the visual system, but the latter does so "on-line," whereas the former does so "off-line." While "on-line" and "off-line" are metaphors, if we try to substantiate them, what we get is something very similar to the psychological/neuroscientific definition, as a straightforward way of understanding the difference between "on-line" and "off-line" perceptual processing is that the former, but not the latter is directly triggered by sensory input. As Currie says, this difference is whether the perceptual processing is "disconnected from its normal sensory inputs."

For Currie, mental imagery is the functioning of our visual system disconnected from its normal sensory inputs. For psychologists and neuroscientists, mental imagery is perceptual processing not directly triggered by sensory input. Substitute "disconnected from" for "not triggered by" and "normal" for "direct" and it may seem that we get almost the same definition.

On the other hand, Currie (1995a) makes it clear (although not in the definition I quoted above) that he takes mental imagery to be a kind of experience—that is, as something necessarily conscious, as does Richardson (and, as we have seen, also some other philosophers).

This emphasis on conscious mental imagery may remind one of the way the concept of mental imagery was used at the time when it was first introduced at the end of the nineteenth century. At that time, psychologists like Francis Galton, Wilhelm Wundt, or Edward Titchener (Galton 1880; Titchener 1909; Wundt 1912) thought of mental imagery as a mental phenomenon characterized by its phenomenology—a quasi-perceptual episode with a certain specific phenomenal feel. This stance led to serious suspicion, and often the outright rejection, of this concept in the following decades when behaviorism dominated the psychological discourse (Kulpe 1895; Ryle 1949; Dennett 1969). It was not until the 1970s that mental imagery was again considered to be a respectable concept to study in the empirical sciences of the mind—by cutting the ties with the conscious phenomenology of imagery. This opened the door to the possibility of unconscious mental imagery and, as we shall see in Chapter 4, we have strong empirical and conceptual reasons to maintain that mental imagery can indeed be unconscious.

Mental imagery is a psychological phenomenon. And, as is normally the case with psychological phenomena, introspecting is not a very reliable guide to them. As we have seen at the beginning of Chapter 1, it is tempting to take mental imagery to be something we all know about—all we need to do is close our eyes and visualize an apple and then introspect what is going on in "our mind's eye." And much of the philosophical research (and much early psychological research) on mental imagery followed this methodology.

I don't want to do that. I think closing our eyes and introspecting will give a very limited insight into what mental imagery is and how it works. So I want to move away from the introspective concept of mental imagery to the psychological concept of mental imagery, which would be something we can characterize in a way that does not rely on our introspection or our experience in general. And the definition that psychologists and neuroscientists use does exactly this: it refers to perceptual processing and sensory stimulation and the relation between the two.

I should add that when we move away from our introspective concept of mental imagery towards a psychological concept, we should not throw the original introspective concept out of the window. Introspection is often unreliable, but it is also what makes us care about the phenomenon in question (mental imagery in this case) to begin with. And all things considered, it would be preferable to have a psychological concept of mental imagery that is not in conflict with the introspective concept of mental imagery.

I defined mental imagery as perceptual representation not directly triggered by the sensory input. Some attractive features of this definition need to be pointed out. First of all, psychology and neuroscience have a lot to say about mental imagery. If we philosophers want to be able to communicate about these issues with empirical scientists, it is a good idea to use their terminology. Understanding mental imagery the way psychologists understand mental imagery can give us a lot of ammunition in our philosophical arguments about mental imagery—in fact, the aim of this book is to do just that.

Second, according to this definition, mental imagery does not have anything to do with looking at tiny pictures in our mind (an idea behaviorists, and especially Gilbert Ryle, were making fun of; see Ryle 1949, chapter 8). Mental imagery is not something we see: it is a certain kind of perceptual processing. So it is in no way more mysterious than other kinds of perceptual processing (like perception proper). Nor do we need to postulate any ontologically extravagant entities (like tiny pictures in our head) to talk about mental imagery any more than we need to postulate these entities in order to talk about perception.

Third, mental imagery is much richer than the sketch we would draw if we had to draw the image that we see in the mind's eye. One argument about the relation between mental imagery and imagination, which I will return to in Chapter 22, is about how different imaginative episodes may use the very same mental imagery. Here is one often-cited example (originally from Peacocke 1985, pp. 19–20; see also Kung 2010, esp. p. 626): Visualizing a suitcase and visualizing a cat hiding behind a suitcase brings up the very same mental imagery: that of a suitcase.[2] But what we imagine is very different. This is not a very helpful way of thinking about mental imagery, partly because there are enormous interpersonal variations about whether these two imaginative episodes in fact bring up the same conscious mental picture, and partly because it conflicts with what we know about the neuroscience of mental imagery. We have strong empirical reasons to think that the perceptual processing in the early visual cortical areas, when we visualize a suitcase and when we visualize a cat behind a suitcase, are very different (Kosslyn et al. 1995a; O'Craven and Kanwisher 2000). From the point of view of this definition of mental imagery, it is irrelevant that the philosopher conjures up the same image consciously. It gives us no reason whatsoever to conclude that the mental imagery is the same.

Finally, this way of thinking about mental imagery makes it possible to talk about the mental imagery of a subject without having to rely on her (notoriously unreliable) introspective reports. Suppose that I put you in an fMRI scanner and map out your early visual cortices. I then detect the direction-sensitive neurons firing in a triangle shape in your primary visual cortex, but your retina has nothing on it as your eyes are closed, or maybe there are just some parts of a triangle on your retina, as in the case of looking at the Kanizsa triangle (see Figure 1). In this case, I can conclude that you have mental imagery of a triangle. It does not matter what you are introspecting. This gives us a concept of mental imagery that picks out a publicly observable phenomenon. It is as scientifically solid a concept as it gets.

Nonetheless, and this is the fourth attractive feature of my definition, the psychological/neuroscientific definition of mental imagery is not completely unrelated to the philosophical (and introspective) one. As I will argue in the next chapter, it is continuous with, and could be considered to be a straightforward extension of, our everyday (and philosophical) conception of mental imagery. Just as the concept of time in the theory of special relativity is an extension of our everyday conception of time (in the sense that our everyday

[2] See Wiltsher (2016, pp. 267–8) for some dissent on this.

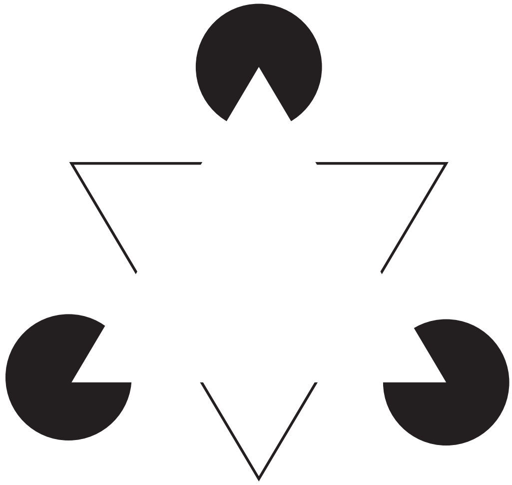

Figure 1 Kanizsa triangle

conception of time could be thought of as a special case of the concept of time in the theory of special relativity), the same is true of mental imagery: our everyday conception of mental imagery could be thought of as a special case of the concept of mental imagery outlined here.

3

Varieties of Mental Imagery

Let's go back to the example of closing your eyes and visualizing an apple. This is undoubtedly one way of exercising our mental imagery: one that many philosophers and non-philosophers consider the standard and stereotypical way of having mental imagery. But it is not at all representative, in at least six respects.

First, it is visual mental imagery. And vision is not the only sense modality. So if we can perceive auditorily, olfactorily, and so on, we can also have auditory, olfactory, tactile, etc. mental imagery. I call all these "mental imagery"—it should be clear that the word "imagery" does not here denote anything that has to do with pictures (which would usually be something visual): mental imagery exists in all sense modalities.

Second, when I ask you to visualize an apple, it is something you do voluntarily and intentionally. But mental imagery does not have to be voluntary (Pearson and Westbrook 2015). One can have flashbacks of some unpleasant scene—this is also mental imagery, but it is not voluntary mental imagery. And some of our mental imagery is of this involuntary 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. As Darwin says in *Descent of Man* (where it is clear from the context that he is talking about what I call mental imagery), "The *Imagination* [can] unite former images and ideas, independently of the will" (Darwin 1871, chapter 3).

Third, when you visualize an apple, you tend to do so in a detached nonactual visualized space: you close your eyes and visualize an apple in this nonactual space that has nothing to do with the space you occupy.[1] But this is not necessarily so. One can also visualize the apple in one's egocentric space, for example, in one's hand or next to one's laptop. Mental imagery can localize the imagined object in one's egocentric space or in some detached nonactual

[1] As Wittgenstein says, "what is imaged is not in the same space as what is seen" (*Zettel*, (Oxford: Blackwell, 1967, 628, see also Chomanski 2018 for a good discussion of the relation between perceived space and the space of mental imagery).

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space. In fact, having mental imagery of something in our egocentric space is not something unusual—we use mental imagery this way very often. When you are looking at your empty living room, thinking about what kind of furniture to buy, you're likely to try to form mental imagery of, say, a sofa not in a detached space "in the mind's eye," but in your living room. And when you're trying to figure out whether this sofa would fit through the main entrance, again, you are having mental imagery of the sofa in the very concrete space of the main entrance of your house (see Briscoe 2018 and many of the chapters in Kind and Kung 2016).

Fourth, 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 (Simons et al. 2017). In fact, lucid dreaming (extremely vivid dreams where we seem to be able to control the dream content), which is widely considered to be a form of mental imagery (see Hobbes 1655; Walton 1990 for a summary), is very much accompanied by the feeling of presence. And hallucination, which is, arguably, also a form of mental imagery, is also clearly accompanied by the feeling of presence (see Nanay 2016a for more discussion of hallucination as mental imagery).

The fifth distinction is about how mental imagery is triggered. As we have seen in Chapter 1, our definition of mental imagery was a negative one: perceptual processing that is not directly triggered by sensory input. This definition tells us what perceptual processing that constitutes mental imagery is not triggered by, but it is silent about what it is triggered by.

When you close your eyes and visualize an apple, this is top-down triggered mental imagery. The imagery is triggered by higher-order mental states. No bottom-up trigger (as your eyes are closed) and no lateral trigger either (assuming that you have sound canceling earphones on and you get no other sensory stimulation from other sense modalities either).

But this is not the only way in which mental imagery can be triggered. It can also be triggered by the sensory input in the very same sense modality—as long as this sensory input triggers the perceptual processing indirectly. I will argue in Chapter 8 that this is exactly what happens in many familiar cases of amodal completion: visual mental imagery is triggered by retinal sensory stimulation around the amodally completed region, which means that perceptual processing in this amodally completed region is not directly triggered by the retinal sensory input.

Finally, mental imagery can also be triggered laterally, by perceptual processing in another sense modality. For example, visual mental imagery can be triggered in the absence of any visual sensory stimulation and also in the absence of any top-down influences by auditory perceptual processing. I will go through a number of examples of laterally triggered multimodal mental imagery in Chapter 13.

I made five distinctions within the category of mental imagery: (a) visual versus auditory versus olfactory versus gustatory, etc. (b) voluntary versus involuntary, (c) egocentric space versus non-egocentric space, (d) feeling of presence or no feeling of presence and (e) top-down versus lateral. We can add more distinctions that will be important in the discussion to follow, for example one between determinate and determinable imagery (as mental imagery is very often not at all determinate, see Chapter 10). But there is yet another distinction, which is much more controversial than the ones I have discussed in this chapter. It is between conscious and unconscious mental imagery and I will spend the entirety of Chapter 4 giving empirical arguments in favor of unconscious mental imagery. I will get into these debates soon. But for the purposes of this chapter, I will assume a much weaker and completely uncontroversial claim only, namely, that mental imagery may be more or less vivid (Kind 2017).

There is a recent body of research on subjects who report not having any conscious mental imagery whatsoever. This condition is called aphantasia (Zeman et al. 2007, 2010, 2015; Dawes 2020; Blomkvist forthcoming). A surprisingly large proportion of the population (according to some measures 5–8 percent) have this condition: they lack conscious mental imagery: when they close their eyes and try to visualize an apple, no image is conjured up (aphantasia is identified in terms of self-report—as we shall see in Chapter 4, it covers a diverse set of underlying phenomena).

Aphantasia is one end of the spectrum. On the other end of the spectrum we find people with extremely vivid imagery experiences—a condition often called hyperphantasia. Most of us are somewhere in between. And we know a fair amount about the neuroscience of what the vividness and precision of mental imagery depend on. There is a linear correlation between the vividness of mental imagery and some straightforward (and very easily measurable) physiological features of the subject's brain (such as the size of the subject's primary visual cortex and the relation between early cortical activities and the activities in the entire brain; see Cui et al. 2007; Bergmann et al. 2016).

But these findings about aphantasia and hyperphantasia and the interpersonal variations in the vividness of mental imagery should also give us some reasons to be suspicious about any kind of reliance on phenomenology and introspection when thinking about mental imagery (see also Kozhevnikov et al. 2009 for some evidence on cross-cultural variations in the vividness of mental imagery).

The interpersonal variations in imaginative phenomenology—the extreme case of which is demonstrated in the aphantasia research—highlight just how unlikely it is that anyone, even the most astute observer possible, could read off a plausible account of mental imagery from their own experiences as these experiences are very different from the experiences of many others.

The same goes for other philosophical debates where mental imagery plays a role, like the cognitive phenomenology debate (Pitt 2004). According to the proponents of cognitive phenomenology, some conscious non-perceptual states have distinctive phenomenal character in the sense that it is "different from what it is like to be in any other sort of conscious mental state" (Pitt 2004, p. 4). So the phenomenal feel that accompanies my belief is different in kind from the phenomenal feel that accompanies my perceptual states. Others argue that cognitive phenomenology is not distinctive—it really just derives from the phenomenology of quasi-perceptual states like mental imagery (both visual and auditory, see, for example, Carruthers 2005, esp. pp. 138–9).

Many (not all) arguments on both sides are firmly grounded in introspection: when you have a belief and you introspect, what kind of mental imagery (if any) is conjured up? If we take the interpersonal variations in terms of the vividness of mental imagery seriously, then this philosophical debate may not be as theoretically interesting as it may sound. People with less-vivid mental imagery will be likely to come down on the distinctive cognitive phenomenology side as they will not be able to discern (sensory) mental imagery when they introspect their non-perceptual mental states and these people will not be drawn to explain the non-perceptual phenomenology in terms of the phenomenology of this sensory mental imagery. But others, with more vivid mental imagery, would be more likely to give an explanation of this kind.[2]

The method of just introspecting and coming up with a philosophical account of mental imagery (and of other mental phenomena) has had a good run in the history of philosophy. But given the interpersonal variations in the phenomenology of mental imagery (and in fact, of all kinds of other mental phenomena), it is just not a very promising option.

[2] It needs to be noted that this debate is in fact even more complex, as some of those who are skeptical of the idea of cognitive phenomenology would deny that occurrent beliefs have any phenomenology at all (not just that their phenomenology is distinct from perceptual phenomenology). I am not sure that the vividness of mental imagery has a lot to do with this aspect of the debate (but see Lennon forthcoming on the potential relevance of the apahantasia research here).

There is no carefully controlled psychological research about how philosophers' intuitions on cognitive phenomenology vary as a result of the vividness of their mental imagery. But there is carefully controlled psychological research about how psychologists' (and philosophers') intuitions vary as a result of the vividness of their mental imagery when it comes to the so-called Imagery Debate of the 1980s (the debate about whether the format of mental imagery is imagistic or propositional; see Kosslyn 1980; Pylyshyn 1981; Tye 1991; see also Chapters 6 and 18). A fairly large study showed that the vividness of imagery has significant impact on theoretical commitments in this debate (Reisberg et al. 2003). Researchers with less-vivid mental imagery were more likely to take the propositional side and those with more vivid mental imagery tended to come down on the imagistic side.

Note that these considerations about the limits of introspection when it comes to mental imagery and imaginative phenomena in general are very different from the familiar line in the empirical sciences (and in philosophy of mind) about the unreliability of introspection in general (see Schwitzgebel 2008; Spener and Bayne 2010). Even if we take introspection to be fully reliable, what we are introspecting in the case of mental imagery is very different in the case of different individuals. Someone closer to the aphantasia end of the spectrum and someone closer to the hyperphantasia end of the spectrum will (reliably) introspect something very different.

These arguments are complimented nicely by Ian Phillips's (empirically based but philosophical) argument that the reason why there is a significant variation in people's reports on their use of imagery is not that some of them use imagery and others don't but that the imagery of some people tends to be conscious and the imagery of some others tends to be unconscious (Phillips 2014; but see also Schwitzgebel 2002 and Chapter 4 for more on unconscious mental imagery).

I want to go back to the many distinctions within the category of mental imagery and the great variety of mental imagery that these distinctions provide us with (I'll set aside the one about the feeling of presence for now). These distinctions are orthogonal to one another, so we get a lot of internal distinctions within this category. Mental imagery can be voluntary and vivid, that localizes its object in a non-egocentric space. Visualizing an apple is of this kind. But it can also be involuntary and not at all vivid (or maybe even unconscious), that localizes its object in an egocentric space (which would be the polar opposite of the kind of mental imagery that we have when we close our eyes and visualize the apple). This latter kind of imagery is what will play a crucial role in the next chapters.

One way of seeing the relation between the concept of mental imagery I use and the introspective concept is that we get the former from the latter by lifting some irrelevant restrictions—exactly those restrictions discussed in this chapter. So if we lift the restriction of voluntariness, no egocentricity and no feeling of presence (and consciousness), we end up with the psychological/neuroscientific concept of mental imagery.

Finally, it is very important to emphasize that my aim here is not to capture what the general public means by mental imagery. I do not want to give an ordinary language analysis of the term "mental imagery." Even fans of ordinary language analysis (I am not among them) should have strong reason not to do so, as "mental imagery" is not an ordinary language term. In fact, none of the languages I am familiar with, other than English, has a term that would mean mental imagery (as distinct from "imagination" or "mental picture"). The term "mental imagery" is a technical term. I don't think there are any pre-theoretical considerations that should persuade us to use the term one way or another. As a result, we should use it in a way that is theoretically fruitful. My aim was to show that using it in a way that is consistent with psychological/neuroscientific consensus is the most theoretically fruitful use of the term.

Having said this, if you, the reader, mean something very different by mental imagery, this is not a reason to stop reading this book. My aim is to show that a certain mental phenomenon, namely the perceptual representations that are not directly triggered by sensory input, would play an important role in a variety of mental processes. I call these perceptual representations mental imagery.

But if you don't want to, call it something else. Call it mental imagery*. Or maybe off-line perception. Or phantom perception. Or use some other label. This book is not about how best to label such perceptual processes. It is about these perceptual processes, which I happen to label mental imagery.

4
Unconscious Mental Imagery

There are three kinds of reasons to think that mental imagery may be conscious or unconscious: conceptual, methodological, and empirical reasons.

First, the conceptual reason. Perception can be conscious or unconscious. If the stimulus is masked or presented for a very short period of time, the subject still perceives it, but has no conscious experience of it (Kentridge et al. 1999; Goodale and Milner 2004; Kouider and Dehaene 2007; Weiskrantz 2009; there is some dissent on this, see below). But if perception per se can be unconscious, it would be completely ad hoc to postulate that mental imagery can't be. Remember that mental imagery is a form of perceptual processing: perceptual processing that is not directly triggered by sensory input. If perceptual processing that *is* directly triggered by sensory input can be unconscious, it is difficult to see why perceptual processing that is *not* directly triggered by sensory input (that is, mental imagery) would have to be conscious.

The second reason is methodological. Most behavioral or neuroimaging experiments on mental imagery—including the most famous ones—often don't actually take the conscious experience of the subject into consideration. Take, for example, the famous mental rotation tasks, one of the most widely used paradigms in the study of mental imagery. There is a linear correspondence between the time required for deciding whether two three-dimensional shapes are the same and the degree of rotation between these two shapes (Shepard and Metzler 1971). Your task is to decide whether two complex three-dimensional shapes are the same. And you are quicker to respond (with a yes or no answer) if the two shapes are oriented in such a way that less mental rotation is required between them.

Whatever these experiments say about mental imagery (and we can stay away from this question), it must be a claim that is silent about whether mental imagery is conscious. These experiments are response time experiments and the reasons for inferring the exercise of mental imagery are not introspective ones, but come from the timing of the subjects' responses, for which they did not have to be conscious of any kind of mental imagery (although they obviously needed to be conscious of the task they were performing). The

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mental imagery involved in this task may or may not be conscious. Therefore, the concept of mental imagery that mental rotation experiments are concerned with shouldn't (and can't) have consciousness as a built-in feature.[1]

The third reason is empirical: positing unconscious mental imagery can explain a number of empirical findings better than not positing unconscious mental imagery. I will give two arguments for this claim.

The first one takes influential paradigms for studying unconscious perception and modifies them in such a way that they are applicable to unconscious mental imagery. I will focus on priming studies and argue that we can use the same experimental paradigm to show that not only perception, but also mental imagery can be unconscious.[2]

Some have recently expressed general doubt concerning the standards for when we can be absolutely certain that perception is unconscious (see Block and Philips 2017 for a summary). These skeptics would not go along with the claim that perception can be unconscious. These worries would be inherited by my arguments. If the skeptics were right (I don't think they are) that the priming studies fail to establish that perception can be unconscious, then my arguments wouldn't establish that mental imagery can be unconscious either. My second empirical argument from aphantasia is not susceptible to these worries.

The first argument for unconscious mental imagery is from priming studies. An important set of findings that shows that perception can be unconscious involves unconscious priming: the subject's behavior is altered by the unconsciously presented stimulus. The general structure of the argument here is that we can infer that the subject perceived something unconsciously if (a) the subject has no conscious awareness of the stimulus presented perceptually to her and (b) this unconscious presentation of the stimulus primes her (often in very similar ways as conscious presentation of the stimulus does).

There is a large number of findings that follow this general pattern when it comes to showing that perception can be unconscious (Kentridge et al. 1999; Goodale and Milner 2004; Kouider and Dehaene 2007; Weiskrantz 2009). But the same general argument could be modified to show that mental

[1] There are, of course, experiments that do consider the subjects' conscious experience, but the aim even in these experiments is to find correlations between conscious experience and publicly observable features of the subjects' behavior (see, for example, Cui et al. 2007; Dijkstra et al. 2017a).

[2] There are additional important and influential considerations for unconscious perception, from unilateral neglect and from dorsal vision, both of which could be modified to show that there is unconscious mental imagery. I will not talk about these considerations here, but will instead focus on what I take to be stronger arguments for unconscious mental imagery (see Nanay 2021a for how the argument from unilateral neglect and the argument from dorsal vision would go).

imagery can be unconscious. In this case, we could infer that the subject had unconscious mental imagery if (a) the subject has no conscious awareness of her mental imagery, and (b) this unconscious mental imagery primes her in the same way conscious mental imagery does.

We have seen the general complications with (a) three paragraphs ago. But in the case of unconscious mental imagery, (b) is also more complicated than it looks. In the case of unconscious perceptual priming, as long as the subject's behavior is altered by the unconsciously presented stimulus the same way as it is altered by consciously seeing the stimulus, we can conclude that it was her unconscious perception that primed her behavior. But in the case of mental imagery, it is much more difficult to find behavior that would be primed by mental imagery, let alone unconscious mental imagery.

Here is one experiment that could provide all the ingredients for the kind of argument I outlined above (Kwok et al. 2019). It is a binocular rivalry experiment. In the case of binocular rivalry, when different images are presented to each eye, our visual experience alternates between these two images. If an image of a cat is presented to the left eye and an image of a dog to the right eye, your experience is not a composite of the two, but rather a quick switching back and forth between a cat and a dog.

Short-term exposure to stimuli immediately before the binocular rivalry task influences the pattern of these alternating experiences (as long as the stimuli are not too strong, which leads to suppression, see Brascamp et al. 2007). Suppose that an image of red vertical lines is presented to the right eye and an image of green horizontal lines is presented to the left eye. If you have been staring at the red wall before this task, your right eye (where red vertical lines are presented) is more likely to win out in the binocular rivalry—more than 50 percent of the time, you will experience the red vertical lines and not the green horizontal ones during the binocular rivalry task.

A relatively new set of findings shows that conscious mental imagery influences the patterns of these alternating experiences in much the same way as conscious perception does (Pearson et al. 2008, 2011; Keogh and Pearson 2011). Again, suppose that an image of red vertical lines is presented to the right eye and an image of green horizontal lines is presented to the left eye. If you visualized a red apple before the binocular rivalry phase, your right eye (where red vertical lines are presented) is more likely to win out in the binocular rivalry.

So conscious mental imagery has an impact on the binocular rivalry pattern. The question is whether unconscious mental imagery has a similar impact. Consider the following experiment (Kwok et al. 2019). Subjects were shown a two-word description of an object on the screen for 3 seconds, which included either the word "red" or the word "green" ("red apple," "red chili," "green apple," etc.). After this, they were instructed either to imagine or to avoid imagining the described object (say, the red apple). In the "avoid imagining" condition, if the subject did in fact, in spite of the instructions, imagine a red apple (or anything red), they had to push a button indicating this.

After this priming phase, the subjects did the classic binocular rivalry task, with a red stimulus presented to one of the eyes and green to the other and the subjects had to report which color was dominant. A number of control conditions were added, the most important of which was identical to the "avoid imagining" condition, with the exception that during the 7 seconds when the subject was supposed to avoid imagining, a highly luminous (neither green nor red but neutral yellow) stimulus was presented in the subject's visual field (Figure 2).

The experimenters found that subjects' binocular rivalry pattern was primed just as much in the "avoiding imagining" condition as in the "imagining"

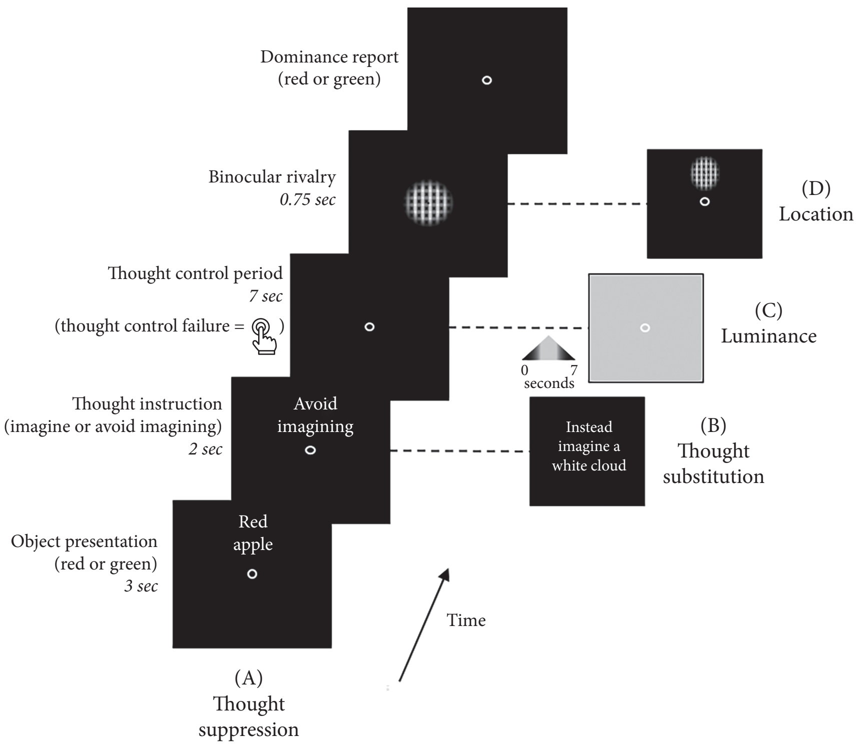

Figure 2 From Kwok et al. (2019)

condition. When the subjects imagined a red apple for 7 seconds, the red experience won out systematically in their subsequent binocular rivalry task. No surprise here. What is more surprising is that even when the subjects were avoiding imagining a red apple (and, again, ruling out those cases when they failed to avoid this) for 7 seconds, the red experience still won out systematically in their subsequent binocular rivalry task.

This result in itself does not rule out the possibility that what primed the binocular rivalry pattern was not unconscious mental imagery, but rather some sort of higher-level representation—maybe the linguistic representation presented on the screen ("red apple") or some other cognitive strategy (see Pearson and Keogh 2019 on the diversity of cognitive strategies in visual working memory tasks, for example). In order to rule out this possibility, the experimenters added the control condition where during the 7-second "avoid imagining" phase, the subjects were presented with a highly luminous (neither green nor red but neutral yellow) stimulus, which flushes out the early visual cortices, interfering with mental imagery (see Sherwood and Pearson 2010). If the priming were really due to non-sensory (say, linguistic) processes, then this should not make a difference. But it did. In the luminance condition, avoiding imagining failed to produce the same priming effect as avoiding imagining without the luminance manipulation did (or as straight imagining did).

These results strongly indicate that it is unconscious mental imagery that primes the binocular rivalry pattern. Remember that subjects had to indicate if their attempt to avoid imagining a red apple broke down. So we know that those subjects whose attempt to avoid imagining a red apple did not break down had no awareness of any red mental imagery during the 7-second period. This unconscious episode nonetheless produced the same priming effect as the conscious one did. Finally, we know that this unconscious episode was in fact unconscious mental imagery (and not some kind of unconscious higher-level (maybe linguistic) representation) given that sensory presentation of an irrelevant sensory stimulus interfered with the priming effect.

The authors of this study did not explicitly draw the conclusion that the experiment demonstrates the presence of unconscious mental imagery, but at least one of the authors of the study would be open to this interpretation (see Pearson 2019; Koenig-Robert and Pearson 2020; but see also Koenig-Robert and Pearson 2019).

The second argument for unconscious mental imagery is from aphantasia. My previous arguments for unconscious mental imagery piggybacked on argumentative strategies about unconscious perception. Skeptics about unconscious perception in general would be equally skeptical about these arguments. The argument I will give here does not rely on any arguments about unconscious perception. It is about aphantasics: people with aphantasia.

As we have seen in Chapter 3, aphantasia subjects report not having any conscious mental imagery (Zeman et al. 2007, 2010, 2015). While it would, of course, be possible to argue that subjects with aphantasia are not *really* unaware of their mental imagery, this may be a more difficult (in any case, different) move than arguing against unconscious priming or unconscious perception in unilateral neglect. So this line of argument may convince some of the skeptics who are not convinced by any arguments concerning unconscious perception.

A subject has aphantasia when she reports not having mental imagery—this is a behavioral criterion. And, as a result, aphantasia may have a number of diverse underlying conditions. Some subjects with aphantasia have difficulties voluntarily conjuring up mental imagery, but they do report mental imagery when dreaming, for example. Some others report no mental imagery at all—either voluntary or involuntary.

In other words, aphantasia is not a monolithic category. Some aphantasics have visual flashbacks and dream vivid dreams, clearly involving conscious visual imagery (Zeman et al. 2020). But they have problems with the voluntary control of conscious visual imagery. Others have no conscious visual imagery at all. My claim is that, at least in some cases of aphantasia, we can explain the behavior of the subjects better if we postulate that they have unconscious mental imagery. At least some aphantasics do have mental imagery, but they do not have conscious mental imagery.

One experiment (Jacobs et al. 2017) that very much supports my claim has a very small sample size: one. This one subject, AI (not actual initials) is a 31-year-old female PhD student, who scored 16 points on the Vividness of Visual Imagery Questionnaire (that is the lowest possible score—the average score of the control group was 61.1 points). She reports not having any mental imagery whatsoever.

The experimental design is the following (Figure 3): the subject first sees the name of a geometric shape (for example, "triangle" or "diamond") for 500 milliseconds. Then she either sees the geometric shape in question framed by four placeholders for 1500 milliseconds or is instructed to imagine this geometric shape within the four perceived placeholders. In the latter condition, only the four placeholders are shown—four dots indicating the corners of the square within which the geometric shape is to be imagined. This is followed

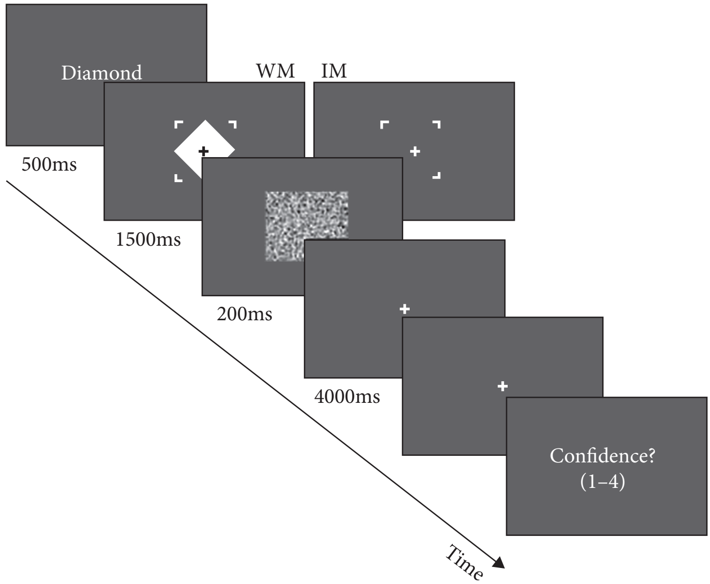

Figure 3 From Jacobs et al. (2017)

by 200 milliseconds of a random noise stimulus to mask the potential afterimages.

After 4 seconds of delay, a random dot is presented, and the subject has to decide whether it is within or without the boundaries of the perceived/imagined geometrical shape. This is followed by a confidence rating of this judgment. The only difference between the first (working memory) condition and the second (mental imagery) condition is that in the latter, the geometrical shape is not seen, but merely imagined within the region indicated by the four placeholders.

The striking finding is that the performance of AI, a subject with aphantasia, was not significantly different from controls on either of these tasks. Controls performed with a 90 percent success rate on the working memory task and with an 89 percent success rate on the mental imagery task. AI performed just around 3 percent worse than the controls, which is a statistically insignificant difference. Her confidence ratings were also very similar to those of the control subjects (and generally quite high, between 3 and 4 on a 1–4 scale). The authors' conclusion is that the subject's aphantasia did not have a statistically significant effect on the performance of either of these tasks.

Let's set the working memory task aside. How could we explain the finding that an aphantasic subject's performance on the mental imagery task is not significantly worse than the controls' performance? The straightforward explanation is that the subject does use mental imagery and uses it in a very similar way to the control subjects when performing the mental imagery task. But while the controls use conscious mental imagery, the subject uses unconscious mental imagery.

So far, evidence seems to support the claim that at least some subjects with aphantasia have unconscious mental imagery. But another experimental finding, on the face of it, seems to go against the existence of unconscious mental imagery among aphantasics. This experiment (Keogh and Pearson 2018), like the experiment I discussed above, also uses the binocular rivalry paradigm. Again, we know that conscious mental imagery influences the patterns of binocular rivalry. The question is, how does this process unfold among aphantasics?

Participants were first taught that upon the presentation of the letter G, they are supposed to imagine green vertical lines and upon the presentation of the letter R, they should imagine red horizontal lines. During the experiment, they were shown one of these letters, which cued them to imagine either red horizontal or green vertical lines for 6 seconds. After this, they rated how vivid their imagery of the lines was. Finally, this was followed by the binocular rivalry task with red horizontal lines presented to one eye and green vertical lines presented to the other (see Figure 4).

There was no statistically significant effect of the imagining task on the binocular rivalry performance of subjects with aphantasia. While imagining red lines in the case of control subjects led to the dominance of the red lines in the binocular rivalry, in the case of subjects with aphantasia, this effect was missing.

There was another difference between aphantasics and control subjects. In control subjects, the priming effect was significantly weakened, when, during

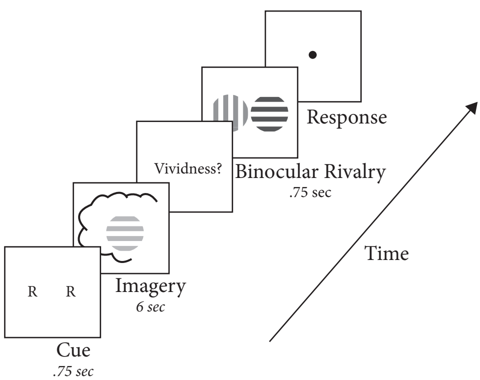

Figure 4 From Keogh and Pearson (2018)

the imagery phase, a luminous (neither red, nor green, but neutral yellow) stimulus was shown. But in aphantasics, the luminous stimulus made no difference (it also made no difference to the invariably low ratings of the vividness of their mental imagery).

On the face of it, these findings may seem to show that aphantasics do not have any imagery, conscious or unconscious. If they had unconscious mental imagery, it would have primed the binocular rivalry performance. But it didn't. One could object that, as aphantasia is not a monolithic phenomenon, it is not to be assumed that all aphantasics have unconscious mental imagery, so maybe the subjects in this study don't. However, given that there were fifteen subjects, all of whom showed the same response pattern, this is not a very satisfying response.

At this point, it is helpful, however, to compare these results to the Kwok et al. (2019) results I discussed above (which was conducted by the same group of researchers). I used the Kwok et al. (2019) study to show that unconscious mental imagery primes the binocular rivalry performance. So if, as I argued above, at least some aphantasics have unconscious mental imagery, their unconscious mental imagery should also prime the binocular rivalry performance. But, as the Keogh and Pearson (2018) experiment shows, this is not the case.

In response to this objection, a crucial difference between the two experimental setups needs to be pointed out. The mental imagery that was supposed to be triggered in the Keogh and Pearson (2018) experiment is voluntary mental imagery. The subjects are asked to visualize a certain stimulus, they count to three and they voluntarily try to conjure up the mental imagery. In the Kwok et al. (2019) study, in contrast, the unconscious mental imagery is involuntarily triggered. In fact, the subjects are trying not to have any imagery—they voluntarily suppress any conscious mental imagery.

So the only conclusion we can draw from the Keogh and Pearson (2018) experiment concerning the mental imagery of subjects with aphantasia is that their *voluntary* mental imagery does not prime their binocular rivalry performance. This says nothing about the possibility that involuntary unconscious mental imagery (in aphantasics or control subjects) would or could prime binocular rivalry performance. And, as the Kwok et al. (2019) study shows, involuntary unconscious mental imagery, at least in non-aphantasic subjects, does prime binocular rivalry performance—so nothing excludes the possibility that it does so also in subjects with aphantasia.

A lot more experimental studies could and should be done on subjects with aphantasia that could convince us conclusively that at least some aphantasics do have unconscious mental imagery. Very few neuroimaging studies have been done on aphantasics. And given the non-monolithic nature of aphantasia, we should expect a variety of different results here. But the hypothesis that some subjects with aphantasia have unconscious mental imagery could be very easily confirmed.

The studies I have focused on show that unconscious mental imagery in aphantasics and conscious mental imagery in control subjects have the same behavioral profile when performing a certain task (see also Pounder et al. 2022). But do they have the same neural profile? What do the visual cortices of the subject AI do in the Kwok et al. (2019) experiment? Given that we can decode the contents of visual imagery from the activation of V1 and V2 (see, for example, Naselaris et al. 2015), it would be relatively easy to check whether AI in fact had a retinotopic representation of a diamond or a triangle in V1 and V2. If so, then it would be very difficult to argue that she does not have unconscious mental imagery.

I argued in this chapter that mental imagery may be, and often is, unconscious. Just as mental imagery can be voluntary or involuntary, it can also be conscious or unconscious. Unconscious mental imagery will play an important role throughout the book.

5

The Unity of Mental Imagery

The way of thinking about mental imagery that I have outlined in the last few chapters lands us with a very wide category that would encompass a lot of very different mental phenomena. Some may think it is a bad thing. I believe that this is in fact an attractive feature of my way of thinking about mental imagery—it gives us a very high-level category of mental imagery, which we can then divide up (along the lines of the distinctions I enumerated in Chapter 3, among others) into useful subcategories.

But the broader category of mental imagery is useful because it gives us more explanatory unification than would other, more fragmented, concepts of mental imagery, as I will argue in the following chapters. Explanatory unification is a theoretical virtue of scientific (and also philosophical) theories (Kitcher 1981). The more diverse sets of findings a theory can explain the more unified it is. My claim is that considering mental imagery to be perceptual processing that is not directly triggered by sensory input gives us a highly unified theory of various mental phenomena in this sense.

In fact, all the following mental phenomena would count as mental imagery according to this definition (some not obviously so):

(a) *"Filling in" the blind spot*: A part of the retina—the blind spot—cannot be stimulated—there are no receptors there. If the light hits this part of the retina it gives rise to no perceptual processing. So we receive no sensory information from that region of the retina. Nonetheless, our perceptual system "fills in" the sensory input of the blind spot on the basis of the sensory input of the surrounding parts of the retina. The perceptual processing of information at the blind spot region of the visual field happens already in early visual cortices (Ramachandran 1992; Fiorani et al. 1992; Komatsu et al. 2000; Awater et al. 2005; Spillman et al. 2006), but it is not directly triggered by sensory input because there is no sensory input at the blind spot.[1]

[1] One may object: hasn't Daniel Dennett's repeated skepticism about "filling-in" the blind spot (for example, Dennett 1991, p. 335ff) demonstrated that this story is incorrect? I don't think so. First, there

Mental Imagery: Philosophy, Psychology, Neuroscience. Bence Nanay, Oxford University Press. © Bence Nanay 2023.
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(b) *Peripheral vision*: Peripheral regions of the retina are much less sensitive than focal ones. And this focal preference is even stronger in early cortical processing. As a result, the represented properties in the peripheral regions of the visual field that our perceptual system processes are much less determinate than the properties of the focal regions. This asymmetry is especially striking when it comes to color vision as there are very few retinal cells in the periphery that are sensitive to color information (Hansen et al. 2009). But the same is true of all other perceptually processed properties, like size or shape. Peripheral vision can also "fill in" some regions of the periphery. "Artificial scotoma" is a region of the visual field where different sensory stimulation is induced from what surrounds it (and this can be no sensory stimulation surrounded by a pattern—for example, a small patch of white in the middle of random visual noise). If this is presented in the periphery, the visual system fills in the scotoma, making it blend in. This filling in process starts very early in visual processing (Ramachandran and Gregory 1991; De Weerd et al. 1995, 1998, 2006; Welchman and Harris 2001; Weil et al. 2007, 2008; Troncoso et al. 2008). Again, the perceptual processing (of the pattern of random visual noise) is not directly triggered by the sensory stimulation at the artificial scotoma (because there is no input at all). This is perceptual processing not directly triggered by sensory input, hence, an instance of mental imagery.

(c) *Amodal completion*: Amodal completion is the representation of those parts of the perceived object from which we get no sensory stimulation. 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

is plenty of empirical evidence that the early cortices do actively "fill-in" the missing part of the visual scene (see, for example, Churchland and Ramachandran 1993; Komatsu et al. 2000; see also Akins and Winger 1996 for a very good overview of this debate). Second, I'm not even sure that Dennett would disagree with anything I say here—his concern in Dennett (1991) was about phenomenology—whether there is conscious filling in. And I'm certainly not arguing that there is. My claim is that there is cortical filling in. The imagery involved in the filling in of the blind spot is almost always unconscious imagery. Finally, Dennett's positive "ignoring" account could also be thought of as a version of my own view, according to which the mental imagery used for "filling in" the blind spot attributes very determinable properties only—this mental imagery is remarkably unspecific. If we frame the debate between the "filling in" account and Dennett's account, the disagreement may turn out to be about the specificity (or determinacy) of the properties attributed to the blind spot. I will say more about the determinacy of mental imagery in Chapter 10.

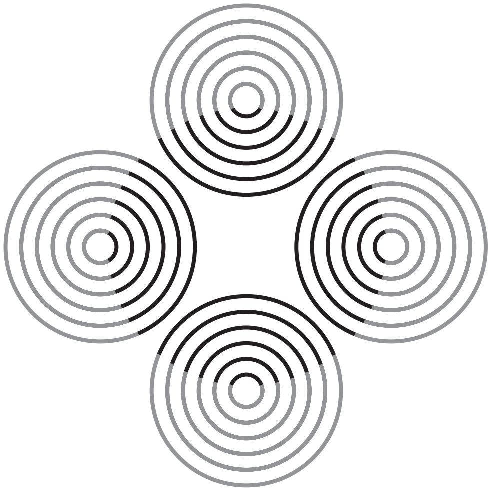

Figure 5 Color spreading illusion

example. We complete those parts amodally.[2] Amodal completion is, as I will argue in Chapter 8, perceptual processing that is not directly triggered by sensory input. It is a form of mental imagery.

(d) *Various optical illusions*: Many (but certainly not all) optical illusions depend on perceptual processes that are not directly triggered by sensory input. One example is the color spreading illusion: this is an optical illusion where we see a grid against a white background and some parts of the grid are colored dark gray, while the rest of the grid is lighter gray (see Figure 5).

When seen from the right distance, those regions of the white background that are surrounded by a darker gray grid are perceived as (very light) gray. Again, these illusory contours are not directly triggered by sensory input. We get monochrome white regions on the retina, but there is processing already in the early visual cortices and this leads to the experience of gray (Watanabe and Sato 1989)—thus the optical illusion. Other optical illusions that depend on perceptual processes not triggered directly by sensory input include the McCollough effect (where the sensory stimulation is in black and white, but the early cortical processing as well as the visual experience is of color), the flickering screen illusion (again, sensory stimulation is black and white, whereas the early cortical processing as well as the visual experience is

[2] Note that the term "amodal" is a bit of a misnomer here: amodal completion in the visual sense modality by any account happens visually.

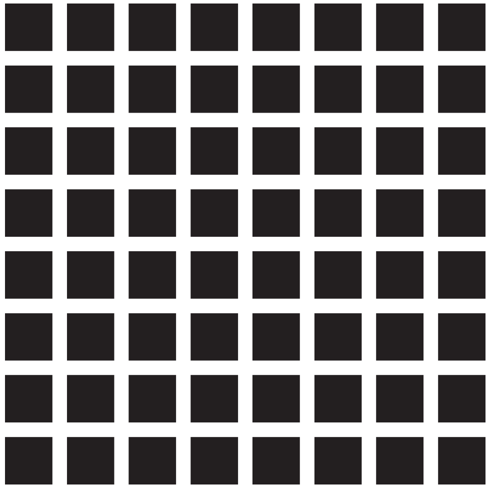

Figure 6 Hermann grid illusion

of various color patterns) and the phantom motion illusion (where the sensory stimulation is motionless, but the cortical processing as well as the visual experience is of motion) (see, for example, Vul et al. 2008; Allefeld et al. 2011; and see Grossberg and Mignolla 1985 for a general overview). It is important that this analysis does not apply to all optical illusions. Refractionary optical illusions, like seeing the straw in a glass of water as broken, have nothing to do with mental imagery—whatever is responsible for the illusion happens before the light hits the retina. Retinal illusions, like the Hermann grid (Figure 6) don't count as mental imagery either—what goes astray here happens during retinal processing, and early perceptual processing is directly triggered by this (already nonveridical) sensory input. But in the case of some illusions, things go astray between the sensory stimulation and early perceptual processing—these are cases of mental imagery.

(e) *Hallucination*: Most (albeit not all) instances of hallucinations would count as mental imagery according to the definition of mental imagery I used (and also according to the definitions of hallucinations used in the psychiatry literature; see Allen 2015 and Nanay 2016a for summaries): it is perceptual processing that is not directly triggered by sensory input. Here is the official medical definition from the *American Psychological Association's Dictionary of Psychology*: "a false sensory perception that has the compelling sense of reality despite the absence of an external stimulus" (VandenBos 2007, p. 427). If we think of hallucination in this way, it very clearly falls under the definitions of mental imagery in psychology that I considered above (Shepard 1978; Kosslyn et al. 1995a; Pearson et al. 2015). Hallucination very much qualifies as "'seeing' in the absence of the appropriate immediate sensory input" (as Kosslyn et al. 1995a would say). And it is also a representation 'of sensory information without a direct external stimulus' (as Pearson et al. 2015 would say).[3] And it also fits my own definition: it is perceptual processing that is not directly triggered by sensory input (see David 2004, p. 108; see also Aleman and de Haan 1998, p. 657 for very similar definitions; and the first chapter of Aleman and Laroi 2008 for a good overview on defining hallucination). Crucially, while hallucinations form a very diverse set of mental phenomena, the early sensory cortices are activated in the vast majority of them (see Kompus et al. 2011 for a meta-analysis and Allen et al. 2008 for a summary; see also Henkin et al. 2000 for some neuroimaging findings on hallucination in less-researched sense modalities of olfaction and taste).[4] But it is mental imagery that is conscious, involuntary, localizes egocentrically, and that is accompanied by the feeling of presence.

(f) *Dreaming*: Dreaming is widely held to be one particular form of mental imagery (Hobbes 1655; Walton 1990). And it counts as mental imagery according to my definition as well: it is perceptual processing that is not directly triggered by sensory input. We have already seen that an example of mental imagery that is accompanied by the feeling of presence is lucid dreaming. But non-lucid dreaming would also count as mental imagery according to my definition—where mental imagery may or may not be accompanied by the feeling of presence (there seem to be a lot of individual differences in this respect). It is also important that dreaming involves early cortical processing, so much so that we can reconstruct dreamed objects and scenes just from the activation of the cortical regions V1–V4 (Horikawa and Kamitani

[3] The minority that considers hallucination to be different from mental imagery (see Ffytche 2008) very clearly means something completely different by mental imagery from the psychological consensus. More precisely, Ffytche (2008) takes mental imagery to be necessarily voluntary and we have seen that this is a highly problematic and unmotivated assumption.

[4] What may constitute an exception is verbal hallucination in schizophrenia, which seems to be brought about by activations of the parts of the brain that are responsible for inner speech (Frith and Done 1988). But it is worth noting that these findings are consistent with activity in the primary auditory cortex (and there is some evidence that there is indeed activity in the primary auditory cortex, which would make verbal hallucination in schizophrenia also a form of mental imagery; see Jones and Fernyhough 2007 and Kompus et al. 2013).

2017). As there is early cortical perceptual processing but no sensory stimulation, this is a clear example of mental imagery.

(g) *Episodic memory*: Mental imagery is also taken to be a crucial, maybe even necessary, feature of episodic memory. One empirical reason for this is that the loss of the capacity to form mental imagery results in the loss (or loss of scope) of episodic memory (Byrne et al. 2007; see also Berryhill et al.'s 2007 overview). An even more important set of findings is that relevant sensory cortical areas are reactivated when we recall an experience (Wheeler et al. 2000; see also Gelbard-Sagiv et al. 2008 for context). Again, the subject's perceptual processing (Brewin 2014) is certainly not directly triggered by sensory input (see also Laeng et al. 2014 for further empirical evidence on the relation between mental imagery and episodic memory and see Chapter 20 for more discussion of the relation between mental imagery and memory).

(h) *Perceptual expectations*: It has been shown that prior expectations of a specific stimulus evoke a feature-specific pattern of activity in V1 similar to that evoked by the actual stimulus (Kok et al. 2014, 2017). This also counts as mental imagery: perceptual processing that is not directly triggered by sensory input. Perceptual expectations will play an important role when I discuss temporal mental imagery in Chapter 12.

(i) *Attentional templates*: In visual search, we use attentional templates. When we look for Waldo in the *Where's Waldo* book, we have a red and white striped attentional template (Stokes and Nanay 2020). When we look for the car keys in the living room, we have a key-shaped attentional template. We know from studies in the neuroscience of attentional templates that these templates that are used in visual search are in fact early cortical processing in the visual system that is not triggered directly by sensory stimulation—in short, they count as mental imagery (Keogh and Pearson 2021).

These cases (a)–(i) are, on the face of it, quite heterogeneous. The common denominator between them is that all of them are perceptual processes that are not directly triggered by sensory input—either because there is no sensory input at all (as in (a), (e), (f), and some instances of (b) and (d)) or because the sensory input does not trigger our perceptual processing (that is, the early cortical processing) directly.

But isn't this way of thinking about mental imagery just too inclusive? What will not count as mental imagery according to this definition? Let's consider a couple of examples.

Afterimages do not count as mental imagery according to my definition. An afterimage is "an image seen immediately after the intense stimulation of the eye by light has ceased. For about a second, the afterimage is 'positive', and then it turns to 'negative', often with fleeting colours. The positive phase is due to after-discharge of the receptors of the eye; the negative phase is caused by loss of sensitivity of the receptors as a result of bleaching of the photopigments by the intense light" (Gregory 1987, p. 13; see Phillips 2013 for a philosophical overview; see also Sperandio et al. 2012 for some further wrinkles about how afterimages are subject to size constancy). In the case of afterimages, there is retinal activation, and the perceptual process it leads to is indeed directly triggered by sensory input (that is, by this retinal activation). The sensory stimulation is not light hitting the retina, but rather an aftereffect of the light hitting the retina, but it is an event of retinal activation nonetheless—it counts as sensory stimulation. And afterimages are triggered directly by this sensory stimulation.

Further, in the Perky experiment, one of the most famous and earliest experiments about mental imagery, subjects are looking at a white wall and are asked to visualize objects while keeping their eyes open. Unbeknownst to them, barely visible images of the visualized objects are projected on the wall, which they take themselves to be visualizing, not perceiving (Perky 1910; Segal and Nathan 1964; Segal 1972; see also Dijkstra et al. 2021). I will say more about what follows and what does not follow from the Perky experiments in Chapter 10, but what is important here is that if we accept my definition (and the definition used in the psychological literature), the subjects in these experiments do perceive (rather than have mental imagery of) the projected images: their perceptual processes are directly triggered by sensory input. I will come back to two other examples of early cortical processes (hyperacuity and constancies) that do not count as mental imagery in Chapter 9.

A sure sign of the explanatory power of a theory is that it can help us to keep apart seemingly similar, but in fact very different, mental phenomena. And my account of mental imagery can do exactly that. A good example of this is phosphenes.

Retinal cells are normally activated by light. But they can also be activated by merely pushing your fingers against your eyeballs. This results in what is called "pressure phosphenes." Pressure phosphenes are caused by sensory stimulation. So they do not count as mental imagery. They amount to perceptual processing that is caused directly by sensory stimulation (of your fingers pushing against your eyeballs). But the more general category "phosphene" is somewhat unfortunate as it lumps together activation of the retina in the absence of light, and the activation of the early visual cortices in the absence of light and of retinal stimulation (often called electrically or magnetically induced phosphenes). The latter counts as mental imagery, the former doesn't.

A precondition of any scientific endeavor, but also of any philosophical endeavor is to carve the world at its joints: to use concepts that pick out natural kinds in the world we are trying to understand. I am somewhat skeptical of the explanatory value of the concept of natural kind in general, for various reasons (see Nanay 2011c, e, 2013b, 2014a), but for the purposes of this discussion, let's just run with it. What are the natural kinds of our mental life?

The phosphene example I just gave can be interpreted in the following way: If we follow our introspective reports, we lump together pressure phosphenes that are brought about because of interference with retinal stimulation and magnetically induced phosphenes, where something goes wrong between the retina and the visual cortices. But these are radicalaly different mechanisms. So this concept of phosphenes does not pick out a natural kind. The concept of mental imagery, as I use it, in contrast, does pick out a natural kind.

More generally, my claim is that the concept of mental imagery, understood as perceptual processing that is not directly triggered by sensory input, is very high up on the naturalness scale. Perceptual processing is an important natural kind. And we cut this natural kind at its joints if we distinguish those perceptual processes that are directly triggered by sensory input and those that are not. Distinctions like voluntary/involuntary or conscious/unconscious would be much further down on the naturalness scale.

This does not mean that we can't and shouldn't make important distinctions within the natural kind of mental imagery—we most certainly do so when talking about the natural kind of water (if water is indeed a natural kind, see Chang 2012): for example, whether it's solid, liquid, or gas. But the distinction between ice and steam will be a theoretically less-important (and less-interesting) one than the one between H_2O and, say, O_2.

We can, and indeed should, make distinctions between different kinds of mental imagery—in Chapters 3 and 4, I attempted to highlight a couple of such distinctions (like the one between voluntary and involuntary or between conscious and unconscious mental imagery). But these distinctions are more similar to the one between ice and steam.

And the same goes for the distinction between top-down and laterally triggered mental imagery, which is easier to make sense of in the light of the examples given in this chapter. Cases (a), (b), and most examples of (d) (that is, blind spot, peripheral vision, and some optical illusions) are good examples of laterally triggered mental imagery. While there is no sensory input at the blind spot or at the periphery of our visual field, the perceptual processing of this missing input is triggered laterally. It is the retinal activation around the blind spot that drives the perceptual processing of the regions around the blind spot, which, in turn triggers the perceptual processing of the missing sensory stimulation at the blind spot. And it is the sensory stimulation of parts of the visual field that are closer to the fovea that drives the perceptual processing of these regions, which, in turn, triggers the filling in of the missing sensory stimulation in peripheral vision (it should be noted, though, that even in the case of peripheral vision, top-down information may play a role in how the missing sensory information gets processed, see, for example, Zhang et al. 2009).

Cases (e), (f), (h), and (i) (that is, hallucination, dreaming, expectations, and attentional templates) are examples of fully top-down mental imagery: dreams and hallucinations are triggered by some higher-level processes regardless of the actual sensory stimulation. (It should be added that the actual input may be incorporated into the mental imagery, like the actual sound of the alarm clock becoming a sound I seem to hear in my dream or the flushing of the toilet that triggers one of the most common hallucinatory experiences of voices—I will say more about these hybrid cases in Chapter 9).

Case (c) (amodal completion), is a mixture between top-down and lateral mental imagery. I will say more about how they are mixed in Chapter 9 and more about the top-down versus bottom-up versus lateral distinction in Chapter 11.

A final potential worry needs to be addressed. I defined mental imagery as perceptual processing not directly triggered by the sensory input. But, given recent advances in neuroimaging technology, we can now make more fine-grained distinctions when it comes to perceptual, especially early sensory, processing. The primary visual cortex is a case in point. Anatomically, the primary visual cortex has seven layers. The middle (4th) layer mainly consists of mainly bottom-up information from the retina, whereas all the other layers consist mainly of top-down information. But there is also a difference between superficial (closer to the skull) and deep (further away from the skull) layers of the primary visual cortex and some neuroscientists want to reserve the concept of mental imagery for processing in the deep layers (see for example, Bergmann et al. 2019). If you close your eyes and visualize an apple, this content can be decoded from the deep layers of V1 (but not the superficial ones). And some of the perceptual illusions I talked about above (in (d)), like the color spreading illusion, can be decoded from the superficial layers of V1 (but not the deep ones). One might think that this could be a reason to posit a substantial distinction between mental imagery on one hand (which amounts to processing in the deep layers of V1) and other forms of perceptual processing that is not directly triggered by sensory input (which amount to processing in the superficial layers of V1).

The problem with this line of reasoning is that the function of the deep and superficial layers of V1 are not as different as one might suppose. Both the deep and the superficial layers get a lot of top-down input and while it is true that the deep layers get more top-down input from further away brain regions than the superficial layers, this difference is a matter of degrees: top-down signals from far-away brain regions can be detected not only in the deep, but also in the superficial layers, and top-down signals from relatively close brain regions also reach the deep layers of V1 (Koenig-Robert and Pearson 2021). Further, most examples I outlined above (and that we have data about) activates both the deep and the superficial layers of V1, for example mental rotation (Iamshchinina et al. 2021) and working memory (Lawrence et al. 2018). Perceptual expectations are also decodable from the deep layers (Aitken et al. 2020). Finally, while there is some evidence that amodal completion activates the superficial layers (Muckli et al. 2015), it has been shown that it also activates the deep layers (Kok et al. 2016).

In short, the distinction between processing in the superficial versus deep layers is very far away from being an absolute one. Mental imagery encompasses both.

6
The Content of Mental Imagery

Mental imagery is a kind of representation. When I visualize an apple, this is a way of representing an apple. And when I amodally complete the back side of an apple, this is a way of representing the back side of the apple. This is consistent with the way psychologists talk about mental imagery. Recall the definition of mental imagery we encountered in Chapter 1 from a review article on the psychology of mental imagery: "We use the term 'mental imagery' to refer to representations […] of sensory information without a direct external stimulus" (Pearson et al. 2015). The question is: what kind of representation is involved in mental imagery and how should we think about its content?

I need to say more about how representations show up in early perceptual processing and what kinds of representations do so. My claim is that early cortical perceptual processing is representational. This is not just a claim about mental imagery. Early cortical perceptual processing is representational, regardless of whether or not it is directly triggered by sensory stimulation. So it is representational both when we perceive and when we have mental imagery. In both cases, the early cortical processing of a triangle represents a triangle.

The representations in early cortical processing are not typically conscious and they are clearly not syntactically structured (that is, not structured the way sentences are). So they are very different from, say, conscious beliefs—the paradigm of mental representations for some philosophers. But they are nonetheless representations in any meaningful, even remotely naturalistic, senses of the term (Shea 2018). I will use two of the most influential accounts of what perceptual representations are, to show that the representations in early cortical perceptual processing do count as *bona fide* representations.

The first account comes from Tyler Burge who takes perceptual constancies to be the mark of perceptual representation (Burge 2010). Perceptual representations represent distal features of the environment in spite of variations in the proximal input. When a car is driving towards you, the outline shape of the car takes up a larger and larger part of your retina, but you still perceptually represent the car as having the same (distal) size. Crucially, this is already true of perceptual processing in the primary visual cortex: there are

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demonstrated lightness and size constancies in the primary visual cortex (MacEvoy and Paradiso 2001; Murray et al. 2006). In short, if constancies are the mark of perceptual representations, then the primary visual cortex already represents perceptually.

Another influential take on representations is that a state can only be a representation if it can misrepresent. One way of spelling out this approach is to say that perceptual representations have the function to carry information about some external state (Dretske 1988; Millikan 1995). Even on those occasions when the perceptual representation fails to carry information about an external state of affairs, it still has the function to do so. And that is what happens when a perceptual representation misrepresents. The retina, to simplify a bit, just slavishly registers whatever is in front of it. It is not capable of misrepresentation—therefore it does not represent. The primary visual cortex, in contrast, is not merely registering the input. It can and does misrepresent. When we look at an illusory contour, the primary visual cortex represents an edge, but the edge is not there (Kok et al. 2016; see Chapter 8 below). It misrepresents. And the same goes for the representation in V4, MT, and so on. Early cortical representations are *bona fide* representations.

So we have a number of different early cortical perceptual representations (both in the case of perception and in the case of mental imagery). The representation in the primary visual cortex represents contours (among other features). The representation in V4 represents colors (among other things). And so on. When we talk about the content of perceptual states (of, say, seeing an apple on the table), the content of this overall perceptual state depends on (or maybe it is even determined by) the content of all these subpersonal representations. And when we visualize an apple, the content of our overall mental imagery also depends on the content of all these subpersonal representations.

I should acknowledge that not everyone is comfortable talking about the content of perceptual experiences. Some philosophers argue that perceptual experiences do not represent anything: they are not representations of objects but relations to the perceived objects (Campbell 2002; Martin 2004, 2006; Brewer 2011; Logue 2012; French 2018). This is not the place to argue against such views (but see Nanay 2014d, 2015c, 2016e, 2022b; Berger and Nanay 2016). However, I don't see why someone who thinks of perceptual experiences in this way could not go along with everything I have said so far, with one tiny modification.

These "relationalists" about perception are interested in conscious perceptual experiences and their claim is that these conscious perceptual experiences are not representations (or else, even if they are, their content does not explain the phenomenal character of our perceptual experience). It would be consistent with relationalism to claim that subpersonal and unconscious representations are involved in early cortical perceptual processing. What relationalists would deny is that the overall perceptual experience that these subpersonal and unconscious representations involved in early cortical perceptual processing give rise to would be a perceptual representation itself (and one whose content depends on the content of the subpersonal representations in early cortical perceptual processing). Instead, they would have a different, but structurally similar, claim about how these early cortical perceptual representations make perceptual experience possible. But relationalists needn't disagree with the existence and importance of early cortical perceptual representations.

Mental representations attribute properties to entities. There are important debates in the philosophy of perception about just what these properties could be and also about what kind of entities these properties are attributed to. But these debates tend to be about conscious perceptual experiences. The debate about the range of properties represented in perception is most often a debate about what properties we perceptually experience (Siegel 2006; Bayne 2009; Nanay 2011a, 2011d, 2012d). So it's about conscious perception (but see Nanay 2012c for an attempt to tease apart the question about what properties perceptual states represent and what properties we consciously experience in perception).

But the same question can be raised about the perceptual representations involved in early cortical perceptual processing. We know that, to simplify a bit, the primary visual cortex represents contours, V4/V8 colors, and MT motions (in the sense of representation specified above).

But what are these properties attributed to? I need to introduce a bit of terminology here. Sensory individuals are the individuals (objects or events) we perceptually represent as having properties. So when I see an apple, I perceptually attribute some properties (say, roundness, redness) to a sensory individual (see Cohen 2004; Nanay 2013a on the concept of sensory individual).

The standard story about visual perception is that a range of properties (definitely shape, color, and spatial location, but possibly also dispositional properties or natural kind properties or action properties) is attributed to ordinary objects (or events). So when I am looking at an apple, my perceptual representation attributes properties to an object: the apple.

According to this view, the sensory individuals of vision are ordinary objects like an apple or a cedar tree. As David Armstrong says, "In perception, properties and relations are attributed to objects" (Armstrong 2004, p. 20; see also Shoemaker 1990, p. 97; Brewer 2007, p. 88, to mention just a few examples). The concept of ordinary object is not as straightforward as it might seem, as it should not rule out shadows and rainbows, which are not physical objects. Here is Mohan Matthen's definition of what would count as an ordinary object: a "spatio-temporally confined and continuous entity that can move and take its features with it" (Matthen 2005, p. 281; see also Cohen 2004; Matthen 2004, 2010; for similar views; but see also Clark 2000, 2004; Nanay 2013a).

A minority position in this classic philosophy of perception debate concerning vision is that these properties are attributed to a spatiotemporal location and not the ordinary object that occupies this spatiotemporal location (Clark 2000, 2004, 2011). And while this view is often quickly dismissed in the case of conscious perceptual representations, the arguments against it tend to be introspection-based arguments (see, for example, Cohen 2004; Matthen 2005). They may or may not work when it comes to conscious perceptual representations, but they definitely won't work in the case of the representations of the early cortical perceptual processing.

In fact, when talking about representations involved in perceptual processing in the primary visual cortex, it would be problematic to talk about properties attributed to objects, as perceptual objects only show up much later in the perceptual processing. The primary visual cortex processes contours, but these contours are not contours *of* objects—they are not bound to ordinary objects like apples. Same for V4: it processes colors, but not the color *of* objects.

So, in the case of early cortical perceptual representations, the long dismissed view, that the sensory individuals that perceptual representations attribute properties to are spatiotemporal regions, seems to be a much better candidate (Nanay 2022c). Things get messier when we turn to non-visual sense modalities, like audition or olfaction, partly because the philosophical debate about their sensory individuals is somewhat more complicated.

The debate about what audition attributes properties to is not about ordinary objects (or events) versus spatiotemporal regions. It is about ordinary objects (or events) versus sounds. And in the case of olfaction, it is about ordinary objects versus odors. And it is not at all clear what kind of entities sounds and odors are. Again, these debates tend to be about conscious auditory and olfactory experiences: about what we hear and what we smell.

But if we ask instead what sensory individuals the representations involved in early auditory cortical processing attribute properties to (I will leave olfaction aside for now because there are some further wrinkles there; see Chapter 14), we get a very different range of options. And, as in the case of vision, the most plausible candidate—one that is not even on the radar when it comes to the debate about auditory and olfactory sensory individuals (although there are some exceptions: Nanay 2013a; chapter 4 and Cohen 2010, for example)—seems to be spatiotemporal regions, as the main function of the primary auditory cortex is the spatial and temporal segregation of the auditory field into auditory units based on the input of frequencies (Bregman 1990). And if properties are attributed to spatiotemporal regions in perception, we have strong reasons to suppose that they are attributed to spatiotemporal regions in mental imagery as well.

We have seen that the content of overall perceptual states depends on the content of these subpersonal early cortical perceptual representations. Similarly, the content of mental imagery also depends on the content of these early cortical perceptual representations. Just how the overall mental imagery representation is put together from the subpersonal representations of early cortical perceptual processing is a complicated question.

So far, this chapter has been about representational content. But questions about the content of representations are difficult to separate from questions about the format of representations. The usual starting point of talking about representational format is the difference between the way pictures and sentences represent. Pictures represent imagistically or iconically and sentences represent non-imagistically or propositionally. They may represent the same thing: say, a red apple on a green table. But they represent this red apple on a green table differently—the format of the representation is different.

So the question is: does mental imagery represent the way pictures do or the way sentences do? This was the central question of the so-called "Imagery Debate" of the 1980s (see Tye 1991 and Cohen 1996 for summaries). It was this debate that made philosophers take the concept of mental imagery seriously again, after a long period of behaviorist-inspired skepticism about anything imagery-related.

The Imagery Debate is historically significant for yet another reason: it helped us to appreciate how interpersonal variations in mental imagery can have a major impact on one's philosophical/theoretical positions. As we saw in Chapter 3, an important and fairly large study conducted at a time when the Imagery Debate was on its way out showed that the vividness of imagery has significant impact on theoretical commitments in this debate (Reisberg et al. 2003), inasmuch as researchers with less-vivid mental imagery tended to opt for the symbolic/propositional side and those with more vivid mental imagery were more likely to take the iconic/imagistic side. Given the dependence on the vividness of one's mental imagery, one might wonder just how substantive the Imagery Debate really was.

There are many ways of characterizing the distinction between imagistic and propositional formats, some more controversial than others.[1] I take the least controversial way of characterizing imagistic content to be Christopher Peacocke's: "representation of magnitudes, by magnitudes" (Peacocke 2019, p. 52—magnitudes are properties that come on a scale; see also Maley 2011; Beck 2014; Lee et al. 2022).[2] And at least according to this criterion it seems crystal-clear that mental imagery has imagistic format.

Early cortical representations represent magnitudes by means of magnitudes. They represent magnitudes like illumination, contours, color, and they do so by means of magnitudes in the early sensory cortices. We have seen in Chapter 1 that the early cortices are retinotopic. If you are looking at a triangle, there is a (somewhat distorted) triangle-pattern of direction-sensitive neurons in your primary visual cortex (see Grill-Spector and Malach 2004 for a summary). This is imagistic representation par excellence. And if you visualize a triangle (or if you amodally complete one) there is also a triangle-pattern of direction-sensitive neurons in your primary visual cortex (Kosslyn et al. 2006). Again, imagistic representation par excellence, at least according to the "representation of magnitudes by magnitudes" criterion. In this sense, we can agree with the recent consensus among psychologists and neuroscientists (including some of the original participants of this debate) who explicitly declared this debate dead (see esp. Pearson and Kosslyn 2015).

To sum up, mental imagery represents the way perception does and understanding the relation between the content of perception and the content of mental imagery is crucial for understanding both mental phenomena. I will say (much) more about the relation between perception and mental imagery in Chapter 7.

The aim of Part I of the book was to make clear what mental imagery, that is, perceptual processing not directly triggered by sensory input, amounts to. The aim of Part II is to argue that mental imagery plays a very important role in everyday perception.

[1] To mention just one often-emphasized difference, very few parts of the sentence "there is a red apple on a green table" represent part of what the sentence itself represents, whereas many parts of the picture of the red apple on a green table represent part of what the whole picture represents (see Kulvicki 2014).

[2] Small terminological point: this is Peacocke's characterization of what he calls "analogue representation" (which he takes to be different from iconic representations). I will use the term "imagistic" to refer to Peacocke's "representation of magnitudes by magnitudes." Less-small terminological point: we can bracket various conceptual issues about the logical relation between analogue and iconic/imagistic representations as all parties in this debate assume that propositional representations do not have analog content in this sense: propositional representations do not represent magnitudes by magnitudes.

PART II
PERCEPTION

7
Mental Imagery in Perception

Some perceptual processing starts with sensory stimulation. The light hits our retina and vision is the complex visual processing of this sensory stimulation. This perceptual processing may include, depending on whom you ask, the interpretation or the elaboration or the embellishment of the sensory stimulation, but it is the sensory stimulation that is processed/interpreted/elaborated on.

But some other cases of perceptual processing are not the processing of sensory stimulation because there is no sensory stimulation to be processed. These perceptual processes would count as mental imagery according to my definition: they are perceptual processes that are not directly triggered by sensory input.

Observant readers could spot the potential for major terminological confusion here. I call one kind of perceptual processing (that is triggered directly by sensory input) perception proper. And I call another kind of perceptual processing (that is not directly triggered by sensory input) mental imagery. So some kind of perceptual processing will count as something other than perception: perceptual processing that is not directly triggered by sensory input counts as mental imagery, not perception. In order to mitigate this potential confusion, I will use the term "sensory stimulation-driven perception" to refer to perceptual processing that is triggered directly by sensory stimulation. So not all perceptual processing is sensory stimulation-driven perception. Mental imagery is not.

My main claim in the next couple of chapters is that what we pretheoretically take to be perception is in fact a hybrid of sensory stimulation-driven perception and mental imagery. But if this is true, then we should reevaluate many generally held assumptions about perception.

An old and influential (Kantian) idea about mental imagery (or imagination) is that it is "a necessary ingredient of perception itself" (Strawson 1974, p. 54). The metaphor and the quote are originally from Kant (*Critique of Pure Reason*, A120, fn. a; see also Sellars 1978; Thomas 2009; Gregory 2018), but it had become a widespread slogan by the nineteenth century. Eugène Delacroix,

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for example, wrote: "Even when we look at nature, our imagination constructs the picture."[1]

There are many ways of substantiating this claim, some more plausible than others. The original Kantian idea amounts to a constitutive claim, according to which perception depends constitutively on imagination (or, more plausibly, on mental imagery). Constitutive dependence claims are notoriously difficult to prove, so I will stay away from them for the purposes of this book (although I toyed with them in Nanay 2017b). Instead, I will defend a relatively modest version of this claim, according to which what we pre-theoretically take to be perception is in fact a hybrid of sensory stimulation-driven perception and mental imagery.

A lot has been said in philosophy and psychology about the relation between mental imagery and perception. Most of this research has focused on the similarities and differences between mental imagery and perception. We will encounter one aspect of this question in Chapter 10 below: the way in which conscious mental imagery appears to be similar to conscious perception. Visualizing an apple feels similar to seeing an apple—how can we explain that?

A much more important set of findings is about the similarity of processing in the case of mental imagery and perception. As we have seen, there is an almost complete overlap between the parts of the perceptual system involved in mental imagery and the parts of the perceptual system involved in perception (see, for example, Bartolomeo 2002; Kosslyn et al. 2006; Boccia et al. 2017; but see also Lee et al. 2012 for some wrinkles, and Dijkstra et al. 2019 and Pearson 2019 for a summary). Further, the capacity limitations (Keogh and Pearson 2017) as well as the patterns of cortical activation are also similar in perception and mental imagery (Page et al. 2011; Clichy et al. 2012; but see also the discussion of the differences in terms of the layers of the visual cortices involves in Chapter 5).[2] Finally, the similarities between the perceptual processes of perception and imagery are also revealed by how mental imagery can lead to low-level perceptual learning (Tartaglia et al. 2009).

Another important set of experimental findings in this context is about our eye movements during visual imagery and visual perception (I will focus on the visual sense modality for ease of exposition, but we have very similar phenomena in the olfactory sense modality; see Bensafi et al. 2003): our eye

[1] Delacroix: *Journal*, 1859, September 1.

[2] See also Cavedon-Taylor (2021a, 2021b) for a discussion of the relation between perception and mental imagery, which is very different from mine.

movement during visual imagery re-enacts that of the perception of the same visual scene. When we visualize a scene, our spontaneous eye movements reflect the content of the visual scene (Brandt and Stark 1997; Spivey and Geng 2001; Laeng and Teodorescu 2002; Mast and Kosslyn 2002; Altmann 2004; Johansson et al. 2006; see Laeng et al. 2014 for a good summary; see also Sartre 1940/1948 for some surprisingly similar claims). For example, when we perceive a pattern in a grid, our eye movements are isomorphic to our eye movements when we visualize the same pattern.[3]

The relation between eye movements in perception and mental imagery are especially intriguing. When we look at an object that moves slowly, our eyes track this movement with small and smooth micro-saccades. When we visualize an object moving, the eye movement, while it follows the same general spatial pattern, is somewhat different. There are no smooth small micro-saccades, but instead larger, often voluntarily triggered eye movements. Interestingly, our eye movements in other forms of mental imagery are more similar to perception. In dreaming, for example, our eye movements are very much like the smooth eye movements with small micro-saccades in perception and very different from the larger eye movements of visualizing (LaBerge et al. 2018).

One may wonder whether these findings point to some kind of relation between the nature of eye movements and the feeling of presence. The two surely co-vary with each other. Perception: we get smooth micro-saccades and we get a feeling of presence. Dreaming: we also get both. Visualizing: we get neither. More research would need to be done to determine whether the eye movements explain the feeling of presence, or maybe the other way round (or neither, and we have a mere covariation between the two).

The findings about the similarities and differences between perception and mental imagery will play an important role in Chapter 10. But an even more important (and surprising) aspect of the relation between perception and mental imagery, as I will argue, is that what we naïvely take to be perception is in fact a mixture of sensory stimulation-driven perception and mental imagery (see Chapter 9).

Let's go back to the Kantian constitutive dependence claim (which I don't endorse): that perception depends constitutively on mental imagery. Claims about constitutive dependence are routinely contrasted with claims about

[3] These findings are not limited to the similarities of eye movements when it comes to perceived and visualized shape properties. The dilation of the pupil also reflects the brightness or darkness of the imagined scene (Laeng and Sulutvedt 2014).

causal dependence. This contrasting claim would be that perception depends causally on mental imagery. As my claim about the perception/mental imagery hybrid is weaker than the constitutive dependence claim, but stronger than the causal dependence claim, I want to outline briefly how it differs from both.

Few would deny that perception depends causally on mental imagery—we have plenty of evidence that mental imagery can change our perceptual state. But lots of things have a causal influence on our perceptual states. For example, LSD in the bloodstream. That does not mean that perception depends constitutively on LSD in the bloodstream. Our perception can depend causally on LSD, but not constitutively. The constitutive claim would be that mental imagery is not like LSD in this respect.

Consider the first two perceptual processes I listed in Chapter 5 that would count as mental imagery under my definition: perceptual processing of the missing information in the blind spot and peripheral vision. Every time we see anything, our perceptual system processes shape and color information corresponding to the space of the blind spot in the visual field, but this processing is not directly triggered by the sensory input from the blind spot because there is no sensory input from the blind spot. So we use mental imagery each time we visually perceive anything. And the same goes for peripheral vision.

In this sense, all instances of everyday perception depend on mental imagery. Do the examples of the blind spot and peripheral vision show that all instances of everyday perception depend on mental imagery constitutively? I don't think so. The filling in of the blind spot or of the indeterminacies of the periphery does have an impact on the content and phenomenology of our perceptual states, but it does not make the perceptual state what it is.

In the literature in metaphysics about the difference between causal and constitutive dependence (see Ylikoski 2013 for a summary), the basic assumption is that X depends on Y constitutively and not merely causally if Y is part of what makes X what it is. You take away Y and X is no longer X. Free elections are constitutive of democracy. If you don't have free elections, you no longer have democracy. Or, to use my favorite quote on constitutive dependence from the film *Caddyshack* (1980), uttered by Ty Webb (Chevy Chase): "A flute without holes, is not a flute. A donut without a hole, is a Danish."

No hole, no donut. Similarly, the Kantian constitutive dependence claim holds that without mental imagery, perception would not be perception. I think that this is almost true, but not quite. More specifically, the third example of mental imagery I gave in Chapter 5, amodal completion, could be thought to provide good reasons for a strict constitutive dependence claim, but I don't think it will get all the way there.

That is why I resist the constitutive dependence talk and will argue in Chapter 8 (and later in Chapter 13), instead, that what we naïvely take to be perception is a mixture of sensory stimulation-driven perception and mental imagery. The proportions of these two vary case by case. And there are some (rare) cases where the mental imagery component is completely missing, which is why the constitutive claim is too strong. Kant said that imagination (most plausibly understood as mental imagery) "is a necessary ingredient of perception itself." I want to tone this down a bit and I will argue that mental imagery is a crucial, albeit not necessary, ingredient of perception itself. But even this claim, even taking ordinary perception to be a mixture of sensory stimulation-driven perception and mental imagery, has radical consequences for a number of problems and debates concerning perception.

8
Amodal Completion

Amodal completion is the representation of those parts of a perceived object that we get no sensory stimulation from. I will argue that one of the strongest cases for the importance of mental imagery in perception comes from amodal completion (as we shall see in Chapter 13, there might be an even stronger case from the multimodality of perception).

In the case of vision, amodal completion 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.[1] We also get amodal completion in non-visual sense modalities. 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.

In the case of audition, when we hear a loud bang while listening to a tune, the auditory system continues to represent the tune even in that brief moment when the bang is the only auditory stimulation. The loud bang blocks (we could say, it occludes) part of the tune. A popular demonstration of auditory amodal completion is the American late night show host Jimmy Kimmel's segment "A week in unnecessary censorship," where he beeps out completely harmless words from famous politicians, making them sound like expletives (see also Young and Nanay 2022 on olfactory amodal completion).

Amodal completion is not a perceptual curiosity: it is part of our ordinary perception. It happens very rarely in real-life situations that we can perceive an object without exercising amodal completion: in natural scenes we always get occlusion because objects tend not to be fully transparent. Stop reading this for a moment and look around the room. Probably very few of the objects in your visual field are fully in view: they tend to be occluded by your desk, your computer, your hand, and so on. More generally, every time we see an

[1] The term "amodal" may come across as somewhat confusing inasmuch as it may suggest some kind of representation that is not connected to any of the sense modalities (maybe some kind of non-perceptual representation). But when it was introduced by Henri Michotte in the 1950s, it merely indicated the perceptual representation of a feature that is not accompanied by the usual visual phenomenology (see Michotte and Burke 1951; Michotte et al. 1964).

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object occluded by another object (which means in every real-life perceptual scenario, barring odd cases of fully transparent visual scenes or very simple visual displays), we use amodal completion of the occluded parts of perceived objects (Bakin et al. 2000). And the same goes for the backside of any solid object—sometimes referred to as self-occlusion. Again, we do not receive any sensory input from the backside of solid three-dimensional objects, but there is nonetheless perceptual processing of this missing information—in a way reminiscent of more familiar cases of amodal completion (Nanay 2010a; Ekroll et al. 2016).

When we see a cat behind the picket fence, we represent those parts of the cat that are occluded by the picket fence. The question is: how do we do so? What kind of representations are the ones that we use in amodal completion?

Amodal completion is early perceptual processing of a contour that is not directly triggered by sensory input. It is well-documented that the amodally completed contour shows up already in the primary visual cortex (see Kovacs et al. 1995; Sugita 1999; Bakin et al. 2000; Lee and Nguyen 2001; Komatsu 2006; Hegdé et al. 2008; Lommertzen et al. 2009; Vrins et al. 2009; Smith and Muckli 2010; Bushnell et al. 2011; Shibata et al. 2011; Lee et al. 2012; Pan et al. 2012; Ban et al. 2013; Emmanouil and Ro 2014; Hazenberg et al. 2014; Scherzer and Ekroll 2015; Thielen et al. 2019; Gerbino 2020). For example, if the Kanizsa triangle (Figure 1, on p. 16) is projected onto the retina, the direction-sensitive neurons in the primary visual cortex along the illusory contours of the invisible sides of the triangle are activated (Maertens et al. 2008; Kok et al. 2016; De Haas and Schwarzkopf 2018). To put it very simply, on the retina, we have the Kanizsa triangle, but the V1 already represents the missing sides of the triangle.

In other words, when you amodally complete the cat behind the picket fence, in V1 there is activation of direction-sensitive neurons that is not directly triggered by the retinal input of where the cat's outlines would be, because there is nothing on the retina that would correspond to these contours. So amodal completion is perceptual processing that is not directly triggered by sensory input. It is mental imagery.

Amodal completion is, of course, in some sense, driven by the retinal image. What determines how the occluded parts of the cat are represented is the retinal input from the non-occluded parts. But the representation of the amodally completed features is not *directly* triggered by the sensory stimulation. The amodally completed features would be directly triggered by retinal input that is homomorphic with the completed features. The perceptual processing of the contours of the picket fence are directly triggered by the retinal input of the contours of the picket fence. But the perceptual processing of the contours of the cat's occluded tail are not directly triggered by the retinal input of the contours of the cat's occluded tail. The perceptual processing of the contours of the cat's occluded tail is mediated by the perceptual representation of the contours of the picket fence and the cat's other (unoccluded) body parts, which, in turn, are triggered by the retinal input of the contours of the picket fence and the cat's other (unoccluded) body parts. This is very much indirect triggering (where the perceptual processing of the contours of the picket fence and the cat's other (unoccluded) body parts mediate between the sensory input and the perceptual processing of the occluded cat parts). In short, it is mental imagery.

Not everyone uses the concept of mental imagery the way I outlined (and what I take to be the consensus view in psychology and neuroscience). Here is a puzzling remark in a paper by Vebjorn Ekroll and colleagues, which may seem to suggest that not everyone is on board with the idea that amodal completion is a form of mental imagery:

> our experience of the hidden backsides of objects is sometimes based on genuine perceptual representations rather than mere cognitive guesswork or imagery, despite the lack of any direct sensory stimulation reaching the eye from the hidden backsides themselves. (Ekroll et al. 2016, p. 3)

This quote seems to present a choice between perceptual representation on the one hand and cognitive guesswork and imagery on the other. In my account, imagery is a form of perceptual representation, so it is definitely on the perceptual side of this divide and has very little to do with cognitive guesswork. Ekroll seems to rely on a very unusual way of understanding mental imagery, probably as active imagination (Ekroll confirmed this in a personal communication in August 2019). If we understood mental imagery this way, then amodal completion is clearly not imagery. If we understood mental imagery as perceptual representation not directly triggered by sensory input, then amodal completion is clearly mental imagery.[2]

[2] One may worry about what happens if I visualize a cat behind a picket fence. Would this, according to my account, amount to the mental imagery of mental imagery? This question could only be addressed by consulting what happens in the visual cortices when visualizing a cat behind a picket fence. If there is early cortical activation that would correspond to the occluded parts of the visualized cat, then it is mental imagery. So the mental imagery of mental imagery would be mental imagery (see Lewis 1983; Lamarque 1987; Currie 1995c; and especially Nichols 2003 on the structurally parallel question about whether and in what sense imagination—not imagery—can be iterated). Thanks to Anders Nes for raising this objection.

Amodal completion is not sensory stimulation-driven perception because the early cortical representation of the amodally completed contours is not directly triggered by the sensory input. Where the direct trigger would be—that is, a corresponding contour on the retina—is blatantly missing. And amodal completion is not a post-perceptual process either, as we have plenty of evidence that amodal completion happens very early in perceptual processing. If amodal completion happens in the primary visual cortex, it is not happening on the level of beliefs/non-perceptual representations—it happens much earlier.

But the proponents of a post-perceptual account of amodal completion could argue, as a last resort, that amodally completed properties are represented by beliefs and this, in turn, activates the primary visual cortex by means of some kind of top-down influence. They could maintain that the early cortical activation is not itself amodal completion—it is a consequence of the amodal completion and amodal completion itself is a post-perceptual phenomenon.

There are two problems with this response, one theoretical, one empirical. First, the theoretical. This response would amount to saying that the retinotopic perception of the visible parts of the object gives rise to a non-retinotopic belief (the actual amodal completion), which then triggers, in a top-down manner, the retinotopic representation of the occluded parts of the object. So, by representing the occluded part by means of a belief, we lose retinotopy, which then somehow gets put back in for the well-demonstrated retinotopic activation of the primary visual cortex. Not a very plausible picture.

Second, and more decisively, there is plenty of empirical evidence that this picture cannot be correct, given what we know about the timing of amodal completion. Amodal completion in the early cortices happens within 100–200 milliseconds of retinal stimulation (Sekuler and Palmer 1992; Rauschenberger and Yantis 2001—this is true even of complex visual stimuli, like faces; see Chen et al. 2009; see also Lerner et al. 2004; Rauschenberger et al. 2006; and Yun et al. 2018 for detailed studies that track the (very quick) temporal unfolding of amodal completion in different parts of the visual cortex). And this is much much shorter than the time that would be needed for perceptual processing to reach all the way up to beliefs or non-perceptual representations and then trickle all the way down again to the primary visual cortex (see Thorpe et al. 1996 and Lamme and Roelfsema 2000 for the temporal unfolding of visual processing in non-amodal cases). To sum up, taking amodal completion to be post-perceptual is not consistent with neuroimaging data about early cortical processing in amodal completion.

It is important to note that the timing data on how amodal completion works does not rule out that amodal completion can be, and often is, influenced in a top-down manner (as top-down modulation does not require the activation going all the way up to non-retinotopic representations and then trickling all the way down). In fact, amodal completion is often, but not always, top-down influenced.

Sometimes the way our perceptual system completes figures amodally is insensitive to our beliefs and expectations. It may even go straight against our beliefs and expectations, as in the case of the horse illusion (see Kanizsa 1972; see Figure 7): our visual field is filled with identical horse shapes, nonetheless, we can't help but complete the occluded shape as one very long horse that is very different from all the other shapes—and not as two normal horses that would be very similar to the ones in our visual field.

But some other instances of amodal completion are very much sensitive to top-down influences (Hazenberg et al. 2014; Hazenberg and Van Lier 2016). When I see you with your hands in your pocket, I amodally complete the occluded hands in a way that is only possible for me because I have seen your hands (or the hands of other humans) unoccluded. Similarly, we are very good at amodally completing letters, numerals, words, and sentences. We are, predictably, much better at amodally completing words in languages we speak than in languages we do not speak. This, again, suggests that the mental imagery that is involved in amodal completion can be subject to top-down influences.

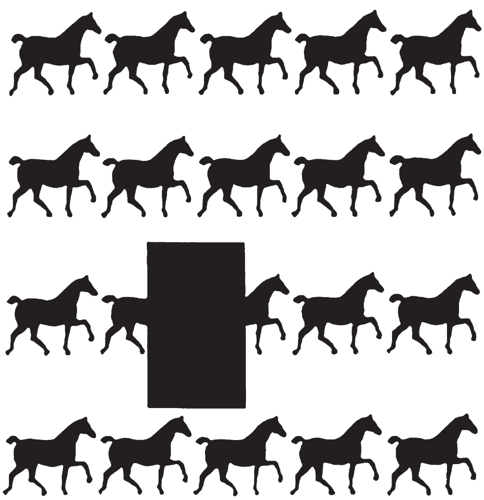

Figure 7 Horse illusion

Figure 8 Bimodal picture

Here is another example. Look at Figure 8. See anything in the picture? Probably not. Now look at Figure 9 and go back to Figure 8 again.

There is a huge difference in terms of your experience, and this is one of the most elegant demonstrations of how there can be top-down influences on our perceptual phenomenology. But the crucial finding from my point of view is not about phenomenology, but about early cortical processing: the direction-sensitive neurons in the primary visual cortex that are located where the completed illusory contour is, behave very differently before and after you looked at Figure 9. Before looking at Figure 9, they did not fire, but afterwards, the neurons that are sensitive to the direction of the completed contour did fire (Teufel et al. 2018, see also Teufel et al. 2015). So perceptual processing in V1 is clearly sensitive to some higher-up level of perceptual processing. I'm not saying that this higher-up level is very high up (so that it would involve concepts), but it is definitely further up than V1. So we have a nice illustration of top-down-influenced amodal completion.

Here is another example, taken from the 1980s classic comedy *Top Secret*. One of the many visual jokes of the film has the main character crawl in the mud, shown in close up and suddenly he faces two East German military boots, framed in a way that we can only see the boots. He looks scared and the camera zooms out, revealing that it is only two boots standing in the mud, there is no soldier in them. Again, we use amodal completion to represent what is outside

Figure 9 Original picture

the frame (a theme I will say a lot more about in Chapter 31), and we use a lot of high-level information to complete what is outside the frame, for example, knowledge that military boots usually continue upwards in soldiers.

In short, amodal completion (just as mental imagery in general) can be, but does not have to be, top-down driven. If one's concept of mental imagery presupposes that mental imagery is necessarily top-down driven (see, for example, Briscoe 2011), they would rightly deny that all instances of amodal completion would be mental imagery. But my concept of mental imagery is neutral about whether it is driven in a top-down manner, and, as I argued in Chapters 1 and 3, this reflects the use of this term in the empirical sciences. Further, one of the advantages of having a broader concept of mental imagery (understood as perceptual processing not directly triggered by sensory stimulation) is that we can make these distinctions within the broader category of mental imagery, which can help us to understand the diversity of amodal completion processes and the ways they interact.

Finally, understanding amodal completion as a subspecies of mental imagery can also help us to better understand the function of mental imagery (Nanay forthcoming b). Most instances of what we normally mean by mental imagery are remarkably useless, so much so that one may wonder how this ability may have evolved. But amodal completion is very useful indeed: spotting the lion's tail sticking out of the bush and amodally completing the rest of the lion is as important for survival as perceiving the lion.

9

Perception/Mental Imagery Mixed Cases

We have a simple argument for the claim that perception is a mixture of sensory stimulation-driven perception and mental imagery. Almost every case of perception is a mixture of sensory stimulation-driven perception and amodal completion. And amodal completion is a form of mental imagery. Hence, almost every case of perception is a mixture of sensory stimulation-driven perception and mental imagery.[1]

The contribution of amodal completion to perception is not trivial. Perceptual states represent what they represent to a large extent as a result of amodal completion. When we see a cat behind the picket fence, it is the (partly occluded) cat that we see, not just those parts of the cat that are in plain sight. And if we see a landscape through a wire fence, we don't just see disjointed squares divided up by the wire—we see the landscape. Amodal completion is heavily involved in making our perceptual states what they are.

One way of demonstrating the importance of the mental imagery component of everyday perception is to highlight the differences between the way perception in fact works and the way it would work without amodal completion.

What would perception be without amodal completion—and, thus, without mental imagery? Here are two possibilities. According to the first one, the amodally completed features are represented, but not amodally. According to the second one, the amodally completed features are not represented at all. The first possibility is fairly thoroughly worked out—as it is the kind of vision Renaissance philosophers attributed to Christ and the "blessed." And it is a form of transparent vision. This is what Bartholomew Rimbertinus said about this "heavenly sight" in 1498:

> An intervening object does not impede the vision of the blessed...If Christ, even though himself in heaven after his Ascension, saw his dear Mother still

[1] The claim is that what we pre-theoretically take to be perception is a mixture of *sensory stimulation-driven* perception and mental imagery. When I refer to "perception/mental imagery mixed cases" in this chapter, the word "perception" in this phrase is to be understood as *sensory stimulation-driven* perception. So I talk about the mixture between *sensory stimulation-driven* perception and mental imagery.

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> on Earth and at prayer in her chamber, clearly distance and the interposition of a wall does not hinder their vision. The same is true when an object's face is turned away from the viewer so that an opaque body intervenes… Christ could see the face of his mother when she was prostrate on the ground… as if he were looking directly at her face. It is clear that the blessed can see the front of an object from the back, the face through the back of the head.
>
> (Bartholomew Rimbertinus, *The Sensible Delights of Paradise* (Venice, 1498), 17rcited in Baxandall 1972, p. 104, p. 172)

As John Kulvicki memorably summarized, "Hide and seek is not one of Paradise's delights" (Kulvicki 2009, p. 389). If perception without amodal completion is heavenly sight, then amodal completion—and a fortiori, mental imagery—clearly makes a significant contribution to what perception is.

I considered the possibility that perception without amodal completion leads to a fully transparent visual world. But this is not the only option. Maybe perception without amodal completion is the exact opposite of a fully transparent visual world. So suppose now that instead of amodally completing them, we just completely failed to represent any occluded features. This would mean that we fail to represent the back side of three-dimensional objects and anything occluded behind anything else. This would amount to having a visual world where only those things are represented that we get sensory input from. Nothing is represented behind anything else. We could not perform even the simplest visually guided action if this were the way we perceived. This would amount to something even less akin to perception than heavenly sight.

A donut without a hole is a Danish and human vision without mental imagery is heavenly sight (or something even weirder: flat vision). And that is more different from human vision than a donut is from a Danish. Wouldn't this be enough to conclude then that perception depends constitutively on mental imagery? I don't think it would because there are perceptual scenarios—rare ones, but nonetheless actual perceptual scenarios—where amodal completion plays no role at all, for example in the case of simple two-dimensional displays, like a red dot in the middle of a homogenous white background.

As a result, I am making a weaker claim than the straight constitutive dependence claim: what we naïvely take to be perception is in fact a mixture of sensory stimulation-driven perception and mental imagery. And we have plenty of reasons to take mixed perception/mental imagery cases seriously. In fact, one could argue that an important desideratum for any account of mental imagery (or of perception) is that it needs to be able to explain mixed cases of perception/mental imagery.

Amodal completion is one example of perception/mental imagery mixed cases. There are others. To use the example from Chapter 3, when I am at the furniture store and I am looking at a sofa, imagining how it would look in the living room, I am looking at an actual object and attributing imagined properties to it—properties it does not have, like being in my living room. And then I go home and look around in my living room imagining the sofa (which is not here, it's still in the furniture store) in my egocentric space in the living room. I am attributing properties ("real" properties in some sense, for example spatial location properties) to an imagined object—to an object that is not there.

These mixed perception/mental imagery cases are widespread. Neil Van Leeuwen has argued for their importance in understanding pretense (Van Leeuwen 2011; see also Schellenberg 2013 and Chapter 26 below on more about pretense and imagery/perception mixed cases). Robert Briscoe calls them "make-perceive" and examines the role they can play in the guidance of our actions (Briscoe 2008, 2018; see also Martin 2002, p. 410 for other examples of the importance of mixed perception/mental imagery cases). If it is true that amodal completion involves mental imagery, then these hybrid states are more than some rare and odd episodes. If amodal completion involves mental imagery, then (virtually) all of our perceptual states are in fact mixed perception/mental imagery states.

And this should not come as a surprise. Let's go back to peripheral vision, which also counts as mental imagery according to my definition. If the periphery is represented by means of mental imagery and the object in the fovea (let's ignore amodal completion for a moment) is represented by means of sensory stimulation-driven perception, then there is clearly a spectrum as one proceeds from the fovea to the periphery—from perception (with very little or maybe no mental imagery involved) through mixed perception/mental imagery cases where there is more and more contribution from mental imagery and less and less from perception to mental imagery with very little perceptual contribution. So, in general, we should expect that most mental states we label as perception and many states we label as mental imagery are in fact mixed cases of the two.

When I say that everyday perception is a mixture of mental imagery and sensory stimulation-driven perception, I don't mean to suggest that this is a 50/50 mixture. The contribution of mental imagery can be, and often is, limited. But this does not diminish the importance of mental imagery when understanding perception in general. We can't fully understand perception without understanding mental imagery.

This is a good place to warn against a possible over-interpretation of these claims about how perception is a mixture of sensory stimulation-driven perception and mental imagery. One such over-interpretation would be to take anything that is not sensory stimulation-driven to be mental imagery. This is clearly not so. Mental imagery is perceptual processing that is not directly triggered by sensory input. So there will be lots of mental processes that are not sensory stimulation-driven that will still not count as mental imagery—those that do not count as perceptual processing. Further, there are many perceptual processes that are (in some sense) not *fully* sensory stimulation-driven, but they still fail to count as mental imagery because they are directly triggered by the sensory input.

To illustrate this point, take hyperacuity. Downstream sensory discrimination (including sensory discrimination in the primary visual cortex) is finer-grained than the packing of retinal cells could afford (Westheimer 1981). So in some cases there is higher spatial resolution in the primary visual cortex than in the retina. This phenomenon is called hyperacuity. Is it mental imagery? No. It is a classic example of early processing working with the sensory input and processing it further. There are no mediating perceptual representations that would trigger the representation of higher spatial resolution laterally. The early processing is triggered directly by the sensory input, although it is enriching the information that is there in the sensory stimulation. Hyperacuity is not mental imagery.[2]

Things are a bit more complicated when it comes to perceptual constancies, but perceptual constancies provide an interesting contrast case to amodal completion, so I will spend some more time on this. As we have seen in Chapter 6, perceptual representations represent distal features of the environment in spite of variations in the proximal input. The same color appears different if the illumination conditions are different (and different colors appear the same if the illumination varies). Objects of the same size appear different if their distance from us is different. And objects of the same shape appear

[2] One may wonder how hyperacuity differs from peripheral vision in this respect. The answer is that in the case of hyperacuity, the only information that is used to enhance the retinal resolution in early cortical processing is the information in the sensory input itself. No information is provided by perceptual representations laterally. In the case of peripheral vision, in contrast, the perceptual representation of the features in the periphery of the visual field is heavily influenced by representations both laterally (by the representation of surrounding features) and in a top-down manner (see the references on this in Chapter 5).

different if their orientation is different. And we know that at least some constancies are already present in the primary visual cortex.

Size constancy is a well-researched example: if two objects project on our retina in a way that they take up equal areas of the retina, but are at different distances, then the one that is further away will occupy a larger part of the primary visual cortex (Murray et al. 2006—see also the findings that the strength of size constancy depends on the size of the V1 of the subject, Schwarzkopf et al. 2011). And lightness constancy and even color constancy are also present at very early stages of perceptual processing (V1 and V4 respectively; see MacEvoy and Paradiso 2001; Bannert and Bartels 2017).[3]

Does this mean that size and color constancy would amount to mental imagery? Definitely not. While both color constancy and size constancy are early perceptual processes, they are very much directly triggered by sensory stimulation—by the retinal input. They do not slavishly copy the input onto the early cortices, but they are nonetheless triggered by this input and triggered directly.

Constancies provide a helpful contrast to amodal completion. Both perceptual phenomena are very important for perception per se, both happen in the early sensory cortices and both go beyond what is presented in the sensory stimulation. But there is a major difference between them. In the case of amodal completion, the early cortical processing that happens where the illusory contour is completed is not directly triggered by sensory stimulation. There is no sensory stimulation that is even remotely close to the part of the visual field that is amodally completed. The perceptual processing of the amodally completed region is mediated by the representation of features in the not amodally completed regions.

In the case of perceptual constancies, in contrast, the early cortical processing that is responsible for the constancies is very much directly triggered by sensory stimulation. It is not mediated by any perceptual representation laterally. When we look at a red square surrounded by a white background, the perceptual processing of the color of the square is influenced by the color of the area surrounding the square, but this perceptual processing is not triggered by the color of the surrounding area. It is triggered by the color of the square and modified by the color of the surrounding area. The processing of the color of the square comes first and it is then modified by the color

[3] A related set of findings shows that size illusion and size adaptation illusion also happen in V1 (Fang et al. 2008; Pooresmaeili et al. 2013). Also, the size of V1 predicts the strength of size illusions (like the Ebbinghaus and Ponzo effects; see Schwarzkopf et al. 2011).

information about the surrounding area. In the case of amodal completion, it's the other way round: The retinal information about the contours in the area surrounding the amodally completed region cannot influence the processing of the features of the amodally completed region, because there is no processing of the features of the amodally completed region in the absence of the representation of the features of the surrounding area.

What makes mental imagery special is that the sensory stimulation makes no direct causal contribution to the early perceptual processing. And this is indeed so in the case of amodal completion. But in the case of constancies, the sensory stimulation does make direct causal contribution. Perceptual constancy is not perceptual processing that is not directly triggered by sensory input. Perceptual constancy is not mental imagery.

There is a famous slogan in machine vision, attributed (wrongly, it seems) to Max Clowes, one of the pioneers of artificial intelligence research: "vision is controlled hallucination" (see Clowes 1971 for similar (but not identical) claims). It would be tempting to summarize the main claim of this chapter by saying that perception is controlled mental imagery. This would not be that significant a deviation from the original Clowes dictum, especially given that hallucination on my account is a form of mental imagery. I think we should resist the temptation to make this strong claim. Almost all perception involves mental imagery: perceptual processes that are not directly triggered by sensory input. But it would be a much stronger claim to say that perception *is* mental imagery (controlled or not). According to my account, mental imagery is an important ingredient of perception, but not a necessary ingredient (this was Kant's claim) and not the only ingredient (this would be Clowes's claim). Sensory stimulation does much more than just control our mental imagery. The main claim of this chapter is much more modest. It is that perception, that is, what we pre-theoretically take to be perception, is in fact the combination of mental imagery and sensory stimulation-driven perception.

10
Attention and Mental Imagery

Close your eyes and visualize the bathroom in the house you grew up in. Now attend to the shape of the sink. And now shift your attention to the color of the sink's taps. Got it? Your mental imagery changes as you shift your attention around, in much the same way as your perceptual state changes as you shift your attention around.

This procedure is often called "image inspection" and it plays an important role in some psychiatric treatments, as we shall see in Chapter 30 (see also Kosslyn et al. 2006). The main point is that image inspection is a matter of moving our attention around. Thus, some parts of the mental imagery are attended, some others are unattended. And as our attention moves around, different parts become attended.

Mental imagery can be attended or unattended. It can be, as we have seen in Chapter 4, conscious or unconscious. And it can be determinate or indeterminate. This chapter is about the ways these distinctions relate to each other in mental imagery in general, but I want to demonstrate the importance of these distinctions in the case of the form of mental imagery that Chapter 8 was about: amodal completion.

Amodal completion can be attended or unattended. I can shift my attention from one perceived object to another and I can do the same when it comes to amodally completed parts of perceived objects. We can attend to some properties of amodally represented parts of perceived objects, but normally we ignore most of these properties (see also De Weerd et al. 2006 for empirical support of this).

And amodal completion, like mental imagery in general, may be conscious or unconscious. Given the sheer amount of amodal completion the visual system needs to do at any given moment, amodal completion is normally unconscious. When I see fifty cats behind the picket fence, I do not form conscious mental imagery of all occluded parts of all the fifty cats. But amodal completion can be conscious if, for example, we are really interested in some of the occluded features. If for some reason I need to attend to the left eye of one of these fifty cats and it is occluded by the fence, I am likely to represent this left eye consciously.

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The relation between these two distinctions (attended vs. unattended mental imagery and conscious vs. unconscious mental imagery) is further complicated by a third distinction, that of determinate versus indeterminate (or determinable) mental imagery.

A bit of background: Being red is a determinate of being colored, but a determinable of being scarlet (Johnston 1921; Funkhouser 2006). There are many ways of being red and being scarlet is one of these: for something to be scarlet is for it to be red, in a specific way. If something is red, it also has to be of a certain specific shade of red.

The determinable-determinate relation is a relative one: the same property, for example, of being red, can be a determinate of the determinable being colored, but a determinable of the determinate being scarlet. Thus, the determinable–determinate relation gives us hierarchical ordering of properties in a given property space. Properties with no further determinates, if there are any, are known as super-determinates.

We have seen in Chapter 3 that mental imagery may be determinate or determinable. One way of cashing out the sense in which mental imagery is less vivid than perception (an old insight from David Hume) would be to say that mental imagery attributes less-determinate properties than perception. But as we have seen, much of perception (for example, peripheral vision) attributes extremely determinable properties (see also Nanay 2018c, 2020e for the role of determinable properties in perception) and some instances of mental imagery can be very determinate indeed (for example, the mental imagery of hyperphantasics, but also the mental imagery of flashbacks to some traumatic events).

And the same distinction also applies to amodal completion. Most of the time we attribute very determinable properties to amodally represented parts of perceived objects. This point is not independent from the previous one: see Yeshurun and Carrasco (1998) and Nanay (2010b) on the relation between attention and the attribution of determinate properties (roughly: attention increases the determinacy of attributed properties, see below). But if, for some reason, you are really interested in the amodally represented parts, you can attribute very determinate properties (determined at least partly in a top-down manner). If I see you with your hand in your pocket, I am unlikely to have a determinate representation of how you move your fingers in your pocket. But if I attend to this very thing, I may attribute more determinate properties to the whereabouts of each of your fingers (which, again, would be determined (at least partly) in a top-down manner).[1]

[1] Given that attention may be conscious or unconscious (Cohen et al. 2012; see also Chapter 20 for further discussion and references), the attribution of more- or less-determinate properties can also happen consciously or unconsciously.

The way attention is exercised in perception and in mental imagery can help us to make progress in an important philosophical debate about the phenomenal similarity between seeing and visualizing.

Look at a red apple. Now close your eyes and visualize this apple. Your perceptual state and your imagery of the apple are very similar in some respects. They are also different in some respects. Some of the oldest questions about mental imagery are about just how similar it is to, and how different it is from, perception. And about how we can explain this similarity (and difference). It should be clear that this question is about one specific subcategory of vision (conscious vision) and one specific subcategory of mental imagery (conscious and voluntary visualizing). But the lessons we can draw from this debate will be more general.

A good starting point for the discussion of the similarity between mental imagery and perception is the Perky experiment. In this experiment, as we have seen in Chapter 5, subjects are looking at a white wall and they are asked to visualize objects while keeping their eyes open. Unbeknownst to them, barely visible images of the visualized objects are projected on the wall. The surprising finding is that the subjects take themselves to be visualizing the objects—while in fact they perceive them (Perky 1910; Segal and Nathan 1964; Segal 1972). The standard interpretation of this experiment is that if perceiving and visualizing could be confused under these circumstances, then they must be phenomenally very similar (but see Hopkins 2012 for criticism and Nanay 2012a for a response; see also Craver-Lemley and Reeves 1992; Reeves and Craver-Lemley 2012; Gow 2019; Dijkstra et al. 2021).

What explains this similarity between perception and mental imagery? An obvious answer to this question is that the phenomenology of these two mental states is similar because their content is similar (Ishiguro 1967; cf. Currie 1995a, pp. 36–7; Kind 2001; Currie and Ravenscroft 2002, p. 27; Noordhof 2002; Nanay 2015a).

The relation between perceptual content and perceptual phenomenology has been an important issue in the philosophy of perception, and one influential view in this context is intentionalism, the view that perceptual phenomenology supervenes on perceptual content—that is, any difference in phenomenology is due to a difference in content. If the phenomenology of mental imagery also supervenes on the content of mental imagery, then the similarity of the phenomenology of mental imagery and of perception can be explained in a straightforward manner by the similarity of the content of these two mental states.

Depending on how we think about perceptual content and the content of mental imagery, we get very different versions of this explanatory scheme.

One widespread way of thinking about perceptual content is in terms of propositional content: perceptual states, just like beliefs and desires, are attitudes towards a proposition. But if we think of perceptual content and the content of mental imagery this way (see, for example, Byrne 2009; see also Currie 1995a, pp. 36–7; Currie and Ravenscroft 2002, p. 27),[2] then it becomes less clear how the similarity of content would explain the similarity of phenomenology. There are many propositional attitudes (beliefs, hopes, desires, etc.) that could share the same propositional content as perception and they do not seem to share the same phenomenology—at least not in the strong(er) sense we are trying to explain here.[3]

I myself have argued that the most promising way of cashing out the phenomenal similarity between perception and mental imagery in terms of content is to think about content as the attribution of properties to entities (Peacocke 1986, 1989; Burge 2010; Nanay 2010a, 2013a). Perceptual states attribute properties to the perceived entity (the sensory individual, see Chapter 6).

Mental imagery attributes properties to the imagined entity. While the entities these properties are attributed to are very different (one is imagined, the other is not), the properties attributed to them (and, crucially, the way they are attributed) are similar. And this makes the two contents similar, which, in turn, makes the phenomenology of the two mental states also similar (Nanay 2015a).

In order to maintain the generality of this account of perceptual content, I will say nothing about whether these attributed properties are tropes or universals (Nanay 2012b) or how this content is structured. The question I take to be crucial to explaining the similarities and dissimilarities between perception and mental imagery has to do with the degree of determinacy that these perceptually attributed properties have.

Some of the properties we perceptually attribute to the perceived scene are determinates or even super-determinates. Some others, on the other hand, are determinable properties. We know that our peripheral vision is only capable of attributing extremely determinable properties. But even some of the properties we perceptually attribute to the objects that are in our fovea can be determinable.

[2] It should be noted that Currie and Ravenscroft are somewhat ambiguous about whether they take perceptual content and the content of mental imagery to be propositional (see Nanay 2016b).

[3] This is not meant to be a knock-down objection to the propositional attitude version of the similar content view—the proponents of this view would have a lot more to say, for example, by appealing to the similarity of contents and attitudes. See Nanay (2015a, 2015b) for more detailed treatments of this topic.

Crucially, attention makes (or attempts to make) the attended property more determinate (see Yeshurun and Carasco 1998 for flagship empirical evidence; see also Nanay 2010a; Stazicker 2011 for philosophical summaries). If I am attending to the color of my office telephone, I attribute very determinate (arguably super-determinate) properties to it. If, as is more often the case, I am not attending to the color of my office telephone, I attribute only determinable properties to it (of, say, being light-colored or maybe just being colored).

An important clarification: a shift of visual attention is not to be confused with eye movement. It is possible to shift one's visual attention without any accompanying eye movement—this is a widely researched phenomenon of the "covert shift of attention" (Posner 1980, 1984; Posner et al. 1984; see also Findlay and Gilchrist 2003). But more often the shift of attention is accompanied by eye movement, which, following the literature, I call an "overt shift of attention." Both in the case of overt and of covert shifts of attention, the determinacy of the perceptually represented property changes depending on the allocated attention. A perk of this way of thinking about attention and perceptual content is that perceptual attention comes out as a necessary feature of perceptual content—something empirical accounts of attention have long assumed (see Nanay 2010b, 2011b; Fazekas and Nanay 2021).

Our mental imagery also attributes various properties to various parts of the imagined scene. The content of imagery is the sum total of the properties attributed to the imagined scene. Some of these properties are determinates or even super-determinates. Some others are determinables. Attention makes (or tries to make) the attended property more determinate.

What then is the difference between perceptual content and the content of mental imagery? The main difference concerns where the extra determinacy comes from. As we have seen, both in the case of perceptual content and in the case of mental imagery, attention makes the attended property more determinate (see also Keogh and Pearson 2017 for similarities in terms of the limitation of attentional capacities in perception and mental imagery). This increase in determinacy in the case of perception comes from the sensory stimulation (for some more wrinkles, see Fazekas and Nanay 2021): if I am attending to the color of the curtain in the top-left window of the building in front of me, this color will be more determinate than it was when I was not attending to it. This difference in determinacy is provided by the world itself—I can just look: the exact shade of the curtain's color is there in front of me to be seen.

In the case of mental imagery, this difference in determinacy, in contrast, is not provided by the sensory stimulation, for the simple reason that there is no direct causal link between sensory stimulation and mental imagery: if I visualize the house I grew up in and you ask me to tell you what exact color the curtain in the top-left window was, I can shift my attention to that color and I can even visualize the exact color of the curtain. However, this increase in determinacy is not provided by sensory stimulation (as I don't have any), but rather by my memories (or what I take to be my memories) or my beliefs or expectations.

Clarifications: First, in the modified Perky experiments (Segal 1972), the picture projected on the wall and the image the subjects were asked to visualize were different, resulting in an interesting juxtaposition of the two images. In this case, it would be difficult to tell whether the subject perceives or has mental imagery—she does both (see Trehub 1991 for some further experiments involving mixed perception/mental imagery). The fact that according to my account the structure of the content of these two mental episodes is the same makes it easy to account for mixed cases like this (see Chapter 9 on such mixed perception/mental imagery cases). The increase in determinacy is provided by both the sensory stimulation and our memories/beliefs in these cases.

Second, my claim is not that attention makes the attended property more determinate, but that it makes *or tries to make* the attended property more determinate. It does not always succeed. And this is so both in the case of perceiving and in the case of visualizing. When I attend to something that I see in the periphery of my visual field and I cannot move my eyes, the shift of my attention tries to make the properties of this object more determinate, but because this object is, and continues to be, in the periphery of my visual field, I will not succeed (at least not as long as the object is far away enough from the fovea). The same goes for mental imagery. If I am asked to visualize my first credit card and attend to its color, I may just simply not remember and in this case, although attention tries to make the attributed property more determinate, it may not succeed.

In short, the difference between perceptual content and the content of mental imagery is not a difference between the structure of these contents—they have the very same structure. The difference is between the dynamics of how the represented properties, and, importantly, the determinacy of the represented properties, change in response to the allocation of attention.

It is important to emphasize that the claim is not that the properties attributed in the content of mental imagery are less determinate than the ones that are attributed in perceptual content. The properties that constitute the content of mental imagery can be very determinate indeed—and most of the properties that constitute perceptual content are not particularly determinate (see Dennett 1996). The claim is that the difference between the content of these two mental states is the way this determinacy comes about.

We have seen that not everyone is on board when talking about the content of perceptual experiences. Some think that perceptual experiences just don't have content. Or even if they do, this content definitely does not explain the phenomenal character of this experience. These "relationalists" will not accept any version of the explanatory scheme I outlined here.

However, as we have seen, there is little disagreement about the existence and importance of early cortical perceptual representations. We have also seen that these representations are present both in perception (that is, early cortical processing that is directly triggered by sensory input) and in mental imagery (that is, early cortical processing that is not directly triggered by sensory input). So a somewhat distant relative of the explanatory scheme I considered above would be to explain the similarity of the phenomenal character of perception and of mental imagery with reference to the similarity of the content of these early cortical perceptual representations.

Recall that the standard explanation of the phenomenal similarity between perception and mental imagery was in terms of the similarity of the content of perceptual states and of mental imagery. What I am proposing now is very different: the relevant content is not that of our overall perceptual state and our overall mental imagery. It is the content of all the subpersonal representations of early cortical perceptual processing (see Martinez and Nanay forthcoming). Nonetheless, this is still an explanatory scheme that explains the similarity of phenomenology in terms of the similarity of content (that is, the content of early cortical representations).

The phenomenology of mental imagery is similar to the phenomenology of perception because there is a similarity of content. But this similarity of content can be cashed out in more detail if we consider the content of a variety of (conscious and unconscious) perceptual representations. The phenomenology of your mental imagery supervenes on the content of various (conscious and unconscious) perceptual representations. And the phenomenology of your perceptual state also supervenes on the content of various (conscious and unconscious) perceptual representations. And given that the content of these representations is very similar in the mental imagery and in the perception case, this accounts for the phenomenal similarity between mental imagery and perception.

To sum up, attention and mental imagery are intertwined in various ways and they are both equally involved in many mental phenomena. For example, they can help us to explain not only how the content of mental imagery differs from perceptual content, but also perceptual expectations (see Judge and Nanay 2021; see also Chapter 12) and top-down influences on perception, a subject I now turn to.

11

Top-Down Influences on Perception and Mental Imagery

One influential debate about perception is about its purity: is perception an encapsulated process that is protected from any kind of top-down influence or is it influenced and modified by top-down information?

What complicates this debate, often referred to as the cognitive penetrability debate, is that it is not at all clear what kind of mental state is supposed to be doing the penetrating and what kind of mental state is supposed to be penetrated. In other words, it is not clear what is "top" and what is "below" in the debate about top-down influences on perception.

Once we clarify these conceptual issues, it seems that there is a wealth of empirical evidence in favor of the claim that there are indeed some top-down influences on perception. But then the question becomes: how does it happen? What is the mechanism by which perception is influenced in such a top-down manner?

And my answer is that if we accept the claim I argued for in Chapter 9 that the vast majority of perceptual states would be a hybrid of sensory stimulation-driven perception and mental imagery and if we add that mental imagery can be (at least partly) determined in a top-down manner, what we should expect is that there will be top-down influences on perception, mediated by mental imagery, given that mental imagery is a crucial ingredient in most instances of perceptual states.

The main source of conceptual confusion concerning debates about top-down influences on perception is that it is not clear what is meant by "perception" in this context. Some (especially philosophers, for example, Siegel 2011; Macpherson 2012; Stokes 2012; but also psychologists, for example, Firestone and Scholl 2014, 2016) take "perception" in this context to be perceptual experience: something we are consciously aware of. If we work with this concept of perception, then the question is whether top-down influences can alter the way we experience a scene—the phenomenal character of our experience: what it is like to perceive this scene.

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Another way of understanding what is meant by "perception" when we talk about top-down influences on perception is perceptual processing and especially early perceptual processing—something neuroscientists (and also most psychologists) worry about. Here the question is whether processing in, say, the primary visual cortex is influenced in a top-down manner.

These two questions are clearly very different—one of them is about phenomenology and the other is about early perceptual processing. And as changes in early perceptual processing are neither necessary nor sufficient for changes in perceptual phenomenology, there is no easy traffic between these two different sub-debates.

I am extremely pessimistic about whether the first of these debates could ever be resolved in a satisfactory manner. One crucial difference between the two positions in this debate is about what is part of our perceptual (as opposed to non-perceptual) phenomenology. Those who argue for the existence of top-down influences on perception (again, understood here as perceptual experience) need to show that there can be two experiences, call them E_1 and E_2 that only differ in that there is a top-down influence in E_2, which is missing in E_1, and that the two differ in their perceptual phenomenology. So the top-down influence results in a difference in perceptual phenomenology. Those who are against the idea of top-down influences on perception (again, on perceptual experiences) can acknowledge that E_1 and E_2 differ only in that top-down influences are present in E_2 but absent in E_1 and they can also acknowledge that E_1 and E_2 differ in their non-perceptual phenomenology—they only need to deny that they differ in their perceptual phenomenology. So the only way of adjudicating between the proponents and the opponents of top-down influences on perceptual experience is by having a very clear distinction between perceptual and non-perceptual phenomenology (Kriegel 2007; Siegel 2007; Bayne 2009; Masrour 2011; Nanay 2011a, 2012c, 2013a).

But we are blatantly missing any such very clear distinction. Take the following example: You're at a dinner party and you're eating what you take to be chicken. Then your host tells you that it is in fact rat meat. Your experience, presumably, changes. The meat tastes different. This may seem to be an indication that your perceptual phenomenology changes—what changes is the way the meat tastes to you. But it might also be that what changed was instead not the perceptual but the non-perceptual phenomenology in this example (that is, the taste itself is strictly speaking the same, but you somehow frame it differently). It is difficult to see what could possibly settle this disagreement. We may be able to tell whether our overall phenomenology changed. But to tell whether this phenomenal change was perceptual or non-perceptual is much more difficult. In other words, if I say that the two experiences differ in their perceptual phenomenology and you deny this, it is not clear how the issue can be decided. Intuitions wildly differ with regards to what phenomenal character counts as perceptual.

And this makes the debate about whether there are top-down influences on perceptual *experiences* a very odd debate. Given that it is not clear what perceptual phenomenology is and how to keep it apart, introspectively, from non-perceptual phenomenology, the question about whether perceptual phenomenology depends on top-down influences relies on this unclear concept of perceptual phenomenology (which is difficult to keep apart from non-perceptual phenomenology by introspective means). It is unclear then how we can make any progress in answering this question—if we take the question about top-down influences to be about perceptual phenomenology.[1]

So, as a result, I take it that the more interesting (and more clearly substantive) debate about top-down influences on perception is about whether early perceptual processing is influenced in a top-down manner. This is what I take to be the question of "top-down influences on perception" in what follows.

Observant readers may have noticed that I have talked about "top-down influences on perception" and not about cognitive penetration so far. There is a reason for this. The term "cognitive penetration" suggests that whatever is doing the penetration is a cognitive state and this is not something I want to be built into the very notion I am analyzing.

When I talk about "top-down" influences on perception, I want to allow for any "top-down" influence—not just those that are labeled "cognitive." And it is not very clear why the label "cognitive" is singled out. "Cognitive" can mean many things. It is sometimes contrasted with "affective," but this is clearly not something we want to do if we are interested in top-down influences on perception as there may be affective influences on perception and they may be as important as (or more important than) non-affective cognitive influences (Schupp et al. 2004; Pessoa and Ungerleider 2005; Schmitz et al. 2009). The term "cognitive" is also often contrasted with "conative," but this is not a useful usage in the present context either as there may be very good reasons to posit top-down influences on perception where it is a desire or an intention that influences our perceptual processing (Nanay 2006; Stokes 2012).

[1] As we have seen in Chapter 3, not everyone agrees that there is such a thing as non-perceptual phenomenology. This disagreement makes the debate about top-down influences on perceptual phenomenology even less straightforward.

Of course, the most straightforward use of “cognitive” may just be one where it is contrasted with “perceptual,” but this oversimplifies things considerably. In fact, one reason why it is better to focus on the debate about whether there are top-down influences on early perceptual processing than on the one about whether there are top-down influences on perceptual phenomenology is that if we focus on the latter debate, the only kind of top-down influence we can talk about is from non-perceptual mental states (typically beliefs) to mental states with perceptual phenomenology (that is, perceptual experiences). But we have seen that addressing any questions about the presence or absence of such top-down influences then requires a very clear distinction between perceptual and non-perceptual phenomenology and we don’t have any such distinction.

If, on the other hand, we consider the debate about whether there are top-down influences on early perceptual processing, we get a more nuanced picture. The question of top-down influences is no longer a yes or no question, as in the case of the phenomenology interpretation (either there is cognitive penetration or there isn’t), but a multifaceted one. Maybe the primary visual cortex is influenced in a top-down manner by V2 and V4, but not by our expectations and beliefs. Or maybe it is only influenced by V2. Or maybe also by our expectations and beliefs. All of these claims would assert top-down influences on early perceptual processing (of which we have very strong evidence; see, for example, Gandhi et al. 1999; Murray et al. 2002; O’Connor et al. 2002; Douglas and Martin 2007; Muckli 2010), but it matters a lot what kind of top-down influences they are (see Lupyan et al. 2010; Block 2014; Vetter and Newen 2014; see also Teufel and Nanay 2017 for a detailed analysis of various kinds of top-down influences on early cortical perceptual processing and the differences between those top-down influences that come from within the visual system and those that come from post-perceptual processing).

How can we be sure that we have discovered a top-down influence on perception? Suppose that you vary the state of a higher-level mental process and this leads to changes in the primary visual cortex. Does this count as evidence for top-down influences on perception?

Clearly not. If I turn my head to the left, this will influence the state of my primary visual cortex: the information that gets processed in my primary visual cortex will be very different. Or if I close my eyes, this will have an even more obvious influence on my primary visual cortex. So we need an additional condition: namely, that the sensory stimulation needs to remain constant. If the sensory stimulation (say, the retinal image) is constant, and a change in a higher-level mental process causes a change in a lower-level perceptual process, we have evidence for top-down influences on perception.[2]

This seemingly not very substantive clarification is in fact very important when it comes to attention. Attentional effects are often ruled out of the discussion of top-down influences on perception (Pylyshyn 1999; Siegel 2011). And, at least on some ways of understanding attention, rightly so.

Overt shifts of attention are ones that are accompanied by eye movements. So if the primary visual cortex changes as a result of difference in overt attention, this does not count as a top-down influence because overt attention changes the sensory stimulation and the primary visual cortex changes as a result of this change in sensory stimulation. So we are right to rule out overt attention as a top-down influence on perception (that is, on early perceptual processing).

Covert shifts of attention, as we have seen in Chapter 10, are ones that are not accompanied by eye movements (Posner 1980, 1984; Posner et al. 1984; see also Findlay and Gilchrist, 2003). So we can keep the sensory stimulation fixed and change the covert attention and if this leads to changes in the primary visual cortex, this would indeed count as a top-down influence on perception (Mole 2015; Wu 2017; Stokes 2018). In short, while overt attention should not be considered to be a source of potential top-down influence on perception, covert attention should be taken to be one of the prime examples of such a top-down influence.

Unsurprisingly, in the context of the book, I want to focus on a different kind of mental phenomenon and the role it plays in top-down influences on perception (without dismissing the importance of covert attention), namely, mental imagery.

As we have seen in Chapter 3, some ways of exercising mental imagery are subject to top-down influences: the apple I visualize will look different depending on my template for what apples look like—which, in turn, presumably depends on what kinds of apples I have encountered in my life. If all these apples were red, I am likely to visualize a red apple. We have also seen in Chapter 8 that amodal completion can also be subject to top-down influences. But then if, as I argued, many of the properties of perceived objects are really represented by mental imagery, and the mental imagery that is involved in

[2] Note that this characterization does not cover adaptation effects or perceptual learning, where the sensory stimulation is constant but the change in lower-level perceptual processing is not caused by higher-level mental processes.

this is, in turn, influenced in a top-down manner, what we should expect is that perception is very much subject to top-down influences.

In other words, the importance of mental imagery in everyday perception gives us very strong reasons to allow for top-down influences on perception. We have seen that what we pre-theoretically take to be perception is in fact a mixture of perception and mental imagery. And at least some of the mental imagery in the mix can be (but doesn't have to be) subject to top-down influences. But then it follows that most perceptual states can also be subject to top-down influences.

It is important not to overestimate the scope of this claim: I am not claiming that all perceptual states are influenced in a top-down manner. I'm not even saying that all perceptual states where amodal completion plays any role are influenced in a top-down manner. We have seen in Chapter 8 that while mental imagery plays a role in most perceptual states, there are exceptions—for example simple two-dimensional displays, where the perceptual state is fully determined by sensory stimulation-driven perception.

Further, there are many forms of mental imagery that do not depend on top-down information. The kind of mental imagery our perceptual system uses to fill in the blind spot is one clear example. The perceptual processing of information that would correspond to the blind spot is not directly triggered by sensory input in the visual sense modality because there is no sensory input that would directly trigger such perceptual processing: the blindspot has no receptors. But this perceptual processing is determined laterally by perceptual processing of the sensory information coming from those parts of the retina that surround the blind spot. No top-down influence is needed and we have no evidence that there are any top-down influences on this form of mental imagery.

The picture we ended up with is one where perceptual processes consist of a sensory stimulation-driven and a non-sensory stimulation-driven component (where by sensory stimulation-driven, I mean directly driven by sensory input of the relevant sense modality). In other words, perception consists in mental imagery and stimulation-driven perception. And mental imagery influences the way the stimulation gets processed. In some very rare examples of simple two-dimensional visual displays, the mental imagery component may be missing. But in the vast majority of perceptual scenarios, it is present and it gets combined with sensory stimulus-driven perceptual processing. And in these cases, much of what we take ourselves to perceive we really partly represent by means of mental imagery. And as at least some of these episodes of mental imagery are subject to top-down influences, perception per se can also be subject to top-down influences (see also Dijkstra et al. 2017b for some empirical support).

We have seen that one advantage of talking about top-down influences on perceptual processing over talking about top-down influences on perceptual experience is that it allows for a more nuanced picture of what is the "top" in these top-down influences. So when I argue that many instances of mental imagery can be subject to top-down influences and, as a result, many instances of perception can also be subject to top-down influences, I should say something about what I take to be the "top" in these top-down influences—what these higher-order mental states are that influence mental imagery and by doing so also influence perception.

And one notorious problem in arguing about top-down influences is that the behavioral or neuroimaging data very often underspecify where the information that is used to enrich or specify the bottom-up processing comes from. Take the example of Figure 8 in Chapter 8 on p. 61, which I used as evidence for top-down influences on amodal completion. My explanation was that the fact that we have early perceptual processing of the illusory contours is explained by top-down influences on this instance of visual mental imagery. But someone could object that the information about the horse's illusory contours is not coded anywhere "top." It is coded, the objection would go, in the perceptual system itself. It is true that this information is learned, but it was learned by means of perceptual learning. So our amodal completion is not at all influenced in a top-down manner in this example—it is influenced, laterally, by information present in the perceptual system.

I think this is a valid move against a large number of claims about top-down influences on perceptual phenomenology. But it is not a valid move against claims about top-down influences on early perceptual processing. While it is very difficult to tell whether the information about the illusory contours of the horse is something that is coded in the perceptual system, what we can say with great certainty is that this piece of information is not coded in the primary sensory cortex. So if this information (about the illusory contours of the horse shape) influences the way the primary visual cortex functions (as is the case when it comes to amodal completion), we do have good reason to conclude that this influence is indeed top-down: it comes from somewhere further up from the primary visual cortex and it influences the primary visual cortex. A genuine top-down influence. Just how far up this information comes from we can leave open. In the case of the Kanizsa triangle, we have evidence that the completion of the illusory contours in the primary visual cortex is subject to top-down influences from the secondary visual cortex (Qiu and von der Heydt 2005). This still counts as a top-down influence on early perceptual processes.

Some champions of cognitive penetration (with emphasis on "cognitive") would, no doubt, be disappointed with this version of top-down influences on perception as nothing I have said here shows that very high-level mental states, such as explicit beliefs would have top-down influences on early perceptual processing. We have seen that mental imagery can be more or less top-down driven. But then it is possible that when it is more top-down driven, it influences relatively late stages of perceptual processing, whereas when it is less top-down driven, it influences relatively early stages of perceptual processing. Nothing I have said here rules out this possibility.[3]

[3] This is an important difference between my account of the relation between mental imagery and "cognitive penetration" and Fiona Macpherson's. Macpherson argues that the cognitive penetration of (color) perception is always mediated by "non-perceptual states with phenomenology" (Macpherson 2012, pp. 49–58). This category of "non-perceptual states with phenomenology," for Macpherson, encompasses imagination, dreaming, and hallucination (Macpherson 2012, p. 50)—in this sense it might be thought to be similar to what I mean by mental imagery (which also encompasses these three mental processes). But for Macpherson these states are necessarily conscious and mediate cognitive penetration by virtue of their phenomenal character (Macpherson 2012, pp. 51–3)—which is very much against the spirit of my own proposal.

12
Temporal Mental Imagery

I defined mental imagery as perceptual representation that is not triggered directly by sensory input. If there is no sensory input and the early cortical representation still happens, this is mental imagery. If there is sensory input, but it does not directly trigger this early cortical representation, this still counts as mental imagery.

How can we apply this definition to the temporal case? Suppose that you have a sensory input, say a triangle in the middle of your retina, which then directly triggers a perceptual representation, say a V1 representation of an isomorphic triangle in the middle of your visual field. This is not mental imagery. We know a fair amount about the time frame of this activation. Visual sensory stimulation reliably leads to V1 activation in 30 milliseconds (see Rolls and Tovee 1994; Thorpe et al. 1996; Rauschenberger et al. 2006 for summaries). So if you have visual input at time T_1 and then at T_1 + 30 milliseconds, you have V1 activation, this is sensory stimulation-driven perception.

In contrast, if you have the same sensory input (of the triangle) at T_1, but the tokening of the perceptual representation happens either earlier or (significantly) later than T_1 + 30 milliseconds, then this would count as temporal mental imagery, because this perceptual representation is not triggered directly by the sensory input. If it happens earlier than T_1 + 30 milliseconds, then it is temporal mental imagery because the perceptual representation is not triggered by the sensory input (as causation has a temporal dimension). And if the tokening of the perceptual representation happens (significantly) later than T_1 + 30 milliseconds, then it is temporal mental imagery because it is triggered by the sensory input indirectly, that is, by the mediation of another representation (which, in turn was tokened at T_1 + 30 milliseconds).

A helpful shortcut to assessing whether perceptual processing is sensory stimulation-driven perception or temporal mental imagery would be to appeal to the concept of temporal correspondence. If the perceptual representation is triggered by temporally corresponding sensory input (where "temporally corresponding" means "being preceded by 30 milliseconds"), it is sensory stimulation-driven perception. If this temporal correspondence is missing, it is temporal mental imagery. We have seen in Chapter 1 that spatial

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correspondence is a good guide to assessing the directness of the causal link between sensory input and perceptual processing, at least when it comes to some properties like shapes. In this chapter, for the sake of the simplicity of exposition, I will use a similar maneuver involving temporal correspondence.

If we have V1 activation but no visual sensory stimulation that would have preceded this V1 activation by 30 milliseconds, then there is no temporal correspondence. The perceptual processing (in V1) is not triggered by temporally corresponding sensory stimulation. We have an instance of temporal mental imagery. Temporal mental imagery is perceptual processing that is triggered by spatially corresponding sensory stimulation in the appropriate sensory modality, but where this perceptual processing does not temporally correspond with the incoming stimulation.

In other words, even if there is spatial correspondence between the sensory input and perceptual processing, if the temporal correspondence is missing, we have a form of mental imagery: temporal mental imagery. For instance, in the visual case, if the perceptual processes retinotopically correspond to the sensory stimulation but fail to correspond to the timing of the sensory stimulation, we have temporal mental imagery.

Temporal correspondence can fail in two directions: the perceptual processing may come earlier than it should—this is a case of "predictive temporal mental imagery." Or it may come later than it should—this would amount to "postdictive temporal mental imagery" (see Viera and Nanay 2020 for more on both predictive and postdictive temporal mental imagery).[1]

One important advantage of this way of thinking about temporal mental imagery is that it can help us to explain a recurring theme in thinking about the experience of time. This was summarized memorably by William James, who writes: "the practically cognized present is no knife-edge, but a saddle-back, with a certain breadth of its own" (James 1890, p. 609).

In other words, our experiences have a certain temporal thickness. But what does this mean exactly? Here is a more contemporary philosophical spin of what James had in mind: "The dynamic content of our experience at short timescales is metaphysically dependent on the content of experience over longer timescales" (Phillips 2011b, p. 808).

[1] A lot has been said in the philosophy of perception about the case of seeing a long-extinguished star. We see it now, but the star no longer exists. It is important to stress that this would not count as an instance of temporal mental imagery. While there is a time delay in both the case of seeing a distant star and in (postdictive) temporal mental imagery, in the latter case, this time delay is between the retina and the early cortical representations, whereas in the former case, the time delay is between the star and the retina. Seeing a long-extinguished star is not temporal mental imagery.

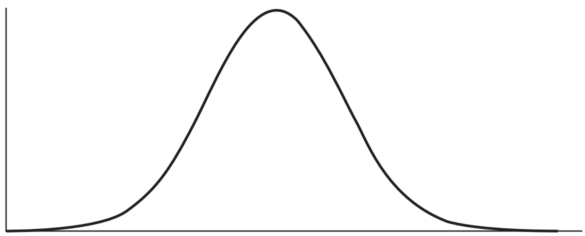

Figure 10 The "saddle-back" of temporal perception

So when we have an experience of, say, watching a football fly through the air and bounce off the goalpost, our experience should not be characterized as the sequence of dimensionless point-like experiences. Rather, our experience of the ball right now somehow represents the ball a split second ago and also represents where the ball would be in a split second. This phenomenon is often described, following James, as the "specious present."

Here is the saddleback William James talks about (Figure 10—note that the two flanks of the bell-shape are not necessarily symmetrical). The middle of the saddle would be the present moment. But we somehow represent the two flanks of this bell-shape as well. The question is: how?

This raises some deep issues about the nature of perception. How is it possible to perceive something that is not present? The ball a split second ago is no longer present. And the ball in a split second is not present yet. According to an influential line of thought in philosophy, we can only perceive what is there to be perceived (for example, Grice 1961). But when it comes to time, only the present is present. So the past, let alone the future can't be perceived.

There are various sophisticated ways of dealing with this problem (for example, extending the temporal dimension of not just the content, but also the vehicle of perceptual representations, see Phillips 2011b. But if we take the concept of temporal mental imagery seriously, then there is no need to complicate things unnecessarily.

We represent the flanks of the bell-shape by means of temporal mental imagery. We know that the early cortical processing of a temporal event has a much wider temporal profile than the retinal event. So some of this perceptual processing will be triggered by corresponding sensory stimulation (the middle), but most of it will not be. It will count as temporal mental imagery, where the early cortical processing is not triggered by temporally corresponding sensory stimulation. It is triggered by sensory stimulation that is either too early or too late.

The further away we veer from sensory stimulation-driven perceptual processing (the middle of the saddle shape), the bigger role temporal mental imagery will play. This could be thought of as the temporal equivalent of the claims I made in Chapter 3 about peripheral vision. In the case of peripheral vision, the part of the scene that is in the fovea is represented by means of sensory stimulation-driven perception, but the further away a part of the scene falls from the fovea, the more significant role mental imagery has in representing it. Similarly, in the case of temporal mental imagery: the present is represented by means of sensory stimulation-driven perception, but the further we depart from the present (either in the direction of the future or in the direction of the past), the more significant role temporal mental imagery plays. The specious present is a hybrid perception/mental imagery state.

This way of thinking about the specious present can help us to make progress in the debate about the perception of time. Suppose that you experience an event with two temporal parts, A and B, where B follows A. What can we say about our experience of these two temporal parts?

There are two dominant philosophical theories that aim to answer this question, extensionalism and retentionalism. According to extensionalism, the experience of this event consisting of two temporal parts A and B is decomposable into the experience of A and the experience of B. And the temporal extension of the vehicle matches the temporal extension of the content (Dainton 2008; Hoerl 2009; Phillips 2011b). Roughly, first you have vehicle (A) with content (A) and then you have vehicle (B) with content (B).

The alternative, retentionalist view denies both of these claims: the experience of the event consisting of two temporal parts A and B is not decomposable into the experience of A and the experience of B. And the temporal extension of the vehicle does not need to match the temporal extension of the content (Broad 1923; Lee 2014).

Without addressing the strengths and weaknesses of these two alternative theories, it needs to be pointed out that my view could be thought of as a mix and match between these two established views. Just like the extensionalist, but unlike the retentionalist, I claim that the experience of the event consisting of two temporal parts A and B is decomposable into the experience of A and the experience of B. But like the retentionalist, and unlike the extensionalist, I claim that the temporal extension of the vehicle does not need to match the temporal extension of the content.

I have been using the term "experience" in the last couple of paragraphs because the proponents of extensionalism and retentionalism are mainly interested in conscious perception of time, or temporal experience, but as with all perception, time perception may also be conscious or unconscious, so I will rephrase the two claims as follows: the representation of the event consisting of two temporal parts A and B is decomposable into the representation of A and the representation of B. And the temporal extension of the vehicle of these representations does not need to match the temporal extension of the content.

The first claim was that the representation of the event consisting of two temporal parts A and B is decomposable into the representation of A and the representation of B. The main novelty of my account, in comparison with extensionalism, is that one of these representations is mental imagery. When A is happening, it is represented by means of sensory stimulation-driven perception, whereas B is represented by temporal mental imagery. And when B is happening, it's the other way round: B is represented by means of sensory stimulation-driven perception, whereas A is represented by temporal mental imagery.

The second claim was that the temporal extension of the vehicle of these representations does not need to match the temporal extension of the content. The extensionalist move of spreading out not just the content, but also the vehicle of temporal representation (or, as they would say, temporal experience) was motivated by the consideration outlined above, namely that perception can't represent something that is not (temporally) present. So when A is happening, we can't perceptually represent B (which hasn't happened yet). And when B is happening, we can't perceptually represent A (which has already happened). The extensionalist solution to this problem is to posit a series of perceptual states that each represent the temporal parts of the event. This solution comes with a price (see Lee 2014; see also the classic objections in Dennett 1991).

But if we take the role of temporal mental imagery in time perception seriously, we do not need to posit temporally extended vehicles (with all the problems this entails). While perception may or may not represent only the present, mental imagery can clearly represent something that is not present. Importantly, temporal mental imagery can represent something that has just happened or that is about to happen. That is the reason why my account does not require that the temporal extension of the vehicle of temporal representations match the temporal extension of their content. Some proponents of retentionalism insist (as a critical point against extensionalism) that our prior sensory responses to the world must leave behind traces in the current state of the perceptual system that can be usefully integrated with the current incoming sensory signals (Lee 2014). My account identifies what these left-behind traces actually are: they would amount to temporal mental imagery.

Temporal mental imagery can represent the past or the future. I will go through a number of examples where it represents the past in Chapters 20 and 21. But I want to give a taste of what it amounts to when temporal mental imagery represents the future (see also Moulton and Kosslyn 2011).

We have seen that prior expectations of a specific stimulus evoke a feature-specific pattern of activity in V1, similar to that evoked by corresponding actual stimulus (Kok et al. 2014, 2017). The finding I want to focus on is about how the beginning of a familiar sequence triggers a time-compressed wave of activity of the rest of the familiar sequence in V1 (Ekman et al. 2017).

In this study, the experimenters familiarized subjects with a particular dot sequence (a dot moving from the top-left of a monitor to the top-right) and using high-speed fMRI they were able to successfully measure activation in V1 for retinotopic locations corresponding with the incoming sensory stimulation. In this way, they were able to map out the trajectory of the dot sequence in V1. They then scanned the visual cortices of subjects in two distinct conditions. In the control sequence they presented subjects with an initial display in which the dot was located at the end-location of the familiarization sequence (that is, the dot was shown in the top-right). And there was activation in V1 in the location of the presented stimulus. In the *preplay* condition, in contrast, subjects were presented with an initial display in which the dot was located at the start location of the familiarization sequence (that is, the dot was shown in top-left). Interestingly, in this condition subjects showed V1 activation that amounted to a time-compressed trajectory of the entire familiarization sequence. That is, V1 encoded a dot moving from the top-left to the top-right of the display. The response was time-compressed in the sense that the cortical processes traced out the expected trajectory of the dot more quickly than they would if they were responding to the actual dot sequence. Furthermore, it was shown that when this cortical pre-play was elicited by the initial dot display, the subsequent detection performance for the location of the dot along that trajectory was enhanced.

In this case, we have predictive (or anticipatory) temporal mental imagery in that we have early cortical perceptual processes that do not temporally correspond to the relevant sensory stimulation. The V1 activity occurs *prior to* the relevant sensory stimulation (see also De Lange et al. 2018 on how expectations modify early cortical processing, both before stimulus onset and after; see also Diekhof et al. 2011, who call this "anticipatory imagery"). Here the temporal mental imagery represents what is about to happen. Chapters 20 and 21 are about cases where the temporal mental imagery represents what has happened.[2]

[2] An interesting case where forward-looking and backward-looking temporal mental imagery combines is sequence memory (see Allen et al. 2014 for a summary). When remembering a tune, for example, what we remember is which notes will follow which ones: we do not remember the entire sequence when we remember the first note. Rather, at each point of the recall of the sequence, we only remember the next couple of notes in the sequence. This would amount to the backward-looking temporal imagery of a forward-looking temporal imagery sequence.

PART III
MULTIMODAL PERCEPTION

13

Multimodal Mental Imagery

There is a lot of recent evidence that multimodal perception is the norm and not the exception—our sense modalities interact in a variety of ways (see Sekuler et al. 1997, Vroomen et al. 2001; Bertelson and de Gelder 2004; Spence and Driver 2004 for summaries; and O'Callaghan 2008a, 2011 as well as Macpherson 2011 for philosophical overviews). Information in one sense modality can influence and even initiate information processing in another sense modality at a very early stage of perceptual processing (even in the primary visual cortex in the case of vision, for example; see Watkins et al. 2006).

A simple example is ventriloquism, which is an illusory auditory experience influenced by something visible (Bertelson 1999; O'Callaghan 2008b). It is one of the paradigmatic cases of crossmodal illusion: We experience the voices as coming from the dummy, while they in fact come from the ventriloquist. The auditory sense modality identifies the ventriloquist as the source of the voices, while the visual sense modality identifies the dummy. And, as it often (not always—see O'Callaghan 2008b) happens in crossmodal illusions, the visual sense modality wins out: our (auditory) experience is of the voices coming from the dummy.

More generally, early cortical processing in one sense modality can be triggered, in the absence of sensory stimulation in this sense modality, by crossmodal influences from another sense modality (Calvert et al. 1997; Zangaladze et al. 1999; James et al. 2002; Pekkola et al. 2005; Ghazanfar and Schroeder 2006; Mast et al. 2006; Martuzzi et al. 2007; Hertrich et al. 2011; Kilintari et al. 2011; Hirst et al. 2012; Iurilli et al. 2012; Muckli and Petro 2013; Chan et al. 2014; Vetter et al. 2014). These are *bona fide* examples of perceptual processing that is not directly triggered by sensory input in this sense modality.

When I am looking at my coffee machine that makes funny noises, I perceive this event by means of both vision and audition. But very often we only receive sensory stimulation from a multisensory event by means of one sense modality. If I hear the noisy coffee machine in the next room, that is, without seeing it, then the question arises: how do I represent the visual aspects of this multisensory event?

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I argue that in cases like this one, we have multimodal mental imagery: perceptual processing in one sense modality (here: vision) that is triggered by sensory stimulation in another sense modality (here: audition). Multimodal mental imagery is neither a rare nor an obscure phenomenon (see Nanay 2018a for an overview). The vast majority of what we perceive are multisensory events: events that can be perceived in more than one sense modality—like the noisy coffee machine. In fact, there are very few perceived events that are not multisensory in this sense. And most of the time we are only acquainted with these multisensory events via a subset of the sense modalities involved—all the other aspects of these multisensory events are represented by means of multimodal mental imagery. This means that multimodal mental imagery is a crucial element of almost all instances of everyday perception.

More slowly: Most of what we perceive, we perceive with more than one sense modality. I call sensory individuals that can be perceived with more than one sense modality multisensory individuals.[1]

As we have seen in Chapter 6, different sense modalities may have different sensory individuals. In the case of vision, the debate is about whether the sensory individuals of vision are ordinary objects or spatiotemporal regions. And in the case of audition, the debate is between those who take sensory individuals to be sounds and those who take them to be ordinary objects (or maybe events). Similarly for olfaction: odors or ordinary objects? And it is not clear what exactly "ordinary objects" are supposed to be either. To make things even more complicated, we perceive some individuals both by vision and by audition (and maybe also by olfaction).

So, for simplicity, I will just say that what we perceive are individuals. Just what kind of individuals they are, I want to leave open. Events are individuals and so are entities. What interests me here is what happens if we perceive individuals that can be perceived with more than one sense modality. I call these sensory individuals multisensory individuals. Note the difference between the terms "multisensory" and "multimodal," as I use them. Multisensory merely means something we can perceive by two or more sense modalities. Multimodality will have to do with the interaction of these senses—something not at all presupposed by the concept of multisensory. Further, when I talk about perception in this context, what I mean is perception that is not necessarily conscious. So, multisensory individuals are the individuals we represent

[1] The mereology of multisensory individuals can get tricky. If one takes the sensory individuals of auditions to be sounds and of olfaction to be odors, then the multisensory individual would be some kind of mereological sum of the sound, the odor and the ordinary object. See O'Callaghan 2015a for a good summary of the options here.

perceptually (consciously or unconsciously) as having properties by means of more than one sense modality.

The question is this: what happens when we perceive multisensory individuals? This should be a central question for any account of perception, given that most of what we perceive are multisensory individuals. People are multisensory individuals—we can see them, hear them, smell them, touch them, maybe taste them too. And the same goes for most of the objects and events around us.

Note the reference to abilities in the way I characterized multisensory individuals: just because we can perceive something with more than one sense modality, it doesn't mean that we do so. Very often we perceive multisensory individuals with one sense modality only. And this is where mental imagery again plays a crucial role.

Multimodal mental imagery is mental imagery that is triggered by sensory stimulation in another sense modality (see Lacey and Lawson 2013 for a variety of examples).[2] If perceptual processing is directly triggered by sensory input, we get sensory stimulation-driven perception. If it is triggered—indirectly—by sensory stimulation in another sense modality, we get multimodal mental imagery. If it is triggered—indirectly—by something else, we get some other kind of (non-multimodal) mental imagery. In short, multimodal mental imagery is mental imagery in one sense modality induced by sensory stimulation in another sense modality.[3]

One might wonder: Why posit (unconscious) multimodal mental imagery in these cases, rather than just denying that there is any mental imagery at all? The answer should be clear in the light of the definition of mental imagery: even though you might not be aware of it, your early perceptual processing in one sense modality is triggered by sensory stimulation in another sense

[2] Much of this chapter is about the intricate connections between different sense modalities. Nonetheless, in the definition of multimodal mental imagery, I am relying on the difference between perceptual processing in different sense modalities. It is important to emphasize that there is no tension between these two claims—in spite of all the intricate links between the perceptual processing in different sense modalities, we can nonetheless identify what distinctively visual perceptual processing amounts to (and this is consistent, in the context of mental imagery, with more than one sense modality contributing to mental imagery in one sense modality; see Hubbard 2013). Multimodality does not imply that there are no distinct sense modalities. See Chapter 14 for more on this worry.

[3] A brief terminological remark: the reference to multimodality in the label "multimodal mental imagery" does not refer to the multimodality of our phenomenology when we have multimodal mental imagery. What "multimodal" refers to in the name of multimodal mental imagery is the etiology of mental imagery: mental imagery is the product of the interaction between (at least) two different sense modalities. The phenomenal feel of multimodal mental imagery, if there is one, may itself be unimodal, say, purely visual. But it is the outcome of the interaction between vision and another sense modality—it is multimodal in this sense. Another term that is used in the literature to refer to this phenomenon is crossmodal mental imagery, see Spence and Deroy 2013.

modality. And we have strong empirical evidence that this is so (see Calvert et al. 1997; Zangaladze et al. 1999; James et al. 2002; Pekkola et al. 2005; Ghazanfar and Schroeder 2006; Martuzzi et al. 2007; Hertrich et al. 2011; Kilintari et al. 2011; Hirst et al. 2012; Iurilli et al. 2012; Muckli and Petro 2013; Chan et al. 2014; Vetter et al. 2014 for findings in various combinations of sense modalities).

Just a couple of quick examples: Priming subjects with auditory stimuli enhances visual discrimination (Chen and Spence 2011a, 2011b). And if blindfolded subjects listen to different (familiar) sounds, their V1 activity is different (Vetter et al. 2014; the same is true of blind subjects, see Vetter et al. 2020). Subjects were blindfolded and they listened to distinctive sounds—birds chirping, people chattering, cars driving by. And their primary visual cortex was scanned while they were listening to these sounds. The crucial result is that these sounds could be distinguished on the basis of the activities of the primary visual cortex alone. So each time we hear some kind of sound we are familiar with, multimodal visual imagery (in the sense of visual processing triggered by auditory input) gets triggered. More generally, manipulations of the sensory input in one sense modality systematically influence perceptual processing (and often phenomenology) in another sense modality.

Let's go back to the noisy coffee machine. When I am looking at my coffee machine that makes funny noises, this is an instance of multisensory perception—my coffee machine is a multisensory individual. And if I hear the noisy coffee machine in the next room, that is without seeing it, then I represent the visual parts of this multisensory individual by means of multimodal mental imagery.

Given that most of the individuals we encounter are multisensory individuals and given that our perceptual access to these multisensory individuals is rarely absolute (that is, encompassing all relevant sense modalities), this happens very often. Multimodal mental imagery is the norm, not the exception.

I argued in Chapter 9 that the vast majority of perceptual states would in fact be a hybrid of sensory stimulation-driven perception and mental imagery. I used considerations about amodal completion in the argument there, but note that we can make an even stronger case for this claim if we take the multimodal nature of perception into consideration.

Multimodal mental imagery is, in some ways, a generalization of the amodal completion case, and the kind of mental imagery that is involved is similar to the mental imagery involved in amodal completion. It is involuntary and localizes in one's egocentric space. It is also normally unconscious, but when it is not, it is sometimes (not always) accompanied by the feeling of presence.

Think of multisensory individuals as mereologically complex individuals. They have many parts. Some of these parts are perceived visually, some others are perceived auditorily, for example. If we think of multisensory individuals this way, it makes multimodal mental imagery very similar to amodal completion. Amodal completion is the representation of those parts of a sensory individual we get no sensory stimulation from. And multimodal mental imagery is the representation of those parts of a multisensory individual we get no sensory stimulation from. It's just that different parts of this multisensory individual are accessible by different sense modalities (see O'Callaghan 2015a, 2015b).

Most of the time, when we form mental imagery of those parts of a multisensory individual that we are not acquainted with, this mental imagery will be unattended and unconscious. But if we are really interested in them, we can attend to them. And such attentional shift may even make some part of a multisensory individual conscious. Further, while most of the time the properties we attribute to those aspects of the multisensory individual that we are not acquainted with are very determinable, we can make them more determinate (again, if we attend to them). Multimodal mental imagery, like mental imagery in general, may be attended or unattended, conscious or unconscious, and determinate or indeterminate (see Chapter 10).[4]

Suppose that I am working in my room and I hear footsteps from downstairs (without seeing who is coming upstairs). I represent the complex multisensory event of someone coming upstairs: I perceive the auditory parts of this event and I represent the other (visual, maybe olfactory) parts of this event by means of mental imagery. But my visual and olfactory multimodal

[4] Sensory individuals are individuals we perceptually attribute properties to. This property attribution can be conscious or unconscious. It is important to keep the concept of "sensory individual" apart from that of "perceptual object" (see O'Callaghan 2014; Spence and Bayne 2014). Perceptual objects are individuals we consciously experience perceptually. There is a debate about whether perceptual objects are multimodal (Nudds 2014; Spence and Bayne 2014). It has been suggested that when we perceive multisensory events, our conscious perception is not multimodal: it is unimodal and it oscillates between the, say, auditory and the visual aspects of these events, never consciously perceiving both simultaneously (Spence and Bayne 2014). Against this, others argued that when we perceive multisensory events, our conscious perception is multimodal: we consciously and simultaneously perceive both the auditory and the visual aspects of this event (O'Callaghan 2014). Nothing I have said here takes sides in this debate: everything I have said is compatible with a multimodal or an oscillation view about conscious perception. Regardless of how the different mereological parts of the multisensory individuals show up in consciousness, our (conscious or unconscious) perception represents both simultaneously. And when one of these parts is missing, it continues to do so.

mental imagery may not be conscious—if I am not too concerned with who is coming upstairs. My olfactory mental imagery of the olfactory aspects of the multisensory event whose auditory aspects I am acquainted with is likely to be unattended, unconscious and very determinable. But if the only two people who can come upstairs are my stinky friend X or my other friend, Y, who uses very nice perfume, and if I really want to know which one it is, I will be likely to fill in the olfactory aspects of the multisensory event in a more determinate way (which can prime me to recognize them by smell more quickly) (see Berger and Ehrsson 2013, 2014, 2018 for more on the way mental imagery and multimodal integration interacts).

Here is a nice experimental illustration of this point. The double flash illusion is one of the most striking crossmodal illusions: you are presented with one flash and two beeps simultaneously (Shams et al. 2000). So the sensory stimulation in the visual sense modality is one flash. But you experience two flashes and already in the primary visual cortex, two flashes are processed (Watkins et al. 2006). This means that the double flash illusion is really about multimodal mental imagery: in the case of the second flash, we have perceptual processing in the visual sense modality (again, already in V1) that is not directly triggered by sensory input in the visual sense modality (but by sensory stimulation in the auditory sense modality).

The multimodal mental imagery that is involved in the double flash illusion is conscious, involuntary, accompanied by the feeling of presence, and localizes in egocentric space. It is accompanied by the feeling of presence so much that we do take ourselves to perceive two flashes, not one.

Recall that mental imagery in general can be triggered laterally or in a top-down manner. Multimodal mental imagery is, in some very real sense, triggered laterally: the auditory processing in the early sensory cortices is triggered by visual processing in the early sensory cortices. But this leaves open the question about whether any top-down influences are involved in multimodal mental imagery.

One example of multimodal mental imagery where no top-down influence plays any role comes from the double flash illusion. As we have seen, in this case, perceptual processing in the visual sense modality (starting with the primary visual cortex) is not directly triggered by sensory input in the visual sense modality, because the sensory stimulation in the visual sense modality has only one flash, whereas even as early as the primary visual cortex, two flashes are processed.

Again, this seems like multimodal mental imagery without any top-down influence. The primary visual cortex is influenced laterally by auditory information (namely, the two beeps), but it is not influenced by any top-down information (some recent findings suggest that the picture may be more complicated as previous exposure to similar stimuli may have an important effect on the crossmodal illusion—see, for example, Roseboom et al. 2013). And there is plenty of evidence that many other crossmodal effects happen very early on in perceptual processing and without any top-down interference (Senkowski et al. 2011; De Meo et al. 2015).

But in many other cases of multimodal mental imagery, top-down influences are very important. One widely used and researched example of multimodal mental imagery is seeing someone talking on television with the sound muted. The visual perception of the talking head in the visual sense modality leads to an auditory mental imagery in the auditory sense modality (for example, Calvert et al. 1997; Pekkola et al. 2005; Hertrich et al. 2011; Spence and Deroy 2013).

The auditory mental imagery will very much depend on factors like the lip movements of the person on the screen. But not only these. If this person is someone you know or have heard speak, your auditory mental imagery will be influenced by this information. If it is Barack Obama (someone you have, presumably, heard before), you may "hear" him speaking with his distinctive tone of voice or intonation, for example (but even if you don't, your auditory cortices behave very differently). This demonstrates nicely the importance of top-down influences on multimodal mental imagery.

The fact that we have auditory mental imagery of Obama's voice and not of someone else's voice (or no voice at all), is explained by top-down influences on auditory mental imagery. When I am listening to Obama's speech with the TV muted, my auditory mental imagery is influenced by various past memories of hearing Obama speak and my expectation of how his voice would sound. Just how far up this top-down influence comes from is a question I want to leave open. Wherever it comes from, it is definitely further up from the primary auditory cortex, and that is enough for it to count as a top-down influence. Multimodal mental imagery—like mental imagery in general—can be, but need not be, subject to top-down influences.

14
Sense Modalities in Mental Imagery

Multimodal mental imagery is defined as early cortical processing in one sense modality triggered by sensory stimulation in another sense modality. But what concept of sense modalities is presupposed in this definition and how can we keep apart the different sense modalities? The aim of this chapter is to clarify the concept of sense modalities in understanding multimodal mental imagery and to talk about the differences between mental imagery in different sense modalities as well as the rich interactions between them.

When I define multimodal mental imagery in terms of early cortical processing in one sense modality triggered by sensory stimulation in another sense modality, I do need to rely on keeping apart the two sense modalities involved. I have been using phrases like "visual processing triggered by auditory input" liberally in the previous chapter. But it is important to emphasize that this way of thinking about multimodal mental imagery does not presuppose any specific way of individuating sense modalities (see Stokes et al. 2014 for a good summary on debates concerning the individuation of the sense modalities). And the talk of, say, visual perceptual processing is very much consistent with the plasticity of the brain.

There are well-documented cases where the visual areas are recruited for other (for example, tactile) tasks (Pascual-Leone and Hamilton 2001; Kupers et al. 2011; Kupers and Ptito 2014). Thus, if we (as we should) take the plasticity of the brain seriously, we should not draw the line between different sense modalities in terms of brain regions. It is important to stress that my account of mental imagery in general, and multimodal mental imagery in particular, does not identify perceptual processing in the different sense modalities physiologically, but rather functionally.

In other words, the difference between visual and auditory processing is not a physiological, but a functional difference.[1] Visual processing is not identified in terms of brain areas, but rather in terms of its function. Just what this

[1] In this sense, my proposal is consistent with the so-called meta-modal brain hypothesis, according to which perceptual processing is, say, visual, not because it is the processing of visual input, but because of the nature of this processing, regardless of where the input comes from (Pascual-Leone and Hamilton 2001).

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function would be is something I would like to leave open, but the function of, say, visual processing could be identified as something like helping small-scale spatial discrimination or transforming input in a way that preserves the spatial homomorphism between the input and the perceptual processing. Normally, the part of the brain that does this is located at a very specific part of the back of the brain in the occipital lobe. But even if, because of the plasticity of our brain, some other part does this processing, we can identify it—functionally, not physiologically—as the locus of visual processing. Similar considerations apply to the other sense modalities.

But the distinction between different sense modalities is important for yet another reason for an account of multimodal mental imagery. Mental imagery works very differently in different sense modalities. We have seen some peculiarities of visual mental imagery and its various forms in Chapter 8. But some of these forms of mental imagery (like peripheral vision or the filling-in of the blind spot) are specific to vision. And mental imagery in other sense modalities has different peculiarities.

Take olfaction (Bensafi et al. 2003; Royet et al. 2013; Young 2016, 2020). The primary sensory cortex devoted to olfactory processing is the piriform cortex. So olfactory mental imagery—early perceptual processing in the olfactory sense modality that is not directly triggered by olfactory sensory input—typically involves the piriform cortex (Djordjevic et al. 2005; Bensafi et al. 2007).

One of the most interesting findings about olfactory mental imagery is that it seems to depend on sniffing (Mainland and Sobel 2006). Sniffing results in piriform cortex activation (Sobel et al. 1998; Koritnik et al. 2009). And voluntarily triggered olfactory mental imagery leads to an increased sniffing rate (Bensafi et al. 2003; Kleemann et al. 2009). Further, if the (often involuntary) sniffing is stopped by some artificial means, the olfactory mental imagery is less vivid (Arshamian et al. 2008).

These findings resemble, at least in a very general structural sense, the findings about the importance of eye movements for visual mental imagery. As we have seen in Chapter 7, if eye movements are artificially suppressed, the subject has difficulties conjuring up visual mental imagery. And each time we have visual mental imagery, the micromovements of our eyes track the imagined outlines. So, while we have an important structural similarity between vision and olfaction inasmuch as the mental imagery in both sense modalities (just like sensory stimulation-driven perception) depends on movements of the sense organ, this movement is very different in the two sense modalities (sniffing vs. eye movements).

Further, just as visual mental imagery can be triggered by auditory sensory stimulation and vice versa, reading olfactorily charged words, for example, can also trigger olfactory mental imagery (not just activation of the piriform cortex, which would be a good enough reason to conclude that there is olfactory mental imagery, but often also the conscious experience, see Gonzalez et al. 2006). And olfactory mental imagery can also be triggered by pictures (of food items; for example, see Gottfried et al. 2002, 2004). There is also evidence for the attentional modulation of olfactory mental imagery (Zelano et al. 2005, 2011).

Olfactory mental imagery can change with exposure. Wine experts are better at having wine-related olfactory mental imagery than novices (although they are not better than them at having any other forms of mental imagery, for example, visual imagery). And wine experts also have stronger and more vivid wine-related olfactory mental imagery than olfactory mental imagery that is not related to wine (Croijmans et al. 2020). Our ability to form olfactory mental imagery changes throughout our life.

An especially exciting and underexplored question concerning olfaction is about olfactory amodal completion (Young and Nanay 2022). Amodal completion in olfaction can take three different forms. There is spatial completion—when the olfactory system fills in sparser parts of the odor plumes. There is temporal completion—when the olfactory system anticipates the next step in an odor sequence. And there is feature-based completion—when the olfactory system fills in a missing feature in a usually co-occurring feature-set of odors. The important differences and similarities between visual and olfactory mental imagery make it clear how we should not generalize from one sense modality to another, but also how multimodal mental imagery occurs—in one form or another—in all sense modalities.

I focused on olfaction because olfactory mental imagery is in some ways the least similar to visual mental imagery, but imagery in all sense modalities has its peculiarities. Just one example: When you use any handheld tool (like a hammer or a tennis racket), your somatosensory cortex, which (to put it somewhat simplistically) maps touch on your body, adjusts immediately and localizes touch as if it were coming from a hammer-or tennis racket-shaped extension of your skin (Miller et al. 2019). There is no sensory input coming directly from the tennis racket itself as the tennis racket itself does not have tactile receptors. This, according to my account, would count as mental imagery: early cortical processing that is not directly triggered by sensory input.

Being clear about the differences between different sense modalities in mental imagery is important for yet another reason. One of the most drawn out debates in philosophy of perception is about the so-called Molyneux's question. Molyneux's question may have originated from the twelfth-century Islamic philosopher, Ibn Tufail, who was the author of the first philosophical novel, *Hayy Ibn Yaqzan*, which was translated to English and published in 1671 and was very widely read afterwards in England (Russell 1994). It is called Molyneux's question, because of a question the seventeenth-century Irish philosopher William Molyneux posed in a letter addressed to John Locke in 1688. The question is simple: suppose that a blind subject is familiar with two very differently shaped objects by tactile perception. If her vision were restored would she be able to tell them apart and identify them visually? So our blind subject handles a cube and a sphere and then when her sight is restored and she looks at a cube and a sphere, can she identify one as a sphere and the other one as a cube? And in the centuries that followed, answering Molyneux's question (and, preferably, giving an original answer) has been a challenge for any aspiring philosopher of perception.

Locke himself answered no (Locke 1690, II, ix), as did George Berkeley (Berkeley 1709, p. 41, p. 110; Berkeley 1710, p. 43). Gottfried Leibniz, directly contradicting Locke, said yes (Leibniz 1704/1765, II, ix). Thomas Reid thought the question was ambiguous (depending on whether it is about two-dimensional or three-dimensional shapes, and also depending on the subject's expertise,[2] we get different answers; see Reid 1764/1997, VI, 3, 7, 11). But the discussion of Molyneux's question did not stop in the eighteenth century (see Degenaar 1996). Gareth Evans gave a very original answer defending the Leibnizian positive answer, kicking off a new wave of debates (Evans 1985; see also Jacomuzzi et al. 2003; Schumacher 2003; Noë 2004; Campbell 2005; Levin 2008; Bruno and Mandelbaum 2010). As Matthen and Cohen 2019 point out, there are by now many, somewhat different, versions of Molyneux's questions and not all of these accounts are answering the same question (see also Glenney 2013; Ferretti 2017).

This was a theoretical question in the seventeenth century and it still was at the turn of the century. But it has been suggested that the question can be answered, given today's medical technology, in an empirical manner. And this is exactly what was done more than a decade ago with congenitally blind people after their sight was restored (Held et al. 2011). What these findings show is that after having their sight restored, these subjects could immediately

[2] In fact, there might be a way of interpreting Reid in a way that the dependence on expertise itself correlates with the vividness of the subject's mental imagery (see Reid 1764/1997, esp. pp. 117–18 (6.11)), which would make Reid's view consistent with mine. But I will not attempt to argue for this historical claim here (or anywhere else).

match one visual shape with another one (just as they could match one haptic shape with another one), but they could not match the shapes across sense modalities: so they could not match a visual shape and a haptic shape—which would have been the task at stake in the Molyneux debate. They did manage to acquire this ability in a couple of days, but not immediately after having their sight restored.

So a tempting resolution of Molyneux's question would be that the data is in and it supports the Locke/Berkeley line of thought. Leibniz and Evans lost (see Connolly 2013; Cheng 2015; and Clarke 2016 for some methodological reasons why we might want to resist this temptation though).

I want to question this conclusion and tackle Molyneux's question on the basis of what we know about multimodal mental imagery. My claim is that Molyneux's question doesn't have a generic answer. While this may be a somewhat disappointing take, the reasons for it, concerning individual differences between blind subjects, are hopefully less disappointing.

There are different forms of blindness. Cortically blind people have damaged visual cortices, so they are unlikely to have any form of visual imagery (but see de Gelder et al. 2015). But most blind people's visual cortices are intact. And many of them can visualize, often as vividly as sighted people. They can also have visual dreams. They also have crossmodally triggered mental imagery (conscious or unconscious; see Vetter et al. 2020). And, crucially, these blind people's visual cortex maps spatial locations in a "retinotopic" manner—where the word "retinotopic" is between scare quotes because these subjects, being blind, have no activation on their retina. Nonetheless, their visual cortices represent the space in front of them (and the various—mainly auditory—stimuli in this space) in a way that is structured exactly the way retinotopic representation of space in sighted subjects is structured (Norman and Thaler 2019). In short, many blind subjects have genuinely *visual* mental imagery. Not just some kind of processing in the part of the brain where we find visual processing in sighted subjects. They have the kind of retinotopic visual processing in their visual cortex that sighted subjects do.

Things are a bit more complicated when it comes to the mental imagery abilities of congenitally blind people, that is, people who are blind from birth (see Arditi et al. 1988). Given the brain's propensity to rewire unused parts of the brain in order for them to do something useful, the visual cortex of congenitally blind people is a prime candidate for performing non-visual functions. And it has indeed been found that the visual cortex of congenitally blind people performs a wide variety of functions that are not about the segmentation of the two-dimensional visual input (Bedny 2017). But this is true of the visual cortex in general, very much including the visual cortex of sighted subjects (see Seydell-Greenwald et al. 2020 for an especially impressive study). Further, the crucial results about the "retinotopic" representation of space in front of the subject I talked about in the previous paragraph also hold for many congenitally blind subjects: their visual cortices also localize (auditory) stimulus in the space in front of them in a way that is structured retinotopically (again, in the absence of any retinal input) (Striem-Amit et al. 2015). So while congenitally blind people rarely have the kind of phenomenal feel that accompanies mental imagery in sighted subjects (Cattaneo et al. 2008; Kupers et al. 2011), given the way their visual cortices behave, we can conclude that they can have visual imagery, that is, early visual processing—again, not just processing where V1 is found in sighted subjects, but retinotopically structured visual processing—that is not directly triggered by sensory input.

In short, some blind people (including some congenitally blind people) have visual mental imagery, some others don't (Aleman et al. 2001, see also Villey 1930 for an early account of this). Those who do would also have multimodal visual mental imagery, that is, visual mental imagery that is triggered by sensory stimulation in a different sense modality. So they would have visual mental imagery of the sphere when they handle the sphere—an instance of multimodal visual mental imagery triggered by touch. And they would have visual mental imagery of the cube when they handle the cube. Blind people who lack visual mental imagery would not have any of this.

The question is, which category of blind subjects is Molyneux's question asking about? The cortically blind subjects would have very little chance to identify the cube and the sphere, but those blind subjects who have visual (and multimodal) mental imagery can use their visual mental imagery to identify the cube which they now see by means of sensory stimulation-driven perception. So depending on the state and use of the visual cortices of the Molyneux subjects, we get very different answers.

The Held et al. (2011) experiments, therefore, should be considered to be a partial answer to Molyneux's question: for some blind subjects, the answer to Molyneux's question might indeed be no. But this is not the final answer. While the original Held et al. (2011) study is not very specific about whether the subjects whose sight was restored in this experiment had the ability to have visual imagery before the operation, it is clear from a follow-up study (which studied the visual imagery of these subjects post-operation), that it is unlikely that they had visual imagery before the operation (Gandhi et al. 2014).

In other words, the reason why the Held et al. (2011) experiment (and its follow-up experiments) only gave a partial answer to Molyneux's question is that they are silent about what the answer to Molyneux's question should be in the case of those blind subjects who do have the ability to have visual mental imagery. And, as we have seen, we have good reason to suppose that as the visual mental imagery of these subjects can be triggered by sensory stimulation in another sense modality (crucially for our purposes, in the tactile sense modality), these subjects would have visual mental imagery of spheres and cubes long before their sight was restored. And then, after the operation, they could and would utilize their visual mental imagery of cubes and spheres in visually recognizing cubes and spheres.[3]

It needs to be emphasized that this is an empirical hypothesis that has not been tested. The empirical hypothesis is that if the sight of those congenitally blind people who have visual mental imagery were restored, they would be able to match seen and felt objects. This empirical hypothesis has not been confirmed or disconfirmed and my aim is to give theoretical reasons for why we should expect this empirical hypothesis to be true. But we will only know for sure if we find congenitally blind people who can be demonstrated to have visual mental imagery and restore their sight. In other words, we would need to conduct a Held et al. (2011) style experiment but with close attention to the visual imagery abilities of the experimental subjects.

In short, Molyneux's question gets very different answers depending on the visual imagery abilities of the blind people in question (see Nanay 2020d for a more detailed argument for this claim). "Blind people" is not a monolithic category. To abuse Tolstoy's famous first line of the novel *Anna Karenina*: all vision is alike, but all blind people are blind in their own way (see also Block 2016 for reusing this line for other purposes in philosophy of perception). Lots of things need to come together for someone to perceive visually. Consequently, lots of things can go wrong. There could be problems with the retina, with the main visual pathway, with the lateral geniculate nucleus, with the early cortices, and so on. Any one of these problems would result in blindness, but very different kinds of blindness (Cattaneo and Vecchi 2011).

Treating blindness as a monolithic phenomenon would paper over these crucial differences. And the Molyneux question does just this: it papers over the crucial differences between very different kinds of blindness. When

[3] I will come back to the importance of keeping the visual cortices of blind subjects in use in Chapter 15.

Molyneux's question was originally posed, this might not have been as obvious as it is now (although Diderot's *Letter to the Blind* paints another story). But now we do know this, so there is no reason why we would want to know the answer to a question about "the blind" as there is no such thing as "the blind." The historical misadventures of trying to answer Molyneux's question is a beautiful demonstration of this.

15
Sensory Substitution and Echolocation

The fact that many blind people have visual imagery is especially important (and especially relevant in practical terms) when it comes to the various means by which blind people's navigational abilities can be improved. I will talk about two of these in this chapter, sensory substitution and echolocation, and argue that both substantially involve the subjects' early visual cortices and, as a result, both count as examples of multimodal mental imagery. The same argument also applies to cane use and Braille (see Burton 2003 for a summary), but in this chapter, I will focus on the more surprising results concerning sensory substitution and echolocation.

Blind subjects can be taught to navigate their environment in some sense "visually" by having a camera installed on their body, the images of which are fed into some other sense modality of the subject. The camera is recording images continuously and these images are transmitted to the subject in real time in the tactile sense modality, for example (it can also be done auditorily, see Meijer 1992). So the images are imprinted on the subject's skin with slight pricks as soon as they are recorded (see Bach-y-Rita et al. 1969; Bach-y-Rita and Kercel 2003). A lot of research has been done about this phenomenon in the last four decades (Meijer 1992; Sampaio et al. 2001; Tyler et al. 2003; Auvray et al. 2007; Amedi et al. 2007; Ward and Meijer 2010; Deroy and Auvray 2012 for summaries; and Chirimuuta and Paterson 2015 for a historical overview of the sensory substitution research as well as the chapters in Macpherson 2018 for the philosophical import of these findings).

The surprising results were that the subjects eventually experienced the scene in front of them "visually"—they talked about visual occlusion, for example, and they were very competent at navigating relatively complex terrains. They "spontaneously report the external localization of stimuli in that sensory information seems to come from in front of the camera, rather than from the vibrotactors on their back" (Bach-y-Rita et al. 1969, p. 964).

Philosophers were quick to jump on these findings for philosophical ammunition in the grand debate about how we should individuate the senses (see, for example, Morgan 1977; Heil 1983, 2011; Peacocke 1983; Hurley and Noë 2003; Gray 2011; Farina 2013; but see also Block 2003). The big question

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was: is "vision" that is assisted by sensory substitution really vision? Or is it tactile perception? Some of the classic ways of individuating the senses (Grice 1962; Keeley 2002; Nudds 2004, 2011) come apart in this odd case: if we individuate the senses according to the sense organ involved, then sensory substitution-assisted "vision" would count as tactile perception. If we individuate the senses according to phenomenology, then it seems to be vision.[1]

In the light of the discussion in Chapter 13, this debate is somewhat misguided. Sensory substitution-assisted "vision" is neither vision nor tactile perception, because it is not perception at all. It is mental imagery—multimodal mental imagery. It is visual mental imagery triggered by tactile sensory stimulation (see Nanay 2017a for a longer version of this argument).

If there is activation in the early visual cortices of the sensory substitution subjects, then they have multimodal mental imagery: early cortical activation in one sense modality (vision) triggered by sensory stimulation in another sense modality (touch or audition).

And, as it turns out, there is indeed activity in the primary visual cortex of these subjects that was clearly not triggered by sensory stimulation as the subjects were blind. They were triggered by sensory stimulation in the tactile sense modality (Renier et al. 2005a; Murphy et al. 2016).[2] So, perception by sensory substitution would count as multimodal mental imagery. It is visual mental imagery triggered by tactile sensory stimulation—it is multimodal mental imagery.

It might be objected, as in Chapter 14, that it is unclear whether the visual cortices of blind people are really visual. But as we have seen, we have evidence that the "retinotopic" representation of space in the cortices of these subjects indicates genuine visual processing (and not some kind of non-visual processing in the brain region where, in sighted subjects, the visual cortex is located, see esp. Norman and Thaler 2019; Seydell-Greenwald et al. 2020).

This is not an entirely novel angle in the sensory substitution debate.[3] Renier et al. (2005b) argue that subjects with sensory substitution devices "visualize." This way of thinking about sensory substitution points in the same direction as the one I outlined here, but talking about visualization is

[1] I say "seems to be" because there are disagreements about the exact phenomenology of these experiences.

[2] Multimodal areas are also involved in later processing of sensory substituted vision (Amedi et al. 2007). But what matters in determining whether this is an instance of visual multimodal mental imagery is whether there is early activation of visual areas. See Chebat et al. (2018).

[3] Interestingly, while the academic discussion of sensory substitution does not talk about mental imagery, some of the publicity material of the most widely used sensory substitution device, vOICe, uses this term surprisingly often. See https://www.seeingwithsound.com/imagery.htm.

misleading for a number of reasons (see also Martin and Le Corre's 2015 detailed criticism of Renier et al. 2005b).

First, visualizing is both a voluntary and an intended act and it seems that sensory substitution-assisted "seeing" is neither. Second, visualizing is something that happens in a necessarily top-down manner, whereas sensory substitution-assisted "seeing" is only top-down inasmuch as normal vision is. Finally, the ultimate conclusion of Renier et al. (2005b) is that sensory substitution-assisted "seeing" is in fact seeing. And they use this claim about visualization as a premise for establishing this conclusion (see, again, Martin and Le Corre's 2015 criticism). Talking about multimodal mental imagery, rather than "visualization," in these cases fends off all of these worries.

Further, the empirical evidence that Renier et al. (2005b) use as support for their "visualization" account also supports my multimodal mental imagery account: subjects with sensory substitution devices undergo the Ponzo illusion (see Figure 11): an illusion that is widely held to be a visual illusion (see Nanay 2009b).

If sensory substitution subjects have real-time multimodal mental imagery, this is exactly what we should expect. Their visual perceptual processing is triggered by tactile sensory stimulation. But the perceptual processing happens in the visual sense modality. Thus, we should expect the usual oddities of this visual perceptual processing, like size constancy illusions, to be present—and they are.

Why is it tempting to think then that subjects who are assisted by sensory substitution devices do in fact perceive? One reason may be that the subjects' perceptual processes are involuntary. But we have seen that mental imagery may be voluntary or involuntary. Another reason may be that the subjects

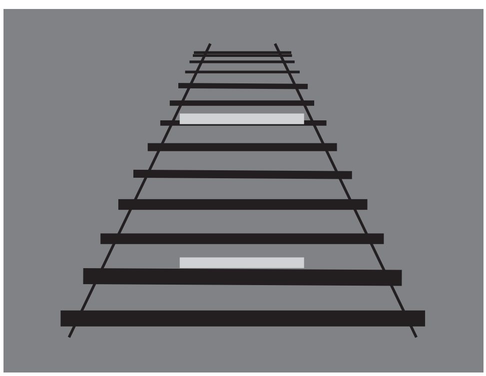

Figure 11 Ponzo illusion

localize the "visual" scene they navigate in their egocentric space—but, again, as we have seen, mental imagery may or may not localize in one's egocentric space. Also, in the reports of these subjects it is not entirely clear whether they have any feeling of presence of the visual scene in front of them. But even if they do, this would be consistent with the claim that they have multimodal mental imagery as mental imagery may or may not be accompanied by the feeling of presence.

An additional reason why one may be tempted to think that whatever sensory substitution can give us must be perception is that it helps us navigate in the world and it is clearly causally influenced, in real time, tracking the change of the visual features of the world around us as they change. How can it possibly be mental imagery then?

It should be clear by now that some ways of exercising mental imagery do track the features of our surroundings in real time and in a causally more- or less-responsive manner (see also Chapter 24 on just how causally responsive these processes are). Amodal completion does, for example. If the cat moves behind the picket fence, my mental imagery that is responsible for the amodal completion changes accordingly. And multimodal mental imagery also tracks the features of our surroundings in real time in a causally (more- or less-) responsive manner: if the noises my loud coffee machine in the next room makes are changing, my multimodal mental imagery of its visual parts also changes. There is nothing about the definition of mental imagery that would exclude the possibility of tracking the changing features of our environment in real time.

A final reason for puzzlement about my claim that these blind subjects have multimodal mental imagery would come from the seemingly obvious assumption that, given that blind subjects can't see, they couldn't have visual imagery either. As we have seen, this is just factually incorrect. It has been known for a long time that blind people also have visual imagery, and sometimes even very salient visual imagery (see Chapter 14 for references). In sensory substitution, this visual mental imagery is triggered by tactile input.

But then there is nothing mysterious about sensory substitution—there are no quick and easy philosophical lessons about the individuation of the senses involved either.[4] Sensory substitution involves perceptual processing and very

[4] There are a lot of exciting empirical questions about sensory substitution, of course; for example, what kind of learning mechanism is responsible for the formation of multimodal mental imagery in the users of sensory substitution devices. The relation to another form of acquired, and somewhat odd, form of multimodal mental imagery, namely, synesthesia is another important new research direction, see Chapter 16.

clearly visual perceptual processing—as the activity in the primary visual cortex shows (and this coincides with the phenomenology of the subjects). And this visual perceptual processing is induced by tactile sensory stimulation—slight pricks on the subject's skin. As clear-cut a case of multimodal mental imagery as it gets. If philosophers want some empirical findings that would help them in the debate about the individuation of the senses, they need to look elsewhere.

Another important phenomenon by means of which visual mental imagery can play a crucial role in visually impaired people's lives is echolocation. Echolocation is a form of perception that bats, dolphins, and some species of whales are known to use. It consists of emitting sounds and given the different rates in which the thus emitted sound waves return to their ears, the animal's brain can gain information about the outline of the features around it.

Echolocation is a well-studied and fairly well-understood phenomenon in bats, dolphins, and some species of whales. But humans can also echolocate, and blind people can as well, some remarkably successfully. The general technique is to emit hardly audible clicks and it is the varying rates of the echo of these clicks that provides information about the features around the subject (Dodsworth et al. 2020).

Echolocation used to be little more than an urban myth, fueled partly by viral videos of blindfolded people cycling or skateboarding while using only their echolocation to navigate their environment, but very few blind people used this mode of perception to get around. This has changed recently as we know more about the mechanism and especially the neuroscience of echolocation (Wallmeier et al. 2013; Kolarik et al. 2014). Further, some non-profit organizations have developed echolocation techniques specifically for blind people, which included methods (for example, alternating louder and quieter clicks) for gaining more complex spatial information (for example, about the scene behind the echolocating subject and about the relative distance between two distal objects, one behind the another).

From our point of view, the crucial findings about echolocation concern the link between echolocation abilities and visual mental imagery. And here a number of different findings point in the direction that echolocation relies on visual mental imagery. First, and most importantly, during echolocation (both in sighted and in blind people), the early visual cortices are active (Thaler et al. 2011, 2014b, Fiehler et al. 2015; Flanagin et al. 2017). Second, people who report more vivid visual mental imagery echolocate better (Thaler et al. 2014a). Third, in sighted subjects, visual stimulation interferes with the ability to echolocate (given that it puts strains on the early visual cortices) (Thaler and Foresteire 2017).

All these results suggest that echolocation is, in fact, a form of multimodal mental imagery. It is early visual processing (in the visual cortices) that is not directly triggered by sensory input in the visual sense modality (given that subjects receive no visual sensory stimulation at all). It is early visual processing that is triggered by auditory input (by hearing the clicks emitted earlier).

This picture is consistent with research on the navigating and localizing abilities of blind subjects. When blind subjects navigate their environment or when they localize auditory or other stimuli, their visual cortices are active (Weeks et al. 2000). This is also true of congenitally blind subjects (Kupers et al. 2010).

As we have seen in Chapter 14, some blind subjects (even some congenitally blind subjects) are capable of having visual mental imagery. And this ability heavily depends on the state of the visual cortices of these blind subjects. If, as I suggested, echolocation is a form of multimodal mental imagery, then the ability to echolocate also depends on the state of the visual cortices of these blind subjects.

And at this point, the theoretical claims of this chapter (namely, that echolocation as well as sensory substitution-assisted "vision" count as multimodal mental imagery) become much more than a categorization issue or a way of merely showing how far the concept of multimodal mental imagery reaches.

The interpersonal variations in these two techniques are huge. Some blind subjects pick up these techniques very quickly and use them efficiently, while others struggle even with the most rudimentary steps. Knowing that both sensory substitution-assisted "vision" and echolocation are forms of multimodal mental imagery could help us to develop techniques for training blind people's visual cortices, which allow for more efficient spatial perception and navigation.

Given the well-demonstrated plasticity of the brain, if a brain region is not used regularly, it is reallocated to do something else. More specifically, if blind subjects have unaffected visual cortices but do not use them, the visual cortices get reallocated (to, for example, auditory or olfactory processing). If they use their visual cortex, it works well, if they don't, it will eventually stop processing visual information, thereby making it impossible for the subject to have visual mental imagery (and, as a result, also making it impossible for them to use their mental imagery for navigational techniques like echolocation or sensory substitution-assisted "vision.")

In short, both of the techniques that help blind people navigate their environment, namely, echolocation and sensory substitution-assisted "vision," rely heavily on the functioning of the early visual cortices. The key insight is that blind subjects can navigate their environment better if their visual cortices are in good condition. But how to achieve that? We can keep the primary visual cortices of blind subjects in shape if we have them use their visual mental imagery. Active reliance on mental imagery prevents the early visual cortices of blind subjects from being reallocated to other brain functions and thereby allows them to make full use of navigation techniques like sensory substitution and echolocation.

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Synesthesia

Some synesthetes hear a musical note and experience it as having a specific color (Ward et al. 2006). Some others experience a specific color each time they see a specific black numeral or letter printed on white background (Sagiv et al. 2006; Tang et al. 2008; Jonas et al. 2011). Synesthesia comes in various different forms: lexical-gustatory synesthesia (strong taste experiences when looking at letters; see Ward and Simner 2003; Jones et al. 2011), colored touch synesthesia (color experiences when touching different things; see Ludwig and Simner 2013), spatial time units synesthesia (spatial experience when thinking about time units like the days of the week or the months of the year; see Smilek et al. 2007; Brang et al. 2011; Jarick et al. 2011). The list could go on.

Given the diversity of phenomena referred to as synesthesia, there are some definitional issues here. Synesthesia has been defined as "stimulation of one sensory domain leading to a perception in another sensory domain" (Harrison and Baron-Cohen 1997), where the "stimulation in one sensory domain" is usually referred to as the "inducer" and the "perception in another sensory domain" is referred to as "concurrent." Others define synesthesia as "the elicitation of perceptual experiences in the absence of the normal sensory stimulation" (Ward and Mattingley 2006) or "stimulation in one sensory or cognitive stream [that] leads to associated experiences in a second unstimulated stream" (Simner 2012). These definitions pick out slightly different sets of phenomena, but from the point of view of this book, it is striking how similar these definitions are to the definition of mental imagery (especially the Ward and Mattingley 2006 definition) or multimodal mental imagery (the other two definitions).

And, unsurprisingly, it has been repeatedly suggested that synesthesia is intricately linked to unusual ways of exercising one's mental imagery, although it is not always entirely clear what the exact connection is. The aim of this chapter is to show that all forms of synesthesia are forms of (often very different kinds of) mental imagery and, further, taking synesthesia to be a form of mental imagery is not just the mere relabeling of the phenomenon, but it has important explanatory advantages, especially when it comes to

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understanding synesthetic experiences that are not triggered by sensory stimulation (see Nanay 2021c for a longer version of this argument).

Synesthesia research makes a distinction between two kinds of synesthetes: associators and projectors (Dixon et al. 2004; see also Ward et al. 2007 for finer distinctions between surface projectors, space projectors, see-associators, and know-associators; and see Edquist et al. 2006 for some further wrinkles). When associators see letters printed in black, they associate colors, but they do not experience the colors of these letters "out there" in their egocentric space. Nor do they experience the letters as having this specific color. Projectors, in contrast, do seem to see colors located where (or sometimes close to where) the black letters are located. While the experience of associators, but not of projectors, is often compared to the experience of mental imagery, I will argue that all instances of synesthesia in fact count as a form of (multimodal) mental imagery.

Synesthesia involves activation of the early cortical areas of the synesthetically activated "sensory streams" (to use the terminology of Simner 2012). So if synesthetes have a color experience when hearing a certain pitch, there will be perceptual processing in their visual sense modality (Barnett et al. 2008). Crucially from our point of view, this perceptual processing happens very early on, in most cases in the primary or secondary visual or auditory cortex (see, for example, Nunn et al. 2002; Hubbard et al. 2005; Jones et al. 2011). As this early perceptual processing is not directly triggered by sensory input, this is an instance of mental imagery.

Nonetheless, not everyone agrees that synesthesia is a form of mental imagery. The synesthetic experiences of projectors are routinely characterized as different from mental imagery. For example, some (for example, Deroy and Spence 2013) claim that the synesthetic experience of projectors is not mental imagery on the basis of the introspective reports of projectors as they say that visualizing feels different from synesthetic experience. Others (for example, Craver-Lemley and Reeves 2013) take synesthesia to be different from mental imagery because they take mental imagery to be necessarily voluntary. We have seen that mental imagery can be involuntary and that different forms of mental imagery can "feel" very different. In other words, these accounts of synesthesia are very much consistent with mine. I will argue below that considering synesthesia to be a form of mental imagery is not a merely verbal move but it has important explanatory consequences.

More generally, there have been intense debates about just what kind of experience synesthetic experience is. Is it a form of perceptual experience

(Cohen 2017; Matthen 2017)? Is it a form of hallucination (Fish 2010)? Or is it some kind of higher-level, cognitive/linguistic experience (Simner 2007)? The problem is that synesthesia doesn't really seem to fit squarely into any of these categories.

The default position about synesthetic experiences is that they are perceptual experiences—maybe somewhat unusual perceptual experiences (see the definitions above from Harrison and Baron-Cohen 1997 and Ward and Mattingley 2006, which explicitly talk about synesthetic experiences as perceptual experiences; and see also Cohen 2017 and Matthen 2017 for summaries). How is the account I am defending here different from this perceptual view? In some ways, the difference is merely terminological, inasmuch as mental imagery is explicitly defined as *perceptual* processing that is not directly triggered by sensory input. In other words, if synesthesia is a form of mental imagery, it is thereby a form of perceptual processing (one that is not directly triggered by sensory input). Hence, the mental imagery view would be consistent with at least some proposals, according to which synesthetic experience is perceptual experience. It would be consistent with Matthen's view, for example, according to which perceptual experience is the "accurate imagistic representation of some occurrence in the world that the subject understands as such" (Matthen 2017, p. 166).

So everybody agrees that synesthetic experience is brought about by perceptual processing. But there is a major distinction between perceptual processing that is directly triggered by sensory input and perceptual processing that is not directly triggered by sensory input. The former is "sensory stimulation-driven perception" and the latter is "mental imagery." As perception per se (as contrasted with perceptual processing) has been widely taken to entail sensory stimulation-driven perceptual processing (after all, it is the causal link via sensory stimulation that ensures the causal connection to the world, which is an essential feature of perception), taking synesthesia to be a result of not just perceptual processing, but sensory stimulation-driven perceptual processing has been the mainstream. In contrast, I will argue that synesthetic experience is not sensory stimulation-driven perception, but mental imagery. I will argue that, by pinpointing that synesthesia is a very specific kind of perceptual process, namely one that is not directly triggered by sensory input, my account provides an explanatorily unified account of synesthesia, which explains the experiences of both projectors and associators as well as less-central cases of synesthesia (where the inducer is not sensory stimulation-driven) as instances of mental imagery.

Here are some further reasons to think that synesthesia is a form of mental imagery. Synesthetes across the board (both associators and projectors) have more vivid mental imagery than non-synesthetes (Barnett and Newell 2008; Eagleman 2009; Price 2009a, 2009b; Meier and Rothen 2013; Amsel et al. 2017; but see also Grossenbacher and Lovelace 2001; Simner 2013 for some wrinkles and exceptions; Chiou et al. 2018 for discussion). And this difference is modality specific—so lexical-gustatory synesthesia subjects have more vivid gustatory mental imagery, but not necessarily more vivid mental imagery in the, say, auditory sense modality (Spiller et al. 2015). Further, synesthesia is very rare among aphantasia subjects (who have no, or hardly any, conscious mental imagery) and relatively frequent among hyperphantasia subjects (who have very vivid mental imagery) (Zeman et al. 2015).

Some instances of synesthesia are multimodal—for example, the pitch and color synesthesia I started the chapter with. Some other instances of synesthesia are unimodal—for example, the grapheme-color synesthesia (of having colored mental imagery of numerals or letters), which seems to be the most widespread form of this condition.

I'll start with multimodal cases. Hearing a certain pitch and having visual synesthetic experience of a certain color is a clear case of multimodal mental imagery: the perceptual processing in the visual sense modality is triggered by sensory stimulation in the auditory sense modality. And seeing a letter and having the gustatory synesthetic experience of a flavor is also a clear case of multimodal mental imagery (where the perceptual processing in the gustatory sense modality is triggered by the sensory stimulation in the visual sense modality).

The question is, then, how this differs from other cases of multimodal mental imagery (like the example of watching Obama's speech on TV muted). The difference is that in non-synesthetic cases of multimodal mental imagery, the crossmodal activation is explained by previous exposure. You "hear" Obama's distinctive tone of voice when you watch his speech muted because you have on previous occasions heard him and seen him (on TV, presumably) at the same time. So when you now only have access to the visual part of this familiar multisensory event, you fill in the familiar auditory part of it.

In the case of synesthesia, the crossmodal activation is not explained by previous exposure. When you see the color purple each time you hear the note of high C, this is not explained by your previous exposure to purple high Cs in the past. Purple high Cs are not familiar multisensory events that you have encountered many times in the past. But that is the only difference between the synesthetic and the non-synesthetic forms of multimodal mental imagery.

And this is true not only of associators (who often report something like involuntary *visualizing* experiences) but also of projectors (who don't). The self-report of many projectors indicates that they take themselves to literally see the color of musical notes. Nonetheless, given that the visual perceptual processing of the color is not directly triggered by visual sensory input (but rather by auditory sensory stimulation), this counts as mental imagery, not perception. The fact that synesthesia subjects can mistake one for the other indicates that the mental imagery involved in synesthesia comes with the feeling of presence (like many forms of mental imagery, see Chapter 3).

So the difference between projectors and associators is merely a familiar difference between different forms of mental imagery—for example, whether it localizes its object in one's egocentric space or not. As we have seen, this is an important distinction between different instances of mental imagery and this distinction also applies within the domain of synesthetic experiences, where one standard way of describing the difference between projectors and associators is that the former's experiences locate the concurrent in the subject's egocentric space, whereas the latter doesn't (Eagleman et al. 2007). Another influential way of keeping the experiences of projectors and associators apart is to ask whether these experiences are accompanied by the feeling of presence or not (on the role of the feeling of presence in various forms of synesthesia, see van Leeuwen et al. 2011; Seth 2014). Some instances of mental imagery are accompanied by the feeling of presence, whereas others are not. Ditto for synesthetic experiences, where this distinction may mark the difference between projectors and associators. In fact, the experience of projectors is, in some ways, more similar to other ways of exercising multimodal mental imagery (like the Obama speech case) with regards to the feeling of presence.

Without taking sides in the complex debates about the phenomenology of projectors and associators (and, again, acknowledging that neither of these are monolithic categories; see Ward et al. 2007 for finer distinctions between surface projectors, space projectors, see-associators and know-associators, etc.), the more general point here is that standard distinctions between different forms of mental imagery can help us understand the difference between projectors and associators.

This explanation puts synesthesia on a continuum with other forms of multimodal mental imagery, ones we experience all the time. And this way of thinking about synesthesia is consistent with a recent set of findings, which shows that synesthesia can be artificially induced in about half of non-synesthetes with only five minutes of sensory deprivation (Nair and Brang

2019). When people who have never experienced synesthesia before are cut off from any kind of sensory stimulation for only five minutes, the result is that, coming out of sensory deprivation, more than half of them experience some form of synesthesia (see also Gatzia and Brogaard 2016 for other examples of artificially induced synesthesia).

If we consider synesthesia to be a form of mental imagery, these findings should not come as a surprise. We know that sensory deprivation induces perceptual processes that are not directly triggered by sensory input, because the subjects get no sensory input whatsoever and because the perceptual system keeps on functioning even in the absence of any stimulation (see Berkes et al. 2011). And these perceptual processes that are not directly triggered by sensory input—that is, this mental imagery—explain why subjects subsequently (that is, after getting out of sensory deprivation) tend to have synesthetic experiences—that is, mental imagery. If we take synesthetic experiences to be plain stimulus-driven perceptual experiences, no such explanation is available. In other words, taking synesthesia to be a form of mental imagery has some immediate explanatory benefits.

This explanatory scheme is only applicable to multimodal cases of synesthesia. But how can we then explain the more widespread unimodal cases of synesthesia, like the most widespread form, grapheme-color synesthesia?

A straightforward way of extending this account of multimodal synesthesia is to say that, just as multimodal cases of synesthesia happen when perceived (or perceptually processed) properties across sense modalities are bound to a multisensory individual in unusual ways, unimodal cases of synesthesia happen when perceived (or perceptually processed) properties in one sense modality are bound to a unimodal sensory individual in unusual ways. So our perceptual system binds shape, size, and color properties to the same unimodal, say, visual, sensory individual. And the reason for this is that most objects we see tend to have shape, size, and color. When we see a banana, for example, our perceptual system tends to attribute properties of all of these three kinds to it (that is, shape, size, and color).

But the perceptual system of some people binds color properties to unimodal sensory individuals in a way that does not correspond to past exposure to unimodal sensory individuals of this kind. Bananas tend to be yellow, so having mental imagery of yellow when presented with a grayscale picture of a banana is something we should expect as long as we have been exposed to yellow bananas in the past (a topic I will come back to in Chapter 18). But the grapheme W does not tend to have a specific color (not even black) and, crucially, our past exposure to the grapheme W is not systematically also an exposure to, say, the color purple. So, given the lack of the past exposure to purple Ws, it is surprising that our visual system would complete Ws with the mental imagery of the color purple.

So, just as we complete multisensory individuals, we also complete unimodal sensory individuals. And just as the completed multisensory individuals can be individuals we do not normally encounter (colors with a certain specific pitch), the completed unimodal sensory individuals can be individuals we do not normally encounter (graphemes with a certain specific color).

I should acknowledge that this is not intended to be a full explanation of all aspects of synesthesia. I haven't said anything about what causes some people and not others to bind properties to these very unusual (multi)sensory individuals. But clarifying how exactly the mental states of synesthesia subjects differ from the mental states of other subjects (that is, in the (multi)sensory individuals that they bind properties perceptually to) should be an important step towards such a full explanation.

It has been suggested that sensory substitution is a form of synesthesia (Proulx and Stoerig 2006; Ward and Meijer 2010; Ward and Wright 2012; Ward 2013; but see Farina 2013 for criticism). We can make sense of this suggestion without being forced to take synesthetic experiences to be similar to the experience of sensory substituted vision (which seem very different indeed) inasmuch as, in my framework, both count as (multimodal) mental imagery: both are explained by early cortical perceptual processing in one sense modality that is triggered by sensory stimulation in another sense modality. But the resulting experiences are very different (as multimodal mental imagery may manifest in very different experiences).

I said earlier in this chapter that taking synesthesia to be a form of (multimodal) mental imagery is not a merely verbal move. It is not just relabeling a familiar phenomenon. Taking synesthesia to be a form of mental imagery can help us understand how synesthetic experience can be triggered in various non-sensory ways.

In the cases of synesthesia I have discussed so far, the synesthetic experience in a specific sense modality is triggered by sensory stimulation (in the multimodal case, by sensory stimulation in a different sense modality). But as it turns out, synesthetic experience can be induced without any sensory stimulation. And, crucially, synesthetic experience in one sense modality can be induced by mental imagery in another sense modality (by sensorily imagining something; for example, see Spiller and Jansari 2008; Spiller et al. 2015).

In other words, it is not only, say, auditory sensory stimulation that can lead to visual synesthetic experience. Auditory mental imagery can also lead to visual synesthetic experience. In other words, early cortical activation in one "sensory stream" can trigger synesthetic experiences in a different "sensory stream," regardless of whether this early cortical activation is triggered by straightforward perceptual input or by perceptually imagining something.

Another example of multimodal mental imagery serving as the inducer of synesthetic experiences in the absence of direct sensory stimulation comes from grapheme-color synesthetes who can also have vivid color experiences, even when they are touching the graphemes (and don't see them) (Newell 2013). This is a puzzling piece of finding on the face of it, but can be explained in a straightforward manner in the present framework: this is yet another instance of synesthetic experience in one sensory stream being triggered by mental imagery in another sensory stream (where this mental imagery is crossmodally triggered by tactile stimulus). The tactile stimulus triggers visual mental imagery of the grapheme and then the visual mental imagery of the grapheme induces the synesthetic experience of color. If we take the concurrent to be mental imagery, this diverse set of synesthetic experiences can all be explained in terms of an early cortical to early cortical influence. Even more importantly, if we consider synesthesia to be sensory stimulation-driven perception, these well-documented forms of synesthesia will not count as synesthesia at all. Taking synesthesia to be mental imagery allows us to explain important, but less-central cases of synesthesia as synesthesia.

Another explanatory perk of taking this route comes from some seemingly odd cases of synesthetic experiences, where the trigger is neither sensory stimulation-driven perception nor perceptual imagining, but rather motoric imagining. The most famous example is swimming-style synesthesia: strong color experiences when seeing, thinking about, or imagining a swimming style—breaststroke, crawl, butterfly, etc. (Nikolić et al. 2011; Mroczko-Wąsowicz and Werning 2012; Rothen et al. 2013).

In the case of swimming-style synesthesia, synesthetic experiences can be triggered in the absence of any kind of perceptual stimulus (it can happen even when your eyes are closed). But then what triggers these experiences? There seem to be two options, both of which would be compatible with the framework according to which synesthesia is a form of mental imagery (again, note that neither of these options are open to those who take synesthesia to be sensory stimulation-driven perception).

The first option is that when you think about, say, breaststroke, you involuntarily visualize a person swimming breaststroke and it is this involuntary visual mental imagery of somebody doing breaststroke that triggers the synesthetic experience (like in the sensory imagination cases; see Spiller and Jansari 2008; Spiller et al. 2015).

The other option is that when you think about breaststroke, you have motor imagery of swimming in breaststroke—you imagine doing the breaststroke. This second option seems to be closer to the subjects' descriptions of their experience. And in this case, it is motor imagery (imagining doing something) that triggers mental imagery in a different "sensory stream" (in this case, color mental imagery). So this is, just like the previous example, an imagery to imagery influence—but the former imagery is motor imagery (see Chapter 27 for more on motor imagery).

In short, if we accept the proposal that synesthesia is a form of mental imagery, we get a form of explanatory unification with regards to the diverse triggers of synesthetic experiences inasmuch as all of them can be explained in terms of early cortical representation → early cortical representation interactions. I argued that the concurrent is mental imagery. And this explains why the inducer is often also mental (or motor) imagery.[1]

[1] There are additional explanatory advantages; for example, taking synesthesia to be a form of (multimodal) mental imagery can explain the complex interactions between synesthetic experiences and some crossmodal illusions, like the double-flash illusion (Shams et al. 2000; Watkins et al. 2006; Roseboom et al. 2013). While synesthesia subjects are more likely to be fooled by crossmodal illusions like the double-flash illusion (which itself relies on multimodal mental imagery), there are some important exceptions and wrinkles (Innes-Brown et al. 2011; Brang et al. 2012; Neufeld et al. 2012; Newell and Mitchell 2016). Given that, according to my account, both synesthesia and the double-flash illusion count as (different) forms of multimodal mental imagery, this interaction (but also the exceptions) can be explained in a straightforward manner, but given the complexity of the issue, I will not do so here.

17
Pain

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.

We have seen in Chapter 9 that what we pre-theoretically take to be perception is really a mixture of sensory stimulation-driven perception and mental imagery. My aim is to argue that the same general picture is also applicable to pain perception. What we pre-theoretically take to be pain perception is also a mixture of sensory stimulation-driven (that is, nociception-driven) pain perception and pain imagery (that is, pain processing that is not directly triggered by nociceptors).

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

In sensory stimulation-driven vision, the light hits our retina and this directly triggers early cortical visual processing. If there is perceptual processing in these regions that is not directly triggered by retinal input, we have to refer to it as visual mental imagery. Similarly, in sensory stimulation-driven pain perception, the nociceptors are activated and this directly triggers pain processing in clearly delineated cortical regions, especially the primary and secondary somatosensory cortices (S1/S2). The somatosensory cortices process tactile and nociceptive information and they do so very differently. So just by looking at the activations of the somatosensory cortices, we can tell whether the processed stimulus was a painful or merely a tactile one (Ploner et al. 2000). Crucially, if there is pain processing in these regions that is not triggered by nociceptors, we have to talk about a specific form of mental imagery: pain imagery.

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Some instances of pain imagery are accompanied by the characteristic (painful) phenomenal character. Some other instances (for example, most cases of imagining that one is in pain; see Derbyshire et al. 2004; Hoenen et al. 2015) are not. We can have activation in the primary and secondary somatosensory cortices 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 pain imagery is not accompanied by any painful phenomenology, it can still influence the phenomenal character of simultaneous nociceptor-driven pain processing.

My claim is that pain perception is a hybrid of nociceptor-driven pain perception and pain imagery. Hence, pain imagery is of crucial importance in understanding pain perception. I will start with examples of pain perception where all we have is pain imagery. These are on one end of the spectrum, where nociception plays no role.

Phantom limb pain (the pain one feels in amputated limbs) 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 pain imagery: the very well-documented activation of somatosensory cortices is 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 limb pain is any less real than nociceptor-driven pain: I am not doubting the reality of phantom limb pain at all when I am describing it as mental imagery.[1] 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, pain imagery is clearly conscious and it is also clearly accompanied by the feeling of presence.

And phantom limb pain is not the only instance of pain that is fully constituted by pain imagery. Another example is the thermal grill illusion. This is

[1] 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 many forms of 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 directly triggered by sensory input, see Chapter 3), 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 (2016a) for a discussion of what form of mental imagery hallucination is.

one of the oldest perceptual illusions involving pain: if the subject touches three bars at the same time, 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 pain 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, in the case of thermal grill illusion, pain imagery is not just one of the ingredients of pain. It is the only ingredient 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 led 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; see also Giummarra and Moseley 2011 for a summary of under what circumstances this experiment could be replicated).

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 cortices without any activity from nociceptors. And what happens in Ramachandran's mirror experiments could be described in the following manner. The experiments triggered subjects' tactile mental imagery of their phantom limb with the help of their visual input (of what appeared to be their phantom limb in the mirror). And this tactile mental imagery is what (causally) modified the pain imagery that is responsible for the phantom limb pain (see also MacIver et al. 2008 and Beaumont et al. 2011 for different ways of using mental imagery in alleviating phantom limb pain; and Moseley et al. 2008 for more details on Ramachandran's mirror technique).

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 visual or tactile imagery (like the experiments in MacIver et al. 2008; Fardo et al. 2015; and Volz et al. 2015), but rather involuntary crossmodally triggered mental imagery. This distinction will play an important role in Chapter 30, when discussing the clinical applications of mental imagery.

One might push back that these are marginal cases of pain perception: phantom limb pain is relatively rare (in comparison with non-phantom limb pain) and the thermal grid is just a clever illusion. Note, however, that much more widespread forms of pain perception also count as pain imagery.

First of all, some forms of referred pain (pain in your knee caused by tissue damage in your thigh, for example) is a clear case of pain imagery: S1/S2 activation *indirectly* triggered by nociception. The S1/S2 processing that corresponds to the referred location is triggered by the mediating S1/S2 processing that corresponds to the location of the actual nociception.[2]

Second, neuropathic pain also counts as pain imagery. Neuropathic pain is caused by nerve damage between the skin and the somatosensory cortices, which lead to chronic pain (which often amounts to a burning feeling), in the absence of nociception. Neuropathic pain is, by definition, pain imagery: the pain processing is not directly caused by nociception because there is no nociception. And given that much of chronic pain (most typically chronic low back pain) involves neuropathic pain (Baron et al. 2016), this means that, for example, chronic low back pain is a hybrid of nociception-driven pain perception and pain imagery. More generally, we have strong empirical reason to believe that nociception-driven pain processing and pain imagery interact at various stages of pain processing (Ploghaus et al. 2003; Koyama et al. 2005; Goffaux et al. 2007; Atlas and Wager 2012; Carlino et al. 2014).

Third, the theoretical framework I am proposing 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

[2] Note that not all referred pain works like this, sometimes it is the neural pathway leading from the nociceptor to S1/S2 that gets scrambled.

depends on our expectations (Koyama et al. 2005; Goffaux et al. 2007; 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 (Ploghaus et al. 1999; Sawamoto et al. 2000; Jensen et al. 2003; Keltner et al. 2006). The crucial finding from our point of view is that the expectations of pain significantly involved sensory cortical areas (S1/S2), which interact with the processing of pain input very early on in cortical processing (Porro et al. 2002; Wager et al. 2004).

Hence, some expectations and anticipations of pain will count as pain imagery, as we have clear evidence that some expectations can activate S1/S2 without any nociceptors being involved (Ploghaus et al. 1999; Sawamoto et al. 2000; Porro et al. 2002; Wager et al. 2004; Keltner et al. 2006). 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 pain imagery as long as the somatosensory cortical areas are not activated at all. But we have plenty of evidence that at least some expectations can activate the somatosensory cortical areas directly, without the involvement of nociceptors. These instances of expectations will count as pain imagery (see also Chapter 12 on expectations that count as mental imagery).[3]

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

I argued that what we pre-theoretically consider to be pain is a mixture of nociceptor-driven processing and pain imagery. This view also has significant consequences for some philosophical debates about the nature and content of

[3] Further, hypnosis induced pain will also count as pain imagery 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.

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—by which I mean that pain processing involves representations. This is not a particularly controversial assumption. A more 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. If pain states are representational states, then the question is: what kind of representational states are they?

There are two major proposals here, corresponding, roughly, to attributing mind-to-world direction of fit, or world-to-mind direction of fit, to pain. Some representations represent the world as being a certain way. Representations of this kind have a "mind-to-world" direction of fit. Some other representations, in contrast, have a "world-to-mind" direction of fit: they do not describe how the world is, but prescribe how the world is supposed to be. The question is, then: does pain have a mind-to-world or a world-to-mind direction of fit? Or, as the question is more often raised in the pain literature, does pain have indicative or imperative content?

According to some, the content of pain states is indicative content: it represents some states of affairs (standardly: the tissue damage or bodily disturbance) 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 bodily disturbance (or the pain experience) is gone). It has a world-to-mind (or desire-like) direction of fit (Klein 2007, 2012, 2015; Hall 2008; Martinez 2010; Klein and Martinez 2018; Barlassina and Hayward 2019).[4] 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—for discussion, see Hall 2008; Martinez 2010; and Bain 2011).

[4] 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"). I bracket some recent controversies about the usefulness and coherence of the term "direction of fit" in what follows (see Frost 2014). See Chapter 25 for more discussion of the concept of "direction of fit."

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 pain imagery also has indicative content: it represents some state of affairs in some way (see Chapter 25 and see also Searle 1983, pp. 13–14; but see Langland-Hassan 2015). 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 pain imagery (mind-to-world). Imperativists would need to say more about how these two claims could fit together (I explore some of the options available to the imperativists in Nanay 2017b—spoiler: none are too promising).

In short, if what we pre-theoretically take to be pain perception is really a mixture between nociceptor-driven pain processing and pain 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 chapter, according to which pain perception is a mixture of nociception-driven perception and pain imagery.

18
Object Files

Perceptual psychology makes a threefold distinction between low-level, mid-level and high-level perceptual representations. Low-level representations track features like contours, colors, and shapes. High-level representations are responsible for categorization and mid-level representations are somewhere in between (see Anderson 2020 on the concept of mid-level visual representations).

How does the concept of mental imagery map onto this hierarchy? It would be tempting to identify mental imagery with low-level perceptual representations, given the emphasis on early cortical processing. But the low-level/mid-level/high-level distinction is about what is represented, not about where in the perceptual system something is represented. In this chapter, I argue that the concept of mental imagery could help us to explain many of the crucial aspects of mid-level vision.

Mid-level vision is neither about features, nor about categories. It is about "objects" (whatever that means; see Carey and Xu 2001; Gao and Scholl 2010; van Dam and Hommel 2010; Green 2018). Mid-level perceptual representations are usually referred to as "object files."

It is difficult to overstate the crucial role the concept of object files has played in vision science of the last forty years. Object files are representations that sustain reference to external objects and keep track of the properties of these objects. The concept of object file, like many of our concepts about the mind, is metaphorical: the general idea is that, just like the police has a file for a criminal that they update with new information as new information about this criminal comes in, our perceptual system opens files about the objects we perceive and then keeps updating these in the light of incoming information.

The concept of object file was introduced in a paper published in 1983 by Anne Treisman, Daniel Kahneman, and Jacquelyn Burkell. They defined object file as "the temporary representation in which the information that pertains to a particular object accumulates and is updated when the object changes" (Treisman et al. 1983, p. 531). An object file is "a temporary episodic representation, within which successive states of an object are linked and integrated" (Kahneman et al. 1992, p. 175).

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A striking feature of these definitions is that it is not clear what makes these object files different from plain perceptual representations. And here many advocates of object files argue that in the case of object files, two representational components are clearly distinguished: one representational component represents the object, without its properties. And the other represents the properties of this object (see, for example, Hommel 2004; Quilty-Dunn and Green forthcoming). Here is one typical statement of this requirement on object files: "the visual system need not know (i.e., need not have detected or encoded) any of their properties [that is, the properties of the objects] in order to implicitly treat them as though they were distinct and enduring visual tokens" (Pylyshyn 2009, p. 267).

The main experimental reason for making this distinction comes from multiple object tracking. Here, the most important experiment shows that the visual system keeps track of a visual object and its properties even through disappearances that are due to occlusion (Flombaum and Scholl 2006; Yi et al. 2008). So a red triangle is moving left, disappears behind the right side of a blue rectangle and then reappears on the left side of the rectangle (maybe even having changed color or shape). The visual system keeps track of the red triangle while it is behind the blue rectangle. But while doing so, its representation of the object (the triangle) must be separate from the representation of its features (like the color red) as the visual system at that point represents only the color blue (as the triangle is fully occluded behind the blue rectangle). Thus, the argument would go, one part of the object file represents the object, the other represents its properties.

In the light of the discussion in the preceding chapters, it should not come as a surprise that the representation of the red triangle behind the blue rectangle is mental imagery. It is early cortical perceptual representation not directly triggered by sensory input. It is not directly triggered by sensory input as the only sensory input at that moment comes from the blue rectangle. The representation of the red triangle is triggered, very much indirectly, by the earlier episode of the red triangle disappearing behind the blue occluder (see the discussion in Chapter 12 on temporal mental imagery).

Further, we know from a variety of findings concerning amodal completion that the amodally completed visual object is represented in early visual cortices and most often already in V1 (see Chapter 8 and Nanay 2018b for a summary). So the occlusion findings are not just consistent with the hypothesis that object files would count as mental imagery, they even predict this claim.

Could we then just conclude that object files constitute yet another perceptual phenomenon that would count as mental imagery? Not so fast. Object files are posited in order to explain a number of visual phenomena besides multiple object tracking. The most important two of these are object-specific preview benefit and trans-saccadic memory. And it is not obvious that mental imagery can do all the explanatory work in these two cases. I take them in turns.

Seeing a stimulus makes us recognize the same (or even just related) stimuli more quickly. But there is a more specific experimental setup that has played a key role in the object file literature. This experimental setup is called the "object reviewing paradigm." You see two circles in different parts of the visual display (one at the top, one at the bottom) and the stimulus (a small picture or a letter) flashes briefly in one of the circles. Then the circles move to different parts of the display, for example, the one at the top moves to the left and the one at the bottom moves to the right.

After this phase, the original stimulus (the small picture or the letter) is flashed again in one of the circles. We have no problem recognizing the original stimulus, regardless of which circle it was originally presented in. But if it was presented in the same circle before, we are quicker to do so. This phenomenon is called the "object-specific preview benefit." So if the letter A was briefly presented in the top circle, which then moved to the left, then we are quicker if the letter A is presented in the circle on the left than if it is presented in the circle on the right.

In other words, the visual system somehow binds the letter A to the circle at the top and then keeps track of this connection as the circle moves around, so that when the A is flashed in the same circle again, it is quicker to recognize it. This is the experimental paradigm that led to the positing of object files. When we see the circle at the top and the circle at the bottom, our perceptual system opens two object files, one for the circle at the top and one for the circle at the bottom. When the letter A flashes in the circle at the top, this information is filed in the object file of the circle at the top. And it remains filed when this circle moves to a different location. As this A is still in the object file of this circle when it is on the left side of the display, when the letter A is flashed again, it is more easily and quickly recognized. This is the classic story about why we should posit object files.

But there are a number of ambiguities in this story. Object files were posited in order to explain the object-specific preview benefit phenomenon. Thus, it leaves open the question about just what kind of representations are the ones that bind the letter A to the circle at the top. The experiments show that there must be some kind of representation that binds the letter A to this circle (otherwise we wouldn't be quicker if the letter A flashed in that circle and not the other one). But they do not specify what kind of representation this may be.

Could this representation be mental imagery? One reason to resist this claim would be to point to findings that allegedly show that abstract, but, in any case, amodal (which, in this context means modality-independent) features need to be represented in these experiments (see Quilty-Dunn 2016, 2020; Green and Quilty-Dunn 2021 for summaries, see also Echeverri 2016).[1] And as mental imagery can't represent features of this kind, object files can't be mental imagery. In order to address this worry, I want to focus on some variations of the object-specific preview benefit experiments.

The first experiment I want to talk about uses the same general setup as the object-specific preview benefit experiments above, but with a minor modification. You see the two circles at the beginning, and a picture of a cat is flashed in the circle at the top. Then the circle at the top moves to the left and the circle at the bottom moves to the right, but instead of seeing the same cat picture again, you hear a meowing sound either from the left (where the circle at the top ended up) or from the right. And the finding is that subjects are quicker to identify the meowing sound as a match with the cat picture if it came from the left (Jordan et al. 2010; see also Zmigrod et al. 2009). The authors conclude that object files (the representations that make this performance possible) "store object-related information in an amodal format that can be flexibly accessed across senses" (Jordan et al. 2010, p. 500; again, amodal here means a format independent of any sense modality, it has nothing to do with amodal completion).

Given that mental imagery does not store information in an amodal format and given that it cannot be flexibly accessed across senses, one might think of this experiment as showing that object files, whatever they are, would not count as mental imagery.

But this would be too quick. We know from a vast amount of studies that sense modalities interact laterally at very early stages of perceptual processing. One nice experimental illustration of this point is the double flash illusion, which we have already encountered in Chapter 13: You are presented with one flash and two beeps simultaneously (Shams et al. 2000). So the sensory stimulation in the visual sense modality is one flash. But you experience two flashes and already in the primary visual cortex, two flashes are processed

[1] See also Beck (2015) for a way of resisting the claim that amodal (again, meaning modality-independent) representations must be propositionally structured. See also Phillips (2020) for some orthogonal issues with Green and Quilty-Dunn's argument.

(Watkins et al. 2006). The processing of the two flashes is almost simultaneous with the two beeps, which shows that this really is a lateral influence (that the auditory information does not go up the auditory hierarchy to form an amodal representation and then trickle down in the visual hierarchy to influence the primary visual cortex).

Here is another experiment I have already mentioned in Chapter 13, which is even more closely related to the Jordan et al. (2010) study. Subjects are blindfolded and they hear various familiar noises (sounds quite similar to the meow auditory stimulus and the ringing phone auditory stimulus used in the Jordan et al. (2010) study), while lying in the fMRI scanner. The important piece of finding is that the activation of the primary visual cortex of these subjects is very different, depending on what auditory stimulus they hear (Vetter et al. 2014).

In the light of these findings (and, again, there are many of these, mapping out all the lateral early influences between all possible sense modalities, see Chapter 13), the Jordan et al. (2010) experiment can be explained in a much more straightforward manner. Only the cat image is stored. But when the subject hears the meowing sound from the left, this promptly activates the early visual cortices (as we have seen from the Vetter et al. (2014) study, even the primary visual cortex). And this cat content-specific activation of the primary visual cortex latches onto the stored early cortical cat image representation on the left, which explains the quicker reaction if the meowing sound comes from the left. No need to postulate anything over and above mental imagery.

Another experiment that could be taken to indicate that mental imagery is not enough to explain all there is to be explained about the object-specific preview benefit modifies the same experimental setup slightly differently. You see the word "fish" flashed in the circle at the top, it moves to the left and then instead of the same word, an image of the fish is presented on the left. Even in this setup we get the object-specific preview benefit (Gordon and Irwin 2000).

This might seem like a rock-solid argument that it must be something like the representation of the abstract concept fish that is triggered by seeing the word "fish" and this abstract concept is stored in the object file and makes it easier to recognize the fish image. And as mental imagery does not store abstract concepts, object files must be very different from mental imagery. So the argument would go.

Again, there is a much simpler and more straightforward explanation. We know a lot about the ways in which linguistic labels change (and speed up) perceptual processes and we also know a fair amount about the timescale of this influence. The crucial piece of finding, both from EEG and from eye tracking studies, is that linguistic labels influence shape recognition in less than 100 milliseconds (Boutonnet and Lupyan 2015; de Groot et al. 2016; Noorman et al. 2018; it should be acknowledged that in these experiments, the onset of the linguistic label preceded the onset of the shape to be recognized). This is a very similar time frame to how long it takes for the stimulus to reach V4 (Zamarashkina et al. 2020)—that is, extremely fast (note that word recognition does take significantly longer, see Hauk et al. 2012).

Crucially, this time frame of less than 100 milliseconds is much, much shorter than the time that would be needed for perceptual processing to reach all the way up to higher-level representations and then trickle all the way down again to the primary visual cortex (see Thorpe et al. 1996 and Lamme and Roelfsema 2000 for the temporal unfolding of visual processing in unimodal cases; and see Kringelbach et al. 2015 for a summary of the relative slowness of non-early cortical processing).

To give you a comparison, we have seen that the amodal completion of simple shapes, like the Kanizsa triangle, is taken to be a lateral (and not a top-down) process on the basis of timing studies, although it happens slightly slower than 100 milliseconds (within 100–200 milliseconds of retinal stimulation (see Chapter 8)). If the 100–200 milliseconds timescale of amodal completion can be explained in terms of lateral influence, without postulating higher-level representations that mediate this process, then the less than 100 milliseconds of the influence of linguistic labelling can also be explained without postulating higher-level representations that mediate this process.

One might wonder how this lateral influence works. Why does a meow trigger the image of the cat? And why does the group of squiggles that looks like the word "fish" trigger the image of a fish? Given the very short time frame, the most likely explanation would be some low-level form of association. But we need to make a distinction between different kinds of associations. We know that if you encounter, say, salt and pepper together a lot, then being exposed to salt (or the word "salt") can trigger the activation of the word or the image of pepper. The same goes for Tom and Jerry or Romeo and Juliet. I will call associations of this kind unbound associations.

Contrast these with what I will call bound associations (for a similar distinction, see Colzato et al. 2006; Hommel and Colzato 2009). If two properties are often co-instantiated in the same object or event, this creates a bound association. I use the term "bound" because if property P and property R have been bound to the same individual a lot before, then instantiating property P can lead to the representation of property R. The association between the shape of the banana and the color yellow is a bound association: we have seen these two properties co-instantiated in the very same object (a banana) a lot before. And, as a result, seeing a banana shape tends to trigger the representation of the color yellow. The association between Tom and Jerry (or salt and pepper) is unbound association as these associated terms have not been bound to the same individual. We know from a number of empirical studies that bound and unbound associations work very differently (see Rappaport et al. 2013 for a summary).

The kind of association that plays a role in the object-specific preview benefit experiments with the meowing sound and the word "cat" is bound association. We have experienced the auditory stimulus of meows and the visual stimulus of cats together a lot. But this is not what explains the effect. Crucially, the auditory property of meowing and the visual property of a cat shape have been bound together before a lot by our perceptual system. Similarly, we have also experienced the word "fish" and the image of a fish together a lot (starting with picture books for toddlers). But, again, this is not what explains the effect. What explains it is that these two properties have also been bound to the same individual before. So this influence from the word "fish" to the image of the fish does not need to be mediated by high-level semantic representations. Nor is it a common or garden semantic association. It is a bound association. This would also explain one of the earliest object-specific preview benefit studies, where the preview is a capital letter and the target is a lowercase letter (Gordon and Irwin 1996, experiment 3). Again, "A" and "a" have been bound to the same sound.

It could be, and has been, argued (see, for example, Quilty-Dunn 2016, 2020; Green and Quilty-Dunn 2021) that association can't be the right explanation, because no effect was found in yet another modification of the object-specific preview benefit experiment, where the preview and the target were words that were supposed to be linked by association. This study used words—for example, the words "doctor" and "nurse"—which are, according to the study, associatively linked (Gordon and Irwin 1996, experiment 4). The association between the words "doctor" and "nurse" is an unbound association. The association between a short word and an image that refers to the same thing and the association between a lowercase "a" and an uppercase "A" are, as we have seen, a bound association. The object-specific preview benefit is not sensitive to unbound associations, but it is very much sensitive to bound associations.

Here is one last piece of evidence against any form of higher-level explanations of object-specific preview benefit. The authors whom the proponents of these higher-level explanations like to cite did conduct a couple of experiments that undercut these higher-level explanations. In the first of these, the preview is a synonym of the target and in the second, the preview is a subcategory of the target (Gordon and Irwin 1996, experiments 5 and 6). So in the first experiment, the subject sees the word "cab" in the circle at the top and then the target stimulus is the word "taxi." In the second experiment, the preview in the circle at the top is a word, like "robin," which is a subcategory of the more general concept that is used as the target stimulus, like "bird." If semantic information were coded in the object file, these experiments would result in object-specific preview benefit: if the amodal and abstract concept of cab or of robin were placed in the object file, it should make the recognition of the synonym of "cab" and the general category of "bird" quicker. But the findings show that there is no object-specific preview benefit in these cases. This indicates that higher-level representations are not involved in the object-specific preview benefit.

To sum up, the object-specific preview benefit paradigm does not justify positing a new kind of representation over and above mental imagery (which is very much consistent with the well-demonstrated dissociation between conscious perception and object-specific preview benefit results; see Mitroff et al. 2005).

The second perceptual phenomenon that is supposed to justify the positing of object files is trans-saccadic memory. When we visually explore the scene in front of us, we move our eyes. And each time we move our eyes, our visual system needs to remap the contents of our visual array. Suppose that you are looking at a fixation cross and there is a triangle at the extreme right-hand side of your periphery. When you move your eyes and fixate on the triangle, the triangle is in your fovea and the fixation cross is at the extreme left-hand side of your peripheral vision.

The transition between these two states is not trivial. At first, the triangle showed up on the right-hand side of your visual field and then it was bang in the middle of it. But your visual system takes this triangle to be the same. So the visual system needs to somehow keep track of this triangle in a way that would assure that its identity is preserved across the radical change in which part of your visual field it shows up.

This phenomenon is called trans-saccadic memory, because the visual system needs to remember from the beginning of the saccade to the end of the saccade what visual objects are where in the visual field. It needs to remember that the visual object that it saccades to, and that is about to appear in the middle of the visual field, is a triangle. In order to explain this phenomenon of trans-saccadic memory, we do need to posit a representation that remains stable from one saccade to another. This is another important reason why people in the empirical literature posit object files. Here is a representative statement: "corrective saccades are executed on the basis of object files" (Schut et al. 2017, p. 138). The question is whether any new and distinctive representations need to be posited to explain trans-saccadic memory over and above representations that we have reason to posit anyway, like mental imagery.

It has been argued that trans-saccadic memory, just like object-specific preview benefit, involves higher-level representations that code for abstract features. I want to go through two key experiments that could be, and have been, taken to support this approach and point out that both are consistent with the claim that the only representation that is needed to account for trans-saccadic memory are mental imagery and other early cortical representations.

The experimental paradigm that is used to examine trans-saccadic memory involves fixating on a cross at the middle of the screen and then presenting a stimulus at the periphery. When the subject saccades to this stimulus, the experimenter changes some features of this stimulus. The subject won't notice this change as it happens while the saccade takes place. The question is, how much this stimulus can change while still counting as the same object. This is tested, as in the case of the object-specific preview benefit experiments, by measuring the reaction time of naming the object in the periphery. If you see a cat picture in the periphery, and you saccade to it, you will be quite quick to name it if it remains the same cat picture. If the experimenters turn the cat picture into a picture of a book during the saccade and you need to name the object depicted after the saccade (you have to recognize it as a book), your reaction time will be slower. The general idea is that you open an object file before the saccade, and you update this very object file after the saccade. If the information after the saccade is very different (as it is when the cat picture is replaced by the book picture), this slows you down.

Here is a twist in this experimental setup. A picture of the lowercase letter ("a") is flashed in the periphery. Then you saccade to this picture, but during the saccade, it is replaced by the uppercase letter ("A") (Rayner et al. 1980, see also Pollatsek et al. 1984). The lowercase letter sped up the recognition of the uppercase letter. This allegedly shows that the information stored in the object file is abstracted away from the specific low-level features of the letters. So, something like an abstract category of the grapheme is encoded in the object file.

As in the case of object-specific preview benefit experiments, these higher-level explanations are unwarranted as a much simpler explanation is available purely in terms of mental imagery. In fact, we can use a very similar explanatory scheme as the one we used in the case of object-specific preview benefit to explain this effect. The only thing that gets encoded in trans-saccadic memory is the image of the lowercase letter ("a"). No abstract category gets encoded. But when the subject is presented with the uppercase letter ("A"), the old image makes it easier to recognize it as a result of the bounded association between the two. None of this requires any representation of any kind of high-level or abstract concept.

The second experiment I need to mention used a slightly more complicated setup. The subject fixated on the cross at the middle of the scene and not one but two stimuli were presented in the periphery, quite close to one another (like the numbers 2 and 3 on a clockface). This was the pre-saccade ensemble of two stimuli. The subject then had to saccade to these and during the saccade these two stimuli were replaced by a single one in between the two old stimuli. The reaction time for naming this new stimulus was significantly lower if the new stimulus was the same as one of the old stimuli. So if a cat image and a book image were presented in the periphery and then during the saccade they were replaced with a single book image, the subject was quicker than if it was replaced by an image of a truck.

In the case of this experiment, the crucial step comes from changing the color of this object. So when the image of a cat and the image of a book were replaced with a single image of a book, the color of this book image changed. The question was whether this color change had any effect on the reaction time. And the results were surprising in that in some cases it had an effect, in others it didn't have any. It depended on whether the color that changed was what is referred to as "diagnostic color"—color that is exceptionally typical of the object kind in question. So if you see a yellow book, the yellow color is not diagnostic—it is not an exceptionally typical trait of books that they are yellow. But if you see a yellow banana, the yellow color is diagnostic—it is an exceptionally typical trait of bananas that they are yellow. Yellow is a diagnostic color of bananas, but not of books.

In those experiments where the presented object in question had diagnostic color, changing this diagnostic color slowed down the reaction time in spite of the fact that the very same image was presented after the saccade (but colored differently). So seeing a yellow banana pre-saccade (as one of the two stimuli) and then seeing a blue banana post-saccade slowed down the reaction time. But the same slowing down did not happen if the object in question did not have a diagnostic color: seeing a yellow book pre-saccade (as one of the two stimuli) and then seeing a blue book post-saccade did not slow down the reaction time. Again, the high-level explanation is that this experiment shows that the abstract category of "banana" is represented in trans-saccadic memory. I don't think this follows. The only thing that is represented in trans-saccadic memory is the image of the yellow banana. And when the blue banana is presented, it is more difficult to recognize given the ongoing representation of the yellow banana in trans-saccadic memory (as the yellow banana creates different visual expectations from a yellow book, involving the color yellow, and this expectation is frustrated by the blue banana, but not the blue book; see, for example, Rappaport et al. 2013 on how searching for bound features (like diagnostic color) is much quicker than searching for unbound features). None of this requires high-level abstract representations of banana-ness in trans-saccadic memory (see also Khayat et al. 2004, Supèr et al. 2004, Malik et al. 2015 for the ways in which trans-saccadic memory relies on the early visual cortices).

Here is an analogy that might be helpful for explaining the role mental imagery plays in these two experimental paradigms. Imagine a ball that has a letter A painted on one side. The ball rolls on, and the letter A is no longer visible because it is now at the side of the ball that is facing away from us. We know from the amodal completion studies that it is still represented amodally—by means of mental imagery. The same goes for the object-specific preview benefit cases.[2] And, mutatis mutandis, for trans-saccadic memory.

The general gist of my argument is that we should not underappreciate mental imagery. Mental imagery is intricately complex. And it can do all the jobs that object files were posited to do.

[2] This effect can last for several seconds (Noles et al. 2005)—a result very much consistent with new findings about the early visual cortices (Fritsche et al. 2022). More generally, the similarity in the mechanisms of amodal completion and the persistence of object files is further emphasized by the experiments in Yi et al. (2008) and Flombaum and Scholl (2006).

PART IV
COGNITION

19
Language

Mental imagery is a perceptual phenomenon, but it has important uses in post-perceptual processing and in our cognition in general. Part II and Part III of the book were about the important role mental imagery plays in perception. This part takes a broader perspective and considers the various roles mental imagery plays in cognition.

Throughout the history of philosophy imagistic mental representations have been routinely contrasted with abstract, linguistic representations (see Yolton 1996 for a summary). The background assumption is that there is a sharp contrast between two different kinds of mental representations: imagistic ones, like mental imagery and abstract, linguistic ones. There is imagistic cognition and there is linguistic cognition and they are very different. So when we talk about the importance of mental imagery in human cognition, the reach of mental imagery is limited as there is an extra layer of mental representations, abstract, linguistic ones, which have nothing to do with mental imagery.

Just how far imagery reaches and how thick this layer of abstract linguistic representations is supposed to be is subject to debate. One way of thinking about the mind in general and mental representations in particular is to model it on language. We have a relatively clear idea about how language represents. So a tempting route would be to use that as a means to describe the way the mind represents as well. This way of thinking about the mind was very influential in philosophy in the 1960s and 1970s, when almost all the most influential philosophers of mind came from a philosophy of language background.

This way of thinking about the mind takes propositionally structured, language-like representations to be the default form of representations in general and mental representations in particular. So the mind represents by means of propositionally structured, language-like representations. Beliefs are propositional attitudes, so they do exactly this—as do desires. This way of thinking about mental representations either flat out denies that the mind could represent in any other way (which would make perception and imagery either propositionally structured or not a representation) or when it allows

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for the existence of non-propositional representations, say, perception or mental imagery, it downplays their importance. This may be one of the reasons why the obsessive emphasis on language at the middle of the twentieth century sidelined the philosophical study of mental imagery.

But here is another way of thinking about the mind. The human mind is not that different from animal minds. In any case, it has evolved from animal minds, so, in order to understand the exquisite complexity of the human mind, we should start with understanding something simpler: the way the animal mind represents. Once we have fully understood that, we can then, and only then address the uniquely human fancy features, like language.

The way animals (at least mammals) perceive is very similar to the way we perceive. And the way animals (again, at least mammals) exercise their mental imagery is also very similar to the way we do so. So the default for understanding how the human mind represents should not be propositionally structured linguistic representation, but rather imagistic representation of the kind that perception and imagery uses. When we have fully understood how imagistic representations work, how they interact with each other, and how they lead to action, then and only then can we begin to address the fancy gloss on top of this fundamental representational machinery, which is uniquely human (Nanay 2021d).

I once described the uniquely human features of the human mind, like language, as the icing on the cake (Nanay 2013a): when we try to analyze the cake, we should not start with the examination of the icing, we should begin with the cake itself. Understanding various features of the icing is a nice extra perk. But if you make inferences about the cake itself from what you know about the icing, you'll get it all wrong.

While I have always sided with this second way of thinking about the mind, and I still do, I think we have very strong reason to question the strict opposition of the imagistic and propositional parts of the mind: of the cake and the icing. Not only is the icing of language a very minor part of understanding the mind. It also relies heavily on imagistic representations, so much so that language processing cannot be fully understood without understanding mental imagery. To use the icing and the cake analogy one last time, the icing, it turns out, is made of many of the same ingredients as the cake itself. This is not particularly surprising: the fancy gloss of uniquely human mental capacities like language processing has evolved from the imagistic animal mind, so these capacities had to use the ingredients that were already present. They had to have imagistic representations as their starting point.

In some sense, this is even worse news for the friends of using language as a means to understand the mind. The way the mind processes language relies heavily on mental imagery. So, taking the way language represents as a starting point won't help us to understand the vast majority of our (non-linguistic) mental representations. But it won't help us to fully understand language processing itself either.

I don't take this way of thinking about the mind to be particularly radical or extreme. Tyler Burge famously said that "representation of physical entities in language and thought is the way it is largely because representation in perception is the way it is" (Burge 2009, p. 293). David Kaplan also says something very similar when he writes:

> Many of our beliefs have the form: "The color of her hair is ___", or "The song he was singing went___", where the blanks are filled with images, sensory impressions, or what have you, but certainly not words. If we cannot even say it with words but have to paint it or sing it, we certainly cannot believe it with words. (Kaplan 1968, p. 208)

My claim is that this reliance of language on imagistic representations is not an exception, it is the rule.[1] We now know that language processing is not completely detachable from imagistic cognition. Both generating linguistic utterances and hearing/reading them utilizes mental imagery. Some of the empirical findings supporting these claims come from neuroimaging. Describing a scene relies on our ability to generate mental imagery—early cortical representations not directly triggered by sensory input (Mar 2004; Zadbood et al. 2017). Further, understanding a description invariably involves mental imagery—again, not necessarily conscious mental imagery, but early cortical representations not directly triggered by sensory input. The crucial finding here is that it is this imagistic representation that is remembered, not the words we heard (Zwaan and Radvansky 1998; Zwaan 2016; Zacks et al. 2018; McClelland et al. 2019), which shows that mental imagery is not a mere byproduct of language processing, but is an important ingredient thereof.

We understand fairly well how this happens. As we have seen in Chapter 18, linguistic labels change (and speed up) perceptual processes and both EEG

[1] An emerging body of findings about iconic representations in language itself (especially in languages other than Indo-European ones and in sign language) gives further support to this view; see for example, Perniss et al. (2010) and Schlenker (2017).

and eye tracking studies show that linguistic labels influence shape recognition in less than 100 milliseconds (Boutonnet and Lupyan 2015; de Groot et al. 2016; Noorman et al. 2018). This means that linguistic and imagistic representations interact at an extremely early stage of perceptual processing—by any account in early cortical processing. Again, all this indicates that imagistic and linguistic cognition are far from being independent from one another—they are deeply intertwined even at the earliest levels of perceptual processing (see also Seydell-Greenwald et al. 2020).

While many of these neuroimaging and timing results are relatively new, the intimate connections between linguistic and imagistic representations have long been postulated in behavioral studies.

Probably the most famous of these go under the heading of "dual coding theory" (Paivio 1971, 1986; Just et al. 2004). According to the dual coding theory, linguistic representations themselves are partly constituted (or at least necessarily accompanied) by mental imagery and this explains why concrete words (that are accompanied by more determinate mental imagery) are easier to recall than abstract words (that are accompanied by less determinate and in some cases very indeterminate mental imagery).

Dual coding theory started with studies of the cognitive underpinnings of mnemotic abilities—the reasons why some people are better at remembering words than others. And while the ways in which remembering words correlates with mental imagery capacities were studied, it turned out that some words are systematically more difficult to remember than others. The examination of a vast dataset of words as well as a vast number of subjects shows that there is a correlation between how easily a word is remembered and how abstract/concrete it is. Abstract words like "homology" are more difficult to remember and concrete words like "homeowner" are easier to remember, even if we control for the frequency of occurrence in language. And dual coding theory explains this difference in terms of the reliance of language processing on imagery: concrete words are remembered more easily because they their processing involves concrete mental imagery, which makes it easier to remember.

Paivio's dual coding theory posited the importance of mental imagery in linguistic processing to explain the behavioral differences between the recall of concrete and abstract words. But the findings of the dual coding theory are exactly what we should expect, given the more recent findings about the automatic and lateral triggering of early cortical representations in early stages of language processing. These older behavioral results and the more recent timing and neuroimaging findings paint the same picture: language processing itself essentially involves mental imagery (see also Calzavarini 2019 for a nuanced analysis of this connection and Liu 2022 on the important role mental imagery plays in polysemy processing).

While nothing of what I have said in this chapter so far is particularly controversial, I want to close with a consequence of this general picture of the relation between imagistic and linguistic representation, which is more controversial. It concerns one of the most widely researched psychological phenomena: the Stroop-effect—(see Stroop 1935; see also MacLeod 1991 for a historical summary).

The Stroop effect has been used in many branches and paradigms of psychological research, including ones I have touched on in this book, like the study of synesthesia, where the real hallmark of synesthetic experience is that it shows the Stroop effect—or, as it is often put, it Stroops (not many experiments get to be used as verbs).

The classic Stroop task is very simple: you have to name the color of words printed on a page. If these words are color words (like "red" or "blue"), where the color named and the color it is printed in are different (say, "red" printed in blue), the reaction time increases significantly.

What explains this odd difference? There are two major explanations, the first one dominant in the second half of the twentieth century, the second dominant in the last twenty years. According to the first one, the Stroop effect is about attention capture. The linguistic stimulus captures our attention, and as a consequence, less attention remains for the processing of the color stimulus (see MacLeod 1991 for a summary). According to the second one, the Stroop effect is about conflict monitoring and control: there are control mechanisms that detect the conflict between the linguistic and the color stimulus and they prioritize the processing of the language stimulus (Botvinick et al. 2001).

The attention account and the conflict monitoring account of the Stroop effect are very different inasmuch as the former gives a fully bottom-up explanation, whereas the latter a top-down one in terms of the effect of the semantic meaning of the word on the processing of color. But they share an important premise, namely, that the Stroop effect is about access to motor control. Depending on whether the word "red" is printed in red or blue, our access to the motor control (of reading the word) is different and this explains the difference in our reaction time. This is clear enough in the attention account, but it is also what is behind the conflict monitoring account, where "conflict may be operationally defined as the simultaneous activation of incompatible representations [...] e.g., representations of alternative responses" (Botvinick et al. 2001, p. 630).

I will argue that the connection between language processing and mental imagery suggests another possible explanation: reading the color word triggers—laterally and automatically—visual imagery of the color and this interferes with the perceived color of the word.

The conflict between the color and the meaning of the word starts much earlier than motor control. Here is an experiment that supports this hypothesis directly (there may be some indirect support from findings about the Stroop effect for color-related words as well (like "sky" (for blue) and "fire" (for red))—see Dairymple-Alford 1972). A recent experiment shows that even if we control for all the attentional and other mechanisms that determine motor control, the activation patterns in V4—the part of the visual cortex that is responsible for color processing—would be difficult to explain unless we posit early sensory involvement in the Stroop effect (Purmann and Pollmann 2015).

Given that V4/V8 is devoted (mainly) to color processing, it is active throughout any color Stroop task. More generally, the involvement of V4 in the Stroop task is somewhat difficult to examine experimentally given that without the functioning of these regions, the effect goes away. So some tricks are required to gain any insight into exactly how early cortical color processing is involved in the Stroop task. The experimenters examined the ways in which the previous trial in a series of Stroop tasks influences the current trial (Purmann and Pollmann 2015). So the question they raised is how your early sensory cortices behave, depending on the order of these trials. If you read the word "red" printed in blue, there is a conflict—it's an "incongruent trial." If you read the word "blue" printed in blue, there is no conflict—it is referred to as a "congruent trial."

The question is whether early sensory processing is different depending on whether an incongruent trial was preceded by another incongruent trial. And what the results show is that activities in V4 are very different, depending on whether the previous trial was congruent or incongruent. Interestingly, the same effect was not observed in language processing regions of the brain, only in V4. If we take the Stroop task to be about motor control, these results make no sense. But if, as I am suggesting, it is at least partly about sensory processing, these results are exactly what we should expect.

The color of the word activates V4 bottom-up (that's perception). And the reading of the word activates V4 laterally and automatically (that's mental imagery). And the processing of the perceived color is slowed down because of the interference of the mental imagery. In short, the conflict between the color and the meaning of the word starts already in perceptual processing.

But language is not the only mental capacity that is deeply intertwined with mental imagery. The following chapters outline how memory, imagination, and emotions all have more to do with mental imagery than is usually assumed.

20
Memory

The term "memory" is used to refer to a wide and very heterogeneous variety of mental phenomena. We have already encountered two, which show the diversity of memory nicely. The first one was trans-saccadic memory, the early cortical representation that maintains perceptually represented features across saccades. And the second one was episodic memory, say, remembering what you had for breakfast this morning (Bernecker 2010; De Brigard 2014; Michaelian 2016; Hopkins 2018). I argued on the basis of experimental results that both trans-saccadic memory and episodic memory necessarily rely on mental imagery (in Chapters 18 and 5, respectively).

In this chapter, as well as in Chapter 21, I want to examine three mental phenomena under the umbrella of the general category of memory, which all fall somewhere between the very simple low-level trans-saccadic memory and the very complex high-level episodic memory: Visual working memory, the Sperling experiments and boundary extension.[1] I will discuss the first two in this chapter, saving boundary extension for Chapter 21.

First, visual working memory is a behavioral category: it is the representation that is posited in order to explain how we manage to reidentify perceptually represented features after the input is gone. A standard setup for the study of visual working memory is a simple display of, say, three small squares of different colors, presented for a short time, followed by a couple of seconds of blank screen (or masking), which is then followed by a slightly different display, where the color of one of the squares has changed (see, for example, Luck and Vogel 2013). If the subject can identify this change, what allows them to do so is the visual working memory.

This sounds very much like past-oriented temporal mental imagery (Keogh and Pearson 2011; Tong 2013). And the connection between visual working memory and temporal mental imagery is further strengthened by studies that

[1] There are other interesting connections between memory and mental imagery that I will only briefly mention here. Imagery training improves memory (in fact, findings along these lines sparked the revival of research into mental imagery in the 1960s; see Luria 1960, 1968; Yates 1966). Another important set of findings is about how vivid imagery can lead to misremembering or the modification of one's memories (Gonsalves et al. 2004; Stephan-Otto et al. 2017a, 2017b).

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show strong interference effects between visual working memory and mental imagery (Hyun and Luck 2007). If, instead of the blank screen, a mental imagery-involving task is presented between the two visual displays (say, a mental rotation task), the subjects' performance on the reidentification task is much worse. This is presumably because the mental imagery that is required for the mental rotation task interferes with the representation that allows us to reidentify the squares. Thus, the representation that allows us to reidentify the squares is either mental imagery or at the very least uses the same resources, which explains why one representation interferes with the other.

Can we then just conclude that visual working memory is a form of mental imagery (just like trans-saccadic memory)? I don't think so. Some (in fact, most) instances of visual working memory would indeed qualify as a form of mental imagery. But there are some relatively recent findings about visual working memory that make the connection between visual working memory and mental imagery even more significant.

It has been shown that the representation that allows us to successfully reidentify stimuli (that is, visual working memory) does not have to involve V1 activation, or even any early cortical activation (Rose et al. 2016; Sprague et al. 2016; Trubutschek et al. 2017; Wolff et al. 2017). More generally, there seems to be remarkable interpersonal variation in people's use of visual working memory, often corresponding to the vividness of subjects' imagery (Pearson and Keogh 2019; see also Jacobs et al. 2017).[2]

These results seem to show that while some instances of visual working memory in some subjects do indeed amount to mental imagery—which also explains the influence of visual working memory in amodal completion (Lee and Vecera 2005, 2010) and on visual processing more generally (Tend and Kravitz 2019), other instances of visual working memory in other subjects are very different. So visual working memory is a heterogeneous category, which is hardly surprising given that it is defined in very broad behavioral terms: the representation that allows us to reidentify stimuli. Mental imagery, in contrast, is, in spite of the wide variety of phenomena that fall under it, less heterogeneous in terms of its implementation. In this sense, mental imagery is more of a natural kind than visual working memory (see also Pearson and

[2] Because of these radical variations in how visual working memory works (Pearson and Keogh 2019, see also Gomez-Lavin 2021), I set aside debates about the format and the allegedly holistic nature of visual working memory, as well as its relation to iconic memory, for the purposes of this discussion (but see Burns 1987; Fougnie and Alvarez 2011; Gross and Flombaum 2017; Wang et al. 2017; Pratte 2018).

Keogh 2019 for a similar point, as well as Gomez-Lavin 2021 for a related skeptical argument about working memory in general).

The second topic concerning memory that I will discuss in this chapter, besides visual working memory, is the Sperling experiment. The discussion about the role of attention in mental imagery in general, and in multimodal mental imagery in particular, has a special perk: it can help us to understand what is going on in one of the most widely discussed experimental findings in philosophy of mind: the Sperling experiment (Sperling 1960; Averbach and Sperling 1961).

The experiment is simple and it involves (although this is rarely stressed) some crossmodal effects. The subjects are presented with an array of twelve letters arranged in three rows of four letters. This is presented for a brief period and subjects could recall three or four of these letters. But here is a slightly different version of the same setup. When this visual display is over, it is followed by an auditory cue (low, medium, or high pitch—subjects are trained to associate these with the top, medium, and bottom row), which indicates the row the subjects should attend to. And now the subjects can recall three or four letters *of the indicated row*. This is a much higher recall rate (per row) than without the post hoc auditory cue. So it seems that we can represent the stimulus of all twelve letters (or almost all of them) even after we cease to see them.

Philosophers love this. The most famous use of the Sperling experiments concerns the debate about phenomenal and access consciousness. And the argument here is that the Sperling experiments show that phenomenology overflows access: there are stimuli we are phenomenally conscious of but that we cannot access (Block 1995, 2011; see also Dretske 2006; Tye 2006).[3] The second experiment shows that at the time of the auditory cue, we must be phenomenally conscious of at least three letters per row, otherwise the cue couldn't have the effect it has. So that's at least nine letters in the matrix. But, as the first experiment shows, we can only recall, so we only have access to, three or four of these letters. So phenomenology overflows access (and at a rate of nine to three/four!). And this would then show that phenomenology could not be reduced to the functional notion of access.

This argument has been criticized in many ways (Dehaene et al. 2006; Kouider et al. 2010; Cohen and Dennett 2011; Carruthers 2017; see also

[3] I do not mean to suggest that Block, Dretske, and Tye are all in agreement about the interpretation of the Sperling findings—see Nanay (2009c) for the differences between Dretske and Tye in this respect.

Phillips 2011a for a very good overview of the debate). My aim here is to step back and instead of arguing about what follows from the Sperling experiments for theories of consciousness, focus on what the Sperling experiments show that would have any relevance in this debate at all. And I aim to point out that the Sperling experiments do not demonstrate anything we should not expect on the basis of the account of (multimodal) mental imagery I outlined here.

We know that the retina remains activated (relatively) long after direct retinal stimulation ceases. A very salient case of this that we have encountered before is afterimage: "an image seen immediately after the intense stimulation of the eye by light has ceased" (Gregory 1987, p. 13). Afterimages are conscious and they only follow very intense sensory stimulation. But we also know that the primary visual cortex also remains activated (relatively) long after retinal stimulation (direct or delayed) ceases.

Crucially, we have strong empirical reasons to think that the retinotopic activation of the primary visual cortex remains present for 200–300 milliseconds after the sensory stimulation stops (Rolls and Tovee 1994; see also Nikolić et al. 2009). And this was following a very brief presentation of the stimulus (for only 16 milliseconds). Newer findings show a 70–100 millisecond echo in the primary visual cortex (Teeuwen et al. 2021; but see also Sligte et al. 2008, which complicates this picture). This cortical process, according to my definition, would count as mental imagery: it is perceptual processing (and very early perceptual processing) not directly triggered by sensory stimulation (because the perceptual processing follows the stimulus presentation with significant delay (much more than the usual 30 milliseconds)). To put it in terms of the terminology used in Chapter 12, the temporal correspondence is missing.

As we have seen in Chapter 12, V1 representation is about 30 milliseconds behind sensory input and movement representation in MT is about 45 milliseconds behind. The 200–300 millisecond delay (but even the 70–100 millisecond delay) is significantly more than this—this is why this representation counts as temporal mental imagery.

So each time we have sensory stimulation, we also have a 200–300 millisecond long mental imagery echo of it. This is in itself a very important fact about the role mental imagery plays in everyday perception, but what I want to focus on is how these findings can help us to understand what is going on in the Sperling experiments.

When the stimulus presentation of the twelve letters is over, we now know that the subjects have mental imagery of the twelve letters and continue to do so for 200–300 milliseconds. And here the auditorily cued attention operates on this mental imagery exactly the way it operates on any kind of mental imagery, something I discussed at length in Chapter 10. There I talked about visualizing the house you grew up in and shifting your attention from the color of the taps to the shape of the kitchen sink—whatever you are attending to will become more salient, and what is not in the focus of your attention (like the shape of the kitchen sink when you are attending to the taps) is likely to remain less salient. And the same goes for the mental imagery of the twelve letters following stimulus presentation in the Sperling experiments: we can attend to the top row, in which case the letters there will become more salient and the letters in the bottom row less salient. And vice versa. If we are not attending to any of the rows in particular, the salience is distributed across the rows.

There is, of course, one slight difference between the mental imagery that subjects have after stimulus presentation in the Sperling experiments and the mental imagery one has when visualizing one's house. The latter is conscious and the former is very unlikely to be conscious. But, as we have seen, this is no reason to dismiss either of them as not really a case of mental imagery. And given that both mental imagery and attention can be unconscious (for the latter claim, see Kentridge et al. 1999, 2008; Jiang et al. 2006; Cohen et al. 2012), just as we can move around our conscious attention in our conscious mental imagery, we can also move around (maybe not voluntarily, but as a result of being cued) our unconscious attention in our unconscious mental imagery (see also Sergent et al. 2011 for direct evidence of how attention influences processing in the primary visual cortex after the stimulus is gone).

A strong reason to think that subjects have mental imagery of the twelve letters in the Sperling experiments is the fragility of the Sperling results when it comes to timing. The effect collapses if the time gap between the offset of the stimulus and the auditory cue is significantly longer than 300 milliseconds (Averbach and Sperling 1961, figure 17; see also Di Lollo 1977; Coltheart 1980), which is exactly the time that the mental imagery following sensory stimulation is supposed to last for (see Rolls and Tovee 1994; Nikolić et al. 2009). The Sperling results can be triggered only as long as the mental imagery of the twelve letters is present.

If we think of this representation of the twelve letters as mental imagery, the Sperling results are exactly what we should expect: those aspects of the mental imagery we attend to are more likely to become conscious than those that we are not attending to—as we have seen in the case of the taps and the kitchen sink. But then what we should expect in cases where we are cued to attend to some aspects of our mental imagery is that these aspects are more likely to become conscious and that's exactly what the Sperling experiment shows. In short, the Sperling results should not surprise anyone: of course those aspects of our mental imagery that we are attending to are more likely to become conscious than those we are not attending to.

How does this emphasis on mental imagery in the Sperling experiments change the philosophical import of these findings? There seems to be an agreement between the proponents and the opponents of the overflow argument about the presence of some kind of representation of the twelve letters at the moment of the auditory cue (see, for example, Coltheart 1980, p. 184; Block 2011; Phillips 2011a, section 5). The question is whether these representations are phenomenally conscious. The proponents of the overflow argument say they are, the opponents say they are not.

In the light of the discussion in this chapter, it should be clear that the assumption that these representations are phenomenally conscious is unsupported, as activation of the primary visual cortex (which is all we can assume here) in no way guarantees any kind of conscious awareness. In other words, my view is in sharp opposition with the overflow view of the Sperling experiment (according to which the representation of the twelve letters is conscious) and in broad agreement with that of Phillips (2011a) (according to which it is unconscious). An advantage of my view over Phillips's is that while Phillips needs to posit such unconscious representation solely in order to explain the Sperling findings, we have independent and very strong reasons to posit mental imagery—(normally unconscious) early cortical representations that are not directly triggered by sensory input.

In this chapter, I discussed two memory phenomena that can be better explained if we appeal to mental imagery. The next chapter is about a third one, where mental imagery plays an even more important role.

21
Boundary Extension

The third of the three memory phenomena I want to discuss is boundary extension (see Nanay 2021e for a longer version of this argument). I am devoting a full chapter to it because it is a nice illustration of how focusing on mental imagery can help us make progress in contested empirical and conceptual questions.

Look at Figure 12A. Now look away, do something else and try to remember the image. What you will recall is more similar to Figure 12B. When we remember a scene, we remember more than what we saw. Literally more: the scene's boundaries are wider than the boundaries of the scene we saw. This phenomenon is called boundary extension.

Boundary extension is one of the most robust psychological findings about memory. It holds across age groups (Seamon et al. 2002); experimental methods (drawing from memory vs. picking a picture that matches our memory, but see Bainbridge and Baker 2020); length of exposure time (how long we are looking at the scene, see Intraub et al. 1996); length of time gap (between seeing the scene and recollecting it, see Intraub et al. 2008); depictive style (photos vs. drawings, Gagnier and Intraub 2012); image content (Candel et al. 2003); and so on (see Hubbard et al. 2010 for a very thorough summary of these findings; and Bainbridge and Baker 2020 for some recent findings that complicate this picture somewhat).

In the philosophy of memory, boundary extension is used as an example of the constructive nature of memory. This fits into a wider set of findings about memory that all seem to demonstrate that memory formation is not a matter of copying perception into our memory. Memories are, rather, constructed on the basis of the scene we see, but their content is not determined by the scene seen (De Brigard 2014; Michaelian 2016; McCarroll 2018; see also Robins 2019, McCarroll et al. forthcoming).

This raises an important philosophical question about the boundary extension findings (Michaelian 2011; De Brigard 2014; Bernecker 2017; Arango-Munoz and Bermudez 2018; Fernandez 2019, esp. pp. 196–8). Is boundary extension explained by perceptual adjustment or by adjustment during memory encoding? Again, look at Figure 12A. Figure 12A is the stimulus. On the

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Figure 12A What you saw

Figure 12B What you recall

basis of this, you have a perceptual experience. Later, you recollect what you saw, and this leads to a memory image of Figure 12B. On the face of it, there are two possible ways this can happen:

(i) Stimulus (Figure 12A) → Perceptual experience (Figure 12A) → Memory (Figure 12B)
(ii) Stimulus (Figure 12A) → Perceptual experience (Figure 12B) → Memory (Figure 12B)

According to (i), boundary extension is a form of adjustment during memory encoding. The stimulus of Figure 12A leads to the perceptual experience of Figure 12A, just like it should. Perception is veridical. The adjustment happens when Figure 12A is encoded in memory—the memory encodes Figure 12B, rather than Figure 12A. As Kourken Michaelian says, "the representation of the scene is modified automatically as a memory of this scene is formed" (Michaelian 2011, p. 326).

According to (ii), in contrast, boundary extension is a form of perceptual adjustment. There is no adjustment during memory encoding: the perceptual experience of Figure 12B leads to the memory of Figure 12B. But when we look at Figure 12A, we experience Figure 12B. The reason for this might be that when we look at Figure 12A, we supplement the stimulus with our own "perceptual schema" and this leads to the experience of Figure 12B (Intraub and Richardson 1989; Intraub 2002, 2012).

My aim is to propose a third explanatory scheme, according to which the extended boundary of the original scene is represented by means of mental imagery. And given the similarities between perception and mental imagery, the memory system encodes both the part of the scene that is represented perceptually and the part of the scene that is represented by means of mental imagery. This means that boundary extension is neither perceptual adjustment nor memory adjustment.

My claim is that boundary extension is a two-step process and we have plenty of empirical evidence for how both of these steps work. I propose the following scheme instead of (i) and (ii) above:

(iii) Stimulus (Figure 12A) → Perceptual experience (Figure 12A) → Mixed perception/imagery experience (Figure 12B) → Memory (Figure 12B)

The first step is that looking at a picture activates early cortical representations of the space immediately outside the boundaries of the picture. Note that this is a different and much weaker claim than the perceptualist's explanation (along the lines of (ii)) that we do have perceptual experience of the space beyond the picture boundaries. But this space is nonetheless represented by the visual system.

What is important from our point of view is that the early visual cortices represent the missing parts of the scene that fall just beyond the picture boundary (Chadwick et al. 2013). This early cortical representation of the parts of the scene just outside the picture boundaries is produced by perceptual processing (again, perceptual processing in the early visual cortices) without direct sensory stimulation. In short, it is mental imagery. Whenever we see a picture, we have mental imagery (in the sense used here) of the scene just outside the boundaries of the picture.

Most of the time, this mental imagery is unattended. But it can also be attended, especially in some examples of visual art, where the artists very explicitly try to evoke our mental imagery of the scene outside the frame. One famous example would be Degas, who liked to place the protagonists of his paintings in such a way that only parts of them are inside the frame. The rest we need to complete by means of mental imagery. In some extreme cases (for example, Dancers climbing the stairs, 1886–1890, Musée d'Orsay), we only see someone's arm or the top of their head and we need to complete those parts of their body that are outside the frame by means of mental imagery. Another example is Buster Keaton, who also used the viewer's mental imagery of the off-screen space in his films, but normally for comical effect. One example is the first shot of his short film *Cops* (1922), where we see the protagonist in close up behind bars and looking depressed. The second shot reveals that he is behind an iron gate talking to a girl, the object of his unrequited love (see Chapter 31 for more examples of this kind).

To sum up, the first step of the boundary extension process is that we represent the scene just outside the boundaries of the picture by means of mental imagery. In other words, looking at Figure 12A leads to a hybrid perception/imagery representation of Figure 12B, where the parts closer to the edges (basically the difference between Figure 12B and Figure 12A) are represented by mental imagery.

The second step takes us from this hybrid perception/imagery representation of Figure 12B to the memory of Figure 12B. And just as in the case of the first step, we have plenty of independent empirical evidence about how this step works. We know (see Chapter 7) that the perceptual system is prone to treat perception and imagery similarly.

Remember that mental imagery is representation that is produced by perceptual processing in the early sensory cortices without direct sensory stimulation. Both perception and mental imagery then amount to representation that is produced by perceptual processing in the early sensory cortices—the only difference between them is about whether mental imagery is triggered by direct sensory input. To use amodal completion as an analogy for a second, if you look at the landscape through a mosquito net, strictly speaking you perceive little squares of the landscape and you represent parts of the landscape that are between these little squares (that are occluded by the net itself) by means of amodal completion. This nonetheless gives rise to a unified visual experience.

The memory system takes the hybrid perception/imagery representation of the scene and transforms it wholesale into memory (regardless of what part of this representation was imagery and what was perception). It transforms the hybrid perception/imagery representation of Figure 12B into memory of Figure 12B. To go back to the amodal completion analogy: when we look at the landscape through the mosquito net, we later recall not only the little squares we actually perceive, but the landscape that is the hybrid of amodally completed parts and perceived parts.

I will argue that this two-step explanation of boundary extension combines the explanatory benefits of the perceptual adjustment and the memory adjustment account. And it does so without inheriting their problems.

As we have seen, the most influential version of the perceptual account of boundary extension is the perceptual schema account (Intraub and Richardson 1989; Intraub 2002). One of the most important objections to this account comes from the experiments that show that boundary extension is also present for scenes with no recognizable objects. So our perceptual system is not in a position to apply a perceptual schema of the scene outside the boundaries on the basis of recognized objects inside the boundaries, for the simple reason that there are no recognized or even recognizable objects inside the boundaries (only random dots; for an example see McDunn et al. 2014; see also Mamus and Boduroglu 2018 for similar results involving semantically inconsistent scenes).

While these are clearly difficulties for the perceptual schema account, they pose no problem for my account as the early cortical representations of the scene behind the boundaries of the picture are not necessarily formed in response to top-down information about the specific objects inside the frame (which would amount to a perceptual schema). They could be based solely on the geometrical features of the patterns inside the frame (see Vrins et al. 2009 for a summary).

Another consideration that militates against the perceptual account comes from subjects with bilateral hippocampal damage (which is a memory disorder). These subjects show much less boundary extension than controls (Mullally et al. 2012; see also Jajdelska et al. 2019). This seems to suggest that boundary extension has to do with memory, not perception, as memory impairment has a significant influence on it. Note, however, that the hippocampus has a well-demonstrated influence on mental imagery (again, on representations that are produced by perceptual processing in the early sensory cortices without direct sensory stimulation). In other words, my explanatory scheme predicts that bilateral hippocampal damage would interfere with boundary extension.

Finally, proponents of the memory account often dismiss the perceptual schema account on the basis of the fMRI findings of Park et al. (2007), which could be taken to show that the early visual cortices are not involved in boundary extension. It is important to point out that the Park et al. findings do not in fact show that the early visual cortices are not involved in boundary extension, something the authors of the study later themselves explicitly acknowledge (see Park and Chun 2014, esp. pp. 63–5). Further, more recent fMRI experiments on how the visual cortices behave in boundary extension (see Chadwick et al. 2013 and Park and Chun 2014 for summaries) show that the early visual cortices are very much involved in boundary extension, just as my account predicts.

So much for anti-perceptual considerations. But the memory account of boundary extension has also been argued to be inconsistent with some empirical findings.

While the emotional content of pictures does not seem to have an effect on boundary extension in general (Candel et al. 2003), for highly anxious subjects, negative arousal (and only negative arousal) does have a consistent effect (towards less boundary extension) (Matthews and Mackintosh 2004). One way of explaining this is that the attention of these subjects is engaged at the central part of the picture (where the emotional content is) and this takes the attention away from the boundaries. More generally, it has been found that if our visual attention is engaged elsewhere, this influences boundary extension (Intraub et al. 2008).

Attention is a perceptual phenomenon, so this seems to be a point in favor of the perceptual account and a point against the memory account. Note, however, that my account can explain these findings in a straightforward manner. Mental imagery is as sensitive to the allocation of attention as sensory stimulation-driven perception (see Nanay 2015a for a summary; see also Chapter 10). So if our attention is engaged elsewhere, this has consequences for the details of the mental imagery of the scene just outside the boundaries of the picture. My account can explain the effects of attention on boundary extension as much as the perceptual account can.

We have seen that my account is not vulnerable to the most widespread objections to the perceptual and memory accounts. On the other hand, some empirical findings seem to support my account.

First, the most consistent way of canceling out boundary extension is by making the frame extremely salient (Gottesman and Intraub 2002, 2003). It is not clear why the prominence of the frame should influence the perceptual schema or the way this scene is encoded in memory, but we can explain this effect in terms of the mental imagery of the scene outside the boundaries of the picture in a much more straightforward manner as the salience of the frame works against the early cortical representations of the scene just outside the boundaries of the picture.

Second, boundary extension can be induced haptically—by means of touch (Intraub 2004). This seems very difficult to explain in terms of memory error or (visual) perceptual schemas. On the other hand, given the vast amount of research on the visual mental imagery of (non-cortically) blind people (see Chapter 15) and also the research on haptically induced multimodal visual imagery (where sensory stimulation in the haptic sense modality triggers mental imagery in the visual sense modality; see James et al. 2002; see also Nanay 2018a for a summary), this finding is exactly what my account would predict, as multimodal mental imagery is triggered in a similarly automatic and involuntary manner as the mental imagery involved in representing the scene just outside the boundaries of the picture.

Finally, there is an objection that could be raised directly about my explanatory scheme (see also Gottesman and Intraub 2003). Explicitly imagining the scene outside frame does not increase boundary extension (Munger and Multhaup 2016). Experimenters asked the subjects to imagine what the photographer would see if she zoomed out, or to imagine the smells and sounds coming from outside the frame, and this did not have an effect on boundary extension. One might think that this is a problem for my account, but it is not. As we shall see in Chapter 22, it is an open debate whether imagination presupposes the exercise of mental imagery (Kind

2001), but even if it does, it is a very specific way of using mental imagery, which is very different from the automatic, involuntary formation of mental imagery outside the boundaries of the picture. And the relation between mental imagery and imagination is exactly the topic I am now turning to.

22
Mental Imagery versus Imagination

Mental imagery is not imagination. Imagining is something we do. We imagine things. It is a mental action and (typically) a voluntary act. Mental imagery is not. Mental imagery is not a mental action and, crucially, it can be involuntary. When we have flashbacks to an unpleasant scene, this is mental imagery; it would not count as imagination in any sense of the term (see also Gregory 2010, 2014; Langland-Hassan 2015; Wiltsher 2016; Arcangeli 2020 on the differences between imagination and mental imagery). It is involuntary mental imagery. The same goes for earworms: annoying tunes that go through our head in spite of the fact that we really don't want them to. Again, this is not auditory imagination, but it is auditory mental imagery. In spite of these differences, as we have seen in Chapter 2, throughout the history of philosophy people used the term "imagination" to refer to what we now would describe as mental imagery.

Thus far, I have just used the term "imagination" as if it were a unitary concept. But it is not. Imagination comes in many forms. Probably the most commonly drawn distinction between different imaginative episodes is between sensory and propositional imagination. Sensory imagination is imagining seeing, hearing, smelling, etc. something. More generally, as Paul Noordhof says, "the distinctive feature of [sensory] imagining is that a condition of its success is to recreate the sensory experience of the thing imagined" (Noordhof 2008, p. 337). Propositional imagination is imagining that such and such is the case. In other words, the former is imagining perceiving x, whereas the latter is imagining that x is F. Imagining seeing the Eiffel Tower from across the river is sensory imagination. Imagining that the Eiffel Tower is in Rome is propositional imagination.

One important question in the philosophy of imagination is about how to draw the line between these two forms of imagination. Another, related, question is which one has anything to do with mental imagery? We have seen that we can have mental imagery without imagination (see the flashback and the earworm examples). But how about the other way round? Can we have imagination without mental imagery? In other words, does imagination necessarily involve the exercise of mental imagery (Kind 2001; Van Leeuwen

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2016; Langland-Hassan 2020)? The answer depends on what kind of imagination the question is about.

There is strong agreement that sensory imagination, for example imagining seeing the Eiffel Tower from across the river, does necessarily involve mental imagery (in this case, visual imagery). But there is no agreement about whether mental imagery is necessarily involved in propositional imagination, for example imagining that Paris is the capital of Italy.

And here we need to introduce yet another category in the discussion of sensory and propositional imagination, namely, supposition (for example, supposing something for the sake of argument; see Arcangeli 2019). In the philosophy of imagination, distinguishing sensory and propositional imagination often involves distinguishing both of these forms of imagination from supposition. So not one, but two division lines need to be drawn: one between sensory and propositional imagination and one between propositional imagination and supposition.

Mental imagery is used heavily in these debates about how to delineate sensory imagination, propositional imagination, and supposition, but, depending on where one stands on whether propositional imagination necessarily involves mental imagery, it is used very differently. Those who believe that mental imagery is necessary for propositional imagination can, and often do, draw the line between imagination (both sensory and propositional) and supposition in terms of mental imagery: imagination involves mental imagery, whereas supposition does not (see Kind 2001 for a modern locus classicus). Those, in contrast, who deny that mental imagery is necessary for propositional imagination can, and often do, draw the line between sensory imagination on the one hand and propositional imagination as well as supposition on the other in terms of mental imagery: mental imagery is necessary for sensory imagination, but not for propositional imagination and supposition. Either way, the relation between mental imagery and imagination is of crucial importance in how the terrain of imaginative states is broken down.

It needs to be pointed out that many of the arguments on either side appeal to introspection (Chalmers 2002; Byrne 2007). If we allow for unconscious mental imagery, as I argued in Chapter 4 that we should, then these arguments would not lead to any kind of conclusive resolution. It may be that no conscious images flash in the philosopher's mind, but it does not follow from this that no mental imagery is involved in this imaginative episode.

And as we have seen in Chapter 19, mental imagery is involved in language processing, so, assuming that propositional imagination relies on language processing, it is also involved in propositional imagination. To go back to my example, imagining seeing the Eiffel Tower from across the river does involve visual mental imagery. But so do episodes of propositional imagination, like imagining that Paris is the capital of Italy. The mental imagery that is involved in imagining that Paris is the capital of Italy (say, the gustatory imagery of good coffee in a Parisian café), may not fix the content of this imaginative episode (something very explicit in Kind 2001). But it is triggered automatically each time we have a mental episode with language-like components. Further, an imaginative episode in one sense modality (say, audition) also automatically triggers early cortical representations in other sense modalities (say, vision) (see Vetter et al. 2014; see also Bergen et al. 2007 for more empirical support and Stokes 2019 for a philosophical summary). Supposition also involves mental imagery for the very same reasons.

So, according to the classic picture, there is a division line between sensory imagination and propositional imagination and there is also a division line between propositional imagination and supposition. I argued elsewhere that the reason why it has proven to be so challenging to draw both these division lines: the logical space between sensory imagination and supposition is not very significant (see Nanay forthcoming c). So there is not much logical space remaining for propositional imagination. Here I want to focus on the ways in which propositional imagination relies on mental imagery.

Let us start with a widely acknowledged and salient difference between imagination and supposition, which is highlighted in the imaginative resistance literature (Walton 1994; Gendler 2000, 2006; Weatherson 2004; Nanay 2010c; Camp 2017). We can suppose any proposition, whatsoever. We can suppose, for the sake of the argument, logically or metaphysically impossible or ethically dubious propositions, for example. But, if the phenomenon of imaginative resistance is a real phenomenon, we can't imagine all propositions.[1] We can't imagine morally dubious propositions, for example, to use the classic imaginative resistance case, that "In killing her baby, Giselda did the right thing; after all, it was a girl" (Walton 1994, p. 37). There are many explanations of imaginative resistance, but one thing they all have in common is that the set of propositions that we can imagine is narrower than the set of all propositions. Hence, the set of propositions that we can imagine is narrower than the set of propositions we can suppose.

[1] According to some views about imaginative resistance, what stops us from imagining these contents is not our inability, but our unwillingness (Gendler 2000). While I will formulate imaginative resistance as an inability, my argument could be reformulated to fit the imaginative resistance as unwillingness views.

Now let's turn to another salient difference between imagination and supposition, which involves the temporal unfolding of these mental processes. If you suppose, for example, when solving a mathematics problem, that a=b, this does not have a very significant temporal profile. As soon as the content of the supposed proposition (that a=b) is grasped, the supposition happened. This is not so when it comes to imagination. When you imagine that Paris is the capital of Italy, this mental episode is not completed when the proposition (that Paris is the capital of Italy) is grasped. If it were so, then all propositions could be imagined and we have seen in the previous paragraph, this is not so. When imagining that Paris is the capital of Italy, grasping the proposition is only the first step. Having grasped the proposition, we then elaborate the imagined proposition (and, arguably, it is exactly this elaboration that fails in those cases where imaginative resistance kicks in). Peter Langland-Hassan captures this feature of propositional imagination when he insists that it is a "rich and elaborated […] thought about the possible" (Langland-Hassan 2020, p. 7). Propositional imagination is "rich and elaborated," whereas supposition is neither rich nor elaborated (or maybe just much less rich and much less elaborated).

The big question is, then, where this elaboration comes from. And given the involvement of mental imagery in propositional imagination, the obvious answer would be that this elaboration happens with the help of mental imagery (see also the research on how, in voluntary imaginative episodes, mental imagery gets more vivid over time, D'Angiulli and Reeves 2003/2004). This would explain why imagination (but not supposition) has an undeniable affective dimension (Moran 1994) and also why imagination (but not supposition) is a skill you can be better or worse at (Kind 2020). Again, this mental imagery does not need to be conscious and even when it is conscious, it does not need to be particularly determinate. It does not need to be able to fix the content of the imaginative episode either.

But at this point one may wonder whether one could find other forms of elaboration that could be used in the case of propositional imagination (which would be missing in the case of supposition). Maybe the elaboration in question is not imagistic, but propositional. When imagining that Paris is the capital of Italy, this proposition is elaborated with the help of further propositions (like the proposition that Paris has good coffee). The problem with this proposal is that suppositions are also elaborated with the help of further propositions, in fact, this is exactly how *reductio ad absurdum* arguments proceed: we suppose the proposition for *reductio* and then elaborate it with the help of further propositions up to the point where we hit a contradiction. So, if propositional imagination were only elaborated with the help of further propositions, this would not explain how propositional imagination differs from supposition (and why we can't imagine propositionally everything we can suppose).

In short, mental imagery is substantially involved both in sensory imagination and in propositional imagination. Sensory imagination is the voluntary use of conscious mental imagery. And propositional imagination is the supposition of a proposition that is elaborated with the help of mental imagery. Mental imagery is not, in contrast, substantially involved in supposition per se (as here mental imagery could be thought of as merely accompanying supposition without being constitutive of it).

I talked about a major distinction within the category of imagination, namely the one between sensory and propositional imagination. But there are imaginative episodes that play a very important role in our life that do not fall clearly into one of these two categories (see Nanay 2009a, 2021f; Kind 2013 for taxonomies of different kinds of imaginative episodes). Imagining being in someone else's situation is one of these (Williams 1973; Wollheim 1973; Velleman 1996). As it has been emphasized, imagining being in someone else's situation is a form of self-imagining, which is often contrasted with propositional imagination. But does this mean that it is an instance of sensory imagination? Crucially, what role does mental imagery play in imagining being in someone else's situation? This is an especially important question, given the importance of imagining being in someone else's situation in decision-making.

Our grand decisions (decisions we struggle with, that we can't make easily and quickly) rely on imagination (see Nanay 2016c).[2] Think back to some of the big decisions you have made over the years. Break up with your partner or not? Which college to choose? Go to grad school or not? Which job offer to take? Which house to bid on? And so on. There are both empirical and conceptual reasons to think that you made all of these decisions by imagining yourself in one of the two situations and then imagining yourself in the other and then comparing the two. Even if you took out the yellow legal pad and drew up the pros and cons, your decision was not based on the direct comparison of the number of pros and the number of cons about how your desires would be satisfied, in the two respective scenarios, given your background beliefs.

[2] These decisions do not need to be, but can be, what these days are called "transformative decisions."

Here is an example from my own past. After college, I was accepted in grad programs in the US and the UK. I thought, probably correctly, that this choice would have a major impact on my life course and was really struggling with this. I could narrow down the US options to what seemed the best (within the US) and I did the same for the UK options. But deciding between becoming American and becoming British was just too difficult. I imagined myself in Britain, at fancy college dinners, wearing a gown and sipping port. And I imagined myself in Californian diners in flip flops with Oreo shake in hand. Not an easy comparison.

The point is that I really had very little idea about just what situations I would find myself in. So I actually imagined myself in imagined situations—ones that were more informed by films I had seen than reality. But the imaginative episodes that play a role in decision-making are even more complicated. Imagination is used not even twice, but three times. Let's suppose I am making this decision now. Who am I imagining in that Californian diner? My future self is very different from my current self, so imagining my current self would not be particularly helpful. It is my future self who has the chance to hang out in California, but the problem is that we don't have any firm information about what our future selves will be like. So it is really my imagined future self who should appear in these imaginative episodes. In short, when we make these grand decisions, we imagine what we imagine to be our future selves in imagined alternative scenarios. Imagination is used three times.

There are strong empirical reasons for thinking that this is how we actually do make decisions (see Nanay 2016c for a summary). This is a descriptive claim. I did not say anything about whether making decisions this way would lead to an optimal decision. On the face of it, not so much. The scenarios we imagine ourselves in have very little to do with the actual situations we would find ourselves in. I spent relatively little time in Cambridge sporting a gown, and really almost no time in Californian diners in flip flops.

Imagining our future selves is especially unreliable, as we systematically underestimate how much we will change in the future, as the psychological phenomenon of the End of History Illusion shows (Quoidbach et al. 2013). We all think that who we are now is the finished product: we will be the same in five, ten, twenty years. But this is not so. Our preferences and values will be very different in the not-so-distant future. This is the End of History Illusion.

There is a final twist here. Remember that decision-making involves imagining your future self in a hypothetical situation. But your future self will largely be formed in response to the decision that you're about to make.

Hence, it is not possible to reliably imagine your future self that will be in California or Cambridge. Your future self will be very different from your present self. So you can't reliably imagine it. And how it will turn out to be will depend on your imaginative episode that you use to make your decision. I ended up spending a fair bit of time both in California and in Cambridge in my life and I can confidently say that a fully Californified version of me would be very different from a fully Cambridgified version of me (see Nanay forthcoming g on the psychological consequences of this).

Now we can address the question about whether and how mental imagery shows up in the imaginative episodes like imagining someone from the inside. And it seems that it is heavily involved in at least one species of imagining someone from the inside, namely, the one that is used in decision-making. A number of empirical studies show that imagery is a crucial part of the imagining that is involved in decision-making. The vividness of imaginative episodes has a major influence on decision-making. If you are deciding between two positive scenarios, the one that is imagined more vividly tends to win out. And if you are deciding between two negative scenarios, the one that is imagined less vividly tends to win out (Austin and Vancouver 1996; Trope and Liberman 2003; see the rich literature on construal-level theory and also on the effects of the vividness of imagination on future discounting in Parthasarathi et al. 2017 and Mok et al. 2020; see also the discussion in Chapter 25). Not only is imagery a crucial ingredient of this imaginative episode (just like it is a crucial ingredient of all imaginative episodes that this chapter considered), it also helps us to explain some important features of the decision-making process.[3]

[3] See also Wiltsher and Nanay (2021) on the role imagination plays in self-knowledge.

23
Emotion

Try to imagine, as vividly as you can, being attacked by a rabid dog, foaming at the mouth, snapping at your feet right there under your desk. This is an important form of mental imagery and highlights that imagery can dramatically affect emotions. On the other hand, the impact of emotions on imagery is equally significant—the imagery that occupies our minds is very often under the control of our dominant emotion, which sometimes alters its fabric and our capacity to control it. In other words, there is a two-way interaction between emotions and mental imagery (see Holmes and Mathews 2010 and Hoppe et al. 2021 for summaries).

First, the imagery → emotion direction is not particularly surprising—after all, you yourself presumably experienced this influence if you really did imagine the scary dog in the example at the start of the chapter. But there have been plenty of experiments that show that imagery doesn't just influence our emotions, it influences our emotions much more strongly, more quickly and with more long-lasting effects than linguistic representations (of the same content; see Holmes and Mathews 2005; Hoppe et al. 2021).[1]

Second, the emotion → imagery direction may be (even) more significant: Neuroimaging data shows that the subject's emotional state influences processing in the primary visual cortex (Vetter et al. 2016) and this effect is especially strong if the visual input is ambiguous (Gerdes et al. 2014). This effect also works crossmodally: an emotionally charged stimulus in the auditory sense modality influences the processing in the visual cortex and vice versa.

Further, it has been known for a long time that emotionally charged stimuli (for example, threat cues) improve accuracy and speed of perceptual processing. But some recent findings show that this effect depends on the subject's capacity to form vivid mental imagery (Imbriano et al. 2020). Emotionally charged input leads to more vivid imagery, which, in turn leads to faster and more accurate responses.

[1] A more surprising example of imagery leading to emotional responses is that amodal completion (of neutral contours) triggers positive valence (Erle et al. 2017).

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My final example of how emotion influences mental imagery is the mood congruency effect (Blaney 1986; Matt et al. 1992; Gaddy and Ingram 2014). The most famous example of the mood congruency effect is mood congruent memory (Loeffler et al. 2013)—we are more likely to recall scary memories when we are scared, for example. But mood congruency also works in the case of mental imagery: your general mood makes it more likely that you form mental imagery that is congruent with your mood. And it makes it less likely that you form mental imagery that is not congruent with your mood. We also encode emotionally salient stimuli in a more detailed manner, which makes it possible to form more vivid mental imagery (Hamann 2001; Phelps 2004; LaBar and Cabeza 2006; Yonelinas and Ritchey 2015).

To sum up, emotions lead to imagery and imagery leads to emotions. There are two ways in which this can happen. The first option is that we have emotion-free imagery, which influences our emotions, and that, in turn, influences our emotion-free imagery. The second option is that our imagery itself is emotionally charged (by which I mean that the content of mental imagery can't be fully specified without reference to emotions).[2] So it is not the emotion-free imagery state that influences our emotions, it is the already emotionally charged imagery that does so. And imagery is not emotion-free, which is merely influenced by our emotions; rather, imagery itself is emotionally charged. This second option would not only be a more parsimonious way of accounting for this bidirectional interaction, but it is also more in sync with empirical findings about the relation between imagery and emotions.

This doesn't imply that all imagery is emotionally charged. If you visualize your long-deceased grandmother, this imagery can be emotionally charged, for example. But when you close your eyes and visualize an apple, your imagery may not be emotionally charged (unless you really like—or hate—apples). The claim is that some but not all mental imagery is emotionally charged.

This claim also follows from some recent accounts of perception, according to which perception itself is emotionally charged as it represents so-called "micro-valences" (Lebrecht et al. 2012). If perception (sensory stimulation-driven perception) is emotionally charged, then it is difficult to see why mental imagery (not sensory stimulation-driven perception) would not be.

I said that imagery itself is emotionally charged. This can mean many things (depending on one's account of emotions and on one's account of mental imagery). It can mean that the imagery attributes emotionally charged

[2] Depending on their views about the relation between affect and emotion, some readers may want to substitute the term "affectively charged" for "emotionally charged," here and throughout the chapter.

properties: not just properties like shape and color, but properties like valence, for example. The imagery, according to this account, represents not just the shape and color properties of the vicious dog, but also its negative valence.

It is important to emphasize that this is just one way of cashing out the claim that imagery is emotionally charged. According to other accounts of emotions, the emotional charge may be due to some non-representational features of mental imagery. And those who may worry that an account of the representation of valences in imagery would force us to take sides in the grand debate about what kind of properties can be perceptually represented (given that valence properties would need to be represented by perceptual representations that constitute mental imagery), would not need to reject the claim that imagery itself is emotionally charged.

Crucially, taking mental imagery itself to be emotionally charged has significant explanatory benefits when it comes to explaining a number of empirical findings. First, it has been known for a while that perceptual learning does not require sensory input: mental imagery alone can lead to perceptual learning as well (see Tartaglia et al. 2009, 2012). But recently it was found that this effect is stronger if the imagined stimulus is emotionally charged (Lewis et al. 2013).

Unless we take mental imagery itself to be emotionally charged, this would be difficult to explain: imagery would need to trigger our emotion, which then in turn would need to influence the early cortical processing. This would amount to a lengthy processing, where first the early cortical representation is induced by means of imagery, which, in turn, activates a higher-level emotional state (and this takes a fair amount of time), which then, in turn, activates the early cortical regions again in a top-down manner, to induce perceptual learning. It is difficult to see how this long and cumbersome way of inducing perceptual learning would be more efficient than the entirely early cortical matter of imagery-induced perceptual learning, where the early cortical representation that is mental imagery induces perceptual learning directly.

Taking imagery to be emotionally charged also helps us to explain the following empirical finding: visualizing an emotionally charged event or person at an emotionally neutral place confers emotional charge to the place (see Benoit et al. 2019). It has been known for a while that seeing a negatively valenced event (say, a fight between two friends of yours) at a neutral place (say, the corridor in front of your office) makes this formerly neutral place inherit the negative valence of the event. So, in the future, when you see the corridor of your office, it triggers slightly (or not so slightly) negative emotions. The crucial finding is that the same process also takes place even if you merely visualize a negatively valenced event at a neutral place. In short, negatively valenced mental imagery confers valence on various components of the imagined scene, which then remain emotionally valenced.

If we take imagery itself to be emotionally charged, this is easy to explain: forming imagery of the negatively valenced event at the neutral location would confer the negative valence to the location because the representation of this location itself is a valenced affair. If, on the other hand, we assume that imagery is emotion-free, the explanation is much less clear. What happens in this scenario is that we form emotion-free imagery of, say, the fight in the corridor. This is not itself a valenced representation. And this emotion-free representation gives rise to the negative emotion.

There are two options here for the opponents of emotionally charged mental imagery. First, this valenced representation may not represent the corridor and the fight at all. In this case, this negative emotion would need to somehow attach itself to the non-valenced representation of the corridor and the fight, but it is unclear how or why this would happen as the corridor and the fight are, by supposition, represented in an emotion-free manner.

The second option is that the valenced representation that the emotion-free mental imagery gives rise to does represent the corridor and the fight. In this case, we should ask how it does so. If it does so by means of mental imagery, then the resulting state is an instance of emotionally charged mental imagery (which is the very claim I wanted to argue for). If, in contrast, it does so by means of a different kind of representation, say, a belief, then we get the following picture: the emotion-free mental imagery of the fight in the corridor gives rise to a valenced belief (or some other valenced non-imagery representation) about the possibility of there being a fight in the corridor. Besides the ad hoc postulation of a number of mental states and processes, which is justified only by the attempt to reject the view that imagery is emotionally charged, it should also be noted that this picture does not in fact explain why such a belief about the possibility of a fight would confer emotional valence to the corridor. In short, taking imagery to be emotionally charged can explain why this emotional infection happens in imagery in a straightforward manner, whereas the alternative can't.

Finally, taking imagery itself to be emotionally charged also has significant philosophical consequences. One of the most important questions in the philosophy of emotion is about what kind of mental states emotions are. Are they perceptual states (Prinz 2004; Döring 2007), quasi-perceptual states (Roberts 2003), beliefs (Solomon 1977; Nussbaum 2001), belief-like states (Greenspan

1988; Helm 2001; Brady 2009;), or maybe states of "action readiness" (Frijda 2007; Scarantino 2014)? One thing that all the parties in these debates agree on is that emotional states are representational states: they have content. When I am afraid of a dog, my emotion is directed at something out there in the world: the dog. They also agree that emotions can be triggered in a variety of ways.

Take the following examples:

(i) I see a scary dog and this perceptual state gives rise to an emotional state (of being afraid of it).
(ii) I remember a particularly threatening encounter with a dog and this episode of remembering gives rise to an emotional state.
(iii) I imagine a particularly threatening encounter with a dog and this episode of imagining gives rise to an emotional state.
(iv) I think about a dog and this gives rise to an emotional state.

In these examples, emotional states are triggered by four different kinds of mental states: perceptions, rememberings, imaginings, and thoughts. In these four examples, we are in a non-emotional state (perceiving, remembering, imagining, thinking) and this gives rise to an emotional state. One important desideratum for any theory of emotion is to explain how emotions can come about in all these routes (by perception, memory, imagination, thought, etc.).

The big question is, again, about the nature of this emotional state: if it represents a dog, does it do so perceptually or rather in a belief-like manner (or some other way altogether)? And depending on which ways the emotional states are brought about, different answers would seem appealing. If we are focusing on emotions we have towards things we perceive, the perceptual theories of emotion will be appealing, as then there is a smooth transition from the non-emotional perceptual state (like the one in (i) above) to the emotional state it gives rise to, which then could be thought of as a perceptual state. If, in contrast, we are focusing on emotions we arrive at via thinking, this may not be such an appealing option and may push one in the direction of judgment theories of emotion.

If we take mental imagery to be emotionally charged, then we can question a rarely questioned assumption that has routinely been taken for granted in this debate. This premise is that the non-emotional state and the emotional state in all these examples are in fact different mental states. It is widely agreed upon that emotional states are different from the non-emotional mental states that give rise to them—they have different content and also normally different phenomenology (see esp. Deonna and Teroni 2012, 2015).

Seeing or remembering the dog does not have emotional valence, whereas the emotional state that these non-emotional states give rise to does have emotional valence. Further, given that the same emotional state (in our example, fear) can be brought about by very different non-emotional states (for example, perceiving, remembering, imagining, thinking), treating the non-emotional state and the emotional state as separate seems like a very good idea: in this way, the emotional state is not constrained by what kind of non-emotional state it has brought about.

How, then, can we decide between the two-state picture (a non-emotional state gives rise to an emotional state) and the one-state picture (there is only one state, which represents in an emotionally charged manner)?

There may be strictly armchair reasons to question the assumption that the non-emotional and the emotional states are separate, maybe for reasons of parsimony (bracketing, for a moment, the issue that parsimony considerations tend to be notoriously problematic, see Sober 2015). When we talk about remembering a threatening encounter with a dog and being in an emotional state, we have no reason to talk about two mental states, rather than one: it is not the case that we remember this dog in an emotion-free manner and then this emotion-free state gives rise to an emotional state. My remembering is itself emotionally charged and what constitutes my emotion is this emotionally charged memory. Similarly, when I think about a scary dog, it's not that I first have an emotion-free thought, which then gives rise to the emotion: my thought about the dog is already emotionally charged.

But then again, simplicity considerations are rarely decisive and there may also be armchair reasons in favor of the two-state picture. Sometimes our emotions are not appropriate. If I see (or imagine) a cute fluffy cat and this triggers the emotion of fear, there seems to be a mismatch between the perceptual (or imaginary) representation of the cute fluffy cat and the emotion it triggers. This can be neatly explained if we endorse the two-state view: the perceptual state gives rise to the emotion, but something went wrong in this transition and the emotion fails to fit the perceptual state it is triggered by. In order to explain why and how emotions can be fitting or non-fitting, we need to posit not one, but two states (Deonna and Teroni 2015). Or so the armchair argument goes.

Moving away from armchair considerations, I want to focus on empirical reasons why we should opt for the one-state picture and not the two-state picture. Here, the considerations about the connection between emotion and imagery become relevant. First of all, note that all the alleged non-emotional states that give rise to emotions (seeing the dog, remembering the dog, imagining the dog, thinking about the dog) are mental states that involve either perception or mental imagery. Seeing a dog is a perceptual state and both remembering and imagining a dog necessarily involves mental imagery (see Chapters 20 and 22, respectively). Finally, thinking about the dog also involves mental imagery, given what we learned about the role of imagery in language processing in Chapter 19. So the alleged non-emotional states necessarily involve mental imagery.

If we also assume, as I argued that we should, given the empirical evidence, that imagery can be, and often is, emotionally charged, then this means that the alleged non-emotional states (seeing, remembering, imagining, thinking) can be, and often are, in fact emotionally charged. There is no need to postulate an extra emotional state that is separate from these representations.

Instead of having to add an additional kind of mental state, namely, emotional state, to the existing inventory of mental states (of having a belief, perceiving, remembering, or imagining), we only need to allow for each of these kinds of mental states to come in emotion-free and emotionally charged varieties. Rather than having to posit emotional states as separate and distinctive mental states (and then having to worry about their format and content), we can use the mental ingredients already present and think of emotions as modified versions of being in these mental states.[3]

How about the cute fluffy cat example that was supposed to motivate the two-state view? Do we need one emotion-free representation of the cute fluffy cat and another emotional representation that represents it as scary? Not at all. Just as many representations represent some features of the represented object correctly and some other features of it incorrectly, the same can be true of the emotional representation that the one-state view posits. When seeing the Müller-Lyer illusion, the length of the lines is represented incorrectly, but the color of these lines is represented correctly. Is this a reason for positing two different mental states, one correct, the other incorrect? I don't think so. There is only one perceptual state that represents both the size and the color of the lines, the latter correctly, the former incorrectly. Similarly, when I see the cute fluffy cat and I am afraid of it, I have one emotional state, which

[3] This account would be consistent with the claim that an emotional state is really a set of dynamically intertwined mental states, some of which would be the "cognitive base" (see, for example, Scherer 2009; see also Barlassina and Newen 2014).

represents some properties of the cat correctly, and some others incorrectly. There may be a mismatch between the way these properties are represented, but this mismatch can be fully accommodated within the one-state picture of emotions.

The one-state picture leaves many features of this one mental state unspecified. The general idea is that the very same mental state that represents the non-emotional features of an event also has emotional valence. These two aspects of this one mental state can be combined in a variety of ways. One possibility would be that this mental state represents both emotional and non-emotional features. So the content of this mental state has emotional as well as non-emotional components. The same mental state would represent the attacking dog as gray, big, and scary. Gray and big are non-emotional properties and scary is an emotional property. But this is not the only way in which the emotional and the non-emotional can be combined in one mental state.

Another option would be a form of adverbialism about emotions: being in an emotional state is just a way of having a belief, perceiving, remembering or imagining: having a belief, perceiving, remembering or imagining in an emotionally charged manner (see Döring 2014; Nanay forthcoming e for a very different take on adverbialism about emotions). It's believing something emotionally, perceiving something emotionally, remembering something emotionally, and so on. So when I see a scary dog and I am afraid of it, I am in a perceptual state. This perceptual state represents the dog in an emotional manner. As Shakespeare said in King Lear (Act IV, Scene 6): "I see it feelingly."

For the purposes of this chapter, I want to remain neutral between these ways of flashing out the one-state account of emotions. The bottom line is that if we take the close link between emotion and mental imagery, we have good reason to opt for the one-state account of emotions.

24
Knowledge

Some philosophers are interested in perception primarily because perception can lead to knowledge. I'm not one of these philosophers. But it is important to see that the picture of perception and mental imagery I outlined in the first half of the book has important implications for the potential epistemic role that perception and mental imagery may play.[1] More precisely, if perception is a hybrid of sensory stimulation-driven perception and mental imagery, then it is, one may worry, not a very reliable way of learning about the world.

First, on the face of it, mental imagery itself (regardless of what it does in conjunction with sensory stimulation-driven perception) is not in a very good epistemic shape. It lacks, by definition, a causal link to the world and even in those cases where the indirect causal link is the most reliable, as in amodal completion, it fails to satisfy the safety and sensitivity conditions of knowledge (Helton and Nanay 2019).[2] But does this mean that mental imagery itself can't lead to knowledge or even new information?

This has been an influential line of thought in the history of philosophy. Jean-Paul Sartre, for example, famously claimed that "nothing can be learned from an image that is not already known" (Sartre 1940/1948, p. 12). Since, on his view "it is impossible to find in the image anything more than what was put into it," we can conclude that "the image teaches nothing" (Sartre 1940/1948, pp. 146–7).

Sartre was not always making a clear distinction between imagination and mental imagery, so it is not clear whether it is imagination or mental imagery that teaches nothing. Contemporary philosophers tend to raise this issue about imagination (Langland-Hassan 2016, 2020; see also Kind and Kung 2016), but the question from our point of view is whether it is true of mental

[1] See also Munro forthcoming on the role of mental imagery in the epistemology of testimony.

[2] Roughly, the safety requirement is the following: Some belief gained by some method is *safe* just in case in all, or nearly all, near worlds where you form that belief on the basis of that method, that belief is true. And the sensitivity requirement is that some belief that *p*, formed by some method *M*, is sensitive just in case in the nearest worlds in which *p* is false and in which that subject uses *M*, *M* does not lead that subject to believe *p* (see Helton and Nanay 2019).

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imagery. And here it seems that even if imagination teaches nothing, mental imagery at least sometimes can and does.

Take the following example. You want to wrap a chocolate box in gift wrap. You estimate how big the piece of paper needs to be in order to cover the whole box and cut a piece of that size from the roll. When you try to use it to wrap the box, you may discover that it is not big enough. Or you may discover that the piece you've torn off is too long, so you will waste some of it. Or you may discover that it's just right.

This task requires mental imagery – visual imagery of the size of paper covering the chocolate box. Your judgment about the size of the paper needed to wrap the chocolate box is based on your mental imagery. Importantly, it does not require the voluntary use of imagination. I might count to three and then set out to voluntarily imagine how the piece of paper I am tearing off would cover the chocolate box, but this is not necessary. More often, you look at the box, look at the wrapping paper and the visual imagery is triggered without you voluntarily imagining anything.

Here, this use of mental imagery gives you new information that you didn't have before. When you look at the chocolate box and form (often involuntarily) visual imagery of the wrapping paper needed, you may find your estimation of the size of the paper unexpected or surprising. Maybe it's larger than you had assumed. Or smaller. Your estimation of the size of the paper needed can be very different before and after forming the mental imagery of the paper covering the chocolate box (and this can, of course, still be different from the size of the paper actually needed, see Gauker 2020; see also Levin 2006; Gregory 2020).

In this example, you formed mental imagery in the basis of visual cues. But you could do the same thing if I ask you what size of wrapping paper you would need to cover a 20x20x3 centimeter chocolate box. In this case, you form the mental imagery on the basis of verbal information. And, as before, the mental imagery you form can give you an unexpected and surprising answer.

In short, mental imagery can lead to new information and even knowledge.

But even if mental imagery can lead to new information and even knowledge, this does not mean that it always, or even often, does so. And given the significant role mental imagery plays in everyday perception—our primary source of knowledge—we need to examine the epistemic credentials of the forms of mental imagery that are involved in perception.

Perception sometimes justifies our beliefs. If I see that it is raining outside, this may justify my belief that it is raining outside. And much of what we know is based on perception. This is true of sensory stimulation-driven perception. But how about mental imagery? Can mental imagery justify our beliefs? If not, then we have a problem. I argued in Chapter 9 that perception per se is a hybrid between sensory stimulation-driven perception and mental imagery. If sensory stimulation-driven perception can justify our beliefs, but mental imagery can't, then there are reasons to worry about the epistemic status of the hybrid of the two (Macpherson 2012; Nanay 2020b).

There are two potential epistemic worries about how the importance of mental imagery in perception complicates perceptual justification. The first one is about the top-down influences on imagery. The second one is about the lack of a direct causal link to the outside world that is built into the definition of mental imagery. I am not sure that the former (often referred to as the cognitive penetration worry) is as serious a problem as it is often made out to be, but in order to keep it apart from the more serious latter worry, I will discuss it briefly, if only to set it apart.

The cognitive penetrability worry is this: If perception is cognitively penetrated, we get a vicious circularity: our beliefs, thoughts, and expectations are supposed to be based on and justified by our perceptual states, but these perceptual states themselves are influenced by our beliefs, thoughts, and expectations (because of cognitive penetration). As Roberto Bolaño says in the novel *2666*, "People see what they want to see and what people want to see never has anything to do with the truth."[3]

The challenge from cognitive penetration was originally focusing on one specific account of perceptual justification, namely, dogmatism (Siegel 2011; see also Lyons 2011): the view that "whenever you have an experience as of p, you thereby have immediate prima facie justification for believing p" (Pryor 2000, p. 536). The argument was that if perception is cognitively penetrated, dogmatism is not an option because the perceptual states that our beliefs are supposed to be justified by are themselves influenced by our existing beliefs and expectations. This argument has been generalized to apply to other theories of justification (not just dogmatism, see Siegel 2011; Tucker 2014; see also Lyons 2015; Ghijsen 2016; Silins 2016).

But is perception cognitively penetrated in the sense relevant for epistemologists? The first thing to note is that for many epistemologists, the

[3] Roberto Bolaño: *2666* (London: Picador, 2009), p. 219. For full effect, the quote continues as follows: "People are cowards to the last breath, I'm telling you between you and me: the human being, broadly speaking, is the closest thing there is to a rat."

relevant sense of "perception" in the cognitive penetrability of perception debate is very clearly the sense of perceptual phenomenology, as many have emphasized the role of *conscious* perception in perceptual justification—a premise it would be tempting to argue against (see Berger et al. 2018), but one I will accept in the present context for the sake of the argument. In Chapter 11, I made a distinction between the claim that perceptual experiences are influenced by beliefs and expectations and the claim that early perceptual processing is influenced in a top-down manner by perceptual (or non-perceptual) processing further up in the visual hierarchy. The former claim would be relevant for epistemology, but it is notoriously difficult to argue for or against. And while we have plenty of evidence for the latter claim, its relevance for classic epistemological questions is not entirely clear.

As a result, it does not seem that top-down influences on perception (or cognitive penetration) should give significant cause for concern to anyone who is interested in perceptual justification. Empirical findings about top-down influences on early perceptual processing do not seem to jeopardize any philosophical account of perceptual justification. Epistemologists are worried about whether our perceptual experiences are influenced by our beliefs or by other cognitive states. They tend not to be too interested in whether the primary visual cortex is influenced by the V4/V8 or the MT (but see Helton and Nanay 2022 on the epistemological significance of such top-down infliences).

Whether or not the worry about top-down influences on perception is a genuine epistemic worry, I want to argue that the real epistemic problem of the importance of mental imagery in perception lies elsewhere.

Mental imagery may or may not be influenced by top-down information. And even when it is, it is not clear how far up this top-down information comes from. But even in those cases where mental imagery is not at all influenced by top-down information, it fails to be directly caused by what it represents. Even in the somewhat trivial case of the blind spot, where, supposedly, no top-down information is being used, the blind spot is filled in by mental imagery—by perceptual processes not directly triggered by the sensory input. So, no matter what way the blind spot is filled in, that has no direct causal connection with whatever is in front of that part of the retina. It follows from the definition of mental imagery that it fails to be directly caused by what it is about.

Sensory stimulation-driven perception is perceptual representation directly caused by the sensory input, but mental imagery is defined precisely by the lack of such a direct causal link to the sensory input. In any kind of broadly externalist account of justification,[4] this raises worries about the epistemic work that mental imagery can do (as the reliability of mental imagery is supposed to depend on the directness of the causal link between mental imagery and what the mental imagery is about).

This does not mean that mental imagery does no epistemic work, as the lack of a direct causal link would be compatible with the mental imagery nonetheless carrying information about the external world reliably—especially if we endorse a concept of reliability that is defined not in terms of a direct causal link, but rather in terms of "having a good track record" (see Goldman 1999 for analysis; see also the discussion of this in the case of amodal completion in Helton and Nanay 2019). But if we take the importance of mental imagery in perception seriously, we need to examine the reliability of these non-direct causal links of mental imagery.

Perception is supposed to be a good source of knowledge because perception tracks truth. But mental imagery is, by definition, a step removed from the truth it is supposed to track. Of course it can track truth, albeit in a fallible manner. The mental imagery used for filling in the blind spot, for example, is really very reliable. It can be fooled, but in the vast majority of cases it isn't. So the mental imagery that is used to fill in the blind spot does track truth—not 100 percent reliably, but nonetheless reliably enough. And the reason we know this is that we know the exact mechanisms of how the visual system uses the sensory stimulation around the blind spot as an input when filling in the blind spot. If this mechanism were less reliable, this mental imagery would fail to track the truth.

But then the same question needs to be asked about those forms of mental imagery that play a more important role in everyday perception: about whether the mechanisms that construct these forms of mental imagery are reliable enough. Whether perception can justify beliefs depends on empirical facts about the reliability of the mechanisms of mental imagery involved in perception.

Again, we can make the default assumption that our perceptual system built pretty good mechanisms for constructing mental imagery on the basis of

[4] I have been working with a broadly externalist conception of perceptual justification: justification requires some degree of reliability. But externalism is not the only epistemic game in town. Internalists think that whether or not my belief is justified depends only on mental states I have conscious access to. So, strictly speaking, internalists could just deny that the reliability of perception has anything to do with perceptual justification at all. I do think that internalists also have a lot to worry about the involvement of mental imagery in perception, especially in the light of some recent findings that show that we *experience* amodally completed features as more reliable than features that are not amodally completed (Ehinger et al. 2017), but I will not pursue this argument here.

contextual or crossmodal information that does co-vary with the scene in front of us. The blind spot is a good example. We can fool the filling in of the blind spot, but this happens very rarely and only in exceptional circumstances (and only in monocular vision, for a start).

But if perception is really a mixture between sensory stimulation-driven perception and mental imagery, then we cannot take it for granted that perceptual justification is unproblematic. We need to examine the mechanisms of mental imagery to see how reliable they are and what role they can play in perceptual justification.

A lot more work needs to be done in order to show that we are justified in moving from (imagery-infused) perception to belief. Again, this is not to say that we can't eventually do so, we surely can. But any such move would need to involve a close empirical examination of the reliability of the processes that constitute mental imagery.

It is also important to stress that when I say that almost all of our perceptual states are in fact mixed sensory stimulation-driven/mental imagery states, I do not mean to suggest that the contribution of sensory stimulation-driven processes and not sensory stimulation-driven processes (that is, mental imagery) is approximately equal. In fact, it happens very rarely that they are equal. But the very fact that the mental imagery component is always lurking in the background should prevent us from taking perception at face value when it comes to perceptual justification.

The conclusion is that the question of perceptual justification is, at least in part, an empirical question—it requires the examination of the reliability of the forms of mental imagery that play a role in perception per se. This is a sense (a fairly narrow sense, to be sure) in which epistemology needs to be naturalized.

PART V
ACTION

25
Desire

We have seen how important mental imagery is for understanding perception and even a number of cognitive phenomena. In Part V of the book, I argue that, maybe even more surprisingly, it is also crucial for understanding many aspects of our motivation and execution of actions, starting with the concept of desire.

I will argue that the goal state of desires is represented by mental imagery. In order to have a desire, one needs to represent the goal state of this desire. In order to have a desire to achieve this goal, we need to represent this goal. The representation of the goal state does not fix the content of the desire. We could have two desires that represent the very same goal state, but nonetheless have different contents (maybe because they represent different ways of achieving the goal state or a different degree of urgency). But all desires need to represent the goal state. And I will argue that representing this goal amounts to having mental imagery of this goal.

Some preliminary remarks about desires: I will not attempt to give an ordinary language analysis of an ordinary language term, namely, desire. It may be that there are mental phenomena that we refer to with the label "desire," but that is not captured by the analysis I give here. I will restrict my argument to occurrent desires, by which I don't mean necessarily conscious desires, but rather desires that play an active role in our mental life at the given moment.[1]

I will also restrict my argument to desires to perform an action. This rules out desires for past states of affairs, for example. Again, I don't want to deny that we can call desires for past states of affairs genuine desires—I'm not doing ordinary language analysis. But I restrict the scope of my argument to desires to do something. And I will assume that a desire to do something can, at least in principle, lead to the action it is about. We can call desires of this kind executable desires.

So why is it that we represent the goal state of our desires by means of mental imagery and not in some other way (say, by having a belief about it)? I will

[1] I set aside the debate about whether standing desires are genuine desires or merely dispositions to form occurrent desires.

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give an empirically inspired argument for this claim and then show that mental imagery fulfills the two most important functional desiderata on the goal state of desires (evidence insensitivity and the relation to perceptual attention).

The argument comes from empirical studies concerning the link between desires and mental imagery. Strong occurrent desire is invariably accompanied by vivid mental imagery (Kavanagh et al. 2009). Further, stronger desires (for example, to smoke) are accompanied by more vivid mental imagery (of smoking-related scenes) (Tiffany and Drobes 1990; see also Tiffany and Hakenewerth 1991). Similarly, desire for consuming alcohol can be induced by the mental imagery of entering one's favorite bar, ordering, holding, and tasting a cold, refreshing glass of one's favorite beer. In fact, this guided mental imagery triggers a stronger desire than actually seeing a glass of beer (Litt and Cooney 1999). More generally, the vividness of mental imagery is correlated with the strength of one's desire for a range of desirable substances and activities (Harvey et al. 2005; May et al. 2008; Kavanagh et al. 2009; Statham et al. 2011; see also the literature on desire thinking (Caselli and Spada 2011; Spada et al. 2013; Sadeghi et al. 2017); and see also Kemps and Tiggemann 2015 and Papies and Barsalou 2015 for summaries).

Mental imagery of neutral scenes, for example a rose garden, reduces desire for a cigarette in people who are trying to give up smoking (May et al. 2010). Mental imagery of unrelated odors has the same effect (Versland and Rosenberg 2007). Desire for eating chocolate can also be reduced by the mental imagery of neutral scenes (Harvey et al. 2005; Kemps and Tiggermann 2007) and also by engaging involuntary mental imagery (by, for example, making a little figurine from clay or playdough without seeing your hands, which is an instance of involuntary multimodal mental imagery, where one's visual imagery is triggered by tactile input (Kemps et al. 2014)).

A useful distinction in the psychological study of desire is the distinction between wanting and liking (Berridge and Zajonc 1991; Berridge and Robinson 1995). Crucially, we can have a strong desire for something we do not actually enjoy—this happens in the case of addiction and also, arguably, in many weakness of will cases. This distinction is incorporated into many contemporary philosophical accounts of desire (Holton 2009). Importantly, vivid mental imagery of the reward can activate the wanting system in the same way as perceptual triggers of the reward can, and this can occur independently of the liking system (Berridge and Robinson 2003).

The interaction between desire and mental imagery is even more complicated. Repeated exercise of mental imagery of a certain food product reduces desire for this food product, which is a case where negatively valenced mental imagery results in the weakening of the desire (Morewedge et al. 2010; but see also Missbach et al. 2014 for some further wrinkles). Even crossmodally triggered mental imagery reduces desire, for example looking at salty food pictures, which triggers olfactory and gustatory imagery, reduces the enjoyment of salty food (Larson et al. 2014; see also Spence et al. 2016 for a summary).

These results show a very close link between desires and mental imagery. But one might wonder whether they also show that the goal state itself is represented by means of mental imagery. And, strictly speaking, they don't. Some of these results show that mental imagery influences desires. Others show that mental imagery is a downstream consequence of desires. In short, if we manipulate mental imagery, the desire changes and if we manipulate desires, the mental imagery changes.

A straightforward way of explaining this two-way influence is by taking the goal state of desires to be represented by mental imagery. A much less straightforward and much less elegant way of explaining this two-way influence would be to posit two different causal relations, namely, from mental imagery to desire and then from desire to downstream mental imagery. So the goal state of desire would not be represented by mental imagery, but it would cause and be caused by mental imagery. While this explanation could not be ruled out, the explanation in terms of the mental imagery of the goal state would be preferable on grounds of simplicity. Simplicity considerations are complex and debatable (Baker 2003; Sober 2015), but it is important to notice that here the alternative explanation would need to posit not one but two mental processes (the imagery → desire causal link and the desire → imagery causal link) and the only reason to posit these is to salvage this alternative explanation. The explanatory scheme I am proposing does not need to posit anything we don't already have reasons to posit.

The goal state of desires has a certain functional profile, and I will argue that mental imagery is well-suited (maybe even uniquely well-suited) to fulfill this functional profile. I will examine two important functional features (or desiderata) of the goal state of desires: its evidence insensitivity and its relation to perceptual attention.

The first functional desideratum is evidence sensitivity. Empirical findings show that our representation of the goal state of our desires is very often (albeit not always) systematically misrepresented—it does not represent the goal state faithfully, but rather a more positively valenced, often even idealized version of the goal state (see Andrade et al. 2012 for a summary of the research on this). So when the smoker has the desire to go outside and smoke a cigarette, the goal state of the desire is represented in a manner that is more positively valenced than we have reason to represent it ("the best cigarette I have ever smoked"). The smoker knows that it is raining, the alleyway is stinky and she has a mosquito bite on her elbow that is really itchy, but none of this shows up in the representation of the goal state. Further, this misrepresentation of the goal state persists in the face of a lot of conflicting evidence (even of the smoker is reminded of the rain and the mosquitos). In short, the representation of the goal state of desires is very often insensitive to evidence. This puts a constraint on what kind of mental state this goal state representation can be.

This desideratum immediately rules out some familiar mental states from being the representation of the goal state of desires. Beliefs, for example, are supposed to be sensitive to contradicting evidence (Helton 2020). But mental imagery isn't. This is not to say that beliefs are always sensitive to contradicting evidence (Harman 1984), but they are supposed to be. There is no such constraint on mental imagery. Thus, given that the representation of the goal state often shows systematic insensitivity to contradicting evidence, it seems that the goal state of the desire is not represented by beliefs. But as mental imagery also often shows systematic insensitivity to contradicting evidence, it satisfies the first desideratum (note that this may show that the representation of the goal state of desire is not a belief, but it does not show that it must be mental imagery, as belief and mental imagery may not be the only two possible representations).

The second functional desideratum is about keeping our attention on the task of achieving the goal state. A desire will not lead to action, if we lose focus of what it is that we wanted and how we wanted to do it. And given that the world is full of desirable things, in order to see to it that your desire gets satisfied, you need to maintain attention to your original desire to prevent it from being dislodged and being replaced by another, new desire. In short, if a desire is to stand a chance to lead to action, it needs to focus your attention on the goal state and the way to achieve this goal state (see, for example, Scanlon 1998).

And here we have a lot of empirical results that the attention in question, that is, the attention that plays a role in maintaining desires, includes a form of visual attention, which uses the resources of visual working memory (see Kemps et al. 2010; see also Andrade et al. 2012 for a summary). As a result, performing tasks that use visual working memory weakens desires and strong desires make us perform badly on tasks that require visual working memory. Given that the only representation that competes for the same resources as visual working memory is mental imagery (see Chapter 20), it follows that the attention that maintains our desires is attention to the desired state of affairs that involves visual (and often also olfactory, gustatory, etc.) imagery. In order to actually get up, go to the kitchen, get out the milk from the fridge and pour myself a glass of milk (or perform some even more attention-demanding goal-directed action), I need to maintain my desire to drink some milk in the face of all the other fun things I could be doing. And I do so by attending to the mental imagery of the goal state (the mental imagery of the milk carton or of the action of drinking the milk). The mental imagery that is involved here does not need to be particularly vivid or determinate. But the more determinate it is, the more likely it is to be able to engage your attention and see you through this daunting task.

Finally, I need to address a potential worry. What is the scope of these claims? What kind of mental imagery is involved in a desire not to do something? More generally, what kind of mental imagery is involved when we have a desire to do something that is difficult to visualize? Maybe the desire to prove the fundamental theorem of Galois's Theory in algebra? How about to desire *not* to prove the fundamental theorem of Galois's Theory in algebra?

The answer is twofold. First, the goal state of these desires is likely to be less specifically (that is, less determinately) represented. The content of many desires seems to be quite indeterminate. As La Rochefoucauld said, "We should earnestly desire but few things if we clearly knew what we desired".[2] And this, again, is a good match with mental imagery that can also be indeterminate. Second, and more decisively, it is important to remember that the claim that the goal state of desires is represented by means of mental imagery does not imply that the overall content of the desire is fixed by the mental imagery alone as the content of a desire is not exhausted by the representation of the goal state of this desire. Finally, if none of this is convincing enough for the reader, as long as we can make a principled distinction between opaque and non-opaque desires (I tried to do so in Nanay forthcoming h), we restrict the claims I defended in this chapter to the latter category, as executable desires (what this chapter is about) would count as non-opaque.

To sum up, we have strong empirical reasons to believe that the goal state of desires is represented by mental imagery and mental imagery satisfies the two desiderata on the functional roles the representation of the goal state of desires plays. The view that the goal state of desires is represented by mental imagery has some fairly surprising consequences for the way we should think about desires. The most important of these is that desires don't have a desire-like direction of fit.

The concept of "direction of fit" has played an important role in the philosophy of mind in the last half-century (Anscombe 1957; Platts 1979; Searle

[2] La Rochefoucauld: *Maximes*, 1665, section 439.

1983; Smith 1987; Humberstone 1992). As we have seen in Chapter 17, some representations represent the world as being a certain way. They attribute properties to objects. If the represented objects have these properties, the representation is correct. If they do not have these properties, they are incorrect. Representations of this kind have a "mind-to-world" direction of fit.

Some other representations, in contrast, have a "world-to-mind" direction of fit: they do not describe how the world is, but prescribe how the world is supposed to be. To take Anscombe's famous example, a shopping list has a "world to list" direction of fit, but if a detective follows the shopper around, making notes about what he buys, these notes have a "list to world" direction of fit (Anscombe 1957). Desires and intentions have a "world-to-mind" direction of fit, whereas beliefs and perceptual states have a "mind-to-world" direction of fit.

While this distinction may seem to be a straightforward one, the concept of direction of fit has been used in a variety of different ways and it has been used to play a variety of different explanatory roles (Gregory 2012; Frost 2014). And there are various distinctions one can and should make between, for example, normative and descriptive theories of direction of fit.

I want to add another distinction between different ways of thinking about direction of fit. Direction of fit can be intrinsic or extrinsic.[3] What I take to be the central and original concept of direction of fit is about the way the representation represents its object. The general idea is that there are two ways of representing: descriptively and prescriptively.

Those accounts of direction of fit that contrast correctness conditions (which is the mark of mind-to-world direction of fit) and satisfaction conditions (which is the mark of world-to-mind direction of fit) assume that direction of fit is intrinsic (Platts 1979; Searle 1983; Velleman 1992; see also Lauria 2017). These accounts construe the content of beliefs as correctness conditions (which is why beliefs have mind-to-world direction of fit) and the content of desires as satisfaction conditions (which is why desires have world-to-mind direction of fit). In other words, the difference in direction of fit between these two kinds of representation, according to this way of thinking about direction of fit, is a difference in content—the representation relation itself. In other

[3] Depending on one's views about the content of mental representations, different concepts of direction of fit will be more appealing. If one takes the paradigmatic mental representations to be propositional attitudes and endorses some form of strict distinction between the attitude and the proposition, then focusing on extrinsic direction of fit would be a more natural choice (as the propositional content remains the same if the attitude changes). If one takes the content of mental representations to include some form of "mode of presentation," then focusing on intrinsic direction of fit would be a more natural choice.

words, beliefs and perceptual states represent descriptively: they represent how things are, while desires and intentions represent prescriptively: they represent in a way that pushes you to change things. There are two different ways of representing.

I call this concept of direction of fit intrinsic direction of fit, as it is supposed to be a feature of the representation relation itself. It is the representation relation itself that has intrinsic direction of fit. Intrinsic direction of fit could be contrasted with extrinsic direction of fit, which is not a matter of the representation relation itself, but rather of how the representation is used or what functional role it plays (Smith 1987; Humberstone 1992; Gregory 2012). If you have a false belief, you need to (or tend to) change your belief—you need to make it fit the world. If, in contrast, you have an unsatisfied desire, you need to (or tend to) change the world in such a way that your desire is satisfied. So you need to (or tend to) make the world fit your desire.

Again, this distinction is not about the way in which the two representations represent. It is about what we should do (or what we tend to do). So, we can maintain this distinction between extrinsic mind-to-world and world-to-mind directions of fit while denying that representations can represent in two different ways. Even if, as one might argue (see below), representations only represent descriptively, that is, even if they can only have mind-to-world intrinsic direction of fit, all the options about extrinsic directions of fit are still very much open. We can still make a distinction between extrinsic world-to-mind and mind-to-world direction of fit as what we should change in the case of misrepresentation is not something that has to be (or even can be) built into the representational relation itself. So, it is possible that the functional role of desires is such that if the desire is not satisfied, we should change the world. And the functional role of beliefs is such that if the belief is not true, we should change the beliefs. It would also be consistent with my claim about intrinsic direction of fit (that is, that there is only mind-to-world intrinsic direction of fit) to deny that the concept of (external) direction of fit is useful or coherent (see Frost 2014).

If the argument I presented in this chapter is correct, then desires don't have world-to-mind (or prescriptive) intrinsic direction of fit. To put it provocatively, desires don't have desire-like direction of fit.

I argued that the goal state of desires is represented by mental imagery. The question is how this goal state is represented: descriptively or prescriptively? The goal state is a state of affairs: me taking out the milk from the fridge, for example. There is nothing prescriptive about the representation of this state of affairs. More generally, mental imagery represents descriptively. Visualizing an apple represents the (imaginary) apple as having (imaginary) properties. And having mental imagery of the goal state represents the goal state (me eating the apple) as having some imaginary properties (of tasting good, tasting bad, tasting neutral, and so on).

More slowly: the question here is more specifically about the intrinsic direction of fit of mental imagery. In other words, the question is whether it represents descriptively or prescriptively. Mental imagery, as we have seen, is perceptual representation that is not directly triggered by the sensory input. It is a form of perceptual representation, and the difference between sensory stimulation-driven perception and mental imagery is that of etiology: one is triggered directly by the sensory input and the other isn't. In other words, mental imagery represents the way perception represents. And as it is universally agreed that perception has mind-to-world intrinsic direction of fit, it follows that mental imagery also has mind-to-world intrinsic direction of fit.

So, the representation of the goal state of desires has descriptive, that is, mind-to-world, direction of fit. Not desire-like direction of fit, but belief-like or perception-like direction of fit as mental imagery has mind-to-world direction of fit. This, of course, leaves open the possibility that desires represent both descriptively and prescriptively, or, as it is often put, that they have both directions of fit: they both describe how the world is and prescribe an action.

Some representations are said to have both directions of fit: they represent the way the world is, and at the same time prescribe how the world is supposed to be (see Millikan 1995; Clark 1997; Pacherie 2000; Pacherie 2011 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 proposal then would be that, besides mind-to-world (descriptive) direction of fit, desires also have world-to-mind (prescriptive) direction of fit. Or maybe while some components of the desire (the representation of the goal state) have mind-to-world direction of fit, the whole desire has world-to-mind direction of fit. Even if desires (or some of their components) have descriptive direction of fit because they represent their goal states descriptively, this does not exclude the possibility that they *also* represent prescriptively.

What would be the justification for positing double direction of fit for desires though? Given that we need to posit descriptive direction of fit in order to account for the representation of the goal state of desires, we would need pretty strong reasons to also attribute the opposite direction of fit. The standard reason why desires are described as having world-to-mind direction of fit is that they play a role in motivating action and if they only represented the world descriptively, this motivating role would be difficult to account for.

This argument has been made against the most influential theory that attributed mind-to-world direction of fit to desires, the besire theory. According to the besire theory, desires are beliefs of a certain kind (thus the witty label). Besire theories come in many colors (Smith 1987, 1994; Lewis 1988; Gregory 2017; see also Lauria 2017), but it is important to point out that the account of desires I am arguing for here is not a besire theory. Beliefs are propositional attitudes and given that according to the besire theory, beliefs and besires are the only building blocks of the mind, it is a fair question to ask how beliefs and further beliefs (as desires are also beliefs) manage to motivate us to act.

My account, according to which the goal state of desires is represented by mental imagery, fares better in this respect. As we have seen, mental imagery can be (although it does not need to be) emotionally charged or valenced (see Chapter 23). If you visualize your long-deceased grandmother, this imagery can be emotionally charged, for example. And valenced imagery can motivate us to act. This has been an old theme in the history of philosophy, going back at least to Aristotle (see McMahon 1973).

Empirical research also shows that valenced imagery can motivate us to act. Valenced mental imagery of performing an action increases the probability of the task completion (at least in the case of tasks we tend to put off; see Renner et al. 2019). Further, as we have seen in Chapter 22, if you are undecided between two positive options, the one that is imagined more vividly tends to win out. And if you are undecided between two negative scenarios, the one that is imagined less vividly tends to win out (Austin and Vancouver 1996; Trope and Liberman 2003). But if valenced imagery can motivate us to act, and if desires represent their goals by means of imagery, then we have no prima facie reason to posit world-to-mind direction of fit to desires.

The proposal that desires do not have desire-like, that is, world-to-mind direction of fit may not be that radical. Some philosophical theories of desire would be consistent with the view I argued for. An important example is Tim Schroeder's empirically informed theory of desire that takes desires to be the mental states that drive reward-based learning (Schroeder 2004). There is no prima facie reason to think that this mental state that drives reward-based learning would need to have world-to-mind direction of fit. The reward-based theory of desire says nothing about mental imagery, but it could be supplemented by an account of the role of mental imagery in desires (which would explain at least some features of the reward-based learning process (see esp. Berridge and Robinson 2003)).

A further consideration comes from phenomenology. It has been pointed out that there is a mismatch between the phenomenology of desires and their alleged world-to-mind direction of fit (Hulse et al. 2004). What shows up in our phenomenology when we have an occurrent desire are only states with mind-to-world direction of fit, say, perception or imagery of the desired object or introspection of my (bodily) states. In other words, on the face of it, and bracketing the usual worries about the unreliability of arguments from phenomenology, positing only mind-to-world direction of fit for desires seems to match our naïve conception of desires.

Finally, the proposal that desires do not have desire-like direction of fit is very much consistent with empirical research on desires. One of the most influential theories of desire in psychology is the "elaborated intrusion" theory (Kavanagh et al. 2005; May et al. 2014). According to this view, forming a desire is a two-step process. First, a mental state intrudes our mind, which represents the desirable state of affairs. This often happens unconsciously, and it is often not clear what triggers this intruding mental state. The second step is that this representation is elaborated with the help of mental imagery.

The first thing to note is that if we parse the elaborated intrusion theory as a philosophical view, it takes mental imagery to be constitutive of desires: the intruding representation is elaborated with the help of mental imagery.[4] Even more importantly, it is also a theory that posits only mind-to-world direction of fit for desires. The original intruding representation has a mind-to-world direction of fit and the mental imagery that is used to elaborate this intruding representation also has mind-to-world direction of fit.

[4] This view about the centrality of mental imagery in desires may also be consistent with those philosophical accounts of desire that construe desires as the appearances of the good (Oddie 2005; Tenenbaum 2007).

26

Pragmatic Mental Imagery

Mental imagery plays an important role not only in desires, but also in action execution. A more obvious claim would be that motor imagery plays such a role, and I will argue in Chapter 27 that it indeed does, but so does bona fide mental imagery. Before I argue for these two claims, it is important to make a distinction between mental imagery and motor imagery. In fact, we can use the general theoretical framework of mental imagery to understand motor imagery better.[1] So before I turn to the discussion of the role of sensory mental imagery in action performance in the second half of this chapter, I will talk about the relation between motor imagery and sensory mental imagery, and continue to discuss motor imagery in Chapter 27.

Motor imagery has been traditionally understood as the feeling of imagining doing something. It is sometimes taken to be necessarily conscious, and not only by philosophers (Currie and Ravenscroft 1997) but also occasionally even by psychologists (Jeannerod 1994, 1997; see also Brozzo 2017, esp. pp. 243–4 for an overview). And as imagining tends to be a voluntary act, motor imagery is also often taken to be voluntary. So the paradigmatic example here is closing your eyes and imagining reaching for an apple.

But just as in the case of mental imagery, examples of this kind are not representative of motor imagery. Motor imagery, just like mental imagery, can be conscious or unconscious (see, for example, Osuagwu and Vuckovic 2014) and it can also be voluntary or involuntary. In order to understand how we can generalize to involuntary and unconscious cases, we should follow a methodological advice from one of the most important researchers working on the cognitive neuroscience of action, Marc Jeannerod.[2]

[1] I have contrasted and will continue to contrast motor imagery (a motor phenomenon) and mental imagery (a perceptual phenomenon). But as motor imagery is undoubtedly a mental representation, this terminology is potentially misleading. To mitigate this, I will say often "sensory mental imagery" in this chapter, to indicate that what I have in mind when referring to mental imagery here is perceptual representation that is not directly triggered by the sensory input.

[2] Jeannerod sometimes also took it for granted that motor imagery is necessarily conscious, he even defines motor imagery once as "the ability to generate a conscious image of the acting self" (Jeannerod 2006, p. 23). But when actually using this concept, he drops the assumption that motor

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Jeannerod writes: "Motor imagery would be related to motor physiology in the same way visual imagery is related to visual physiology" (Jeannerod 1994, p. 189). And rightly so: if visual imagery is "early" cortical activation that is not directly triggered by sensory input, then motor imagery is "late" cortical activation that does not directly trigger bodily movement (see Nanay 2020a).

More slowly: In the case of visual perception, light hits the retina and this retinal stimulation then triggers processing in the primary visual cortex (V1) and then in other early cortical visual areas like V2, V4/V8, or MT. When processing in these early cortical areas is not triggered directly by retinal stimulation, we have mental imagery.

We get the converse picture with motor imagery. To simplify a bit, when we perform an action, before our body moves, there is processing in the primary motor cortex (M1). And before that, we get processing in the premotor cortex and in the supplementary motor area (SMA) (and before that, in the posterior parietal cortex (PPC)). So processing in PPC, SMA, the premotor cortex, and M1 triggers bodily movement. When processing in the motor cortex does not directly trigger bodily movement, we get motor imagery. Motor imagery is cortical motor processing that does not directly trigger motor output.

The paradigmatic example of imagining grasping the apple will come out as motor imagery on this definition as we have a large and growing literature on the involvement of the motor cortex in conscious and voluntary motor imagery (like deliberately imagining doing something). Processing in the premotor cortex and the supplementary motor area during conscious and voluntary motor imagery has been known for a long time (Roland et al. 1980; Fox et al. 1987; Decety et al. 1990, 1994; Stephan et al. 1995; Filimon et al. 2007). The same goes for the posterior parietal cortex (Aflalo et al. 2015).

There have been some controversies about the involvement of the primary motor cortex in voluntary motor imagery (Roland et al. 1980; Decety et al. 1994; Stephan et al. 1995). But more recently there is converging evidence that the primary motor cortex is active during conscious and voluntary motor imagery (Gandevia and Rothwell 1987; Georgopoulos et al. 1989; Porro et al. 1996; Roth et al. 1996; Schnitzler et al. 1997; Richter et al. 2000; Miller et al. 2010; Saruco et al. 2017; see also Dechent et al. 2004 for an error theory of why earlier studies failed to find the involvement of M1 in motor imagery).

imagery is conscious. See esp. Frak et al. 2001; Jeannerod 2001; and the discussion between Jeannerod and Rizzolatti following Rizzolatti 1994 about unconscious imagery (also confirmed in personal communication, Nottingham, March 2001).

It is important that this is a functional, not a physiological, way of defining motor imagery (just as the definition of mental imagery was also functional and not physiological). In the case of mental imagery, processing in V1 that is not triggered directly by visual input was not necessary for mental imagery. If the V1 is silent, but there is processing in V2 or V4 that is not triggered directly by visual input, we still get mental imagery. What is important is that mental imagery is perceptual processing not directly triggered by sensory input.

Similarly, I'm not claiming that activity in M1 that does not directly trigger bodily movements, is necessary for motor imagery. Even if M1 is silent but the premotor cortex or the SMA is not, and there is no overt movement, we can still talk about motor imagery (see, for example, Gentili et al. 2004; Hanakawa et al. 2008; Gandrey et al. 2013). It is important that we do not need to resort to neuroimaging in order to find out whether the subject exercises motor imagery—we can also use behavioral methodology. One such behavioral method involves eye tracking, as motor imagery evokes very specific eye movement patterns that are very different from visual mental imagery (and that is present both in conscious and in unconscious motor imagery; see Poiroux et al. 2015 for a summary of the research on this).

Here is a brief way of summing up the structural relation between mental imagery and motor imagery. Whereas mental imagery is the first stop of perceptual processing that is not directly caused by any input, motor imagery is the last stop of motor processing that does not directly cause any output.

This way of thinking about motor imagery can also help us with a notorious unclarity about the traditional, phenomenological way of zeroing in on motor imagery as the feeling of imagining doing something. As acknowledged by all involved in this debate, not all imaginative episodes of doing something would count as motor imagery: you somehow need to imagine doing something from a first-person, and not a third-person perspective. Jeannerod himself made a distinction (following the practice in sport psychology) between internal (first person) and external (third person) imagery, and only the former would count as motor imagery (the latter would be sensory imagery of me doing something; see Jeannerod 1994, p. 189). As this phenomenological distinction between first-person and third-person imagery is vague (something acknowledged by Jeannerod 1997), using the functional criterion is preferable.

I have emphasized the symmetry between the way sensory mental imagery relates to input and motor imagery relates to output. But the relation between sensory and motor imagery is more complex. To put it very simply, motor imagery necessarily involves sensory mental imagery. This is hardly surprising when we think of conscious examples of motor imagery: imagining touching the camera of my laptop involves some form of sensory mental imagery (maybe visual imagery of my finger touching the camera, or, maybe, more minimally, proprioceptive mental imagery of my finger being at a different location from where it is now).

But there are also empirical reasons to think that motor imagery necessarily involves sensory mental imagery. In a recent experiment (Kilteni et al. 2018), subjects had to imagine touching their right index finger with their left index finger. We know that self-touch is very different from being touched by someone else (as the famous example of the impossibility of tickling oneself shows). But imagining touching one's finger has a very similar sensory profile to actual self-touch (and very different from touching or being touched by someone else or an inanimate object). The researchers conclude that motor imagery necessarily entails representing the sensory consequences of the imagined action. In terms of this book this amounts to having (temporally forward-looking) sensory mental imagery (see also Bennet and Reiner 2022 for further support for this claim).

This intertwining of motor and sensory imagery makes it even more problematic to rely on introspective ways of identifying motor imagery (and keeping it apart from motor imagery-free sensory imagery of our own body). But even more importantly, the necessary involvement of sensory mental imagery in motor imagery makes mental imagery even more important for understanding various components of action planning and action execution, as we shall see in Chapter 27. This book is about mental imagery, not motor imagery (a topic that would deserve a book-length study in itself), so I will only briefly discuss, in Chapter 27, the role of motor imagery in action execution. But there are lots of exciting questions about motor imagery that I want to leave open here, especially the extent to which various aspects of motor imagery (its content, for example) could be explained in terms of the sensory imagery it necessarily involves.

I will come back to the concept of motor imagery in Chapter 27. But this chapter is about a form of mental imagery that nonetheless is crucial for action execution: pragmatic mental imagery.

Mental imagery, unlike motor imagery, is perceptual representation. It can nonetheless play an important role in action execution (see also Van Leeuwen 2011 for a related argument). Some of our actions (in fact, most of our actions) are perceptually guided actions: our perceptual states trigger and guide our actions. When we pick up a coffee cup to drink from it, this is a perceptually guided action: our perceptual state represents the spatial location of the cup, which then guides your reaching movement.

In Nanay 2013a, I called perceptual states of this kind, that is, perceptual states that guide our motor actions, "pragmatic representations." Pragmatic representations represent those parameters of the situations that are necessary for the successful performance of actions. Just what these parameters are could be debated: they may include the properties of the objects one acts upon, the properties of one's own body, one's bodily movement that is needed to complete the action, or maybe the properties of the goal state the action is aimed at (see Poincaré 1905/1958; Bach 1978; Brand 1984; Jeannerod 1997; Millikan 2004; Pacherie 2011; Nanay 2013a; Butterfill and Sinigaglia 2014 for very different proposals about this).

I argued that whatever else needs to be represented about the situation that is necessary for the execution of the action, some egocentrically represented properties of the objects definitely do need to be represented. Pragmatic representations represent exactly these: shape, size, and spatial location of the distal objects the action is directed at. These properties are egocentric in the sense that they represent the shape, size, and spatial location of the distal objects as related to our own body: the size as related to our grip size, the spatial location as related to our own spatial location, and so on. In other words, these egocentric properties are relational properties: they are relations between the properties of the object and our own properties (say, the relation between the size of the cup and my grip size).

Simple representations of this kind are involved in the performance of all bodily actions. These properties need to be represented in order for the agent to be able to perform the action at all. Suppose that the action is to pick up a cup. If I didn't represent the size of the cup, I would have no idea what grip size I should approach it with. If I didn't represent its spatial location, I would have no idea which direction I should reach out towards. And so on.

Pragmatic representations are genuine representations: they can misrepresent. If I represent the shape-property of the cup correctly, then I will be more likely to approach it with the appropriate grip size, which makes it more likely that my action will be successful. And if I represent the spatial location of the cup correctly, I will be more likely to reach out in the right direction, which, again, makes it more likely that my action succeeds. I also argued that pragmatic representations are genuine perceptual representations, but I will not need this stronger claim for the purpose of the argument in this book. But pragmatic representations represent relational features of perceived objects.

Pragmatic representations do not need to be (and arguably they normally are not) conscious. But then how do we know what property (say, shape-property or spatial location property) they attribute to the cup? Clearly not by introspecting. We can infer what shape-property this pragmatic representation attributes to the cup from the grip size I approach the cup with. And we can infer what spatial location property it attributes to the cup from the direction of my reaching. In other words, if the shape-property the pragmatic representation attributes to the cup changes, this affects my behavior, that is, the grip size of my approaching hand, directly. And if the spatial location property the pragmatic representation attributes changes, this also affects my behavior—the direction I reach out towards (see Jeannerod 1997 for a number of case studies of how intervention on the pragmatic representation leads to observable changes in our behavior). In one famous experiment, in the middle of the performance of the reaching movement, the target was changed—either its spatial location or its size. And this influenced the action execution—the reaching movement changed direction during the execution of this action. The subjects were almost always unaware that anything has changed (Goodale et al. 1986; Pelisson et al. 1986; Paulignan et al. 1991).

So far, I have talked about cases where there is a cup in front of me and I am looking at it as I am performing the action. These are perceptually guided actions. A (sensory stimulation-driven) perceptual state guides my action. When I pick up the cup, while looking at it, the visual feedback helps me to do so. I can adjust my movements in the light of my visual experience of how my action succeeds: if my initial reach was too forceful, I can adjust its course in response to the visual feedback (as we have seen in the previous paragraph, some of this happens unconsciously; see Paulignan et al. 1991).

But I can also perform this action, and do so fairly successfully, without looking. I am looking at the cup, I then close my eyes, count to ten and then reach out to grab it. In this case, it is my mental imagery that guides my action. It is a special kind of mental imagery inasmuch as it attributes very similar properties as pragmatic representations do: egocentric spatial location properties (that allow me to reach out in the appropriate direction), egocentric size properties (that allow me to approach the cup with the appropriate grip size), and so on. And it is also, like pragmatic representation, a genuine representation, as it can misrepresent (Nanay 2013a, 2022a). I call this kind of mental imagery "pragmatic mental imagery."

Manipulating pragmatic mental imagery leads to observable behavioral changes in the same way as manipulating pragmatic representations leads to observable behavioral changes: if your pragmatic mental imagery attributed a different size-property to the cup, you would approach it with a different grip size.

In this example, the pragmatic mental imagery was formed on the basis of your perceptual state: you looked at the cup and then you closed your eyes, but it is this visual information that the mental imagery is based on. But pragmatic mental imagery is more than just some kind of echo of sensory input. Suppose that you are in your bedroom and it is pitch-dark. You want to switch on the light, but you can't see the switch. You are nonetheless in a position to switch it on given your memory of the room's layout and the location of the light switch in it. In this case, your pragmatic mental imagery is formed on the basis of your memory.

But pragmatic mental imagery can be triggered by completely non-perceptual means as well, for example if I blindfold you and then explain to you in great detail where exactly the coffee cup is in front of you, how far exactly to the left and how far exactly ahead, and so on. Your pragmatic mental imagery can still guide your action, but it does so without any (visual) input. In our everyday life many of our actions, especially our routine actions, like flossing, are in fact guided by pragmatic mental imagery.

Pragmatic mental imagery has been actively used in medical training. Surgeons who perform rare operations are often trained with the help of visual mental imagery for these operations (as they can't prepare by conducting surgery of this kind). And such visual imagery training helps surgeons to be more precise with their procedure (Sanders et al. 2004, 2008; Immenroth et al. 2007).

Pragmatic mental imagery also plays an important role in some of our pretense actions. Take the following pretend action. I pretend to raise a glass and take a sip from it, even though my hands are empty. How is this pretend action different from the actual action of taking a sip from an actual wine glass? Obviously, there is no glass in one case and there is glass in the other case. But how are our mental processes different? What representational state allows me to hold my hand and move it towards my mouth in the way that I do?

According to the two most influential accounts of pretense, the representational states that bring about pretense actions are either an actual (conditional) belief and an actual desire (Nichols and Stich 2003) or a "belief-like imagination" and a "desire-like imagination" (Currie and Ravenscroft 2002; Velleman 2000; Doggett and Egan 2007). While these accounts may explain some pretense actions, they are less well-suited for examples like taking a sip from an imaginary glass. The belief (or the belief-like imagination) that I am making a toast does not specify what grip size I should maintain while I am performing the action. Nor does the desire (or desire-like imagination).

And we cannot rely on pragmatic representations either (whose job it would normally be to help us to have the appropriate grip size): they attribute egocentric shape, size and spatial location properties to perceived objects, but there is no perceived glass—I am raising my empty hand. My proposal is that the representational state that allows me to hold my hand and move it to my mouth is pragmatic mental imagery.

When I am pretending to raise my glass with nothing in my hands, I presumably have belief-like imagination that I am drinking a glass of wine (and maybe corresponding desire-like imagination), but in order for this belief-like imagination to have any influence on my actual movements, I also need to have pragmatic mental imagery that allows me to hold my fingers and move my hand in a certain way. This pragmatic mental imagery attributes properties like egocentric weight, shape, and spatial location properties to the imagined glass in my hand. We have pragmatic mental imagery of the weight-property, the shape-property, the size-property, etc. of the nonexistent glass, and the attribution of these properties guides my pretend action: it guides the way I hold my finger (as if around a glass), the way I raise my hand (as if raising a glass), etc. This pretend action cannot be explained without appealing to pragmatic mental imagery.

It is important to emphasize that I do not need to consciously visualize the glass in order to attribute various properties to it by means of mental imagery. Nor does this mental imagery need to be triggered voluntarily. But I do need to attribute egocentric shape, size, etc. properties to the glass by means of mental imagery—otherwise I would not know how to move my hand.

In the example of pretending to take a sip from a nonexistent glass, my belief, my desire, as well as my pragmatic representation, are all “imaginary”: belief-like imagination, desire-like imagination, and pragmatic mental imagery. But in other cases of pretend actions, our pragmatic representation is not imaginary: we do not need pragmatic mental imagery. Here is an example: I am taking a sip from a glass of cheap and bad red wine, and I pretend that I am taking a sip from a glass of 2004 Brunello di Montalcino. I may be using belief-like imagination (and, presumably, desire-like imagination), but the pragmatic representation that guides this action is exactly the same as it would be if I were not pretending. Pretense can happen without pragmatic mental imagery.

This leads to a non-monolithic account of pretense actions. Some of our pretense actions can be explained with the help of belief-like (and desire-like) imagination. Some can be explained with the help of pragmatic mental imagery. And in some cases, we need to appeal to both kinds of imaginary states.

Neil Van Leeuwen highlighted an important special case of pretense that he calls "semi-pretense"—a mental state somewhere in between pretending and performing a real action (Van Leeuwen 2011). His example is a scenario where two kids, who are watching some other kids jumping off the highdive, are evaluating the quality of the dives by holding up their fingers. Is this a real action? In some sense, it is: they are genuinely evaluating the dive of their friends. But it is also pretense inasmuch as they pretend to be judges who give points for each dive. It is not full pretense though—they do not hold up placards with numbers, they merely use their fingers.

Van Leeuwen argues that the two mainstream accounts cannot explain semi-pretense because there is no middle ground between beliefs and belief-like imagination (or between beliefs and conditional beliefs).

My account can explain "semi-pretense" because it allows for the "integration of perception and imagination,"—this should be clear enough in the context of this book. Sometimes, for example, when I am pretending to stab you with a sword with my hands empty, I attribute all the relevant properties to the nonexistent sword by means of pragmatic mental imagery. Some other times—for example, when I am pretending to stab you with a sword and I in fact hold an umbrella in my hand—I attribute some of these properties perceptually (its weight, for example), but I attribute others by means of mental imagery (for example, the property of where the end of the sword is and how sharp it is). In this case, some of the properties are attributed by my pragmatic representation, and some others by my pragmatic mental imagery.

27

Motor Imagery and Action

What triggers the execution of actions? Suppose that there is a cup of tea next to your computer while you're working. You want to take a sip, you have a belief that the tea is not too hot and it would quench your thirst, you have a (distal) intention to take a sip. But you're not doing it. And suddenly, you find yourself taking a sip. What happens in that moment when this action is triggered? What mental state is there at the moment of action execution that was not there a second before? I take these to be among the most important questions of philosophy of action (see Brand 1979; Nanay 2014b).

The question about what triggers actions also has serious implications for our everyday life and well-being. In the case of taking a sip of tea, I wanted to do so and I formed an intention to do so. The question was just how this desire and intention gave rise to the actual bodily movement. But there are other cases where the executed action goes against our desires and even our intentions. Akratic actions are obvious examples: next to your computer is the TV's remote control, not a cup of tea. And you want to finish the grant proposal and have an all-things-considered intention to do so, but you nonetheless find yourself switching on the TV. How is that action triggered?

Addictions of various kinds raise the same problem (Brevers et al. 2012). Recovering addicts have a very strong desire not to relapse. But when they do relapse (when their "relapse actions," as I will call them, are triggered), what triggers these actions?

The concept of motor imagery can help us to address these questions. As we have seen in Chapter 26, motor imagery is cortical motor processing that does not directly trigger motor output. While there has been a fair amount of research in psychology and neuroscience on motor imagery in the last thirty years or so, it is only recently that we start to understand the important role motor imagery plays in action initiation. And if, as these findings suggest, motor imagery plays an important role in action initiation, we can make progress not only in understanding action initiation in general but also in understanding what goes wrong in akratic actions and in relapse actions.

The question of action initiation is widely studied in neuroscience and psychology. Neuroscientists of action make a distinction between the

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preparation for a movement and the execution of that movement. The set of findings I want to focus on here is about one major difference between these two phases of action execution: the inhibition of action during the preparation for a movement and the lifting of this inhibition shortly before the execution begins (see Porter and Lemon 1993 for an overview). This difference is at the segmental spinal level, that is, not in the brain, but in the spine. There is a sharp decrease of spinal reflexes during preparation for a movement (which prevents motor neurons from spontaneous firing) and an increase again shortly before execution (Requin et al. 1977; Bonnet and Requin 1982; Fourkas et al. 2006; see also Kyriakatos et al. 2011).

Motor imagery, like action execution, but unlike action preparation, increases spinal excitability (Bakker et al. 1996; Bonnet et al. 1997; Li et al. 2004; Guillot et al. 2007; Aoyama and Kaneko 2011). Further, motor imagery training increases spinal plasticity (Grospretre et al. 2019). So whatever increases spinal excitability is there both in motor imagery and in action execution. This means that the increase in spinal excitability is not sufficient for triggering the action: in the case of motor imagery, we have an increase in spinal excitability, but no action performance.

Given that both motor imagery and action initiation increase spinal excitability—and therefore the "readiness" to perform an action, one should ask how motor imagery might contribute to the triggering of the bodily movement.

The relation between motor imagery and actual action performance has been investigated for a long time (see especially Marc Jeannerod's work: Jeannerod 1994, 1997, 2006; see also McCormick et al. 2013). It has been known for decades that there is a substantial overlap between the brain regions involved in motor imagery and in action execution (see Miller et al. 2010 for a summary). But the main emphasis of the research on the connection between motor imagery and action performance has been on how motor imagery can help us to make our action performance more accurate (see the vast amount of research in sport psychology on this (Feltz and Landers 1983 is a classic summary)). What I want to focus on is a much more recent body of findings, which is not about how motor imagery can modify the ways in which actions will be performed, but about how it can help trigger action execution (see Nanay 2020a for a longer version of this argument).

And there are some important recent results that suggest that motor imagery can make it more likely that the bodily movement is triggered (most of the findings at the moment seem to be limited to some simple bodily movements only in healthy subjects; see Rodrigues et al. 2010; Stins et al. 2015; but see also Schwoebel et al. 2002 and Fourkas et al. 2006). Further, incongruent motor imagery interferes with action execution (Ramsey et al. 2010).[1] These findings suggest that the initiation of actions is made more probable by having motor imagery of the performance of this action and it is made less probable by having motor imagery of some other actions (see also Nanay 2017c).

Nothing in these empirical results suggests that motor imagery reliably leads to action execution. All that follows is that it makes the triggering of action execution more likely by pushing the spinal excitability further and further up. But the mere fact that motor imagery is a factor in what triggers actions is something that could have a significant impact on understanding the mechanism of action initiation. Thinking about the role of motor imagery in action initiation helps us to understand how akratic actions are triggered.

You are working on your computer and suddenly the idea of watching TV instead pops into your head. And then you find yourself reaching for the remote. My claim is that one of the mental states that has contributed to the triggering of the action of reaching for the remote is motor imagery. As a result, one thing we can do if we want to resist the temptation of watching TV would be to manipulate our motor imagery (see Papies and Barsalou 2015; Cornil and Chandon 2016).

The link between motor imagery and akratic actions is even more straightforward in cases we might call "obsessive procrastination." You know that you need to work on a grant proposal that is due tomorrow, but you are instead playing a video game. You know you need to stop, but you keep on playing. If we understand the role of motor imagery in action initiation, this is not surprising at all. When playing a video game, you already have your motor imagery engaged in the video game and this leads to the initiation of the action of playing another level, rather than getting up and going to your computer to work on the grant proposal.

I should emphasize that these are supposed to be partial explanations. There are many mental states that are involved in performing akratic actions (Nanay 2020f) and I do not want to pretend that I can explain all of them. My aim is to highlight an important mental antecedent of akratic action that we may have more control over than other, less clearly understood motives of akratic actions.

On a pragmatic note, it seems to follow from this that if you feel the temptation to reach for that remote control, then not imagining doing so (or

[1] Another relevant finding in this context is that congruent hand posture during motor imagery facilitates spinal excitability, whereas incongruent hand posture makes spinal excitability less likely (Vargas et al. 2004).

imagining performing other actions) may help you to resist this temptation, whereas imagining doing so will increase the probability that you succumb to the temptation.

And here we can plug in one of the most celebrated results of sport psychology about motor imagery. It has been found that the precision and even the strength of complex motor actions is increased merely by the subject looking at the object these actions are performed with or on. The explanation of this is that the mere perception of this object triggers motor imagery and this repeatedly triggered motor imagery contributes to the better (more accurate, more forceful) performance of this action (Feltz and Landers 1983; Bakker et al. 1996).

What is relevant from these findings for our purposes is that merely perceiving an object, with which we are used to performing an action, triggers motor imagery of this action. So, seeing a remote control will trigger motor imagery of grasping it and pushing the on button. And merely seeing a glass of wine will induce motor imagery of lifting it up and taking a sip.

So one, simple and not always available, way of reducing the chance of performing an action we do not want to perform is to make the objects that are required for performing this action perceptually unavailable (that is, to hide that remote or not to have Facebook open in your browser, for example). Or, if this is not an option, the same can be achieved by making these objects inaccessible by a well-trained motor routine. If we don't perceive this object, the motor imagery is less likely to be activated. And if we do perceive it, but the motor routine is not well-trained, the motor imagery is, again, less likely to be activated.

This proposal could also be taken to be continuous with some influential philosophical accounts of resisting temptation (that is, resisting the initiation of the tempting action). Richard Holton argues that it can be detrimental to our determination to resist temptation to think about the tempting action (Holton 2009, pp. 126ff.). The present proposal could be thought of as extending this general approach. Rather than focusing on *thinking* about the tempting action (whatever that means), the aim here is to identify just what kind of mental processes would be needed to push us over the threshold of action initiation. And my answer is that this mental process is motor imagery. This also explains what could be dubbed, for the benefit of *Fawlty Towers* fans, the "Don't mention the war" phenomenon: often focusing on not doing something leads to the performance of the very action we are trying hard not to perform.

One advantage of this view of the role of motor imagery in action initiation is that it can help us to explain some empirical findings about addiction treatment. The study I want to focus on is about alcoholics who were trained to use a joystick when presented with pictures of alcohol and of non-alcoholic beverages (Wiers et al. 2011; see also Palfai 2006; Wiers et al. 2010). Subjects in this experiment had to move the joystick away from themselves when presented with pictures of alcohol and they had to move the joystick towards themselves when they saw a picture of non-alcoholic beverages. Subjects in the control group were either not trained in any ways, or were trained to respond to some other, not alcohol-related feature of the picture.

The result was that those who were trained to make avoidance movements in response to pictures of alcohol showed significantly more progress at recovery (Wiers et al. 2011). In some cases, even a single training session had a significant positive effect (see esp. Wiers et al. 2010). It is not clear how we can explain this effect—it was not clear to the experimenters who conducted these studies either. Wiers et al. (2011) hypothesizes, very tentatively, that maybe emotions are involved (roughly, retraining the action tendencies lead to emotional change). But it is not clear how this connection would work and how such a change in emotions would lead to such rapid improvement in recovery.

If we accept that motor imagery plays an important role in action initiation, we get a much more straightforward explanation. As we have seen, incongruent motor imagery interferes with action execution (Ramsey et al. 2010). And the joystick exercise these subjects perform trains them to have motor imagery in response to pictures of alcohol that is incongruent with approach behavior. As a result, their action execution (of reaching for alcohol in relapse situations) is less likely to be triggered (see also the alternative explanation, anticipated in Wiers et al. 2011 and elaborated in Mylopoulos and Pacherie 2020, in terms of approach bias, which may be complimentary of my explanation).

This is a very promising way of treating addictions. One important marker of addiction is that addicts' attention is captured by addiction-relevant stimuli (see Brevers et al. 2011 for a summary of the vast literature on this; see also Anderson and Yantis 2013 for how this fits into long-term value-driven attentional effects). And the term "addiction-relevant stimuli" here does not merely mean stimuli that is directly connected to the addiction (in the case of gambling addiction: the roulette table), but a much wider range of stimuli that would be somehow very distantly related to the addictive behavior (for example, the shirt you once wore in the casino, and so on).

It is not an option to hide all possible addiction-relevant stimuli (because they are everywhere). So addicts perceptually encounter addiction-relevant stimuli all the time and their attention is captured by these stimuli. And the intense capture of the addict's attention makes the triggering of motor imagery also more intense. So the only available option seems to be to reprogram the motor imagery itself, which, as we have seen, is not an impossible task.

In short, perception can lead to unwanted motor imagery and unwanted motor imagery can lead to unwanted action. We can interfere with this process at various points: we can manipulate what we see, we can manipulate what kind of motor imagery perception gives rise to, and we can also manipulate what kind of action motor imagery contributes to. Understanding the role of motor imagery in action initiation can help us to manage the triggering of our unwanted (akratic, relapse) actions more efficiently.

The picture of action initiation I outlined differs from the mainstream philosophical accounts of action in one important respect. In these mainstream views, all the causally efficacious mental states are mental states we have access to: mental states that we are aware of, be them beliefs and desires (Davidson 1980) or intentions (Searle 1983; Bratman 1987; Mele 1992).

But the worry would be that this is not so when it comes to motor imagery. So one could argue that motor imagery is something that we merely postulate theoretically in order to explain some odd phenomena—it could be thought to be a theoretical entity, opening the door for various versions of antirealism about theoretical entities.

My response is threefold. First, we often are aware of motor imagery. As we have seen, motor imagery may or may not be conscious. If it is conscious, it can be subject to introspection. And this introspective access to our motor imagery (again, bracketing worries about just how reliable introspection is) could justify one's beliefs about the expected success of the action to be performed. In this sense, motor imagery can not only be conscious, it could also have significant epistemic import.

This response (that motor imagery may or may not be conscious) addresses a potential pushback, namely that philosophy of action should not take into consideration a merely subpersonal state that causally contributes to action execution (after all, there are many of these, along the motor nerve). The answer is that motor imagery is not a merely subpersonal state. Even if we accept the personal/subpersonal distinction as unproblematic (I myself don't think we should), a state that can become conscious, if attention is allocated to it, is not a subpersonal state. In other words, motor imagery, although it can be unconscious, is a bona fide mental state (an analogy: perceptual states can also be, and often are, unconscious; nonetheless, it would be odd to deny that perceptual states are bona fide mental states).

Second, I don't see any problem with postulating mental states if the only way in which we can explain the agent's complex behavior is by postulating these mental states. We have extremely rich and varied evidence that our introspective access to our own mind is limited and often systematically misleading. But then we should not expect that we are aware of all the crucial building blocks of the mind and of all the causal ingredients of action performance.

Finally, the fact that some causally relevant components of action initiation are unconscious is not a bug, but a feature (Nanay 2014b). There are many actions where we are not aware of whatever moves us to act. Impulsive actions would constitute one kind of example. We just find ourselves acting—we have a sense of ownership of our action, but we do not have a sense of having initiated it. Akratic actions, as we have seen, would be another.

But there are even more prosaic cases. You're lying in bed in the morning, having hit the snooze button three times already and you know you need to get up, but somehow you just don't. And then all of a sudden, you find yourself getting up. You are not aware of the state that moved you to act. Here is a literary example by Robert Musil:

> I have never caught myself in the act of willing. It was always the case that I saw only the thought—for example when I'm lying on one side in bed: now you ought to turn yourself over. This thought goes marching on in a state of complete equality with a whole set of other ones: for example, your foot is starting to feel stiff, the pillow is getting hot, etc. It is still a proper act of reflection; but it is still far from breaking out into a deed. On the contrary, I confirm with a certain consternation that, despite these thoughts, I still haven't turned over. As I admonish myself that I ought to do so and see that this does not happen, something akin to depression takes possession of me, albeit a depression that is at once scornful and resigned. And then, all of a sudden, and always in an unguarded moment, I turn over. As I do so, the first thing that I am conscious of is the movement as it is actually being performed, and frequently a memory that this started out from some part of the body or other, from the feet, for example, that moved a little, or were unconsciously shifted, from where they had been lying, and that they then drew all the rest after them.[2]

[2] Robert Musil: *Diaries*. New York: Basic Books, 1999, p. 101. See also James (1890) and Goldie (2004, pp. 97–8).

Many of our actions are like this. And we should not dismiss these cases as rare instances of unimportant actions. Some of our actions of great importance are also like this: going in for that first kiss (assuming you don't do it by counting to three), for example.

Any philosophical account of action needs to take actions of this kind seriously. But if so, then we need to postulate a mental state that we do not have to be aware of. So we could turn the tables and argue that it is precisely those accounts of action, which do not posit causally efficacious mental states that we are not aware of, that are problematic.

To go back to the structural analogy between mental imagery and motor imagery, one way of summarizing the philosophical upshot of the proposal outlined in this chapter is that just as understanding sensory imagery is a crucial part of understanding perception per se, understanding motor imagery is an equally crucial part of understanding action per se. Just as perception would be very different if mental imagery played no role in it (in amodal completion as well as multimodal perception), action would also be very different if motor imagery played no role in it. Philosophy of action should take the concept of motor imagery seriously. And as motor imagery, as we have seen, involves sensory mental imagery, this provides yet another reason why mental imagery plays an important role in explaining actions.

28
Cognitive Dissonance

Cognitive dissonance was originally defined as a "nonfitting relation between cognitions," which gives rise to an unpleasant feeling (Festinger 1957, p. 3). And this unpleasant feeling leads to a change in one's attitude. To update the terminology a bit, if you have two representations that clash with one another, this can lead to a negatively valenced state, which then, in turn, leads to a change in your attitude.

Consider the following example:

> Subjects had to undergo some kind of initiation ritual when they joined a discussion group. One of these rituals involved enduring minor electric shocks. The more painful these shocks were, the more strongly the subjects felt towards the group (Gerard and Mathewson 1966; see also Aronson and Mills 1959; Ma et al. 2014). You suffer more to be part of a group and then you are more loyal to them. This can be explained as a way of dealing with cognitive dissonance: if the group you just joined is not great, then what did you endure the severe pain for? For nothing? For being part of a mediocre group? This is the conflict that creates an unpleasant feeling and you get rid of this unpleasant feeling by denying that the group is mediocre. If you suffered so much to join, then the group must be great. In fact, it must be fantastic.

There are hundreds of cognitive dissonance experiments (for some classic studies, see, for example, Festinger et al. 1956; Brehm and Cohen 1962; Festinger and Maccoby 1964; see also Thibodeau and Aronson 1992 and Cooper 2007 for overviews). In the original formulation of cognitive dissonance, the "nonfitting relation" stands between two different "cognitions." Thus the name, cognitive dissonance. But it is not clear what kind of mental states "cognitions" are meant to be. According to the dominant view in philosophical discussions of cognitive dissonance, these representations are beliefs. I will argue against this view and then outline an alternative involving mental imagery. And I will show that this alternative account has significant explanatory benefits over the belief account.

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According to the mainstream view of cognitive dissonance, especially in philosophy (Quilty-Dunn and Mandelbaum 2018, 2019; Mandelbaum 2019; Bendana and Mandelbaum 2021; Quilty-Dunn ms), but also in psychology (Aronson 1992), the conflicting representations are beliefs. A key component of this explanatory scheme is the "self-concept" (Aronson 1969, 1992).

The "self-concept" is a set of beliefs that one holds about oneself. These beliefs are very deeply embedded in one's cognitive economy. As Aronson writes, "at the very heart of dissonance theory, where it makes its clearest and neatest prediction, we are not dealing with any two cognitions; rather, we are usually dealing with the self-concept and cognitions about some behavior" (Aronson 1969, p. 27).

This self-concept is a set of beliefs one holds about oneself. More specifically, these beliefs are beliefs that one is competent (smart, not an idiot), beliefs that one is good (moral, not a jerk) and beliefs that one is stable (not changing their mind randomly). Following the philosophical terminology (Mandelbaum 2019; Bendana and Mandelbaum 2021; Quilty-Dunn ms), I will call beliefs of this kind core beliefs. Core beliefs are supposed to be the cognitive center of gravity in our mind. It is very difficult to change them (even if there is conflicting evidence) and they color all our cognitive processing (Mandelbaum 2019; Bendana and Mandelbaum 2021).

If we accept the existence of core beliefs, then we can give an explanation of cognitive dissonance in terms of a logical contradiction between the beliefs involved. The general idea is that while logical contradiction between any two beliefs is not sufficient for cognitive dissonance, the logical contradiction between a core belief and another belief is indeed sufficient. And logical contradiction is also necessary, although this often involves not two but at least three beliefs. Here is an example of how this kind of explanation would go in the initiation experiment with regards to the underlying reasoning (I changed the wording slightly to fit the example in this chapter).

> I just underwent severe shocks to join a discussion group and this made me think that the group I joined is great. :
>
> (Premise 1) I put a lot of effort into joining the [discussion group]
>
> (Premise 2) Only an idiot would put a lot of effort into joining the [discussion group] without liking the [discussion group]
>
> (Premise 3) I am not an idiot
>
> (Conclusion) I must like the [discussion group] (and the appeal of the group is raised) (Bendana and Mandelbaum 2021; see also Quilty-Dunn ms)

I will call this explanatory scheme the "cognitive dissonance syllogism" as, according to the proponents of the belief account, each time we undergo cognitive dissonance, we go through syllogistic reasoning of this kind (granted, this reasoning is mostly unconscious according to the belief account; see Lieberman et al. 2001; Quilty-Dunn ms).

Premise 3 of the syllogism is the core belief, and this is the premise that remains unshaken, leading to a change in our attitude about the discussion group. And some of the empirical support the proponents of the belief account appeal to in defense of this cognitive dissonance syllogism is about the importance of core beliefs in this syllogism. More specifically, if the core belief is taken out or weakened (by giving the subjects bogus tests that suggest that they are worthless or stupid), this leads to the collapse or at least the weakening of the cognitive dissonance effect (Glass 1964; Stone and Cooper 2003). Thus, the cognitive dissonance syllogism only works if the core beliefs are also part of it.

While this is an extremely elegant way of making the original idea of cognitive dissonance more precise, I will argue that there are empirical problems with it. I will then go on to outline an alternative involving mental imagery, which fares better about these problems.

The first empirical objection is about the location of the neural underpinnings of cognitive dissonance. Given the complexity of cognitive dissonance, a number of different brain regions are involved in cognitive dissonance, especially ones that are associated with emotions. This would be consistent with the belief account. But more surprisingly, the activation of the primary visual cortex is very different in cognitive dissonance versus no dissonance conditions (keeping all other parameters fixed; see Izuma et al. 2010; de Vries et al. 2014). If cognitive dissonance is all about beliefs and the contradictions between them, this finding is very difficult to explain.

The second empirical problem is that, in a much-hyped set of studies, it was found that music reduces cognitive dissonance (Masataka and Perlovsky 2012; Perlovsky et al. 2013). Again, it is difficult to see how the belief account could explain this as music does not have any effect on our logical inferences.

The third empirical problem is that we have substantial empirical evidence that some animals are also capable of cognitive dissonance (Harmon-Jones et al. 2017). But even if animals have beliefs (which would be difficult to deny, even though some philosophers have done so, see Davidson 1980), we have no evidence that they have anything reminiscent of a "self-concept" or core beliefs. Nor do we have any evidence that they are capable of the logical reasoning that would be required by the cognitive dissonance syllogism.

These empirical problems with the belief account point in the direction of the alternative I want to offer to the belief account. The main idea is that the conflicting representations are not beliefs, but imagistic representations. Imagistic representations are mental representations that represent imagistically (in an imagistic format, see Chapter 6). Mental imagery is imagistic representation, as is perception, but there may be other kinds of imagistic representations. And my claim is that the representations involved in cognitive dissonance are imagistic representations. I will argue that this way of understanding cognitive dissonance has significant explanatory benefits over the belief account.

As we have seen in Chapter 23, mental imagery can be, and is very often, emotionally charged. If the representations that are involved in cognitive dissonance are emotionally charged, then we do not need any conflict between such representations in order to generate the emotional state that characterizes cognitive dissonance. In the original conceptual framework of cognitive dissonance, the conflict, or "nonfitting relation" between two representations yields a negative emotion. But as long as we allow for emotionally charged representations, we do not need to postulate two representations and a "nonfitting relation" between them in order to explain the emotional impact of cognitive dissonance. All we need is to postulate one emotionally charged imagistic representation. And, as we have seen in Chapter 23, we have plenty of independent reasons to posit such emotionally charged imagistic representations.

We can now put together the alternative explanatory scheme of cognitive dissonance. As a result of the prompt or the experimental setup, you come to attend to a negatively valenced imagistic representation. Attending to this negatively valenced imagistic representation amounts to a negative emotional state. This negative emotion, in turn, makes you behave in a way that weakens this negative emotion—a simple move here would be to attend to something else.

And we know fairly well how this attending to something else works from research on "experiential avoidance." Experiential avoidance happens "when a person is unwilling to remain in contact with particular private experiences . . . and takes steps to alter the form or frequency of these experiences or the contexts that occasion them" (Hayes et al. 2004; see also Tolin et al. 1999; Wieser et al. 2009). And this is exactly what happens in the last step of cognitive dissonance resolution.

Let us go through the initiation example I used earlier to introduce cognitive dissonance to demonstrate how this explanatory scheme works:

> You undergo the electric shocks to join the boring discussion group and then you are asked whether you think the group is great. When you need to answer this question, you need to consider the two options: great or not so great. If you consider that the group is not great, this brings to mind an imagistic representation (a memory image) of you enduring the electric shocks, all in order to join a mediocre group. Not a pleasant image. So you divert your attention to the other option, namely, that the group you joined is great, and choose that option.

This explanation is simpler than the ones given in the framework of the belief accounts. Again, the main difference is twofold: the nature of the representations (imagistic vs. beliefs) and the origins of the negative emotional state (the emotionally charged imagistic representation itself versus some form of "nonfitting relation" between two beliefs). According to the imagistic representation account, the resulting attitude change is brought about by an attentional shift, roughly along the lines of experiential avoidance.

I will now argue that the imagistic representation account can handle all the empirical objections raised against the belief account. I raised three empirical objections to the belief account. All of these could be taken to be empirical support for the imagistic representation account.

First, given that mental imagery is known to activate the early visual cortices, including the primary visual cortex, the imagistic representation account predicts that the primary visual cortex behaves differently in cognitive dissonance. And this is exactly what was found. Second, the imagistic representation account can also explain why music interferes with cognitive dissonance, as both music processing and mental imagery compete for the same early cortical resources.

Third, how could the imagistic representation account accommodate cognitive dissonance reduction in animals? We have seen that this is difficult to make sense of within the framework of the belief account. Even if we can attribute beliefs to animals, we have no independent evidence that would justify attributing complex inferential apparatus of the like that is required by the cognitive dissonance syllogism. There is no indication of anything reminiscent of core beliefs either. On the other hand, we have independent evidence that animals have emotionally charged imagistic representations (see Kremer et al. 2020 for a summary; see also Nanay 2020c). The ability to explain cognitive dissonance among non-human animals is a major strike in favor of the imagistic cognition account (and against the belief account).

Finally, after having railed against the belief account, I should end on a pluralistic note. Cognitive dissonance is a diverse phenomenon and it is far from clear that one and only one explanatory scheme can explain all of its very different instances. So, it is very much possible that some instances of cognitive dissonance can be explained by the belief account. But not all of them can be. And thinking of cognitive dissonance as a reaction to emotionally charged imagistic representations could explain many central cases.

29
Implicit Bias

Some of our behavior is biased. By this I mean that the behavior goes against our reported beliefs. And often we are not fully aware of these biases. The question I want to raise in this chapter is about the mental representation that is responsible for this biased behavior. This representation mediates between the trigger and the biased behavior. And my claim is that this representation is neither a propositional attitude nor a mere association (as the two major accounts of implicit bias would claim). It is mental imagery (see Nanay 2021b for a more elaborated argument for this claim).

I am interested in the representation that mediates between the trigger and the biased behavior, which I will refer to as "biasing representation." But this picks out a lot of things. When people are reluctant to throw darts at the picture of the face of a loved one or to drink lemonade from a sterilized bedpan (Rozin et al. 1986; see also Gendler 2008), we also get behavior that goes against our beliefs (which represent these actions as harmless). The term "implicit bias" is more often used to describe a more specific phenomenon: representation about certain racial and gender groups (as well as other social groups) that influences our behavior in such a way that it goes against our beliefs (Greenwald et al. 1998, Greenwald and Nosek 2009; Dunham et al. 2008).

Here is an example. In an elevator you might stand a little bit farther away from people whose skin color is different from yours. You may or may not be aware of this. But you think of yourself as someone who does not make distinctions between people because of their skin color. So your behavior is biased in the sense that it goes against your belief. And the mental representation (presumably about people with various skin colors) that is responsible for this behavior is what this chapter is about.

Implicit bias is a genuinely heterogenic phenomenon (see Holroyd and Sweetman 2016 for a detailed taxonomy; and Johnson 2020 for even more heterogeneity). The two main candidates for biasing representations in the literature are the following. This biasing representation might be an association—between a specific skin color and a specific trait, say, being dangerous. Or this biasing representation might be a propositional attitude—an attitude towards

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the proposition that people with this specific skin color tend to be dangerous. My aim is to carve out and defend a third option, according to which this representation is mental imagery: perceptual processing that is not triggered directly by sensory input. I will argue that this view captures the advantages of the two standard accounts without inheriting their disadvantages.

In short, empirical findings show that the biasing representation would need to be both sensitive to semantic content and insensitive to logical form. But associations are not sensitive to semantic content. And propositional attitudes are not insensitive to logical form. I will argue that mental imagery is much better suited to fulfill the theoretical role of the biasing representation: it is sensitive to semantic content (unlike associations) and insensitive to logical form (unlike propositional attitudes). My aim is not to completely dismiss the associationist or the propositionalist account of implicit bias (or both), but rather to reframe the debate by adding an extra important ingredient to any explanation of implicit bias (be they associationist, propositionalist): mental imagery.

Some clarifications: there is emerging evidence that implicit bias may not be unconscious: we may be more aware of our "implicit" attitudes than the initial bias findings might suggest (Nier 2001; Ranganath et al. 2008; Hahn et al. 2014; Machery 2016; Toribio 2018; Berger 2019). Nothing I say in this chapter takes sides on this issue. Further, there have been some debates about just what the most highly publicized indicator of implicit bias, the online freely available Implicit Association Test, shows or does not show (Forscher et al. 2016). As I take the Implicit Association Test to be only one of many experimental procedures that aim to demonstrate implicit bias, I will set this debate aside. If the reader is skeptical of the Implicit Association Test, this is not a reason to be skeptical of the broader phenomenon of biased behavior in general.

Let's suppose that your implicit bias makes it more likely that when you think of a caregiver, you think of a woman. This is, in fact, a very widespread example of implicit bias. The question is: what is the underlying biasing representation? The classic candidate is association. You have probably seen more female caregivers than male caregivers. And, following the mechanism of classic conditioning, you formed an association between being a caregiver and being a woman. One way to think about associations is as some kind of connection strength in your mind between the concept of being a caregiver and the concept of being a woman. When one concept is activated, the other one is very likely to be also activated. So when you hear someone talk about a caregiver, this gives rise to you thinking of a woman. Association is supposed to be quick, not under our voluntary control and, according to many (see Mandelbaum 2016 for a summary), symmetrical (it goes both from caregiver to woman and vice versa).

The alternative view is that the underlying biasing representation is a propositional attitude—typically a belief (Levy 2015; Mandelbaum 2016—some psychologists also often talk about propositions in this context, although what they mean by this tends to be something very different, see De Houwer et al. 2001; De Houwer 2009, 2011, 2019).[1] So you have a propositional attitude that caregivers are (likely to be) women. And it is this propositional attitude that explains your biased behavior. In the case of propositional attitudes, the relation between being a caregiver and being a woman is not symmetrical. The propositional attitude that caregivers are (or tend to be) women is different from the propositional attitude that women are (or tend to be) caregivers (see esp. Mandelbaum 2016).

I will argue that the biasing representation is neither an association nor a propositional attitude: it is mental imagery.

On the one hand, implicit bias is sensitive to the semantic content of our representations (Mandelbaum 2013, 2016; see also Nanay 2021b). It is sensitive to the content of representations other than the biasing representation. The content of the biasing representation is combined with the content of other representations, which then produces the biased behavior (Rozin et al. 1990; Sechrist and Stangor 2001; Gawronski et al. 2005; Newman et al. 2011; Cone and Ferguson 2015). Here is one example: People generally pay more money for clothes worn by celebrities than for identical clothes that are fresh off the shelf. But experiments show that they pay a little less if these clothes were washed since the celebrity wore them (Newman et al. 2011). This is biased behavior. We have two representations here. The first one (A) is the biasing representation about the connection between the clothes and the fact that they were worn by a celebrity. And this explains why we pay a lot of money for clothes worn by celebrities. But we also have another representation (B) about the connection between clothes and washing. And our biased behavior that we pay less money for washed celebrity clothes than for unwashed celebrity clothes, is explained by the interaction between the

[1] What De Houwer means by proposition is very different from what philosophers mean by propositional attitudes. Proposition, for De Houwer, means any representation that represents a relation (De Houwer 2009, 2011). Needless to say, many kinds of representations would qualify according to this definition, besides propositional attitudes. Some perceptual states would count, as would mental imagery.

biasing representation (A) and the representation about washing (B). In short, biasing representations can enter into content-sensitive transitions.

On the other hand, implicit bias is not sensitive to logical form (Madva 2016; see also Nanay 2021b). So, exposure to sentences like “It is not true that old people are bad drivers” strengthens implicit bias about old people’s bad driving as much as exposure to sentences like “Old people drive badly” does (Gawronski and LeBel 2008; Deutsch and Strack 2010; Deutsch et al. 2009).

In light of these findings, both of the classic accounts of implicit bias are problematic. The biasing representation would need to be both sensitive to semantic content and insensitive to logical form. But associations are not sensitive to semantic content. And propositional attitudes are not (normally) insensitive to logical form. I will argue that mental imagery is much better suited to fulfill the theoretical role of the biasing representation: it is sensitive to semantic content (unlike associations) and insensitive to logical form (unlike propositions).

My claim is that the biasing representation is mental imagery. This mental imagery is often emotionally charged, often action-guiding and often unconscious. It is always involuntary.

Given that inference is a relation between propositional attitudes, and mental imagery is not a propositional attitude (as it has imagistic content), mental imagery does not enter into inferences. But not all content-sensitive transitions between mental states are inferences and there can be content-sensitive transitions between mental states with imagistic content.

Mental imagery can lead to, and even justify, various other mental processes in a content-sensitive manner. Here are two examples: First, you are trying to wrap a box in gift wrap (see Chapter 24). You look at the box, you look at the gift wrap and how big a piece you tear off depends (in a content-sensitive manner) on your exercise of mental imagery. Second, you are playing snooker or billiards and you need to sink a ball at the other end of the table, with a lot of other balls in the way, but you figure out a way of making the cue ball ricochet twice before hitting the ball exactly from the right angle. In both of these two examples, there are content-sensitive transitions between mental imagery and other mental processes, but neither of them is an inference: these transitions are not mediated by beliefs or other propositional attitudes. And neither of them is an association (cf. Mandelbaum and Quilty-Dunn 2019).

Taking the biasing representation to be mental imagery can explain many examples of biased behavior. Take the example I started the chapter with, when subjects are reluctant to drink lemonade from a sterilized bedpan. The perceptual state of seeing the yellow liquid in the bedpan-shaped drinking vessel triggers the mental imagery of urine and it is this biasing representation that explains our reluctance. The imagery itself does not have to be conscious (although it might be). It is emotionally charged (presumably the emotion is disgust). And it is action-guiding in the sense that it interferes with our action.

Here is another example (from Gendler 2008). The chef reorganizes her kitchen. The cleaver used to be above the dishwasher, but it is now next to the stove. She knows this—she placed the cleaver from here to there herself. But in the rush of preparing a meal, she still reaches to where the cleaver used to be—above the dishwasher. This is biased behavior: it goes against her beliefs. And we can explain this in terms of the mental imagery that she has of the cleaver above the dishwasher. Again, this mental imagery does not have to be conscious. But, in this example, it is very much action-guiding mental imagery—it guides the chef's action the same way as the mental imagery of the light switch guides your action in your pitch-dark bedroom (see Chapter 26).

Could we explain the chef's behavior in terms of an unconscious belief? No. We know from a vast amount of studies in the neuroscience of "attentional templates" that visual actions of the kind performed by the chef amount to early cortical processing in the visual system that is not triggered by sensory stimulation—in short, to mental imagery (Keogh and Pearson 2021; see also Chapter 10). The belief view does not explain this. The mental imagery view does.

And the same explanatory scheme also applies to biased behavior concerning other racial and gender groups. Subjects (who are not black) are more likely to misperceive a tool as a gun if a black person holds it than if a white person does so (Payne 2001; see also Siegel 2020). Here, again, the perceptual state of a black person holding a wrench gives rise to the mental imagery of a black person holding a gun. Again, this mental imagery does not have to be conscious—and when white people rate black people as more dangerous, it is possible that the mental imagery that grounds these judgments is not conscious. The same is true of the biased behavior of standing further away from some people than others in the elevator.

It is easy to see that mental imagery fits the profile of biasing representation we identified above. Given that implicit bias is insensitive to logical form, we need biasing representations that are also insensitive to logical form. And mental imagery is a good candidate for this as well. And as implicit bias clearly depends on our background beliefs and other mental states, this rules out associationism. But it does not rule out the view according to which the biasing representation is mental imagery, as mental imagery can also be combined with beliefs.

Mental imagery is very much sensitive to semantic content and especially top-down influences. If I visualize a cat, the features of the cat I visualize very much depend on what kinds of cats I have seen in my life and also on my background beliefs and knowledge about cats. The chef's mental imagery of the cleaver depends on previously stored memories. And we have plenty of empirical evidence about how mental imagery can be influenced in a top-down manner (see Chapter 11).

It is important to note that this dependence of mental imagery on top-down information does not mean that the content of mental imagery is conceptual content or that a concept is attached to the mental imagery. Mental imagery is perceptual processing, which may or may not be influenced in a top-down manner. But even if it is, this does not entail that its content is conceptual. To take the example of the bedpan, the mental imagery of the yellow liquid, which is triggered by the perception of the bedpan, does not have to have concepts like "urine" attached to it. It is enough if the valence of the mental imagery is influenced in a top-down manner (by its association with urine). Mental imagery is influenced by our concepts—it does not have to be conceptual.

Finally, a somewhat odd feature of the implicit bias literature in philosophy is that it often focuses on the relation between concepts: the concept of being a homemaker and the concept of being a woman, for example (see Del Pinal and Spaulding 2018 for discussion). But this focus is in tension with the vast majority of empirical findings about implicit bias, where the trigger of biased behavior is a perceptual state. And the biasing representation is the representation that mediates between the perceptual trigger and the biased behavior. My account has a wider range of explanations of the perceptual (or quasi-perceptual, if you wish) nature of this mediating biasing representation than the classic views. The classic views would be committed to saying that the perceptual state triggers a concept, and that concept is either associated with, or is propositionally related to, another concept and this other concept is responsible for the behavior. We have both empirical and conceptual reasons to think that perception is not always linked to actions by means of concepts (see Jeannerod 1997 and Nanay 2013a for summaries). If so, then my account can explain the mediation between perception and action without any direct appeal to concepts.

One may wonder whether the mental imagery account is a genuine alternative to the associationist and propositionalist account. After all, the trigger somehow leads to mental imagery and the mental imagery somehow leads to action. So, one could argue that even if we accept the mental imagery account, the nature of these transitions is still an open question, and these transitions can be explained either in an associationist or in a propositionalist manner. This is a fair point, but it should also be pointed out that the question about how a perceptual state gives rise to mental imagery and then how mental imagery turns into behavior is a very different question from the one about what kind of connection between concepts leads to biased behavior. So even if the associationism versus propositionalism debate is not put to bed entirely, we have made some progress.

Take microbehavior, for example. One striking phenomenon often discussed under the heading of implicit bias is how our biasing representation influences our microbehavior (Chen and Bargh, 1997; Bessenoff and Sherman, 2000; Wilson et al. 2000; McConnell and Leibold, 2001; see also Levy 2015 for a summary)—not what answer we choose in a questionnaire, but, for example, how much we look in the eyes of people with different skin color, how far away we stand from them in an elevator and so on. And here the mental imagery account has a real advantage. If the biasing representation is (pragmatic, action-guiding; see Chapter 26) mental imagery, then we have a direct and straightforward way of explaining how little differences in one's (action-guiding) mental imagery are responsible for little differences in one's behavior.

There are some structurally similar accounts in the implicit bias literature, and I need to contrast my account with them. I will focus on two of these, Neil Levy's patchy endorsement account (Levy 2015) and Ema Sullivan-Bissett's unconscious imagination account (Sullivan-Bissett 2019).

The general moral is that both Levy's concept of patchy endorsement and Sullivan-Bissett's concept of unconscious imagination are far into the propositionalist side of the divide. Levy explicitly claims that the biasing representations are "patchy endorsements," which "have some propositional structure" (Levy 2015, p. 816) and that they "feature in some inferences" (Levy 2015, p. 816). Mental imagery does not have propositional structure (not even some!) and it does not feature in inferences.

Similarly, Sullivan-Bissett's view, according to which the biasing representation is unconscious imagination, is more permissive towards the propositionalist than mine as she would allow at least some of the unconscious imaginative episodes to be propositional attitudes. Imagination is not the same as mental imagery—imagination is a very specific exercise of mental imagery. And while there are good empirical and theoretical reasons to think that mental imagery can be, and often is, unconscious, it is much more controversial to say that imagination can be unconscious (see Kind 2001 for a classic argument against this view, but see also Brogaard and Gatzia 2017, Church 2008, as well as Chapter 22).

The question about what these biasing representations are is crucial not just out of theoretical interest. If we want to try to eliminate implicit bias, very different procedures would be needed depending on what these biasing representations are. Further, as we will see in Chapter 30, some of the most efficient ways of counteracting implicit bias involves mental imagery. This gives us yet another strong reason in favor of the view that the biasing representation of implicit bias is mental imagery.

30
Clinical Applications of Mental Imagery

Mental imagery is a crucial ingredient of a wide variety of mental phenomena. Understanding the role of mental imagery in these mental processes can also help us to do something about the malfunctioning of these processes. This chapter is about the use of mental imagery in the service of treating various negative conditions in clinical practice.

An important development in various branches of psychiatry is to manipulate the mental imagery of patients, in order to improve their condition, by means of techniques such as "imaginal exposure," "systematic desensitization," and "imagery rescripting." There are reports of the success of this methodology in the case of mental disorders ranging from bipolar disorders, schizophrenia, and post-traumatic stress disorder to obsessive compulsive disorder and depression (Holmes et al. 2010; James et al. 2015; Murphy et al. 2015; Clark et al. 2016; Slofstra et al. 2016; see Pearson et al. 2015 for a summary).

Take post-traumatic stress disorder, as an example. The main symptom of post-traumatic stress disorder is the recurring and involuntary negative mental imagery of the traumatic event. When soldiers come back home after serving in war zones, for example, vivid and extremely negative mental imagery (in various sense modalities) is often triggered by various sensory stimuli (proverbially by fireworks, but also, for example, the smell of a barbecue) (see, for example, Clark and Mackay 2015).

Another example is depression, where one of the most important indications of the level of depression is the lack of future positive mental imagery (see Ji et al. 2017 for a summary). Schizophrenia has been shown to be associated with more vivid negative mental imagery, which is responsible for changes in perception (Maróthi and Kéri 2018). And mental imagery has also been taken to be a central component of (especially non-restrictive) eating disorders as well as many forms of addiction (Sommerville et al. 2007; Kadriu et al. 2019). Finally, negative imagery plays a crucial role in anxiety disorders (Hirsch and Holmes 2007).

Given the centrality of mental imagery in these conditions, a number of techniques have been developed to change the subjects' negative mental

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imagery. One way of doing so is by weakening the subjects' mental imagery (by making them perform tasks that compete for the same mental resources). A famous example of this is to have subjects with recent[1] trauma play Tetris, a mental imagery-involving game, which competes with the traumatic mental imagery, thereby preventing the traumatic event from being consolidated in memory (Holmes et al. 2010).

A related, and much hyped technique is "eye movement desensitization and reprocessing," used to treat anxiety as well as post-traumatic stress disorder and addiction. The subjects have to recall the traumatic or anxiety-producing event while performing various directed eye movement exercises (see van den Hout et al. 2013 for details). While "eye movement desensitization and reprocessing" is not, on the face of it, an imagery treatment, it can be straightforwardly explained in terms of the role of mental imagery in episodic memory.

As we know from a number of studies (see Chapter 3), mental imagery is a central ingredient of episodic memory. We also know that episodic memory is constructive (see Chapter 21): remembering an event we have experienced is not the mere accessing of the memory trace, but the active construction of a memory. Remembering an event changes the way it is encoded (so next time you will remember it differently). Finally, we have also seen the role of eye movements in mental imagery (see Chapter 7). If we put these three pieces together, this explains why "eye movement desensitization and reprocessing" works the way it does.

When the subject recalls the traumatic event while moving their eyes, this reduces the vividness of the mental imagery involved in that episodic memory, given that incongruous eye movement reduces the vividness of mental imagery. And as the very act of remembering an event changes its representation in memory, when this memory gets re-encoded, it will be encoded in a less vivid manner.

Further techniques involving imagery consist of changing one's mental imagery in various ways, for example by questioning its validity/reality, or by re-describing it in different terms, or just by manipulating it, the way one can imagine a cupcake with a cherry on the top and then replace, in imagination, the cherry with a raspberry.

In the treatment of some (non-restrictive) eating disorders, the desirability of food items can be regulated with the help of voluntary mental imagery of

[1] "Recent" here means something that has happened less than six hours ago, which is widely held to be the window of memory consolidation.

unrelated food items. For example, imagining the taste and smell of desirable food makes the subjects choose a smaller portion of another food item that they also like (and that is in front of them; see Cornil and Chandon 2016; see also Chapter 25; Harvey et al. 2005; Andrade et al. 2012 on the motivating role of imagery in craving).

Finally, imaginal exposure means that the usually involuntary imagery (in post-traumatic stress disorders, phobias, or panic attacks) is conjured up voluntarily. For example, phobia of spiders can be treated very quickly and efficiently by imaginal exposure alone—even one session of 10 minutes of voluntarily conjuring up mental imagery of spiders leads to a much less intense emotional reaction to spider-related stimuli one week later (Hoppe et al. 2021).[2]

It is important that almost all the clinical procedures described so far rely on the manipulation of the conscious and voluntary mental imagery of the subjects: they ask the patients to visualize a certain event. But as we have seen, this is just one way of triggering mental imagery and one that is dependent on a lot of factors that might prevent the patient from succeeding in visualizing what she is asked to visualize. Voluntary mental imagery is hard to maintain and even harder to control. If the experimenter asks me to visualize a spider, I may or may not do it. And even if I do visualize it, I may just have a quick flash of a spider and then I just think of something else instead.

Inducing involuntary mental imagery, on the other hand, could bypass these blocks and it could provide a more efficient way of interfering with the patients' mental imagery. This is what happens in the Tetris experiment, for example, which is one of the most successful and widely replicated uses of mental imagery in clinical practice. But, given that mental imagery can also be automatically induced by means of crossmodal activation, there are many more options of bypassing the worries about voluntary mental imagery.

The role involuntary imagery can play is especially promising in the light of findings according to which voluntary visualization suppresses non-visual sensory activation (Amedi et al. 2005). So, voluntarily visualizing an apple prevents activations in the olfactory or gustatory sense modalities. Given the multimodal nature of perceptual episodes, this makes voluntary visualizing much more impoverished than perceiving when it comes to non-visual sense modalities and this, in turn, can weaken the effect of imagery treatment.

[2] While these techniques work very well on average, there is great variability of the efficiency of this method between subjects (see, for example, Williams et al. 2013; Blackwell et al. 2013).

Inducing mental imagery crossmodally (hence, involuntarily) obviously does not have these undesired consequences.

Here is a demonstration of how involuntary mental imagery can be used in a much more efficient manner than voluntary imagery. The most widespread cause of tinnitus is the malfunctioning or reorganization of the auditory cortex (Muhlnickel et al. 1998—I set aside some rarer forms of tinnitus, like "objective tinnitus"). And one of the quickest ways of treating tinnitus is by playing music with the tinnitus tone and its octaves blocked out. So, if the tinnitus is a C# tone, then the subjects are made to listen to tunes they know well, but each time a C# note would come up, there is just silence (Okamoto et al. 2010). This is clearly a case of auditory mental imagery. The subjects have auditory imagery of the C# tone, and this auditory imagery is involuntarily triggered (by the surrounding non-C# notes). And this involuntarily triggered auditory imagery of the C# tone weakens the tinnitus already after a relatively short period of time. Voluntarily forming auditory imagery of the C# tone has no such effect.

With this understanding of clinical uses of mental imagery, I want to go back to two important imagery phenomena I discussed earlier in the book and draw some conclusions about what we can do about them. I start with the continuation of the argument in Chapter 29 concerning implicit bias. While implicit bias is not a clinical condition and counteracting implicit bias is not a clinical procedure, understanding the role of mental imagery in clinical contexts can help us understand not only how to and how not to counteract implicit bias, but also what implicit bias is.

Among the most efficient ways of manipulating implicit bias, we find many techniques that manipulate mental imagery. For example, visualizing or putting ourselves imaginatively in the shoes of a member of another racial or gender group can reduce implicit bias significantly. And, crucially, the extent of this reduction correlates with the details and vividness of the imagery involved (Blair et al. 2001; Blair 2002; Lai et al. 2014; see also Peck et al. 2013 for further relevant findings and Markland et al. 2015 for the impact of mental imagery on implicit preferences more generally).

But why would evoking mental imagery (in this unreliable way, which is difficult to control and maintain) be an efficient way of counteracting implicit bias? It is difficult for the propositionalist to explain this: if the biasing representation is a propositional attitude, then propositionalists would need to explain why mental imagery—a perceptual process—has a direct impact on it (while mental imagery does not routinely justify beliefs, as we have seen in Chapter 24). Even more importantly, they would also need to explain why mental imagery has more impact on it than other perceptual processes (like actual stimulation-driven perception).

Similarly, according to associationism, the best way to unlearn an association is extinction and extinction is achieved by repeated exposure to perceptual stimuli that goes against the association (if the association is between A and B, then the extinction would involve exposure to A and non-B or non-A and B). But the research I cited shows that manipulating mental imagery is a more efficient way of counteracting implicit bias than extinction and it is unclear how the associationist could explain this.

The mental imagery view is, obviously, well-suited to explain this—if the biasing representation is mental imagery, then it should not come as a surprise that the bias can be reverted by manipulating the subject's mental imagery.

It is important that this procedure relies fully on the manipulation of the conscious and voluntary mental imagery of the subjects: they ask the patients to visualize certain faces, or imagine themselves to be certain people consciously and voluntarily. But as we have seen, this is just one way of triggering mental imagery and one that is dependent on a lot of factors that might prevent the subject from succeeding in visualizing what she is asked to visualize. It is also difficult to control whether the subject does in fact visualize the outgroup face she is asked to visualize. Finally, such visual imagery is difficult to maintain for longer than a couple of seconds. Nonetheless, in spite of all these practical problems, the imagery-involving procedure is among the most efficient ways of reducing implicit bias. Using the considerations in favor of involuntary and crossmodally triggered mental imagery can help us considerably in counteracting implicit bias more efficiently.

Yet another phenomenon where the clinical uses of mental imagery could be of help is pain (see Chapter 17). More and more empirical research has been focusing on the role of mental imagery in pain treatment. 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 (Winterowd et al. 2003; Berna et al. 2012; Gosden et al. 2013). Finally, one of the most efficient ways of treating chronic pain is to alter the mental imagery of patients (Moseley 2004, 2006; MacIver et al. 2008; Philips 2011; Fardo et al. 2015; Volz et al. 2015).

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. This intrusive spontaneous mental imagery was not detachable for her from the pain itself. 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 MacIver et al. 2008; Fardo et al. 2015; and Volz et al. 2015 for very similar case studies).

This coping imagery (like the intrusive recurrent mental imagery of a burning hole at the locus of the pain) is often involuntary. But modifying this involuntary coping imagery (and making it compete with the intrusive imagery more efficiently) can help the patient even more (see Berna et al. 2012). Coping imagery has also been extensively used for preparing patients before surgery (Tusek et al. 1997). All these findings about the importance of imagery in pain treatment lend further support to the claim I made in Chapter 17 about the central role of imagery in pain perception.

A lot has been said about using imagery to promote mental health in self-help circles (see, for example, Rossman 2000). My dentist told me last week to imagine being on the beach listening to the waves crashing. It didn't help. So there would be good reason for skepticism about the health benefits of imagery. But part of the practical benefits of the book is that by clarifying what role mental imagery plays in our mental life, it makes it easier to find out how and why mental imagery can help us in clinical contexts.

PART VI

APPENDIX

31

Mental Imagery in Art

The importance of mental imagery can be traced beyond the confines of neuroscience, psychology and philosophy of mind.[1] To show the reach of the concept, I want to explore the role mental imagery plays in a philosophical subdiscipline that, at first glance, may seem as far removed from neuroscience, psychology, and philosophy of mind as possible: aesthetics.

Mental imagery plays an important role in our engagement with, and appreciation of, artworks, which makes mental imagery a crucial concept in aesthetics (see also Lopes 2003; Nanay 2016d; Stokes 2019). While mental imagery may also play a crucial role in artistic creation, as many artists and composers like to emphasize, I will focus here on the importance of mental imagery in engaging with artworks.

A property is aesthetically relevant if attending to it makes an aesthetic difference (Nanay 2016d). This aesthetic difference can be of various kinds: prompting an aesthetic experience (whatever that may be), strengthening or weakening our identification with a fictional character, triggering a *frisson* (Nanay forthcoming d), appreciating a narrative twist, and so on.

Here is an example from Nanay 2019b. If you look at Bruegel's *The Fall of Icarus*, without knowing the title and without knowing much about the painting, you probably see a nice diagonal composition, half landscape, half seascape, with a peasant at the center. But if you know that it is supposed to depict the fall of Icarus (presumably because you've read the title), you will probably start looking. Where is Icarus? I don't see anyone falling. You feverishly scan the picture for some trace of Icarus and then you find him (or at least his legs) just below the large ship. You are now attending to that property and this makes a significant aesthetic difference in your experience of the picture. The whole picture will look very different now. So the depiction of Icarus's legs would count as an aesthetically relevant property.

It should be clear that aesthetically relevant properties are not the same as aesthetic properties: properties like being beautiful, being graceful, or being

[1] One such field of research is ethics, where we now know that mental imagery plays an important role in moral judgment (Amit and Greene 2012).

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ugly. Icarus's legs are not aesthetic properties: they are neither pretty nor ugly. Aesthetic properties are notoriously difficult to define (Sibley 1959). Aesthetically relevant properties are much less complicated: any property can be an aesthetically relevant property as long as attending to it makes an aesthetic difference to your experience.

The crucial question from our point of view is how aesthetically relevant properties are represented. The Icarus example shows that they can be represented perceptually: we see Icarus's legs and seeing them makes an aesthetic difference. But not all aesthetically relevant properties are perceptually represented. Some are clearly non-perceptual. If we think that a painting was painted by Vermeer and then find out that it is a forgery, this may make an aesthetic difference to our experience. But the property of being painted by Vermeer is not a perceptually represented property, regardless of how liberal we are with what properties are perceptually represented (Siegel 2006, 2007; Masrour 2011; Nanay 2011a, 2011d, 2012c, 2012d; see also Stokes 2014).

From the point of view of this book, the most important cases are those where aesthetically relevant properties are represented by means of mental imagery. I will argue that there are very many of these and, as a result, we should take mental imagery to be a key concept in aesthetics (see also Nanay forthcoming f).

Before turning to the specific arts, I want to highlight the aesthetic relevance of two distinctions that I have been using throughout the book. The first one is between determinable and determinate imagery: sometimes artworks aim to evoke mental imagery that is very determinate, but other times the evoked mental imagery is deliberately determinable. This difference is very significant in different artistic traditions. For example, literary and pictorial modernism almost obsessively opts for determinable mental imagery, as we shall see below.

The second familiar distinction is about whether imagery is influenced in a top-down manner. As we have seen, mental imagery can be influenced in a top-down manner, hence, understanding mental imagery is crucial for explaining how our beliefs and knowledge show up in our engagement with artworks. Here is Marcel Proust, whose novel contains what I consider to be the most rigorous and most insightful account of mental imagery in art appreciation (and in general), making the same distinction:

> If I could stand still for a second to give a closer look to everything, to all details, I would see a blemish on her nose, traces of rash on her skin, an awkward smile, a clueless glance, maybe a bulging belly and not what I had

> imagined; for each time I saw a pretty face or a graceful line, I would complete it charitably with a beautiful shoulder or a charming gaze, on the basis of a memory or pre-imagination, which I had always carried with me, although seeing a living creature glanced only for a second could be as misleading as the quick reading of texts, when reading one syllable without seeing what follows it prompts us to complete the word in a way that is dictated by our memory only.[2]

We can now examine how mental imagery colors and sometimes even constitutes our engagement with art.[3] I start with visual art and music and then turn to literature and conceptual art.

A somewhat obvious way in which mental imagery plays a role in our engagement with visual arts follows from the simple fact that most pictorial art does not normally encompass the entire visual field. So those parts of the depicted scene that fall outside the frame, could be, and very often are, represented by means of mental imagery. We have already seen two examples of this in Chapter 20. The first one was Degas, whose paintings often feature protagonists who are placed in a way that only parts of them are inside the frame. The rest we need to complete by means of mental imagery. The second example was Buster Keaton, who also uses the viewer's mental imagery of the off-screen space in his films, but normally for comical effects. The use of off-screen space in a certain tradition of art films has been analyzed by Noel Burch, with special emphasis of Jean Renoir's *Nana* (1926) and some Ozu, Antonioni, and Bresson films (Burch 1973, pp. 17–31), especially concerning the technical details of how these artists direct our attention to aesthetically relevant properties (of various kinds) that fall outside the frame in these works, and the role mental imagery plays in this process (see also Bonitzer 1971–1972; Saxton 2007).

But mental imagery is also often used within the picture frame. Michael Baxandall assembled a great variety of fifteenth-century sources about the importance of visual imagery in the ways in which fifteenth-century Italian observers engaged with religious pictures, especially pictures of the Madonna. As Baxandall's textual evidence, for example from the treatise "Zardino de

[2] Marcel Proust: *A L'Ombre des Jeunes Filles en Fleurs*. 1919, p. 457.

[3] This claim is less surprising if we consider non-Western aesthetic traditions. A key concept in Japanese aesthetics is that of "hidden beauty" or Yugen, the appreciation of which involves something akin to mental imagery (of the hidden and incomplete aspects) (Saito 1997). And the eleventh-century Islamic philosopher Ibn Sina also heavily emphasized the importance of imagery in our experience of beauty (Gonzales 2001). See Nanay (2022d and forthcoming a) on the importance of mental imagery in non-Western aesthetic traditions.

Oration" written in 1454, shows, fifteenth-century observers filled in the details of paintings that were left intentionally underspecified or blank by the painter with their own personal mental imagery and this explains some of the visual features of, for example, depictions of Madonna's face (Baxandall 1972).

To move a bit closer to the present, in the 1950 American film *Harvey*, the character played by Jimmy Stewart is an alcoholic and he hallucinates a six-foot three-and-a-half-inch-tall rabbit (or pooka…). We don't see anyone, but the Jimmy Stewart character clearly does. And, crucially, all the scenes with the imaginary rabbit are framed as if there really were a rabbit in them. So when we see the Jimmy Stewart character in an armchair having a conversation with Harvey, this shot is framed in a way as if there really were a six-foot-tall creature next to him. This framing is aesthetically relevant and its choice clearly relies on the viewer's mental imagery.

In this example, we have a fairly good idea what we're supposed to form a mental imagery of—the Jimmy Stewart character gives a fairly accurate description of Harvey's alleged appearance. But there are examples where we are in a much less fortunate epistemic situation. One classic example is Buñuel's *Belle de Jour*, where the Chinese businessman shows a little box to the Catherine Deneuve character, who is clearly fascinated by what is inside. She sees it, he sees it, but we, the viewers don't. There is a humming voice coming from the box, but we never see what is inside. We have a very indeterminate (crossmodally triggered) visual mental imagery of what could possibly be in the box—whatever is in the box is left intentionally indeterminate.

The French film director, Robert Bresson often uses mental imagery in this indeterminate manner, so much so that he even takes this use of mental imagery to be the mark of a "good" director (or, as he would put it, of a cinematographer, not merely of a director): "Don't show all sides of the object. A margin of indefiniteness" (Bresson 1975/1977, p. 52).

One relatively simple use of mental imagery inside the frame comes from the abundance of occlusion in most everyday perceptual scenes (and, as a result, in most depicted scenes). Hiding aesthetically relevant properties in occluded parts of depicted objects has a long history, Rogier Van der Weyden plays with this in his *Seven Sacraments* (Antwerp), where he depicts one of the characters in a way that only the tip of his nose and chin are visible. Antonioni's *L'Eclisse* (1962) uses occlusion in a way that is clearly aesthetically relevant—for example when we first see the two protagonists in the same frame both half occluded by the same giant column. And Godard's *Vivre sa Vie* (1962) starts with a long (seven minute) scene where the two main protagonists are filmed from behind—we hear their conversation, but we do not see their faces. We need to use mental imagery to represent very important aesthetically relevant properties.

Some less high-brow examples: Monty Python's *How not to be seen* sketch relies entirely on the comic effects of mental imagery that we use to represent occluded people. Also, in the sitcom *Seinfeld*, one of the recurring characters, Mr Steinbrenner is only ever shown occluded. We sometimes see his head from behind, but his face is occluded. When we first see him, we only see his hand when he shakes hands with George, but the rest of his body is occluded behind a wall. And we sometimes see the shadow of his profile, but the only way we can represent his face is by means of mental imagery.

In the Seinfeld example (and in the Godard example as well), the use of occlusion is really a game or a running (visual) gag. But it can also be used in a more disconcerting manner, where the occluded parts of the scene are represented as something that is potentially dangerous or uncertain. Marguerite Duras's *India Song* (1975) is a clear example, where the vast majority of the shots have a large occluded space, typically another room, in the background, where something potentially important could be happening, but we never see what that is. Rene Magritte's paintings and Andres Serrano's or Issei Suda's photographs almost always hide some aesthetically relevant features behind an occluder in a way that we can only form very indeterminate mental imagery of what is occluded (see also Nanay 2019a on the role mental imagery plays in some works of portraiture). And Apichatpong Weerasethakul's films use this effect as the general emotional background that creates a sense of anxiety because we have no idea what is hidden behind, say, the jungle in *Tropical Malady* (2004).

Again, this, unlike the Seinfeld example, saddles us with deliberately indeterminate mental imagery. There is, presumably, a fact of the matter about how Mr. Steinbrenner looks (and the same goes for how Nana looks in Godard's *Vivre sa Vie*). But there is no fact of the matter about what is in the box in *Belle de Jour* or in the next room in *India Song* or in the jungle in Apichatpong Weerasethakul's films. And this is what makes these aesthetically relevant properties that are represented by means of indeterminate mental imagery, disconcerting. As Proust says, "It's so soothing to be able to form a clear picture of things in one's mind. What is really terrible is what one cannot imagine".[4]

[4] Marcel Proust: *Swann's Way* (1913) (trans. C. K. Scott Moncrieff). New York: Modern Library, 1928, p. 525.

The next form of imagery I want to examine is multimodal mental imagery. While it was not referred to in these terms, multimodal mental imagery was a significant theme in classical aesthetic theory, starting with Lessing, Goethe, and Schopenhauer, who all argued against the use of multimodal mental imagery in visual art as it dilutes the purity of art forms (Gombrich 1964). So they insisted that visual works should not evoke auditory mental imagery (for example, by depicting someone screaming).

But multimodal mental imagery has become extremely widespread in the last 150 years or so of visual art. We have already seen one example of multimodal mental imagery in the *Belle de Jour* scene. But it is difficult to overemphasize the importance of this way of using aesthetic imagery in certain art films. Early film theorists, who were exasperated by the advent of talkies in the late 1920s, took the use of what I call multimodal mental imagery to be one of the saving graces of the invention of sound (see, for example, Balazs 1930).

Multimodal mental imagery became a hallmark of 1960s European modernist art films. In some of his films, Jean-Luc Godard used sound primarily as a prompt for triggering visual mental imagery (see Levinson's 2016 sensitive analysis of the use of sound in *Masculin/Feminin* (1966) from this point of view). And both Bresson and Michelangelo Antonioni used sound this way for much of their career, and they were also very explicit about this way of using sound in their theoretical writings and interviews. As Bresson said, "The eye solicited alone makes the ear impatient, the ear solicited alone makes the eye impatient. Use these impatiences" (Bresson 1975/1977, p. 28) and "A locomotive's whistle imprints on us a whole railroad station" (Bresson 1975/1977, p. 39). And here is Antonioni giving a textbook definition of multimodal mental imagery: "When we hear something, we form images in our head automatically in order to visualize what we hear" (Antonioni 1982, p. 6). Both Bresson and Antonioni use multimodal mental imagery that is indeterminate and that is also very much emotionally charged. As a last quote, to illustrate the emotional potentials of multimodal mental imagery, here is Proust again:

> "The senses are chasing each other so that you can enjoy scent, flavor and touch without the help of the hands or the lips; and this art of the intertwining, makes it possible […] to conjure up forbidden caresses, touches and tastes from the color of faces or breasts".[5]

[5] Marcel Proust: *A L'Ombre des Jeunes Filles en Fleurs*. 1919, p. 572.

As a counterbalance to this high-brow overkill, it needs to be emphasized that multimodal mental imagery can also be used in a very different manner and still be aesthetically relevant. As Ridley Scott repeatedly emphasizes in his interviews about his *Alien* trilogy, the Alien is shown relatively rarely because having mental imagery of it is much scarier than seeing it. This general credo has been used in suspense for a long time (from Hitchcock films to *Jaws*). Finally, the recurring joke on *Friends* about the ugly naked guy who lives across the street (but whom we never see) clearly utilizes multimodal mental imagery.

Next up: temporal mental imagery. Aesthetically relevant properties are often represented by means of temporal mental imagery. In Henri Cartier-Bresson's *Behind Saint-Lazare Station* (Paris, 1932), we see a man jumping across a puddle, with moderate success. What we see in the picture is a man in the air. But the mental imagery of his landing in the puddle is very much aesthetically relevant.

Further, in the case of some of Vermeer's paintings, what is striking is that while the paintings depict an action (woman pouring milk from a jug, measuring something on a scale, reading a letter, and so on), the mental imagery of the scene a second ago and the mental imagery of the scene in a second would look exactly the way the picture looks. In sharp opposition to the Cartier-Bresson example, in these Vermeer paintings, the temporal mental imagery does not represent something different from what we already see in the picture. And this clearly adds to the tranquility of these paintings.

A special case of temporal mental imagery would deserve much longer discussion: some of our expectations in temporal art forms amount to mental imagery. This is a well-researched topic in music psychology, where some expectations clearly count as mental imagery, in the sense of early auditory processing that is not directly triggered by auditory sensory input (Kraemer et al. 2005; Zatorre and Halpern 2005; Leaver et al. 2009; Herholz et al. 2012; Yokosawa et al. 2013; see also Judge and Nanay 2021 for a philosophical summary). The same goes for some expectations in film as well (the classic 80s comedy, *Top Secret* (1984) being a treasure trove of violated visual expectations that clearly involve temporal mental imagery; see Chapter 11 for a typical example).

But it needs to be noted that this does not mean that all of our expectations concerning an artwork would amount to mental imagery. When I go to see the new James Bond film, I have a firm expectation that Bond will not die at the end (as we have learned recently, we may be terribly wrong about this . . .). But this has nothing to do with mental imagery. Nonetheless, at least some expectations (of the more immediate kind) would amount to mental imagery and some uses of them (for example various violations of these expectations) are clearly aesthetically relevant.

Mental imagery also plays a crucial role in our appreciation of music, primarily as a result of the importance of musical expectations, which are a form of auditory mental imagery (but see also the importance of multimodal mental imagery in musical listening, summarized in Nanay 2023). Expectations play a crucial role in our engagement with music. When we are listening to a song, even when we hear it for the first time, we have some expectations of how it will continue. And when it is a tune we are familiar with, this expectation can be quite strong (and easy to study experimentally). When we hear Ta-Ta-Ta at the beginning of the first movement of Beethoven's *Fifth Symphony* in C minor, Op. 67 (1808), we will strongly anticipate the closing Taaaam of the Ta-Ta-Ta-Taaaam. Much of our expectations are fairly indeterminate: when we are listening to a musical piece we have never heard before, we will still have some expectations of how a tune will continue, but we don't know what exactly will happen. We can rule out that the violin glissando will continue with the sounds of a beeping alarm clock (unless it's a really avant-garde piece…), but we can't predict with great certainty how exactly it will continue. Our expectations are malleable and dynamic: they change as we listen to the piece (Judge and Nanay 2021).

Expectations are mental states that are about how the musical piece will unfold. So they are future-directed mental states. But this leaves open just what kind of mental states they are—how they are structured, how they represent this upcoming future event and so on. At least some forms of expectations in fact count as mental imagery. And musical expectations (of the kind involved in examples like the Ta-Ta-Ta-Taaaam) count as auditory temporal mental imagery: they are auditory representations that result from perceptual processes that are not directly triggered by the auditory input. The listener forms mental imagery of the fourth note ("Taaaam") on the basis of the experience of the first three ("Ta-Ta-Ta") (there is a lot of empirical evidence that this is in fact what happens—see Kraemer et al. 2005; Zatorre and Halpern 2005; Leaver et al. 2009; Herholz et al. 2012; Yokosawa et al. 2013). This mental imagery may or may not be conscious. But if the actual "Taaaam" diverges from the way our mental imagery represents it (if it is delayed, or altered in pitch or timbre, for example), we notice this divergence and experience its salience in virtue of a noticed mismatch between the experience and the mental imagery that preceded it.

The Ta-Ta-Ta-Taaaam example is a bit simplified, so here is a real-life and very evocative case study, an installation by the British artist, Katie Peterson. The installation is an empty room with a grand piano in it, which plays automatically. It plays a truncated version of Beethoven's Moonlight Sonata. The title of the installation is "*Earth-Moon-Earth (Moonlight Sonata Reflected From The Surface of The Moon*" (2007)). Earth-Moon-Earth is a form of transmission (between two locations on Earth), where Morse codes are beamed up to the Moon and they are reflected back to Earth. While this is an efficient way of communicating between two far-away (Earth-based) locations, some information is inevitably lost (mainly because some of the light does not get reflected back but it is absorbed in the Moon's craters). In "*Earth-Moon-Earth (Moonlight Sonata Reflected From The Surface of The Moon*" (2007), the piano plays the notes that did get through the Earth-Moon-Earth transmission system, which is most of the notes, but some notes are skipped. Listening to the music the piano plays in this installation, if you know the piece, your auditory mental imagery is constantly active, filling in the gaps where the notes are skipped.

I will say very little about the use of mental imagery in theater, because of the obviously huge role it plays there. Peter Brook described theater as taking place in an "empty space": "I can take any empty space and call it a bare stage. A man walks across this empty space whilst someone else is watching him, and this is all that is needed for an act of theater to be engaged" (Brook 1968). This empty space is filled in with the help of our (top-down and often quite specific) mental imagery. I will only give one very evocative example of a theater performance that took place in the Iranian theater space Rooberoo Mansion in Tehran (I deliberately omit the name of the group for potential censorship complications). The only performer is a woman wearing a burka (like many women in public in Iran) and at some point of the performance she tells the audience that she is completely naked under the burka and raises questions about the legality of this. It is difficult to even begin to understand the audience's engagement with the piece without appealing to visual imagery.

Reading a novel tends to lead to mental imagery in a variety of sense modalities. This triggering of mental imagery is typically involuntary: you do not need to count to three and voluntarily conjure up the mental imagery of the protagonist's face, instead, you have involuntary mental imagery episodes somewhat reminiscent of flashbacks (this claim comes with the usual proviso that there are huge interpersonal variations in this, and many aphantasics don't report any mental imagery while reading). While this kind of mental imagery is often visual (when you have imagery of the protagonist's face or the layout of the room that they are in), it can also be auditory (of the protagonist's tone of voice, for example), olfactory, or even gustatory (see Starr 2013 for a wide-ranging analysis with an emphasis on multimodal mental imagery; and Stokes 2019 for the role such mental imagery plays in reading fictional works). Further, the more vivid the reader's mental imagery is, the more likely it is that information from the novel is imported into the reader's beliefs about the real world (Green and Brock 2000).

At the end of the first book of *In Search of Lost Time*, Marcel Proust gives a brief but very sophisticated account of how words trigger mental imagery, which is also indicative of the way Proust himself manipulates the reader's mental imagery. He makes a distinction between names and words and argues that names trigger more specific or more determinate mental imagery than words. Here is what he says:

> Words present to us little pictures of things, lucid and normal, like the pictures that are hung on the walls of schoolrooms to give children an illustration of what is meant by a carpenter's bench, a bird, an anthill; things chosen as typical of everything else of the same sort. But names present to us—of persons and of towns which they accustom us to regard as individual, as unique, like persons—a confused picture, which draws from the names, from the brightness or darkness of their sound, the colour in which it is uniformly painted.[6]

Both names and words lead to mental imagery, but then, in turn, mental imagery influences or colors the name or word when we encounter it the next time. So throughout the unfolding of the novel, names/words and the mental imagery they occasion evolve in parallel, influencing each other.

Other writers also actively reflect on how they manipulate the reader's mental imagery. George Orwell points out the importance of mental imagery in understanding metaphors when he says, in *Poetics and the English Language*, that "The sole aim of metaphor is to call up a visual image" (see also Davidson 1978; Green 2017, see also Liu forthcoming on the importance of mental imagery in poetry).[7] We might add that this imagery is often not

[6] Marcel Proust: *Swann's Way* (1913) (trans. C. K. Scott Moncrieff). New York: Modern Library, 1928, p. 556.

[7] The importance of mental imagery in understanding metaphors has also been influential in Islamic aesthetics, going back all the way to the works of the ninth-century aesthetician, Abu Al-'Abbas Tha'lab (Tha'lab 1966).

visual, it can be auditory, olfactory, etc. And here is a final example about literature from the third part of Roberto Bolaño's novel *2666* ("The Part about Fate"). This part of the book introduces a New York-based journalist, Oscar Fate. After about eighty pages of description of Fate's life in New York City, it is revealed that he is in fact African American. This comes after very explicit nudges to form mental imagery of him as Caucasian, confronting the readers with their own implicit racial bias.

While discussions of mental imagery crop up in most fields of aesthetics and art history (including by some of the most influential art historians, like George Kubler; see Kubler 1987), the role of mental imagery is probably the most salient if we turn to conceptual art. Many conceptual artworks actively try to engage our mental imagery in an unexpected manner. Here are two illustrative (and famous) examples, but the point can be generalized.

Marcel Duchamp's *L.H.O.O.Q. Rasée* (1965) is a picture that is perceptually indistinguishable from a faithful reproduction of Leonardo's *Mona Lisa*. But Duchamp earlier made another picture (*L.H.O.O.Q.*) where he drew a mustache and beard on the picture of *Mona Lisa*. Duchamp's *L.H.O.O.Q. Rasée* (because of its title, where "rasée" means "shaven") is a reference to this earlier picture and we, presumably, see it differently from the way we see Leonardo's original: the missing mustache and beard are part of our experience, whereas it is not when we look at Leonardo's original. And it is difficult to see how we can describe our experience of *L.H.O.O.Q. Rasée* without some reference to the mental imagery of the missing beard and mustache. What is interesting in this example is that the mental imagery of the beard and mustache is influenced in a top-down manner, not only by our prior knowledge (about how the world is) but also by our prior art historical knowledge.

The second example is Robert Rauschenberg's *Erased de Kooning drawing* (1953), which is just what it says it is: all we see is an empty paper (with hardly visible traces of the erased drawing on it). Again, it is difficult to look at this artwork without trying to discern what drawing might have been there before Rauschenberg erased it. And this involves trying to conjure up mental imagery of the original drawing. Again, these are two classic examples. But there are more. The vast majority of Ai Weiwei's works, for example, rely heavily on our mental imagery.

In fact, it is not easy to find an example of a conceptual artwork where mental imagery plays no role. But there are some. One example would be Robert Barry's *All the things I know*, which is nothing but the following sentence written on the gallery wall with simple block letters: "All the things I know but of which I am not at the moment thinking—1:36 PM; June 15, 1969." I'm really not sure that this work has much interest in enticing the viewer's mental imagery. It is going for a much more cerebral effect. Nonetheless, in the vast majority of conceptual artworks, mental imagery is a necessary feature of appreciating the artwork.

I hope I managed to show how much mental imagery can matter in aesthetics. And also how it can matter in many other touchy-feely parts of life. It is not just philosophers, psychologists, and neuroscientists who should take this concept more seriously. We all should.

Afterword

Is There Anything That Is *Not* Mental Imagery?

In some ways, this book must be a frustrating read. I went through a great number of mental phenomena and argued that they are all just mental imagery or at least heavily depend on mental imagery. Here are some such mental processes or phenomena: synesthesia, sensory substituted vision, echolocation, hallucination, attentional templates, pain, perception per se, amodal completion, object files, much of memory, boundary extension, emotions, desire, cognitive dissonance, and implicit bias. And this is not all. Not even all that I talked about in this book.

Further, I deliberately avoided writing in this book about some of the mental phenomena that also have a lot to do with mental imagery. Meditation and altered states of consciousness have been shown to involve a fair amount of mental imagery (Kozhevnikov et al. 2009), but I decided not to include these in the book, given that the empirical work is not very well-developed on this. The same goes for creativity, where mental imagery has long been thought to play an essential role (see Nanay 2014c for a critical summary). And while I mentioned dreams and hallucinations as clear examples of mental imagery, I did not say too much about them (but see Nanay 2016a; Fazekas et al. 2021).

An obvious question then—and I am sure a question that at one point in reading the book, readers asked themselves—would be: What is *not* mental imagery? Is there anything left in the mind that is not just straight-out mental imagery? In various previous writings, I railed against approaches of the mind that force one unitary explanatory scheme on all mental functions (see, for example, Nanay 2013a). Am I doing the same with mental imagery?

In this afterword, I want to highlight what is not mental imagery. Mental imagery is a form of perceptual processing. And even within the category of perceptual processing, it is a fairly narrow slice: it is representational processing. So non-representational (say, retinal) perceptual processing is not mental imagery. Nor is post-perceptual processing (however one draws the line between perceptual and post-perceptual processing). Finally, and most importantly, mental imagery is (representational) perceptual processing that is not directly triggered by sensory input. In other words, any kind of perceptual processing that is directly triggered by sensory input will not count as mental imagery.

In short, there is a lot in our mind that is not mental imagery: anything non-perceptual is automatically out. But even within perception, anything too late, anything too early, and anything sensory stimulation-driven are also automatically out. The vast majority of our mental processes are not mental imagery.

But, and this is really what the book was about, many of our mental processes have a lot to do with mental imagery because many of those mental processes that are not mental imagery nonetheless are intricately intertwined with mental imagery. To take just one example from one of the last chapters, a desire is not mental imagery: it is something completely different. But I argued that mental imagery plays a crucial role in explaining desires.

To put it differently, mental imagery is a neatly delineated and somewhat narrow perceptual process. But it plays a crucial role in a surprisingly large set of our mental phenomena. And I tried to identify some of these in the book.

But then another question arises: sure, there are lots of mental processes that are not mental imagery, but is everything in our mind explained by mental imagery? Is it the case that if we have understood mental imagery, we have thereby understood the whole mind?

While I tried to argue that we can explain a lot of our mind with the help of mental imagery, it is important to emphasize that mental imagery is not a silver bullet for explaining the entire mind. Especially in Part IV and Part V of the book, I tried to push explanations in terms of mental imagery as far as I could, so it is important to show the limits of such explanations.

Although some have argued otherwise (see, for example, Barsalou 1999), I don't see any overwhelming evidence that abstract or mathematical reasoning would rely on mental imagery in any explanatorily meaningful manner. I did highlight some role that imagery can and does play here in Chapter 19 (see also Mancosu 2005), but I don't think there is evidence that mental imagery drives or explains abstract or mathematical reasoning.

More generally, while I argued for the importance of imagery in decision-making, I don't think rational reasoning is explained by mental imagery. So right there we have a major exception from the explanatory sweep of mental imagery. You might think that rational reasoning constitutes a big chunk of the mind. I would vehemently disagree: I happen to think that very little of what goes on in our mind is rational reasoning and there are empirical reasons for thinking that this is so (see Chapter 19 and Nanay 2021b for some references).

Even more importantly, most of the things we care about in life have little to do with rational reasoning and a lot to do with mental imagery.

As an illustration, let me close the book with the example I began. Henri Cartier-Bresson, prisoner of war, sitting in a hut, visualizes the sea behind the mountain range he can see from his window. This mental imagery colors his perception of the mountain range. And it also gives a positive valence to this perceptual state. And this makes him happier, more hopeful. This is a great example of how mental imagery can make a positive difference in our life. As we have seen from a number of case studies in psychiatry, it can also make a tragically negative difference as well. We are better off paying attention to how it works and how it can impact our perception, our mind, and our life.

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