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Extending Sensorimotor Enactivism to Flavour and Smell

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In memory of my dad, Nick Millar

(20/09/58 – 17/11/18)

Declaration of Authorship

I declare that this thesis has been composed solely by myself and that it has not been submitted, in whole or in part, in any previous application for a degree. Except where stated otherwise by reference or acknowledgment, the work presented is entirely my own.

Signed

Date

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Abstract

This thesis explores whether sensorimotor enactivism can be extended to flavour and smell perception. Sensorimotor enactivism claims that perceptual experience is constituted by skilful bodily engagement with the world. This engagement is said to be imbued with an implicit understanding of sensorimotor contingencies — law-like relations holding between bodily activity and sensory changes. The sensorimotor approach is intended as a non-visuocentric theory of perception, purporting to offer an account of all varieties of perceptual experience. However, until now there has been no sustained research into the application of sensorimotor enactivism to flavour and smell. Moreover, some researchers have argued that these senses are problem cases for the theory, and that facts about flavour and smell serve to refute the approach. This thesis responds to such worries and addresses the gap in the literature. It argues that sensorimotor enactivism can be extended to flavour and smell and offers a positive account of how we should think about our perceptual experiences through these modalities.

Flavour and smell, it will be argued, do not allow immediate perceptual access to ordinary physical objects like roses and tomatoes. But rather, they give us immediate access to odours and flavours. In order to understand what our perceptual access to such entities consists in, this thesis draws upon tools from Gestalt psychology. Gestalt psychology allows for a modality-neutral way of thinking about perceptual organisation and helps us to arrive at a useful notion of 'perceptual objecthood'. The entities we perceive through

flavour and smell are much more diffuse than the ordinary three-dimensional objects that we perceive through sight, and the phenomenology of these kinds of perception seem particularly difficult to articulate. I argue that flavour and smell are still akin to other senses like vision in that they allow us to perceive the world as segregated into discrete perceptual objects, which exhibit figure-ground segregation and perceptual constancies. An understanding of perceptual organisation and objecthood allows for a more refined sensorimotor approach and will help us to arrive at solutions to further philosophical queries, such as whether flavour and smell are multisensory, and what the role of memory is in these perceptual experiences.

Lay Summary

Philosophy of perception has, for the most part, focused its attention on vision. However, if we shift our focus to other senses like taste and smell, philosophical queries about perception might have to be answered differently. This thesis explores the application of a theory of perception, known as 'sensorimotor enactivism', to these lesser-explored senses. It argues that sensorimotor enactivism can be usefully extended to flavour and smell and offers an account of how we should think about these forms of perception.

Sensorimotor enactivism's big claim is that *perception* is a kind of *action*. More specifically, it says that perception is an active process of skilfully exploring the environment. The *skilful* aspect of this exploration is said to consist in a kind of attunement to how our own body movements can induce different sensations. For example, we are attuned to the way that moving our eyes to the left brings about different sensations than moving them to the right. Without this kind of understanding of how our bodily activities can bring about sensory changes, our experiences would be extremely confusing. The world would appear to shift whenever we moved our eyes. Instead, we experience a stable and coherent world despite such dramatic sensory changes. The sensorimotor approach says that our perceptual experiences are the way they are because of our attunement to the myriad of different ways our bodies can perceptually interact with the world.

The sensorimotor approach, however, might not seem plausible when applied to flavour and smell. Some philosophers argue that these senses are uninformative in comparison

to sight. For example, the sense of smell may appear to only allow for the experience of vague, fragrant properties in our immediate surroundings, whereas vision allows us to experience objects at a distance, arrayed before us in space. Moreover, while sensorimotor enactivism takes perception to be an active process, some philosophers deny that this can be said of flavour and smell. Tasting salt on our tongues or experiencing the overwhelming smell of a passer-by's aftershave may appear not to involve active exploration of the environment. Researchers have argued that flavour and smell thus present a problem for sensorimotor enactivism.

I argue that such worries do not refute sensorimotor enactivism, and that our perceptual experiences in these senses bear interesting analogies with our experiences through other senses like sight and hearing. Smelling and tasting involve complex bodily activities and through such activity, we can garner a great deal of information about parts of the environment. I propose that flavour and smell perceptually parcel up aspects of the world into single entities or 'perceptual objects' in much the same way that sight allows for the experience of segregated objects like tables and chairs.

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This thesis is dedicated to my dad, who passed away last November. It is probably due to inheriting his enjoyment of puzzle solving and analytical nature that I became interested in philosophy in the first place.

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1. Introducing sensorimotor enactivism and perceptual organisation

1.0 Introduction

Sensorimotor enactivism[1] is the view that perceptual experience depends constitutively on an attunement to sensorimotor contingencies — predictable or law-like relations between sensory stimulation and bodily activity. In other words, perceivers have a kind of attunement to how their bodily movements induce sensory changes. This attunement is sometimes referred to as *sensorimotor understanding*, *sensorimotor knowledge* or *sensorimotor skill* (and I use these terms interchangeably) and throughout this thesis precisely how we should understand this concept will emerge. Through the possession of this sensorimotor understanding, a perceiving organism is said to attain direct perceptual access to the objects in its environment.

This view was first set out by O'Regan and Noë (2001a), but related views and important precursors are evident in Hurley's (1998) account. Sensorimotor enactivism draws upon Gibson's (1966/1983; 1979) ecological approach to perception and Merleau-Ponty's (1945/2012) embodied phenomenology of perception, and it also bears resemblances to Varela, Thompson, and Rosch's (1991) autopoetic variant of enactivism.[2] Sensorimotor

[1] The approach is also known as sensorimotor contingency theory, or just sensorimotor theory. Recently Noë (2010; 2012) has referred to his approach as 'actionism'.

[2] For discussion of the different types of enactivism and the ancestors of the approach see Ward, Silverman, and Villalobos (2017).

theory has continued to be developed both by the theory's originators and through secondary literature (see for example Hurley and Noë, 2003; Noë, 2004; 2006a; 2010; 2012; O'Regan, 2011; for a collection of secondary works see Bishop & Martin, 2014). However, despite the interest the theory has attracted, there has still been little investigation of whether the approach is successful as an account of non-visual experience.

The sensorimotor approach is intended as a non-visuocentric theory of perception, offering an account of all varieties of perceptual experience. In fact, Noë (2004, e.g. pp. 72–73; pp. 96–100) argues that touch, not vision, should be our model for perception since touch more obviously involves bodily movement and active probing of the environment. But most discussion of the sensorimotor approach still centres on the visual case, and there has been especially little written about how the sensorimotor approach may apply to flavour[3] and smell — the so-called 'chemical senses'[4] (though see Cooke & Myin, 2011 for one exception, and for explicit opposition to a sensorimotor approach to the chemical senses see Gray & Tanesini, 2009 and Young, 2017). This thesis will address this gap in the literature and outline how the sensorimotor approach can be extended to

[3] This thesis focuses on *flavour* rather than *taste* (in its narrow, technical sense) because we rarely, if ever, experience the so-called 'basic tastes' (sweet, salt, bitter, sour, umami) without them presenting simply as aspects of *flavours* (i.e. the sweet, sour, citrusy flavour of an orange). Some have argued that the term 'basic taste' does not truly refer to anything (Delwiche, 1996; Erickson, 2008; Spence, Smith, & Auvray, 2014). Our tasting activity gives rise to flavour experiences, rather than simple taste experiences.

[4] For simplicity, I will use the term 'chemical senses' to refer to flavour as well as smell. However, strictly speaking, flavour involves a combination of chemical senses (gustation, retronasal olfaction, trigeminal stimulation) but also contributions from other somatosensory senses (see Smith, 2015a).

flavour and smell. It aims to offer an empirically and phenomenologically satisfying account of how we ought to understand flavour and smell perception within such a framework.

This first chapter outlines the central commitments of the sensorimotor approach and the value of engaging in the philosophy of flavour and smell perception. We shall see that failing to show that the approach can be extended to these senses would constitute a major omission in the theory. I also argue that supplementing the sensorimotor approach with certain ideas from Gestalt psychology will help to provide a phenomenologically adequate account of these senses. Among the wide-ranging differences between the sensory modalities, perceptual organisation is a unifying factor. These principles of perceptual organisation will, in future chapters, allow us to arrive at modality-neutral notions of figure-ground segregation and perceptual objecthood that can be applied across the senses.

1.1 Tenets of the sensorimotor approach

1.1.1 Attunement to sensorimotor contingencies

Sensorimotor enactivism claims that perception is constitutively dependent upon an implicit understanding of, or attunement to, sensorimotor contingencies. This attunement is often referred to as 'sensorimotor understanding' or 'sensorimotor knowledge', but sensorimotor theorists emphasise that this 'knowledge' is not of the

propositional variety. It is intended as a kind of Rylean *know-how* rather than propositional know-that (e.g. Noë, 2004, pp. 117–122; see Ryle, 1949 for his seminal formulation of the distinction between knowledge-how and knowledge-that).[5] Perception is taken to be a practical bodily skill like riding a bike, and the perceiver need not be able to articulate their understanding. There has been some debate about what this sensorimotor understanding amounts to (e.g. see Roberts, 2009; Silverman, 2018), and as chapter 2 highlights, examination of the chemical senses can help provide some clarification of this notion.

Sensorimotor contingencies include such things as the characteristic ways that sensory stimulation on the retina changes as the eye rotates. This is predictable and is based upon 'the size of the eye movement, the spherical shape of the retina, and the nature of the ocular optics' (O'Regan & Noë, 2001a, p. 941). Similarly, visual contingencies include the sensory impact of blinking, which causes the retinal image to go blank, and saccadic eye movements. Auditory sensorimotor contingencies, on the other hand, include the way that head movements alter temporal asynchrony between the right and left ears, and how movements towards or away from a sound source affect the perceived volume (*ibid.*). The distinctive patterns of sensorimotor contingency associated with each modality are said

[5] See, however, Stanley & Williamson (2001) for criticism of the contrast between knowledge-how and knowledge-that. See Noë (2005a) for a response.

to offer a method for individuating the senses (O'Regan & Noë, 2001a, p. 943; Noë, 2002; see chapter 5 for discussion).

There are also sensorimotor contingencies related to the properties of particular objects, such as the sensory changes that occur as we perceive the different sides of a tomato (see O'Regan & Noë, 2001b, p. 88). These patterns explain why seeing a tomato differs from seeing a pineapple — we are attuned to the different kinds of sensory input induced by our interactions with these differently shaped and coloured objects. In this way, the sensorimotor approach is intended to offer an explanation of the quality of our perceptual experiences. Our experiences are the way they are because of the patterns of sensorimotor interaction involved. The phenomenal character of seeing the colour red, touching velvet, hearing bells ringing, smelling the scent of a rose or tasting chocolate are all to be explained by types of sensorimotor engagement involved in each perceptual episode.

Positing these different types of sensorimotor contingency is supposed to help solve two puzzles about conscious experience, which have been referred to as the 'comparative explanatory gaps' (to be contrasted with the 'absolute explanatory gap') (Hurley & Noë, 2003).[6] There are two types of comparative gap: the *intermodal* comparative gap — the

[6] Whether the approach also makes progress with the 'absolute explanatory gap' or 'hard problem' of consciousness — the question of why physical phenomena should be accompanied by conscious experience at all — is more controversial. Initially, O'Regan and Noë claimed that the sensorimotor approach overcomes the explanatory gap (2001a, p. 960; pp. 962–963), but Noë has since seemingly retreated from this claim (e.g. 2004, p. 231). The absolute explanatory gap is not something this thesis addresses.

problem of explaining why a subject has, say, a visual rather than an auditory experience; and the *intramodal* comparative gap — the problem of explaining why a subject has, say, a visual experience of a tomato rather than a visual experience of a pineapple. In both cases, the character of conscious experience is to be explained in terms of the different sets of sensorimotor contingencies governing one's skilful worldly interactions. The approach aims to provide a phenomenologically satisfying explanation of why experience feels the way it does.

The idea that perceptual experience is constituted by attunement to sensorimotor contingencies is often supported by evidence from sensory substitution devices (e.g. Hurley, 1998, chapter 9; O'Regan & Noë, 2001a; 2001b; Noë, 2002; Hurley & Noë, 2003) and visual adaptation to reversing goggles (e.g. Hurley, 1998; Hurley & Noë, 2003).[7] Tactile vision substitution system (TVSS) devices are composed of vibrators or electrodes

[7] Both the sensory substitution and reversing goggle results have been questioned as sources of support. For example, Jesse Prinz (2006; 2009; 2012, chapter 6) offers arguments that attempt to undermine these types of evidence for the sensorimotor approach. One line of criticism is that the phenomenology of experience remains tactile/auditory in the sensory substitution case: 'none of the testimony that I have read persuades me that users experience anything visual' (2006, p. 4) and vision remains unadapted in the goggles case. There is reason, however, to be sceptical of these arguments. Prinz's claims conflict with reports of those subjects who do report visual phenomenology from sensory substitution (e.g. see Ward & Meijer, 2010 for examples from auditory visual sensory substitution) and do report visual adaptation to the goggles (Taylor, 1962). Moreover, the sensorimotor approach can also concede that elements of the experiences may *not* adapt (see Myin & Degenaar, 2014 for discussion). We would expect elements of sensory substitution experiences to remain *unlike* vision to the extent that the sensorimotor contingencies involved are still not quite the same as those involved in normal visual experience. Similarly, the sensorimotor approach allows for partial adaptation to new sensorimotor contingencies, so in the goggles case one might still experience writing as reversed even if other aspects of experience have gone back to normal (see O'Regan & Noë, 2001a, p. 953; see also Ward, 2016 for detailed discussion of how we ought to interpret such findings). Thus, such objections can be challenged. I shall not go into further detail about such debates here, since even if certain evidence for visual sensorimotor theory were undermined, the approach may still be successful in relation to flavour and smell.

attached to the skin, and they receive feedback from a head-mounted camera. Output from the camera is transduced to provide corresponding tactile stimulation on the skin of blind (or blindfolded) subjects. Initially the subjects only experience tactile sensations from the device, but after an adaptation period during which they actively move around the environment, they begin to experience quasi-visual effects. TVSS-perception is unlike touch in that it does not require physical contact with objects. And much like vision, the TVSS devices allow subjects to perceive distal three-dimensional objects arrayed before them in space. Subjects start being able to 'see' with the devices when they become attuned to these vision-like sensorimotor contingencies. The sensorimotor approach predicts that TVSS-perception will replicate ordinary vision to the extent that the relevant visual sensorimotor contingencies are replicated. Similar effects have been found with 'The vOICe' auditory visual substitution devices, which convert visual input into auditory soundscapes (Ward & Meijer, 2010).

Initially, right-left reversing goggles dramatically disrupt subjects' experiences, flipping the visual field and resulting in movement causing confusing sensory effects and distortions (Kohler, 1962; Taylor, 1962). Veridical proprioceptive feelings of movement conflict with visual experience. As Hurley & Noë state, '[M]ovements of your eyes, head, limbs, and whole body quickly demonstrate that the old patterns of sensorimotor contingency no longer apply' (2003, p. 149). However, after an extended period of adaptation, the conflict between vision and proprioception dissipates. This adaptation period (much like in the TVSS case) involves the subject engaging in sensorimotor interactions with the

environment. Reports vary, but Hurley & Noë (2003) along with Taylor (1962) characterise the adaptation as involving visual experience gradually correcting itself. Objects on the left are once more correctly seen as being on the left, for example. Others have suggested that it is really subjects' proprioception and behavioural dispositions that reverse in accordance with visual experience (Harris, 1965; Harris, 1980). Ward (2016) argues convincingly that perception and one's practical behavioural capacities are constitutively entwined, and so one ought not to expect one to adapt without the other adapting too, suggesting that neither of the above interpretations is quite right.[8] Importantly, for the sensorimotor theorist, the experienced shift is explained by an adaptation to new patterns of sensorimotor contingency. Passive exposure to changing stimuli is insufficient for the adaptation; it requires purposeful interaction with the world.

1.1.2 Perceptual duality

Much of the time, we are largely unaware of the sensory changes that occur as we interact with the world. We generally simply perceive whole objects, rather than attending to transient changing sensations. However, if we adopt a particular attentional stance we *can* notice at least some of these sensory changes as we engage in bodily activity.[9] This is

[8] Ward (2016) also highlights that close attention to the reports from Kohler's subjects supports such an interpretation. Parts of the world with which the subjects are intentionally and fluently interacting are perceived veridically, while the rest may still be experienced as still reversed. This suggests that veridical perception and fluent behavioural capacities return together.

[9] We may never detect certain sensory changes, such as, for example, the sensory changes induced by most involuntary saccadic eye movements.

manifested in a kind of experienced *duality* to perceptual experience (emphasised especially in Noë's later works, e.g. 2004; 2012).

There are different ways to cash out the idea that perceptual experience exhibits a duality. With some interpretations of the sensorimotor theory, consciously experienced sensory changes or 'raw sensations' occur prior to the acquisition of sensorimotor understanding.[10] According to this kind of approach, it is possible to have *sensory* experience (perhaps experienced as a mosaic of conscious sensations rather than coherent worldly objects) without sensorimotor abilities. With other versions of the approach these sensory changes can only reach the level of conscious experience once the subject has already acquired the sensorimotor skills required for perception (for example, see Beaton's, 2016 interpretation of Noë's approach, particularly p. 267, fn. 7). With this approach, perception and the experience of sensory change co-arise. According to either of these glosses on Noë's sensorimotor approach, once we do have perceptual skills, we can at times attend to the sensory changes that are induced through bodily activity. Here I assume that with this kind of sensorimotor approach, the sensory changes are experienced (at least largely) as what Noë (2004) refers to as *perspectival properties* or *p-properties* — relational properties between the perceiver's body and parts of the environment. For example, if we focus our attention we can notice that, perceived from an angle, there is a sense in which a plate looks elliptical, and this elliptical shape changes

[10] This appears to be what is suggested at various points by Noë (2004) in his discussion of changing 'appearances' and 'looks' (e.g. see chapter 3 and pp. 228–230).

as we move. We can also notice that even though the plate is a uniform colour, there are visible differences in patches of light and shadow.

Perceptual duality can serve as evidence for the perceptual constancies that underlie it. For example, when we notice how the plate looks a uniform colour, but in another sense has visible differences in patches of light and darkness, we are attending to features of colour constancy. Such constancies have been taken to be a hallmark of perception, as distinguished from proximal sensation (e.g. Burge, 2009; 2010; see discussion in chapter 2). According to the sensorimotor approach, these constancies are a product of sensorimotor skill. We perceive a plate as being a constant size and shape despite perspectival and sensory changes, because of our attunement to sensorimotor contingencies.

The idea that perceptual experience has this dual character is controversial. Some researchers are unconvinced that we really experience changing perspectival properties, or criticise Noë's characterisation of them (for example, see discussions in Siewert, 2006; Briscoe, 2008; Kelly, 2008; Martin, 2008; Hopp, 2013).[11] A number of philosophers specifically object to the implication that we experience constant properties and perspectival properties *simulaneously* (Siewert, 2006; Kelly, 2008). I agree with these

[11] Others, such as sense-datum theorists, have argued that we don't perceive the constant, *non-perspectival* properties of things (we only truly perceive the elliptical shape of the plate and the facing sides of the tomato). We only *judge* that the plate is round and the tomato spherical. I shall not discuss this possibility here, but Noë argues that this is an epistemological point rather than a phenomenological one (see Noë, 2005b for discussion).

researchers that it is phenomenologically implausible that we can direct our attention to both at once. As Kelly suggests (2008, pp. 685–686), the redirection of attention is akin to an aspect shift; we can't see an image as both a duck and a rabbit at the same time. However, the idea that we can attend to both perspectival and non-perspectival aspects of the world at once doesn't seem to be an important part of Noë's position (see discussion in Noë, 2008). The sensorimotor theorist can agree that one must undergo an attentional shift to notice perspectival properties.

We generally perceive the world before us without noticing transient perspectival changes as we move around, and only attend to these perspectival properties when we adopt a particular detached, 'painterly' attitude. However, these changing perspectival properties are still important insofar as they provide valuable evidence of the perceptual constancies that underlie them, and they mark a distinction between perceptually present aspects of the world and ephemeral sensory changes. In the chapters to come, I argue that an analogous duality can also be experienced in flavour and smell perception, a step on the way to vindicating a sensorimotor approach to flavour and smell. We will also see that the constancies underlying such duality are a necessary condition for perceptual objecthood.

1.1.3 Perceptual presence and the world as an 'outside memory'

The sensorimotor approach has the purported benefit of providing a solution to the problem of perceptual presence (Noë, 2004, pp. 59–65). This is the puzzle of how we have

a perceptual awareness of hidden aspects of objects and scenes — 'that which, strictly speaking, I do not perceive' (*ibid.*, p. 60). We perceive a tomato as spherical, but how can this be when we do not have sensory contact with the back of it? The sensorimotor approach offers a solution: the hidden parts of objects are present as *accessible*. Through our sensorimotor skills, we have access to the whole, spherical tomato:

> Our perceptual sense of the tomato's wholeness — of its volume and backside, and so forth — consists in our implicit understanding (our expectation) that movements of our body to the left or right, say, will bring further bits of the tomato into view. Our relation to the unseen bits of the tomato is mediated by patterns of sensorimotor contingency. (Noë, 2004, p. 63)

Implicitly understanding how movements provide sensory access to different parts of the environment enables an experience of richly detailed scenes and whole objects. We do not need neurally-realised models of this detail because the detail is already there in the world, ready to be accessed through skilful bodily activity. This idea is sometimes expressed in the claim that the world serves as an 'outside memory' (O'Regan, 1992);[12] through bodily activity, we access the world's detail as and when required.

In this way, the sensorimotor approach serves as an alternative to orthodox cognitive science, according to which the brain constructs a richly detailed model or representation of the environment (i.e. views descending from Marr, 1982; see discussion in O'Regan & Noë, 2001a, p. 940). Because of the sensorimotor approach's opposition to this kind of view, it has often been taken to eschew internal representations altogether. However, it

[12] C.f. Brooks' (1991) claim that the world is its own best model.

does in fact remain compatible with positing representations that play an important role in perception, as long as these representations are not taken to be fully *constitutive* of perceptual experience. Noë clarifies this:

> No doubt perception depends on what takes place in the brain, and very likely there are internal representations in the brain (e.g., content-bearing internal states). What perception is, however, is not a process in the brain, but a kind of skillful activity on the part of the animal as a whole. (2004, p. 2; see also p. 22)

Some researchers offer representation-friendly versions of the sensorimotor approach that are largely in line with orthodox cognitive science (e.g. Seth, 2014). Other sensorimotor theorists (e.g. Silverman, 2013) adopt positions more in line with the anti-representational 'radical' enactivism of Hutto and Myin (2013). This is not a debate this thesis addresses; I take my core arguments to be compatible with either representation-friendly or anti-representational versions of the sensorimotor approach.

The idea that visual experience isn't realised by the activation of a high-fidelity, richly detailed model of the world before us is supported by research into change and inattentional blindness (for discussion see O'Regan & Noë, 2001a). Large portions of the visual field can change without subjects noticing, due to distractors such as the appearance of 'mud splats' or a global flicker across the visual field (e.g. O'Regan, Rensink, & Clark, 1999). Similarly, providing subjects with an attention-intensive task can cause them not to notice strikingly unusual events. In a famous demonstration of this, viewers who were engaged in counting how many times a basketball was passed among players often failed to notice the appearance of a person in a full-body gorilla suit (Simons &

Chabris, 1999). These unnoticed occurrences may be very surprising to subjects who felt they were, at once, seeing a whole detailed scene before them. They are, however, consonant with the sensorimotor approach's claims regarding the world serving as an outside memory. We focus our attention only on small aspects of the field at any one time, allowing us to entirely miss the gorilla. The impression of a richly detailed field before us is, according to Noë (2004), because of our ability to *access* the world and its detail, even if in an important sense we don't currently perceive these details. Our experience of the world is less determinate than might be initially thought.

1.1.4 An omission in the literature: the 'chemical senses'

Most of the discussion among sensorimotor theorists, and their detractors, relates to vision. And the approach succeeds, I think, in providing an empirically and phenomenologically plausible account of visual experience (although one need not accept this in order to endorse the positive arguments relating to the chemical senses throughout this thesis). However, if sensorimotor enactivism is to serve as a general account of perception, and if it is to close the aforementioned 'comparative explanatory gaps', it must also offer a satisfactory account of very different kinds of perceptual experience. In this regard, since flavour and smell haven't been discussed, there is an omission in the literature surrounding sensorimotor enactivism. As we shall see throughout the following chapters, the approach (in combination with certain ideas from Gestalt psychology) is empirically and phenomenologically apt as an approach to flavour and smell.

Philosophy of perception has taken vision to be the paradigm, and among the five Aristotelian senses, the chemical senses are perhaps considered the furthest removed from sight. One important difference between vision and the chemical senses is the type of entity with which we are put in perceptual contact. Vision allows us to perceive ordinary, three-dimensional objects or 'medium-sized dry goods'[13] as some would say. We see tomatoes, pineapples, cats and roses. However, philosophers of olfaction have, for the most part, reached a consensus that the sense of smell does not allow the immediate perception of these ordinary objects, but rather the perception of *odours* (e.g. Lycan, 1996, 2000; Batty, 2010a, 2011, 2014a, 2014b; Richardson, 2013; Carvalho, 2014; Young, 2016).[14] There has been little discussion regarding the objects of flavour perception (though see Smith, 2007; 2013b; 2015b; 2016 for discussion of realism about flavours), but in chapter 4 I argue that for analogous reasons to the odour case, tasting allows the immediate perception of *flavours* rather than ordinary objects.

Even though we often talk as though we taste tomatoes and smell roses, it is (at least, in the first instance) tomato *flavours* and rose *odours* that we perceive. The reasons for this, regarding olfaction, have been outlined by several researchers (e.g. Lycan, 1996; Batty, 2010a; Richardson, 2013; Young, 2016). Olfaction is not sufficiently attuned to the presence and absence of objects like roses and rubbish bins, or to the way these objects

[13] This phrase is attributed to J.L. Austin.

[14] For a somewhat different type of account see Mizrahi (2014), who argues that we olfactorily experience properties of *stuffs*, which are constitutive of both source objects and the volatile molecules that emanate from them.

change over time, to constitute a means of perceiving them. Richardson makes this point: 'For example, cooking odours linger in the kitchen long after the food is eaten, and the sillage of your perfume is the scented wake you leave in the elevator after you've stepped out of it' (2013, pp. 403–404).[15] For this reason, she argues that olfaction does not allow *perceptual* contact with ordinary objects. Instead, it only allows for 'thought contact' with them; we can only perceive *that* roses or food are there. We have a cognitive attitude, such as a belief, towards these objects. If we *perceptually* access any objective aspects of the world through smell, it doesn't seem that those aspects are ordinary, three-dimensional objects.

We do, however, perceive the presence and absence of, and changes to, *odours.* That odours, and not ordinary objects, are the immediate target of olfactory perception is further supported by the fact that odours can be produced artificially, and perception of these artificial odours does not appear to be automatically non-veridical. As Lycan states:

> In particular, there are objects other than roses that set off the rose smell — artificial rose smells can be made of any substance whose molecules are shaped similarly to those of roses. The point is not that the nose can be fooled. Au contraire; it is that in the artificial case, the nose is not fooled, and the rose smell is not incorrectly tokened. An artificial rose that produces the rose smell is smelled correctly, for it does have that smell even though it is not a rose. (1996, p. 90)

[15] Richardson distinguishes the olfactory case from visual cases where a time-lag occurs, such as the visual perception of stars. In the case of seeing stars, even though there is a time-lag, we still take ourselves to be sensitive to the presence, absence and changes to these objects over time. The same is not true of olfaction. She asserts, 'The comings and goings of, and changes in the particular sources of odours just don't make very much difference to olfactory experience' (2013, p. 404).

Thus, seemingly *odours* are the immediate objects of olfactory experience.[16] The idea that odours do not merely serve as causal intermediaries (like light in visual experience), but are themselves what we perceive through olfaction has been referred to as the 'odour view' (e.g. Richardson, 2018). Chapter 3 provides another reason for endorsing the odour view. Namely, we shall see that it is *odours* rather than the source objects that fulfil the criteria for perceptual objecthood (figure-ground effects and constancies). Chapter 4 highlights that analogous arguments apply to flavour perception.

Sensorimotor interaction with the world is supposed to allow us to access meaningful, perceptually present wholes and, for the most part, these entities have been associated with ordinary physical objects (tomatoes, plates, cats, etc.). It is not *prima facie* clear whether the experience of odours and flavours can be said to involve access to perceptually present wholes, or whether the experience is more nebulous. Thus, there is a question about whether our experiences through the chemical senses are of the right sort to be compatible with the sensorimotor approach.

Potential problems with applying the sensorimotor approach to the chemical senses are further exacerbated by other traits that have been attributed to taste and smell. For example, it is often thought that the sense of smell lacks the kind of informational and

[16] This is compatible with the possibility that we also *indirectly* perceive or represent ordinary objects through the sense of smell (Lycan, 1996). With such an account, we indirectly represent roses *via* the act of smelling the odour. See Cavedon-Taylor (2018) for discussion of how this position contrast with the more 'austere' idea that odours are the only intentional objects of olfactory perception.

phenomenological richness exhibited by vision. According to Batty (2010b, p. 103), 'When compared to visual experience, olfactory experience seems incredibly impoverished'. This alleged lack of informational import often goes along with claims that the sense of smell is aspatial and/or that odours are undifferentiated spatially (e.g. Lycan, 2000; Wilson & Stevenson, 2006; Matthen, 2005; Batty, 2011; 2014b; Carvalho, 2014). This has led some researchers to argue that the chemical senses (and, in particular olfaction), don't allow for the perception of discrete entities (see chapter 3 for discussion). Batty (2010a; 2011), for example, argues that olfaction only allows us to perceive that there is an undifferentiated 'something or other' in one's vicinity that instantiates properties. She thinks that compared to vision, olfactory experience is 'just plain smudgy' (2010a; 2014b). Such an approach wouldn't seem to allow for the kinds of perceptually present particulars to which, according to the sensorimotor approach, we gain access through sensorimotor attunement. Rather, they would seemingly only allow for a more minimal kind of experience. Chapters 3 and 4 dispute such claims and argue instead that smell and flavour perception allow for the experience of discrete perceptual objects.

Some researchers deny that the chemical senses are even perceptual modalities. Burge (2010), for example, has argued that the chemical senses do not exhibit perceptual constancies, and thus, they do not allow for perceptual experience at all. According to Burge, they instead involve merely proximal sensation. If the chemical senses are non-perceptual, the sensorimotor approach may not be applicable to them at all since it purports to be a theory of *perceptual* experience, rather than of proximal sensation.

Moreover, perceptual constancies are a central aspect of the sensorimotor approach; it is through an understanding of how bodily movements induce changing sensations that we perceive constant parts of the world. So, if flavour and smell lack constancies, this could present a problem for the extension of the account to these senses. On a similar note, Gray and Tanesini (2009) argue that flavour perception provides a counterexample to sensorimotor enactivism since, they claim, it does not involve distinctive perspectival and non-perspectival aspects. They do not think the chemical senses have the kind of dual phenomenal character that the sensorimotor approach ascribes to perceptual experience.

Others argue that the chemical senses do not involve the skilful interaction with the world required by a sensorimotor approach. Humphrey (2001, p. 987) asserts:

> When we taste salt on our tongues, or smell musk in our noses … how can these experiences plausibly be thought to depend on sensorimotor contingencies? There is simply nothing we do by way of exploration with our tongues (or our noses ...) that could provide requisite information.

The chemical senses might thus be too simple and devoid of complex bodily activity for the sensorimotor approach to apply. In chapter 2, I respond to these kinds of arguments.

In order to respond to the highlighted challenges, and to present a phenomenologically satisfying account of flavour and smell, this thesis draws on Gestalt approaches to perceptual organisation. Gestalt psychology gives us tools to understand odours and flavours as perceptually present *wholes*, despite the important differences between them

and ordinary physical objects. Flavours and smells aren't just nebulous sensations or smudgy 'something or others' in one's vicinity, rather we experience them as parsed up in meaningful ways. The Gestalt approach provides the beginnings of a framework for thinking about perception in a modality-neutral manner. In the next section, I introduce this approach.

1.2 Perceptual organisation and Gestalt psychology

Throughout this thesis I draw on aspects of Gestalt psychology.[17] This section introduces the Gestalt grouping principles and outlines why they are useful tools for understanding the organisation of the perceptual landscape.

There is a precedent for the integration of an embodied approach to perception with insights from Gestalt psychology. Merleau-Ponty, for example, made extensive use of the ideas and discoveries of the Gestalt psychologists, particularly the so-called Berlin school of the 1920s. Theorists such as Koffka, Köhler and Wertheimer held that experience isn't stitched together from an assortment of discrete, piecemeal sensations, but instead has a holistic character. The perceptual landscape is segregated into unified entities, which cannot be meaningfully dissected further. For Merleau-Ponty, drawing on these Gestalt psychologists, perception requires a figure-ground structure:

[17] Other aspects of the Gestalt approach will be disregarded. For example, I do not incorporate or discuss their claims of psychophysical isomorphism (the proposed resemblance between structural properties of the brain and the perceptual world) (e.g. Köhler, 1947, pp. 60–63).

> When Gestalt theory informs us that a figure on a background is the simplest sense-given available to us, we reply that this is not a contingent characteristic of factual perception, which leaves us free, in an ideal analysis, to bring in the notion of impressions. It is the very definition of the phenomenon of perception, that without which a phenomenon cannot be said to be perception at all. The perceptual 'something' is always in the middle of something else, it always forms part of a 'field'. (Merleau-Ponty, 1945/1962, p. 4)

Noë (2004, p. 135) also endorses this idea:

> A perceptual experience does not analyze or break down into the experience of atomic elements, or simple features. Experience is always of a field, with structure, and you can never comprehend the whole field in a single act of consciousness. Something always remains present, but out of view.

The aforementioned studies into inattentional blindness and claims about the world serving as an external memory are suggestive of this kind of figure-ground structure. We focus our attention on a figure (the basketball), while everything else is relegated to background (including the gorilla). The background is less clearly specified than the objects of our attention, and yet we still have the impression of a detailed scene before us in virtue of our access to the environment. Within the sensorimotor approach, the figure-ground structure of experience is thus closely related to its explanation of perceptual presence in terms of skilful access. The parts of the world perceived as figures are generally targets of our attention and are accordingly more readily accessed/accessible than those experienced as background.

It is controversial, however, whether olfaction and flavour allow for this kind of figure-ground structure. If they do not, they may not count as truly perceptual (as per the quotes from Merleau-Ponty and Noë above) or may not allow for the experience of discrete

entities. The grouping principles of Gestalt psychology provide tools for investigating whether different types of perceptual experience exhibit a figure-ground structure. These principles describe the circumstances under which aspects of the environment will (ceteris paribus) be perceptually grouped into unified figures, separated from the background. As we shall see, at least some of these principles seem to apply across the senses and thus, they are especially useful when we expand the scope of our investigation beyond vision.

One reason why they will be of value in understanding flavour and smell is because, as highlighted above in 1.1.4, the chemical senses do not allow the (immediate) perception of ordinary physical objects. We visually experience the world as perceptually organised into discrete, meaningful components, segregated from everything else around them (i.e. as exhibiting a figure-ground structure). The objects of visual experience usually correspond to ordinary, physical objects (with some potential exceptions, such as rainbows and holes). We see tomatoes, apples and roses, and the visually perceived boundaries of these objects are specified by the boundaries or edges of these physical entities. We have a fairly clear pre-philosophical understanding of the divisions between physical objects, and by the same token, we arrive at a (rough and ready) understanding of the structure of visual perception with relative ease. The world is generally visually carved up in accordance with the divisions between ordinary objects.

The chemical senses, on the other hand, do not perceptually organise the world in accordance with the divisions between ordinary physical objects. They allow us to experience odours and flavours, not roses and tomatoes. People generally don't have such clear pre-philosophical intuitions about the divisions between these kinds of diffuse entities. This, combined with the fact that we are very visual creatures and tend to be less attentive to our flavour and smell experiences, makes the perceptual organisation of our experiences through these senses less prima facie apparent. The phenomenology of flavour and smell experiences seems especially difficult to grasp and articulate. This is evidenced a lack of consensus among researchers about whether these senses even meet the criteria for *perception* (as discussed above, Burge, 2010 argues that they do not), and if they do allow for perception, whether or not they allow the perception of discrete particulars (see discussion in chapters 3 and 4). Flavour and smell thus present challenges for phenomenological examination, and the Gestalt principles can aid us in overcoming such difficulties. Although this thesis does not offer explicit arguments in favour of the Gestalt framework, that the approach better allows us to understand and articulate the phenomenology of our experiences will serve as a kind of proof of concept for it.

As the following chapters demonstrate, a number of the Gestalt principles are applicable across the senses. Gestalt psychology thus provides a modality-neutral framework for thinking about the perception of particulars that don't map neatly onto three-dimensional

physical objects.[18] In doing so, this approach shifts the focus away from ordinary physical objects towards *perceptual objects,* allowing for a refinement of the sensorimotor approach.[19]

1.2.1 The Gestalt grouping principles

The Gestalt psychologists (e.g. Wertheimer, 1923/1938; Metzger, 1936/2006) set out various perceptual grouping principles. Perception involves grouping together features and segregating these groupings from their backgrounds. Grouping and figure-ground segregation are aspects of the same phenomenon: in order for some parts of the environment to be meaningfully unified into a single, bounded figure, they must also be perceived as distinct from their backgrounds. Being grouped into a *single* object already implies a separation from whatever else is around them (see chapter 3 for more discussion). The grouping principles have mainly been explored in relation to vision. However, Wertheimer (1923/1938) and Metzger (1936/2006, p. 27) do briefly discuss their application to audition, with Bregman (1990) in more recent years advancing a detailed account of this. Metzger also discusses how they may pertain to touch (see especially 1936/2006, Ch. 4),[20] and argues that Gestalt organisation applies across all the

[18] See Van Valkenburg and Kubovy (2004), who also argue that looking to perceptual organisation can serve as a useful modality-neutral approach. They argue that such an approach can bridge rifts in various different theoretical approaches to perception.

[19] I conceive of *perceptual objects* as including (some) ordinary physical objects (tomatoes, cats), as in the visual case, but also including items that aren't so easily classified as such (e.g. flavours, smells, holes, shadows). Chapter 3 provides more detail.

[20] See also Gallace and Spence (2011) for in-depth discussion of Gestalt principles and touch.

'higher senses', which he thinks encompass vision, touch, hearing and a sense of movement (*ibid.*, pp. 26–27).

Not all the Gestalt principles are directly applicable to all the senses, however. As Metzger states, 'Not every Gestalt law can be transferred unmodified to hearing, for instance not the law of closure and even less so the law of symmetry' (Metzger, 1936/2006, p. 27) and there has been very little discussion of whether any of these principles apply to the chemical senses. In chapters 3 and 4 I argue that the chemical senses also operate in accordance with a number of the grouping principles and tend towards the overarching rule of Prägnanz (to be explained below). This will provide reason to extend notions of figure-ground segregation and perceptual objecthood to these senses. Below I outline the grouping principles that will be of particular relevance in the chapters to come.

Principle of Prägnanz/Good Form: The most fundamental Gestalt principle is the law of Prägnanz, or good form, which states that percepts are organised in the most orderly, simple, and harmonious way possible. Koffka (1935, p. 110) states, 'psychological organization will always be as "good" as the prevailing conditions allow'. All the other principles are subsumed by this overarching principle. The other principles (such as those described below) specify elements of what it means for perceptual organisation to be prägnant (e.g. similar and proximal elements should be grouped together, while dissimilar and non-proximal elements should not be). Each grouping principle is defeasible if other principles allow a more prägnant gestalt to emerge.

While the definition of ‘prägnanz’ was left intentionally vague, Wertheimer appealed to readers’ intuitions about the concept:

> On the whole the reader should find no difficulty in seeing what is meant here. In designing a pattern, for example, one has a feeling how successive parts should follow one another; one knows what a "good" continuation is, how "inner coherence" is to be achieved, etc.; one recognizes a resultant "good Gestalt" simply by its own "inner necessity"... (1923/1938, section VII)

He also offered examples. Although the shapes in Fig. 1.1.a. all contain the same irregular hexagon (Fig.1.1.b.), they each have a tendency towards a different perceptual organisation (Figs 1.1–1.4 all adapted from Wertheimer, 1923/1938; see also discussion in Metzger, 1936/2006, pp. 23–25). We don’t immediately see the irregular hexagon hiding in these shapes, as this would not be the most prägnant interpretation of the images. Although there is nothing especially complex or disorderly about the irregular hexagon itself, the lines that would remain should the hexagon be experienced as segregated would appear odd and arbitrary. The same cannot be said in the case of Fig.1.1.c, where the remaining lines form an orderly grid pattern in their own right. In this image, then, we continue to see the irregular hexagon as a clearly individuated figure. We don’t divide the perceptual environment into haphazard parts, but rather into simple, orderly wholes. Thus, perceptual organisation can be intuitively understood as prägnant without necessarily knowing exactly which of the more specific grouping principles are in operation. Plausibly the same can be said of perception in other senses (for example, we organise sounds into simple and orderly streams).

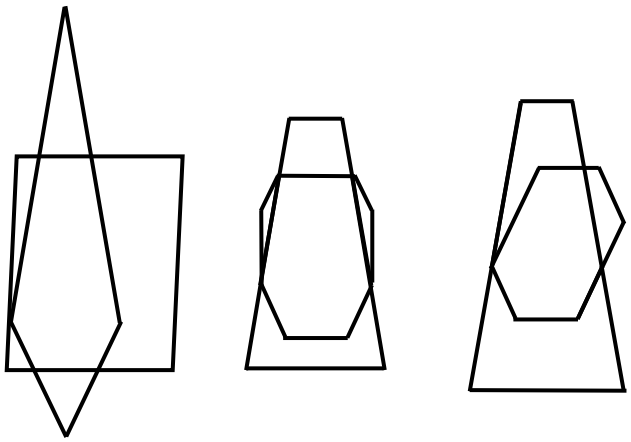
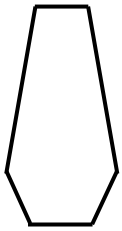
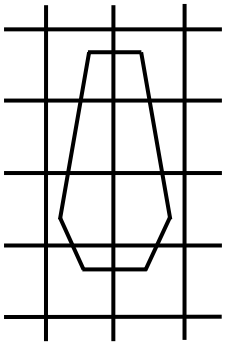


Fig 1.1. a. Images that each hide the same shape. Adapted from Wertheimer (1923/1938, Section VII)



b. An irregular hexagon, hidden within the shapes in 1.a



c. The same hexagon within a different image. This time the hexagon remains clearly visible.

Principle of Similarity: The principle of similarity tells us that (*ceteris paribus*) we group together similar features/parts of the world (and equally, are more likely to segregate *dissimilar* features). For example, in Fig. 1.2 we tend to group together the similarly coloured circles into sets of two when they are uniformly spaced. In the auditory case, we are more likely to group together sounds that are similar on the basis of factors such as timbre, frequency and/or volume (e.g. McAdams & Bregman, 1979; Bregman, 1990).

Principle of Proximity: The principle of proximity tells us that we are more likely to group together items in close proximity. In Fig. 1.3, we group the circles into sets of two by virtue of their proximity. Bregman (1990) suggests that an auditory analogue of this is separation in time (p. 19). For example, something akin to Fig. 1.3 could be replicated auditorily by using sets of temporally proximate beeps. Just as in the visual case, we would be likely to group together the proximate stimuli, although in the auditory case the relevant proximity is usually temporal rather than spatial.[21]

Principle of Common Fate: We are more likely to group together items that follow a 'common fate'. Birds flying together as a flock are readily experienced as a unit, for example. And, as in Fig. 1.4, if dots start to move at the same speed in the same direction, they are likely to be experienced as belonging together. Again, analogues of this principle

Fig. 1.2. Grouping by similarity

Fig. 1.3. Grouping by proximity

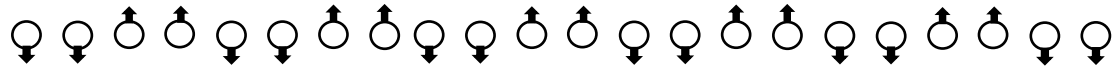


Fig. 1.4. Grouping by common fate. The arrows depict direction of movement.

[21] In some instances, proximate location is also a relevant factor in sound stream grouping and segregation, and it is particularly useful when other cues are ambiguous or uninformative (e.g. Darwin & Hukin, 1999; Bronkhorst, 2000). However, spatial location is considered a weak cue in the auditory case, especially when grouping and segregation occurs over short time scales (e.g. Bregman, 1990; Buell & Hafter, 1991; Darwin & Hukin, 1997; Schwartz, McDermott, & Shinn-Cunningham, 2012).

appear to apply to audition. Bregman (1990, p. 249) argues that this principle can be expanded to include elements that *change* together in proportional and synchronous ways. This would apply in cases where, for example, frequency components change synchronously by proportional amounts and are therefore more likely to be experienced as grouped.

1.2.2 Sensorimotor enactivism and the Gestalt approach

Although visual examples such as those in Figs 1.1–1.4 are commonly used in describing the Gestalt grouping principles, chapters 3 and 4 argue that these principles also have application to smell and flavour. Chapter 5 adds that these principles can be used in determining whether *multisensory* object perception is occurring. The grouping principles provide the beginnings of a framework for thinking about 'perceptual objects' experienced through non-visual modalities. The chemical senses are very different from vision, and there has been little agreement regarding to how to characterise the phenomenology of these senses. Using the grouping principles, we can determine whether olfaction and flavour perceptions are sufficiently similar to other, paradigmatic kinds of object perception for us to attribute object status to them. The Gestalt approach will help us to achieve a phenomenologically adequate account of the chemical senses. Because of this, the sensorimotor approach can benefit from it. Equally, the sensorimotor approach provides a satisfying way of cashing out the Gestalt approach. With the sensorimotor approach, it is through our sensorimotor attunement that we are able to

perceive whole gestalts. Thus, the two approaches complement one another.

One might wonder at this point, though, how the tenets of the sensorimotor approach relate to Gestalt psychology's descriptions of the circumstances under which we tend to group together parts of the environment. A full investigation of this is beyond the scope of this thesis, but here I offer some initial remarks on this issue, and we shall return to some of these issues in chapters 6 and 7.

The ways we group together certain salient items and segregate them from the background is plausibly a product of being creatures within a particular ecological niche, with particular types of bodies and interests, engaged in particular kinds of sensorimotor interaction with the world. The chemical senses often function to guide us in avoiding harmful substances and dangerous situations such as decaying food, fire and gas leaks. They also aid us in seeking out beneficial ones, such as nourishing food. Olfaction also allows for the recognition of kin (e.g. Porter, Balogh, Cernoch, & Franchi, 1986) and it may aid in mate selection (see Wilson & Stevenson, 2006, pp. 138–140 for a review of the evidence). Plausibly, if the chemical senses involve perceptual grouping at all, they group flavours and odours in such a way as to serve these kinds of functions.[22] This is hospitable to a sensorimotor approach, according to which perception and bodily engagement with

[22] The ways we group and segregate aspects of the olfactory world can also be changed. According to research by Li, Howard, Parrish, and Gottfried (2008), whether we discriminate odours from one another can be altered by a process of aversive conditioning. When presenting subjects with initially indistinguishable odours, pairing one of the odours with an electric shock, can result in them learning how to discriminate the two. See also Chapter 6 for discussion of the role of prior experiences in perceptual organisation.

the world are constitutively entwined. The chemical senses are also closely tied to hedonic valence and emotional memories, and they also allow for aesthetic experiences, as exemplified by particularly good wine or perfume. The things that are salient in these senses are quite different from those which are salient in visual experience, just as our embodied activity in these senses is different from that involved in vision. We might perceptually group together certain complex collections of molecules because this combination indicates the presence of something hazardous nearby, or perhaps because they remind you of the perfume your Grandmother used to wear.

In chapter 6 we will see that what counts as the most prägnant perceptual organisation can vary depending upon one's prior experiences and history of embodied activity. How exactly the Gestalt principles shape perceptual organisation can be influenced by previous experiences, but they also seem to play a crucial role in the perception of *novel* objects, with which the subject does not have prior encounters. In these cases, the Gestalt principles appear to provide heuristics for one's initial exploration of the environment. That similar and/or proximal items tend to belong together allows for initial object-related sensorimotor expectations about what sensations will be induced by one's movements in a given environment. With the sensorimotor approach, perception is constituted by sensorimotor skill, which can be exercised either through protracted coupling with the environment or through a counterfactual attunement to how movements would induce sensory change (to be discussed further in chapter 2). We shall see that the Gestalt

grouping principles play a particularly important role in the former kind of sensorimotor attunement (chapter 6).

1.3 Conclusion

We have seen that a disregard for the non-visual modalities (and in particular, flavour and smell) constitutes an important omission in the sensorimotor approach. The sensorimotor approach purports to account for all varieties of perceptual experience, but this presents various challenges given the important differences between vision and the chemical senses. Here I outlined a variety of these differences, which will be discussed further in the chapters to come.

I also introduced the notions of perceptual organisation and the Gestalt grouping principles. Perceptual organisation can serve as a unifying, modality-neutral approach to understanding perceptual experience. In the visual case it is easy to take the structure of perceptual experience for granted due to its close connection to ordinary, three-dimensional objects. Senses like flavour and smell do not allow us to pick out such physical objects, however. Our intuitions regarding the perceptual organisation of flavours and odours are less clear-cut. The Gestalt grouping principles provide a framework for thinking about the perceptual world in non-visuocentric terms, enabling an understanding of perceptual groupings that don't map neatly onto three-dimensional physical objects. In the next chapter, I offer the beginnings of a sensorimotor approach to flavour and smell and address arguments that take these senses to present problems for the theory.

2. Towards a sensorimotor approach to flavour and smell[23]

2.0 Introduction

Sensorimotor enactivism takes perceptual experience to be constituted by a kind of attunement to sensorimotor contingencies — law-like relations between sensory inputs and bodily activity. This attunement allows the perception of invariant worldly features amid sensory changes, which can be manifested as a kind of duality to perceptual experience. For example, we might notice that a plate viewed from an angle looks elliptical in one respect, while also looking round in another. Several philosophers have argued that flavour and (orthonasal) smell[24] are problem cases for this approach, and others, while not explicitly targeting sensorimotor enactivism, have offered accounts of the so-called chemical senses that would conflict with its core tenets. In this chapter, I respond to these objections and obstacles for the sensorimotor approach, and in doing so offer the beginnings of a sensorimotor account of the chemical senses. I do not aim to convince the reader of the sensorimotor account here, but rather to show that flavour and smell do

[23] This chapter is an adapted version of a forthcoming publication of the same name in *Mind & Language.*

[24] Flavour perception involves gustation, retronasal olfaction, tactile and trigeminal stimulation, but these discrete components are generally experienced as unified (e.g. see Smith, 2015a). 'Taste' refers to the gustatory contributions to flavour, allowing for the experience of the properties of sweet, salty, sour, bitter and umami. However, we rarely, if ever, experience gustatory stimulation in isolation from other aspects of flavour such as touch and retronasal stimulation outside of experimental settings. Thus, as Spence, Smith, and Auvray (2014) point out, *taste* is likely best conceived of as simply an aspect of flavour. I do not believe this understanding of taste has any noteworthy impact on the arguments presented here, but it is a motivation for not focusing in on taste as a separate perceptual/sensory modality. Here I treat orthonasal olfaction as a distinct sense modality to flavour and use the term 'smell' only to refer to this orthonasal variety of olfaction. See chapter 5 for discussion of the individuation of the chemical senses.

not present problems for the approach. Considerations of the chemical senses also provide positive contributions to our general understanding of sensorimotor enactivism, placing certain constraints on the approach and clarifying what kind of sensorimotor account should be endorsed if it is to be extended to flavour and smell.

The chemical senses have traditionally been construed as especially simple and passive senses, involving mere proximal stimulation rather than the perception of distal objects and properties. I consider two main types of argument, both of which are related to these intuitions: (1) flavour and/or smell is possible without bodily activity, and (2) sensorimotor enactivism's proposed duality between perspectival and invariant worldly features — e.g. the plate appearing elliptical from a certain perspective but also still being seen as round — doesn't apply in the case of the chemical senses. Both of these arguments, if successful, would show that the sensorimotor approach is inaccurate as a general account of perception. The first type of objection relies upon the idea that flavour and smell can occur without sensorimotor activity. The second relies upon the idea that, unlike the other senses, the chemical senses are devoid of perceptual constancies, thus not allowing for the distinction between perspectival and non-perspectival aspects of experience posited by the sensorimotor approach.

This chapter responds to these objections and argues that they fail to show that sensorimotor enactivism cannot be extended to the chemical senses. Section 2.1 discusses claims that flavour/smell can occur without skilful bodily activity. This first

objection does not present great difficulty for the sensorimotor account. As highlighted below, it targets only a specific interpretation of the sensorimotor approach, which takes current bodily activity — rather than the subject's sensorimotor understanding — to be constitutive of perception. In 2.2 I respond to (the perhaps more difficult) arguments that take our flavour and smell experiences to be devoid of the sort of duality required by the sensorimotor approach. I outline constancies in flavour and smell perception and the way that they are manifested at the level of experience as a kind of perceptual duality, discussing how this approach allows for a kind of objectivism about flavours and smells. Finally, in section 2.3, I examine the notion of *sensorimotor understanding*, which is at the heart of my responses to the objections covered throughout this chapter. Considerations of flavour and smell provide important lessons about how we ought to construe the notion of sensorimotor understanding.

2.1 Objection 1: Motionless perception

As we saw in chapter 1, sensorimotor enactivism takes perception and action to be inextricably tied together: perception is constituted by a type of bodily skill or *sensorimotor understanding.* The motionless perception objection hinges on the idea that skilful sensorimotor activity isn't necessary for certain kinds of perceptual experiences, and that sensorimotor enactivism therefore fails as a general theory of perception. These arguments claim that *motionless perception* is possible and therefore the sensorimotor approach fails. These kinds of objections have been posed against the sensorimotor

approach since its inception and have been applied even to those senses (vision, touch) that provide the paradigmatic examples upon which sensorimotor enactivism relies. Such arguments feature prominently in the commentaries on O'Regan and Noë's seminal (2001) paper *A sensorimotor account of vision and visual consciousness.*[25]

This sort of argument might seem to be especially convincing when it comes to the chemical senses. For example, in his commentary on O'Regan & Noë's (2001) paper, Humphrey (2001, p. 987) asserts:

> When we taste salt on our tongues, or smell musk in our noses … how can these experiences plausibly be thought to depend on sensorimotor contingencies? There is simply nothing we do by way of exploration with our tongues (or our noses ...) that could provide requisite information.

For Humphrey, it is clear that taste and smell can't depend constitutively upon sensorimotor skills. Taste and smell, he thinks, don't involve complex sensorimotor exploration. Prinz shares the intuition that the sensorimotor approach is particularly implausible when applied to the chemical senses: 'Consider two perfumes: they may smell different even if they do not have different consequences for action (especially if they are equally appealing). Do we sniff different smells differently?' (2006, p. 11). How could taste and smell depend constitutively upon the mastery of sensorimotor contingencies?

As an initial response to these objections, it is worth noting that olfaction and flavour

[25] See the comments from: Humphrey, 2001; Niebur, 2001; Nusbaum, Skipper, & Small, 2001; O'Brien & Opie, 2001; Pylyshyn, 2001.

perception *do* in fact involve a rich array of bodily activities. As will be discussed in more detail in chapter 3, olfaction involves sniffing (of changing speeds and intensity), moving one's head and body to seek out odour sources, and so forth (see Mainland and Sobel, 2006 for a review of the empirical evidence showing that sniffing is a crucial component of olfactory perception; see Porter and colleagues, 2007 for a study illustrating impressive human odour trail tracking abilities).[26]

Flavour perception involves tongue, mouth, cheek and jaw movements of various kinds (as well as the motor systems involved in swallowing and respiration), inducing gustatory, retronasal olfactory, tactile and trigeminal stimulation (e.g. see Shepherd, 2015). Chewing, sipping, swallowing, etc., all involve highly complex bodily activity. Without such bodily activity, flavour perception is impoverished (Burdach & Doty, 1987; de Wijk, Engelen, & Prinz, 2003) and the movements impact the way the flavour is perceived. For example, Burdach and Doty (1987) found that without mouth movements, flavour intensity is weak. They thus suggest that retronasal olfaction is a dynamic process, and that 'mouth movements play a role in retronasal odor perception analogous to that played by sniffing in orthonasal perception' (p. 353). Retronasal olfaction can also be enhanced through more advanced tasting techniques (e.g. in the case of wine tasting) such as deliberately keeping the usual barrier between the base of the tongue and the

[26] Here I take 'sniffing' to simply refer to the inhalation of air through the nostrils. Thus, breathing through the nose involves sniffing under this conception. For further arguments for the necessity of bodily activity in olfaction, see chapter 3. For now, it suffices to note that even if it does turn out that (in some limited circumstances) smelling without sniffing is possible, this will not threaten the developmental version of the sensorimotor approach set out in what follows.

soft palate open (Buettner, Beer, Hannig, & Settles, 2001). This can be achieved by bending the head forward to stop liquid flowing into the pharynx, or by putting only a small amount of liquid in the mouth. Swallowing can enhance flavour intensity in contrast to spitting (Burdach & Doty, 1987; Land, 1996) and different chewing patterns can influence one's perception of food tenderness (Braxton, Dauchel, & Brown, 1996). Moreover, different properties of the food itself can induce distinct types of chewing activity (e.g. Foster, Woda, & Peyron, 2006; Woda, Foster, Mishellany, & Peyron, 2006).

Thus, at least in typical tasting and smelling experiences, the chemical senses do allow for complex bodily exploration of features of the environment. Moreover, it is plausible that these kinds of bodily activities are *skills* that we develop. For example, perfumers and wine tasters seem to have more refined abilities in this area than the untrained population, and are able to pick out aspects of scents and flavours that most of us miss.[27] However, it may still be the case that these senses are *less* complex and action-involving than the others, and perhaps sometimes motionless flavour and smell perception is possible. Humphrey's example of salt on the tongue may be such a case. Similarly, Young (2017) argues that olfactory science provides cases where bodily activity is unnecessary for olfactory perception (though chapter 3 challenges such claims with regard to olfaction).

[27] It might be thought that wine tasters do not really have better perceptual abilities, but only better verbal abilities to describe wine in accordance with standardised terminology. Such terminology may be set out in a linguistic tool such as the Wine Aroma Wheel (Noble, et al., 1984). However, evidence suggests that wine tasters are better able to discriminate wines even where they lack the linguistic abilities associated with formal training in wine tasting (Melcher & Schooler, 1996; Hughson & Boakes, 2001).

These objections, however, do not refute the sensorimotor approach. The sensorimotor theorist can concede that it is empirically implausible that every instance of perception requires skilful bodily activity *at that time*. Indeed, the implausibility of this has already been highlighted in the visual, auditory and tactile cases. For example, Prinz (2006) and Aizawa (2007; 2018) refer to cases of paralysis where subjects are still able to perceive. Aizawa (2007, pp. 22–24) discusses surgical patients who recalled experiences of sound, vision, pain and touch despite being under general anaesthetic and neuromuscular blockade. He concludes that 'cases of complete paralysis found in the use of neuro-muscular blockade show that perception is possible without the exercise of sensorimotor skills' (p. 24). Prinz similarly argues that '[p]erception is not impaired by spinal cord injuries that cause paralysis, by paralysis of the eye muscles or brain structures that control them, by atrophy of motor cortex in Lou Gehrig's disease, by destruction of action-control centers in parietal cortex …' (p. 10), thus (he thinks) making it implausible that perception depends constitutively upon action. For these reasons, Prinz and Aizawa argue that perception only depends *causally* upon sensorimotor activity.

Fortunately, there is a well-known response to this branch of objections. Namely, arguments relating to the apparent non-necessity of bodily activity for perception tend to rely on a specific interpretation of the sensorimotor approach. As has been pointed out elsewhere (e.g. Shapiro, 2011; Loughlin, 2014), there are different ways to interpret sensorimotor enactivism's claim and the motionless perception argument only targets the strongest of these interpretations. In particular, these problems only target an

interpretation of the claim, whereby for perceptual experience the agent must — *at that time* — deploy sensorimotor understanding by engaging in bodily activity. With a weaker interpretation, it is enough that the subject has *at some point* acquired the requisite sensorimotor understanding through bodily activity, allowing for motionless perception imbued with this kind of sensorimotor attunement. Even in O'Regan and Noë's initial (2001a) responses to comments, they clarify that '[i]t is not our claim that action is necessary for experiencing. Our claim, rather, is that knowledge of the ways movements effect sensory stimulation is necessary for experience' (p. 1015), and this knowledge does not require *current* movement. Others who have emphasised this kind of temporally flexible/dispositional sensorimotor approach include, among others, Beaton (2013), Loughlin (2014), and Myin (2016).

Endorsing this weaker, developmentally focused interpretation of the sensorimotor claim can side-step motionless perception cases. Individuals who are currently motionless can perceive because they have in the past engaged in sensorimotor exploration, allowing the acquisition of sensorimotor understanding. According to such an approach, people have engaged in olfaction and flavour perception throughout their lives, thus developing an understanding of how their motor activity will induce olfactory and gustatory changes. With this account, it may still be the case that current bodily activity (of the varieties highlighted throughout this section) is required for *some* types of flavour and smell experience. For example, as we shall see in 2.2.2, complex, temporally extended flavour and smell experiences may necessitate more extensive bodily activity. Yet, cases such as

salt on the tongue giving rise to perceptual experience while motionless are still consistent with this weaker interpretation of the sensorimotor approach.

One might wonder though if this weaker, developmental version of the sensorimotor theory is satisfactory when it comes to the chemical senses, because new-born babies exhibit responses to tastes and smells. This may lead to a suspicion that the chemical senses are simple, innate abilities rather than sensorimotor skills that develop over time. Young (2017) presents this style of argument against a sensorimotor approach to the chemical senses. I tackle this worry in section 2.3. For now, let us move on to a second, and perhaps more challenging, problem for the sensorimotor approach.

2.2 Objection 2: Flavour and smell lack constancies

With the sensorimotor approach, we detect invariances or constancies amid our changing perspectives on the world and this is what explains 'perceptual presence' — the perceived veridicality and completeness of aspects of the world, despite the limitations of our sensory access. For example, what allows us to perceive a tomato as a complete object is having an implicit grasp of how we would have to move to gain sensory access to those aspects of the tomato with which we don't have immediate sensory contact. We implicitly understand how our movements will induce sensory changes. This view requires a distinction between invariant, perceptually present aspects of the world (such as whole tomatoes), and the sensory changes that we manipulate through bodily activity. Researchers such as Gray and Tanesini (2009) and Burge (2010) have argued that the

chemical senses fail to exhibit these kinds of perceptual constancies, and thus that our experiences lack the requisite duality for the sensorimotor approach.

As explained in 1.1.2, in the case of visual perception, we often experience a contrast between invariant perceptual objects and our perspectival sensory relationship with the environment (i.e. *perspectival* properties). I can notice that a plate in some sense appears elliptical from an angle, but also perceive it as round. Objects remain constant even though our perspectives on the world continuously shift. Noë (2004, pp. 123–161) also applies this idea to colour perception, appealing to the phenomenon of colour constancy. Colour perception is explained by a grasp of how one's own movement or movement of the light source will alter the perspectival properties that one experiences. In one sense I perceive the colour of surfaces as invariant in different illumination conditions, but at the same time I notice visible variations in the apparent colour of patches of shadow or bright illumination.

Some researchers (e.g. Gray & Tanesini, 2009; Burge, 2010; Todd, 2018) have argued that the chemical senses do not allow for this kind of perception of invariances. Gray and Tanesini (2009) present a sustained attack on Noë's version of the sensorimotor approach on these grounds, taking flavour perception to provide a counterexample. While they agree that tasting is plausibly an *activity* — wine tasters learn techniques such as smelling, swilling, and gurgling (p. 725) — they reject the idea that there is a duality to the experience. There is, in their view, no dichotomy between perspectival and non-

perspectival aspects of flavour perception. Instead, flavour 'is just a matter of one kind of property' (p. 730*)*.[28]

They admit that flavour varies with circumstances, but they do not think these sensory changes are indicative of perceptual constancies. For example, they note that after a meal 'one is badly placed to appreciate the taste of things' (p. 731). However, this is, they say, an example of perception in poor circumstances, as opposed to ideal ones, rather than a case of differing perspectival properties. Thus, tasting after a meal is more like looking at things without wearing glasses, than seeing a tomato from a particular perspective (*ibid.).* They simply don't think that flavour perception involves the invariant kinds of features that, say, visual perception exhibits (invariant shapes and colours of objects, etc.). Although we might notice variations in taste among sips or bites, there is 'no equivalent for taste of the experience that the colour has also not changed' (p. 730).

Gray and Tanesini (2009) are not alone in having this intuition. Recently Todd (2018) has made similar remarks, also denying that amid flavour sensations we are able to pick out a unified overall flavour or flavour profile: 'Although from one moment to the next we may latch onto, focus our attention on any one particular component—a particular odour or

[28] Although Gray and Tanesini use the term 'taste' more frequently than 'flavour' throughout their paper and offer some discussion of the so-called basic tastes (sweet, sour, salty, bitter and umami), for the majority of the paper they are focused on *flavour* (or 'taste' in its more expansive, everyday sense). For example, they say, 'Wine connoisseurs might be able to recognize, say, a Riesling by its looks, scent and taste. But they do not experience a homogeneous Riesling-taste; instead, they immediately notice its scent of petroleum' (p. 8). This is a paradigmatic example of flavour perception, and thus, I assume they intend *flavour* perception to serve as a counterexample to the sensorimotor approach.

taste or texture—in what sense is that sensation we've latched onto *the* flavour of X?' (p. 288). Todd's (2018) primary target here is the kind of flavour realism espoused by Smith (2007; 2013b; 2015b; 2016), but many of his comments also challenge the sensorimotor approach. With Smith's proposed account, flavours are objective features of food and beverages. Smith states (here using the terms 'tastes' and 'flavours' interchangeably), 'Tastes are properties a wine has that give rise to certain experiences in us; and they cannot be reduced to, or equated with, those experiences' (2007, p. 62) and '[t]he term flavour does not describe a construct of the brain, but it is a technical term used to describe the sapid and odourous properties of a solid or liquid, including properties of its temperature and texture, as well as the power to irritate the trigeminal nerve' (2013b, p. 310). Those who wish to endorse a sensorimotor approach to flavour can agree with Smith's account of what flavours are. A sensorimotor approach to flavour and smell, much like Smith's flavour realism, takes us to access objective parts of the world through these senses. Thus, the sensorimotor approach can be taken as one way of elaborating upon Smith's realism about flavours; we access these objective flavours (i.e. the relevant 'sapid and odourous properties' of food or drink) through sensorimotor engagement with the world.

Todd (2018), like Gray and Tanesini, denies that flavour perception allows for the perception of objective, unified aspects of the world through sensory change. He argues that the temporal structure of olfactory and flavour experiences shows that there cannot

be a unified, overarching flavour/smell.[29] He believes that tasting only allows for ephemeral experiences, and denies that there is any flavour beyond this to be found:

> Whether we conceive of it as a perception-like unified impression of all the elements we've encountered while tasting, or rather as a judgement we make on reflection, it is unclear how we are to tell in advance that the temporal part we are tasting is a temporal part of the overall (future) flavour of X. Indeed, I suggest that for the case of complex objects like wine, or a meal, this question is in fact unanswerable, because there is no identifiable, unified overall flavour or flavour profile; or at least none that can be described nondemonstratively (p. 288)

These issues relating to the temporal nature of flavour perception and olfaction are discussed towards the end of section 2.2.2. For now, it suffices to note that both Todd (2018) and Gray and Tanesini (2009) argue that there is no constant flavour amid sensory change. Gray and Tanesini explicitly take sensorimotor enactivism to be false in the case of flavour on these grounds. With their construal of the sensorimotor approach (*ibid.*, pp. 2–7), an experiential duality is what evidences perceptual experience being *constituted* by an attunement to the way one's movement induces sensory changes. In the flavour case, they deny there is such a duality. This leads Gray and Tanesini to the conclusion that while sensorimotor skill is *causally* important for perception, there is a fundamental problem with the claim that sensorimotor skill *constitutes* perceptual experience. Sensations induced by movement aren't the building blocks of flavour perception, because they are all that there is to flavour perception.

[29] Todd (2018) also argues that the *affective* nature of flavour perception and olfaction shows objectivism about flavours and smells to be false. This chapter does not respond to these claims but see Smith (2007) for the other side of the debate. See also chapter 6 for discussion of affect and the chemical senses.

Burge (2010), like Gray and Tanesini (2009) and Todd (2018), presents arguments that call into question whether sensorimotor enactivism can be extended to flavour and smell. Burge's focus is perceptual constancies, which he defines as the 'representation of distal attributes, as distinguished from registration of proximal stimulation' (p. 422). Although he doesn't specifically target the sensorimotor approach, he argues that neither flavour nor smell relies upon these perceptual constancies in its operation. If successful, these arguments would demonstrate that a key tenet of the sensorimotor approach fails in the case of the chemical senses. He groups the chemical senses with other sensory systems such as capacities to sense heat and pain, and various interoceptive sensory systems such as those that affect heart regulation and vascular constriction (p. 421). He states, 'There appear to be no perceptual constancies—no traction for perceptual as distinguished from sensory psychology' (*ibid.*). Thus, there is no space for an experience of a distinction between changing perspectival properties and invariant, non-perspectival properties.

According to Burge, constancies are central to perceptual experience and for this reason taste and smell are in fact largely *non-perceptual*. The chemical senses don't allow for what he calls 'objectification' — an abstraction away from proximal stimulus, which is supposed to provide a distinction between perception and sensory discrimination. This objectification is achieved through the exercise of perceptual constancies. Where there are no constancies, Burge says (speaking of pain, but presumably intending this to extend to taste and smell) there is 'no explanatory need to invoke veridicality conditions or representational content' (p. 421). With such an approach, taste and smell allow only

proximal stimulation of sense receptors, without enabling the subject to (veridically or non-veridically) attribute these sensations to an invariant distal object/feature.[30]

In the next two sub-sections, I argue that Burge (2010), Gray and Tanesini (2009) and Todd (2018) are mistaken in claiming that the chemical senses don't involve constancies and/or the perception of invariance among sensory change. I begin by responding briefly to Burge's empirical arguments against constancies in the chemical senses, before moving on to more detailed phenomenological and empirical reasons for taking there to be perceptual constancies in flavour and smell, which can be manifested as a kind of duality in perceptual experience.

2.2.1 An initial response to Burge

The reasons Burge cites for denying constancies in taste and smell are empirical. His main concerns are based upon the character of olfactory and gustatory stimuli. He notes that the chemical blends that the olfactory system detects are changing and amorphous (p. 415), lacking the permanence required for constancies. He argues that most animals simply rely upon proximal registration of intensities on one or other side of the body to locate food/prey, which in his view does not involve perception. This kind of homing

[30] Burge does concede that the chemical senses could be supplemented with conceptualisations, allowing for a degree of objectification. For example, we think of food as having a taste beyond the gustatory stimulation we experience. However, according to Burge's account, this is not down to the senses themselves, but rather is a product of conceptual association and memory (p. 415). The operation of the chemical senses themselves is to be explained entirely in terms of functional responses to proximal stimulation. For some discussion of the role of memory in perception, see chapter 6.

activity involves a kind of 'mimicking' of direction constancy, says Burge, but lacks true representation marked by veridicality conditions (p. 424). Similar remarks apply to taste: he takes it to involve mere proximal chemical stimulation. Taste profiles that go beyond the proximal stimulation in our mouths 'do not seem sufficiently important to animal well-being to have forced evolution of constancy capacities for determining such taste profiles in gustatory systems' (pp. 415–416).

I am unconvinced by Burge's claims regarding the 'mimicking' of constancies. It is not clear how an animal's behaviours 'mimicking' direction constancy differs from the behaviours manifested by *real* direction constancies. Why wouldn't an animal making use of bilateral variance in proximal registration of intensities to uncover the invariant direction of prey count as a case of perceptual constancy? Burge suggests that the difference is that in cases of true directional constancy, distal sources of stimulation can be localised without 'serial sampling' (p. 427). It isn't clear, however, that there really is a salient distinction between olfaction and vision in regard to whether serial sampling is involved. With some approaches to perceptual experience, one might argue that visual experience is constructed of serial samples received through eye saccades. However, with the sensorimotor approach, this is not the basis of perceptual experience. As Hurley (1998, p. 430) says of vision, '[a] frozen field of view provides only impoverished information, and normal vision is not compounded of snapshot-like units but is essentially dynamic'. Although the dynamic patterns of interaction involved in olfaction differ from those in vision, with a sensorimotor approach, both emerge through an attunement to the sensory

patterns that our bodily movements can induce. Our perceptions of odours are not simply a matter of olfactory snapshots, but rather a grasp of invariances amid this sensory change. In the next section, I provide empirical and phenomenological evidence that we do experience these kinds of invariances in our flavour and smell perceptions.

2.2.2 Constancies, duality and objectivity

Gray and Tanesini (2009), Burge (2010) and Todd (2018) all agree that flavour perception involves changing sensations but dispute the idea that we also experience perspective-independent properties, with Burge and Todd also extending this diagnosis to olfaction.

Tasting involves different ways of moving the mouth and tongue, which results in different patterns of sensory stimulation. This allows the perceiver to access different aspects of the flavour. Letting chocolate melt on the tongue will result in different types of sensory stimulation than from chewing the chocolate. Wine tasters use wide-ranging techniques to detect different aspects of a wine's flavour, such as drawing air through the wine (aspirating the wine), 'chewing' the wine, swirling it around their tongue, and so on. Likewise, whether one sips, swishes or gurgles wine also will result in different patterns of sensation and adjusting one's breathing techniques and patterns of swallowing further alter the tasting experience. There is no clear sense in which the varied techniques of a wine taster are superior or inferior to one another. Sipping, swishing, aspirating and 'chewing' are all useful methods of engaging with the wine. Thus, I do not take these to be instances of 'perception in poor circumstances' versus 'perception in ideal ones'

(contra Gray & Tanesini, 2009, p. 731), but simply instances of one's changing sensory relationship with the wine[31] (i.e. *perspectival properties*, to use Noë's terminology). Importantly, though, as is argued below, there is phenomenological and empirical evidence that amid all these sensory changes, we also experience invariant flavour properties.

First, it seems that we often think and talk as though we experience an invariant flavour, beyond the sensory changes induced by our engagement with the food/drink. For example, we often think of the same bar of chocolate as having the same flavour throughout each mouthful, despite the variations discussed above. If we ask someone what a particular type of chocolate bar tastes like, it would be unusual for them to reply that 'if I let it melt it tastes one way, and if I chew it, it tastes another way.' In one sense, we are aware that if we interact with the chocolate in different ways this alters our sensory relationship with the chocolate, but in another we think of *the flavour* of the chocolate bar, as constant and as being a property of *the chocolate bar itself*. Smith (2015b) highlights that wine tasting involves concentrating on ephemeral sensations but that '[t]he whole can exhibit something untraceable to the parts, and in the case of great wines it is this holistic, elusive quality that we attend to most and that novice tasters can acknowledge through the rush of pleasure it causes.' Such comments are suggestive of a

[31] This changing sensory relationship involves gustatory, retronasal olfactory, tactile and trigeminal aspects. However, it is rarely possible to experience the contribution of retronasal olfaction as distinct from 'taste' due to the phenomenon of oral referral - the apparent *mislocalisation* of olfactory stimuli to the oral cavity (see Spence, 2016 for overview).

unified experienced gestalt beyond the changing sensations.

Empirical and phenomenological evidence of constancies provides further grounds for believing that we perceive invariant odours and flavours, alongside the sensory changes highlighted above. For example, both olfaction and flavour perception appear to exhibit constancies related to *intensity*. In the case of smell, changes in sniff vigour do not alter the perceived intensity of an odour (Teghtsoonian & Teghtsoonian, 1982). Consonant with the sensorimotor approach, when the changes to airflow rate are not under the control of the subject but are instead controlled artificially by a special device, this constancy effect does not occur. Relatedly, the rate at which a subject moves their mouth while tasting impacts the number of stimuli released by food/drink. However, according to research by Theunissen and Kroeze (1996), changes in the rate of mouth movement don't cause a subject to perceive the food's flavour as more intense. They suggest this may be a product of a kind of constancy analogous to the olfactory case.[32]

Careful examination of the phenomenology of olfactory and flavour perceptions indicates that such constancies are manifested in terms of a duality to experience (see also 4.3 for a more detailed examination of constancies in flavour perception). If I take a vigorous sniff

[32] Flavour involves very wide-ranging and complex bodily activities and involves an interplay of gustatory, retronasal olfactory, tactile and trigeminal components. Thus, even if there is a constancy relating to mouth movement speed and intensity, there will be trickier cases where it is less clear whether only one's perspectival relationship with the flavour is changing, or whether the objective flavour itself is changing. For example, by chewing food, the texture is changed, and this thereby also alters the flavour, and temperature can also cause such changes. There is not space here for a full investigation of this issue, but it is worth being aware that fully parsing out the objective flavour from the changing perspectival properties will be a complex issue for the sensorimotor theorist. See also the discussion of temporally extended flavours and odours below.

of my coffee, there is a sense in which I *can* notice a difference in odour intensity from when I take a smaller sniff. The fact that I am sampling *more* volatile particles is reflected in my perceptual awareness and the experience has a greater strength to it. However, I do not attribute this change to the coffee odour itself. It doesn't seem that the smell has become stronger; I perceive the odour itself as remaining of the same intensity between these sniffs. Likewise, if I alter my savouring activities, this may induce stronger flavour sensations, but often I do not take these changes to be down to changes in the food's flavour itself. In both cases, there is an aspect of the experience which is perspectival in that it depends upon our current bodily engagement rather than on the flavour/odour itself. Bodily activity results in different sensory relationships with the same perceptual object, and with the sensorimotor approach, it is our attunement to these sensorimotor contingencies that allows for a stable experience of the invariant, overarching perceptual objects.

Another type of constancy exhibited in olfactory experience (and plausibly also flavour, though the empirical evidence in this area is sparser) is *amodal completion*. This phenomenon is also often talked about in the literature in terms of 'filling-in', although for the sensorimotor theorist, there is strictly speaking no need to 'complete' or 'fill in' anything. The claim is that perception is constituted by an attunement to sensorimotor contingencies, rather than merely the immediate gappy sensory stimulation. When smelling an odour, we only usually detect some of the molecules typical of that particular odour, and yet are still capable of recognising the odour for what it is, such as coffee, for

example (see, e.g. Barnes, Hofacer, Zaman, Rennaker, & Wilson, 2008). This too is manifested at the level of conscious experience in terms of a duality of experience. When smelling coffee or wine, one can notice that different sniffing activity allows the detection of different aspects of the odour (perspectival properties), and yet still perceive that the odour is a wine/coffee odour. This is much like how when we see an object, although we are only in immediate contact with its facing side, our perception is as of a whole object.

Although the best evidence for this type of perceptual invariance amid change comes from the olfactory case, there is also suggestive empirical evidence in relation to flavour. In particular, manipulating expectations can induce flavour constancies. For example, consumers tend to assume rates of saltiness will remain the same across mouthfuls, and manipulating these expectations can result in a perceived constancy even if subsequent mouthfuls are less salty (Dijksterhuis, Boucon, & Le Berre, 2014). Such findings are consonant with the sensorimotor approach, according to which it is our sensorimotor expectancies that allows for these constancies. Implicit expectations about the kinds of salty sensations that will be induced through tasting give rise, on this view, to the overall constant perception of flavour.

Similar evidence of this kind of constancy comes from Woods et al. (2010) who found that an expectation of homogenous taste caused subjects to perceive sips of different drinks to be more similar, up to a point where the differences between the drinks were too great. In several trials, it was made to appear that drinks were being poured from the same jug,

creating an expectation of sameness. In these instances of homogenous taste expectation, tasters deemed these drinks to be more similar than in cases in which drinks were shown to be from different jugs. Woods et al. claim that this shows that expectations regarding flavour act to smooth out variations in taste 'within a window of taste differences' (p. 174). Plausibly, we learn that certain food types have particular flavours, and such expectations allow us to experience flavour perception as relatively constant. Woods et al. claim, 'These results lend readily to the possibility of perceptual constancy in taste' (p. 179). It may be that subjects do not have enough time to fully explore a drink's flavour when briefly sipping it. With the sensorimotor approach set out, a subject's sensorimotor expectations ensure they do not experience gappy sensory stimulation (see 4.3.2 for further discussion). Instead, one's attunement to sensory changes gives rise to a perception of homogeneity, in much the same way that visual experience presents itself as of a richly detailed scene, even though we have limited sensory information at any one time.

Sensorimotor theorists take the world itself to serve as an outside memory store, which, in the visual case, can be accessed through eye movement (and head and bodily movements) as and when required (O'Regan, 1992). This is said to give rise to the 'illusion' that we are perceiving a richly detailed world before us, despite only having immediate sensory access to certain aspects of the world. As discussed in chapter 1, this view is supported by studies on inattentional and change blindness, which suggest that the brain does not construct a richly detailed internal representation of the environment (e.g. see

O'Regan & Noë, 2001a for discussion). Surprising changes can occur in the visual scene without the perceiver noticing, despite the impression that the perceiver is seeing the whole detailed scene. Relatedly, Noë invokes the idea that the world is 'virtually present' (2004, pp. 49–52). When viewing the online version of the *New York Times,* your computer will only download one article at a time as required, rather than downloading the whole edition of the newspaper. Yet the whole paper is *virtually* present, as the whole of it is accessible. Similarly, when we see the environment, we visually connect to parts of the world when needed rather than having to construct a detailed inner representation, and thus the world is *virtually* present due to our dynamic access to it.

The aforementioned cases of amodal completion in smell and flavour directly map onto these lines of support for the sensorimotor approach. With a sensorimotor approach, our understanding of how to bring other parts of the world into view allows for this apparently detailed experience of the world. Extending this idea to the chemical senses, our understanding of how to access further aspects of a flavour or odour through additional savouring or smelling enables the experience as of a gestalt perceptual object (a notion to be cashed out in the next chapter). Plausibly, in cases where we don't already have clear flavour or smell expectations, or where our expectations are violated, it is only through a longer experience of a flavour or odour unfolding, whereby we develop new sensorimotor understanding, that we become aware of the invariant flavour/odour.

As we saw in 1.1.2, in the visual case, we often just see whole objects, and only notice our

changing perspectives on the world if we adopt a particular 'painterly' attentional stance. In the case of flavour and smell, this is likely also true. We generally simply experience the odours and flavours, and only notice our changing perspectives on these phenomena if we adopt a similar kind of attentional stance (perhaps the stance of the wine taster or the perfumer, rather than the painter). The wine taster seems to be especially adept at attending to their rapidly changing sensory relationship with the wine. For example, in describing the process and the difficulty of wine tasting, Smith (2015b) states, 'Wine tasting is exacting, requiring short but sustained feats of concentration. There is the quick, almost ephemeral, moment of sipping and swallowing a wine whose precise character may elude us at first … We must concentrate on the sensations at each stage without impeding the normal progress of the liquid across the palate by which the wine has its effect on us.'

It is also worth noting that the invariances we detect through skilful sensorimotor activity allow for a kind of objectivism about smells and flavours.[33] According to a sensorimotor approach, it is through an implicit grasp of how smelling and savouring induces sensory changes that we can perceive gestalt odours and flavours. Against Burge's claims (2010), we pick out genuine, salient patterns of invariance as we interact with the world via the chemical senses. For example, when we perceive an odour, we are perceiving real

[33] As noted above, Smith's body of work (e.g. 2007; 2013b; 2015b) sets out a related objective approach to flavour perception.

collections of volatile chemicals, and we experience it as exhibiting constancies because we pick out patterns of invariance through worldly exploration. The aforementioned constancies demonstrate that there is more to our olfactory engagement with the environment than a set of olfactory snapshots or serial samples, and similar remarks apply to flavour.

Finally, I would like to briefly address Todd's (2018) worry, mentioned in the previous section, that there cannot be an overarching, objective flavour or smell because flavours and smells themselves change and evolve over time. Todd is not explicitly targeting the sensorimotor approach, but rather an objectivism about olfaction and flavour experience (e.g. see Smith, 2015b) that takes there to be a unified flavour or smell beyond the changing sensations. However, it should be clear that this worry targets the sensorimotor approach to the chemical senses. A similar challenge has been posed against the sensorimotor approach in relation to temporally extended *sounds* (Clark, 2006), and has been responded to by Noë (2006a). Whether similar responses can be made in defence of a sensorimotor approach to the chemical senses has implications for the viability of extending the approach.

Recall that Todd (2018) argues that the temporal nature of flavour perception and olfaction presents a problem for there being an overarching, unified flavour or smell. He argues that odours are intrinsically temporal,

> not merely in that they change through time, but in that they can develop through time. They change, trivially, in coming into being (and into awareness) and fading away; but they can also develop in taking on new properties, dimensions, or aspects. An odour may start off as sweetly floral and then take on sharper floral or citrus aspects (p. 287).

While I do not think this kind of description applies to all the odours we encounter (or even the majority of them), I agree that this captures the phenomenology of the perception of some complex odours. Some scents do change significantly over time rather than merely fading away. A perfume may have a refreshing top note that is evident when the fragrance is first applied, before blending into an aromatic middle note, which eventually trails away into a sustained, heavier base note. These different aspects of a fragrance can be gradually revealed one by one. Other scents are simpler — there is not much of an olfactory trajectory when it comes to the smell of a lemon or a rose.

Contra Todd (2018), however, the existence of complex scents and flavours that evolve over time is not at odds with there being an overarching flavour or smell. The overarching flavour and/or smell is temporally extended and may exhibit an objective trajectory, and this trajectory is something that one's perceptual investigations can uncover. Noë discusses this issue in relation to the perception of sustained sound-streams: '[Y]ou hear them as having a certain trajectory or arc, as unfolding in accordance with a definite law or pattern' (2006a, p. 29). Our sensorimotor attunement can extend to such trajectories — through a grasp of such arcs, the changes to sound-streams can become perceptibly present, along with the more constant aspects of the sound-streams (such as the timbre or volume). Perceiving the structure of these auditory trajectories requires skilful

engagement and a degree of familiarity. For example, Noë notes that we may struggle to perceive unfamiliar, experimental music as anything more than 'mere noise' (p. 31), but once we become familiar with a style of music, we are better able to perceive the acoustic trajectory's structure and complexities.

Some complex flavours and odours also follow these kinds of arcs. For example, Smith (2015b; 2016) argues that wines have a temporally extended, dynamic flavour profile, and 'the wine has that evolving flavor independently of each moment of tasting' (2015b). Likewise, the way that an odour evolves to allow top notes to morph gradually into middle and then base notes is, importantly, not equivalent to the fleeting sensory changes we experience by detecting different aspects of a flavour or smell. Such flavours and odours unfold in a definite manner (and in the case of perfumes and wines, this may be carefully planned out by the designer of the fragrance or the wine-maker) rather than mapping onto nebulous sensory changes as we engage in tasting and smelling activities (involving different mouth and tongue movements, or rates and intensities of sniffing, for example). In the case of these evolving, complex flavours and smells, more temporally extended perceptual engagement will likely be a requirement in order to fully perceive the overall flavour or smell profile. Simpler flavours and odours will be perceptible through a lesser degree of extended tasting and smelling, in part because there is not the same degree of change over time to uncover. This is unsurprising given the phenomenology of our flavour and smell experiences: it seems that I can perceive the unified odour of lemon very quickly (because of my pre-existing sensorimotor understanding, according to the view set out),

whereas to perceptually make sense of the evolution of a complex perfume, I may need to engage in more temporally extended smelling activity.

In sections 2.2.1 and 2.2.2, I responded to the worries of Gray and Tanesini (2009), Burge (2010), and Todd (2018) by outlining the ways which the chemical senses allow for the perception of invariant, objective aspects of the world. Now we move on to some further challenges for the sensorimotor theorist. The idea that we can perceive unified odours and flavours through a mastery of sensorimotor contingencies presents some puzzles when we consider how the chemical senses develop. In the next section, I consider how the notion of *sensorimotor understanding* ought to be understood if we are to allow for a sensorimotor account of the chemical senses.

2.3 Developing sensorimotor understanding and the chemical senses

Sensorimotor understanding is crucial to my responses to the argument about the chemical senses lacking constancies and the motionless perception argument. Motionless perception is possible only where one has already developed the requisite sensorimotor understanding, and sensorimotor understanding allows for the perception of constancies amid sensory changes. In this section I discuss how the chemical senses can inform our conceptualisation of sensorimotor understanding.

Recall that in 2.1 I suggested that the sensorimotor theorist could side-step arguments about motionless perceiving by relying upon a kind of developmental argument. It can be

argued that subjects have already acquired the relevant sensorimotor understanding to be able to perceive odours/tastes, even in the current absence of the motoric elements of smelling/tasting. Once we have an implicit understanding of how bodily movements will induce sensory changes, we need not *actually* perform these movements. The sensorimotor approach must rely on *counterfactual* sensorimotor understanding. We experience the whole tomato as present, even without moving to look at the back of it. Similarly, having a tastant placed on the tongue may allow a perceptual experience because we have certain expectancies about how, if we *were* to move our jaw or tongue, this would cause certain types of sensory changes. This counterfactual sensorimotor understanding is supposed to develop over time. And this developmental notion of sensorimotor understanding allows the sensorimotor theorist to draw on the empirical evidence from the cases such as Bach-y-Rita's tactile vision substitution systems (TVSS) and vision reversing goggles discussed in chapter 1.[34]

Recall, a number of sensorimotor theorists have drawn upon the example of TVSS (e.g. Noë & O'Regan, 2001a; Noë, 2004; Hurley & Noë, 2003). TVSS devices are composed of a head-mounted camera, which sends signals to a matrix of electrodes or vibrators attached to the subject's skin or tongue. The electrodes/vibrators produce patterns of stimulation that correspond to changes in the visual information received by the camera. Initially, users of such devices only experience tactile stimulation, but after a period of adaptation

[34] See Hurley, 1998, chapter 9 for detailed discussion of these cases of adaptation, along with other relevant developmental results.

they begin to have vision-like experiences. However, it was found that only subjects who were allowed to actively move around — and thus learn how their movements induced particular sensory effects — experienced this vision-like perception. They must reach a certain level of proficiency in using the device before they have such experiences. Again, this supports a developmental interpretation of the sensorimotor claim: perception is something that we learn to do over time. Cases of adaptation to vision inverting goggles, which distort the way the light enters the eyes, also suggest that we become attuned to sensorimotor contingencies over time (eg. Noë, 2004, pp. 8–10).

However, this developmental approach may seem to pose a problem for the sensorimotor theorist when applied to the chemical senses. Evidence suggests we can perceive olfactory qualities from a very early stage in our development, which has led to suspicion of the developmental notion of sensorimotor understanding. In particular, Young (2017), arguing that olfaction is a problem for the sensorimotor approach, asserts:

> …the developmental line of reply will not help in this instance, as the olfactory system is on-line and allows us to perceive the olfactory qualities of odorants as neonates if not in utero… (p. 106)

There is a potential inconsistency between the developmental version of the sensorimotor approach required to alleviate the motionless perception worry and the apparent olfactory abilities of neonates. Young's idea is that olfaction cannot be something we develop over time as a sensorimotor skill because even neonates can smell. He cites studies that relate to the fact that new-born infants turn their heads towards the

smell of their mothers' breast milk (e.g. Stein, Ottenberg, & Roulet, 1958). The objection is implicitly premised on the notions that (1) neonates are able to smell but (2) they have not engaged in the relevant sensorimotor activity that would be required to develop perceptual skills according to the sensorimotor approach. There is reason, however, to question both of these premises, but doing so places certain constraints upon the notion of sensorimotor understanding.

2.3.1 Neonates and the developmental line of argument

New-born babies have apparent olfactory abilities: they turn their heads towards the smell of their mothers' breast milk (e.g. Stein, Ottenberg, & Roulet, 1958), and show specific responses to the smell of their own mother's breast milk in contrast to a control breast milk odour (Sullivan & Toubas, 1998). As noted above, Young (2017) thinks this shows the developmental version of the sensorimotor approach to be false, since (1) neonates are able to smell but (2) neonates have not had the opportunity to develop sensorimotor understanding. There is scope to challenge either one of these premises. The sensorimotor theorist can: a) reject the first premise by denying that the neonate is actually perceiving, or b) reject the second by taking sensorimotor understanding to be something that must be learned from experience, but take sensorimotor learning to have already begun in utero.[35]

[35] A further option not discussed here would be to take (a degree of) sensorimotor understanding to be innate, so (at least some) perception need not be learned from experience.

Contra Young's first premise, it is questionable whether neonates' responses to breast milk odours are truly perceptual. It has been suggested that lactating mothers' breast secretions may contain a particular stimulus, which is a candidate human pheromone. It is thought to be this specific stimulus to which neonates respond (see Wyatt, 2015 for review). All babies respond to areola secretions with suckling and nipple search behaviour, and it is doubtful whether such responses can truly be said to based on olfactory perception.[36] If this is not a perceptual phenomenon, the sensorimotor approach is not threatened by apparent neonate olfaction, and it remains a possibility that smell (and, perhaps also flavour perception) is a skill developed over time after birth. Moreover, if neonates are unable to engage in olfactory perception, this would appear to further bolster the idea that perception is a skill developed over time, even in the case of the 'simple' chemical senses. However, it may perhaps still be the case that neonate responses to areola secretions are on a continuum with olfactory perception, even if they themselves aren't perception-based responses.

If it turns out that neonates are engaging in (at least a rudimentary type of) genuine olfactory perception, Young's second premise can instead be challenged. It may be that a degree of sensorimotor learning can occur in utero, allowing for some rudimentary perceptual abilities from birth. Numerous flavour and smell eliciting compounds are present in amniotic fluid, and after around six months of gestation, foetuses actively

[36] I am grateful to an anonymous reviewer of the paper based on this chapter for their helpful comments on this issue.

inhale this fluid as they mimic breathing motions (Schaal, Marlier, & Soussignan, 1998). This allows them to obtain chemosensory information in a manner similar to orthonasal olfaction. Towards the end of gestation foetuses also swallow amniotic fluid, which mimics certain tasting behaviours. Thus, while foetuses do not seem to engage in genuine smelling (since their nostrils are full of fluid), they do engage in activity closely connected to our tasting and smelling behaviours. While this idea requires further empirical investigation, it is far from clear that neonate olfactory and gustatory abilities present an immediate problem for the sensorimotor approach.

Evidence suggests certain sensory abilities, beyond the case of taste and smell, begin to develop in utero. For example, research suggests that foetuses also develop a basic understanding of their own bodily behaviours, gaining tactile and proprioceptive abilities. Foetuses engage in self-touch, and they display a sensitivity to their own bodily movements. Using four-dimensional ultrasound (which takes 3D images of foetal movements over time), researchers have found that from 19 weeks, foetuses are able to (in some sense) anticipate their own hand-to-mouth movements.[37] They open their mouths before their hands make contact, suggesting these movements cannot be mere accidents, and that they have some kind of understanding of the associated sensorimotor contingencies (Myowa-Yamakoshi & Takeshita, 2006). From 22 weeks, foetuses' reaching

[37] This doesn't directly support prenatal sensorimotor learning with regard to the *chemical senses* but does support the more general claim that sensorimotor skills can be developed in utero (in this case, in relation to proprioception and tactile sensation).

movements show the characteristic kinematic patterns of intentional actions (involving distinctive acceleration and deceleration phases depending upon the target of their movements), involving motor planning (Zoia, et al., 2007). For example, when moving to touch fragile parts of their bodies, such as their eyes, they will move more slowly. Motor control is an ongoing process of learning that is evident even at the prenatal stage.

Neonates' apparent olfactory responses therefore do not rule out sensorimotor enactivism's claim that perception is a skill. Whether they have truly perceptual olfactory abilities is questionable, but even if their responses do indicate a kind of rudimentary olfactory perception, this may be based upon prenatal learning. The work surveyed above suggests that olfactory activity begins as a very minimal ability, perhaps not even classifiable as perception or as the sense of smell as we know it. At the other end of the scale are highly trained perfumers and wine tasters, who have the ability to (in some sense) smell things that most of us cannot. Wine experts have greater discriminatory (Solomon, 1990) and identificatory (Marino-Sanchez, et al., 2010) abilities than novices, detecting distinctions between flavours with greater accuracy than non-experts and demonstrating more refined abilities to describe and identify smells.

2.3.2 How should we understand sensorimotor understanding?

We have seen that flavour and smell don't present a problem for the sensorimotor enactivist, and in overcoming various challenges, I have outlined the beginnings of a plausible sensorimotor approach towards the chemical senses. The preceding discussion

also places certain constraints upon the notion of sensorimotor understanding. Sensorimotor understanding is supposed to be an implicit, practical understanding of how our movements give us sensory access to different aspects of the world. It cannot require that the subject is making current, actual movements because of the motionless perception cases discussed above, so it must be counterfactual species of understanding.

Sensorimotor theorists deny that sensorimotor understanding is an intellectual or propositional kind of knowledge of the world; instead it is supposed to be a type of know-how — an understanding of how to act and access different aspects of the world. However, despite these proclamations, sensorimotor theorists have been criticised for being inconsistent in whether they flesh out this notion in a non-cognitivist, or a more cognitivist and intellectual, manner (e.g. Hutto, 2005). If it turns out that pre-natal olfactory and gustatory learning occurs, this adds weight to the claims that sensorimotor knowledge should not be treated as an intellectual or propositional kind of know-that. And even if one rejects neonate perception and prenatal sensorimotor learning, the chemical senses are often considered more primal and simple than the supposed 'higher senses' like vision. Extending the sensorimotor approach to the chemical senses thus bolsters the idea that sensorimotor understanding does not require propositional knowledge (it is hard even for human adults to describe their flavour and smell experiences in propositional form).

It may be puzzling that a simple type of practical attunement, potentially even manifested

by babies, could still be counterfactual in the sense required by the sensorimotor approach (e.g. see Silverman, 2018). However, many paradigmatic cases of practical understanding involve a sensitivity to counterfactual states of affairs. For example, one might know how to play the piano. This involves a kind of sensitivity to the different notes that will be produced by hitting each key. Likewise, knowing how to ride a bike involves a practical, and yet counterfactual, understanding of the effects of pedalling, changing the gears, pulling the break, and so on. Knowing how to ride a bike and how to play the piano are kinds of practical knowledge: they are abilities to engage in an activity in a way that is sensitive to the impact that different types of movements would have. Similarly, knowing how to access different aspects of the environment involves a sensitivity to the sensory stimulation that will be induced by bodily movement.[38]

While there is much work to be done in the provision of a fully fleshed out sensorimotor account of smell and flavour, we have seen throughout the preceding discussion how perceptual constancies in the chemical senses can be appealed to in service of developing a sensorimotor account. An ability to act in a way that is sensitive to sensorimotor contingencies can allow for the perception of unified, gestalt odours and flavours (notions to be fully cashed out in the next two chapters), alongside more transient sensations. Moreover, there is something objective about these unified gestalts; we detect genuine

[38] Here I am in agreement with Silverman's (2018) interpretation of the sensorimotor approach. He argues that we ought to construe sensorimotor knowledge as an ability to act in a way that is sensitive to sensorimotor contingencies (p. 165).

patterns of invariance through our sensorimotor engagement. Constancies in the case of the chemical senses, such as amodal completion, directly parallel the sensorimotor claims about the world serving as an external memory store, and the world being 'virtually present'. We only ever have limited immediate sensory contact with odours and flavours, but other aspects are present as accessible to the perceiver. Those who are convinced by such claims in the visual domain ought to recognise that analogous perceptual phenomena are occurring in the case of flavour and smell.

Having argued that the chemical senses do not present a problem for the sensorimotor approach, in the next chapter, I begin the positive task of setting out a phenomenologically adequate account of the chemical senses. I elucidate the notion of 'perceptual objecthood' and the applicability of this concept to olfaction.

3. Smelling objects[39]

3.0 Introduction

Objects are central to perception and our interactions with the world. We perceive the world as parsed into discrete entities that instantiate properties, and these items capture our attention and shape how we interact with the environment. For example, our visual experience divides the world up into clearly distinguished, meaningful units like flowers, dogs and chairs. The objects we perceive are key to our understanding of the world; concepts, beliefs and desires relating to objects are ubiquitous. However, to understand the nature of these entities, we need to uncover the criteria for perceptual objecthood. What conditions must be fulfilled for something we perceive to be an *object,* as opposed to, say, a range of nebulous, unbounded *properties*? And could the sense of smell allow the perception of discrete objects?

Philosophers have claimed that compared to visual perceptions, olfactory experiences are 'smudgy' (e.g. Batty, 2010a) and do not involve the perception of discrete objects. Rather, they only allow for the perception of either nebulous olfactory properties (Matthen, 2005) or objects in a very weak sense. These weaker object-based approaches include a non-phenomenological variety of objecthood from Lycan (1996; 2000) and an existentially quantified variety from Batty (2010a; 2010c; 2011; 2014a; 2014b), whereby all olfaction

[39] This chapter is an adapted version of my paper of the same name (Millar, 2017), published in *Synthese*.

allows us to perceive is an undifferentiated *something or other* in one's vicinity that instantiates properties (Batty, 2010a). This chapter argues against such views in favour of a robust kind of olfactory objecthood. We experience odours as discrete units that bear properties and retain their identities through perspectival change. I argue that figure-ground segregation (which underpins object individuation) and perceptual constancies (which, I claim, underpin various object recognition skills) are individually necessary and jointly sufficient for this type of objecthood. Paying attention to Gestalt psychology, the role of bodily movement and tactile stimulation in olfaction, and olfactory phenomenology, I argue that these criteria apply to the olfactory case.

The structure of this chapter is as follows. Section 3.1 provides background on the debates surrounding the issue of perceptual objecthood. Section 3.2 offers two empirically tractable criteria for assessing whether discrete perceptual objects are exhibited in a given perception — susceptibility to figure-ground segregation and perceptual constancies. While the importance of these aspects of object perception has been highlighted elsewhere, I offer a novel argument for the claim that they are individually necessary and jointly sufficient for objecthood. Section 3.3 argues that both figure-ground segregation and perceptual constancies are exhibited in olfactory perception. First, in 3.3.1, I argue in favour of a kind of non-spatial figure-ground segregation in smell. Drawing analogies with the other senses, I suggest that the Gestalt grouping principles — thought to govern how features are grouped together and segregated from everything else within the perceptual field — can provide valuable evidence for a non-spatial form of figure-ground segregation

in olfaction. In 3.3.2, I argue that contrary to majority opinion, that there can also be *spatial* olfactory figure-ground segregation. To see this, we need to look to empirical evidence showing that tactile stimulation and bodily movements play a crucial role in olfactory phenomenology. Finally, in 3.3.3, I highlight a number of perceptual constancies exhibited in olfactory experience, considering both olfactory phenomenology and empirical research.

3.1 Background

The notion of perceptual objecthood that is of primary concern in this chapter is a robust phenomenological sense of objecthood: single, discrete entities exhibited in our experience that nonetheless exhibit many distinct properties. For example, in the case of vision, when we perceive a flower, we perceive it as a single object, despite it consisting of a long green stem, petals of different colours and so forth. This relies on our capacity for *object individuation* — perceptual systems can discern that groups of features belong to the same individual. Another crucial aspect of perceptual objecthood is that we perceive objects as remaining constant amid changes in our own perspective, movements of the objects themselves and, within limits, as they change over time. As Rüdiger von der Heydt says in a recent review article, 'One characteristic of perceptual objects is continuity (object permanence). When an object is briefly occluded by a foreground object and then reappears, it is perceived as the same object. A token seems to persist' (2015, p. 6). Likewise, O'Callaghan tells us that 'objects perceptibly persist and survive changes' (2016,

p. 1273). This apparent persistence of an object is closely connected with our *object recognition* abilities (see section 3.2.2 for discussion of the connection between perceptual constancies and object recognition), which are considered important aspects of object perception. Object recognition encompasses abilities such as tracking objects, perceiving them as complete objects despite occlusions or the limitations of our particular perspective (amodal completion), and perceiving them as persisting through time.

As discussed in chapter 1, the Gestalt psychologists uncovered an array of principles that appear to govern when we perceive worldly features as grouped together. Examples of this include: the 'law of common fate', which states that we tend to group together elements that move together; the laws of similarity and proximity, which say that features perceived as similar and/or in close proximity are more likely to be perceived as grouped together into objects; the law of closure, which says that features are more likely to be perceived as grouped if they are part of a closed figure; and the overarching law of good form or 'Prägnanz', which says that we tend to group together elements that are coherent, balanced, simple and so forth (Wertheimer, 1923/1938). Researchers have found that many of these regularities apply not only to visual perception but also perceptions via other senses, such as audition (e.g. Bregman, 1990) and touch (Gallace & Spence, 2011). This motivates some of the discussion of perceptual objecthood because there are significant similarities in how we perceive and parse the world via our different senses, suggesting that there may be a notion of objecthood applicable to non-visual perception. Here I aim to find non-visuocentric necessary and sufficient conditions for a

robust notion of perceptual objecthood. Gestalt principles such as *similarity* and *proximity* as formulated by Wertheimer, are not themselves suitable for this because they are defeasible and seem to be neither necessary nor sufficient for object perception.[40] However, as section 3.3 argues, they still provide strong evidence of figure-ground segregation.

Although a number of researchers have considered whether we perceive objects through non-visual modalities such as audition (e.g. Kubovy & Van Valkenburg, 2001; Griffiths & Warren, 2004; Matthen, 2010), taste (Stevenson, 2014), and smell (for detailed discussions see Lycan, 1996; Batty, 2010a; 2011; 2014a; 2014b; Carvalho, 2014; Young, 2016),[41] most discussions of objecthood still centre on the visual case, which is often taken to be paradigmatic of object perception. Perhaps this is in part because in the visual case these perceived objects are mainly ordinary, three-dimensional objects. When we look at a red ball, rather than merely seeing features such as redness and roundness, we can perceive these features as belonging to an object that is red and round. Yet even in the visual case, perceptual objects are a broader category than everyday objects like balls and flowers. O'Callaghan (2016, p. 1274) argues that we see items such as shadows and rainbows in an object-like way even though they aren't ordinary material objects. We still see such items as being, like the ball, spatially arrayed in our visual field and as exhibiting

[40] This defeasibility perhaps excludes the law of Prägnanz, which instead faces the problem of being left too intentionally vague to itself provide satisfactory necessary and sufficient conditions. Moreover, as I shall argue, objecthood also requires constancies in addition to grouping/segregation.
[41] See also briefer remarks on such issues from Peacocke (1983) and Matthen (2005).

(relatively) clear boundaries, and as persisting over time and as we move around. Thus, an adequate phenomenological account of objecthood ought to allow for such cases.

The challenge of providing a satisfactory account of objecthood is even more pronounced when considering the sense of smell. In contrast to the visual case, it is controversial whether we perceive olfactory objects *at all.* Our olfactory perceptions are unlike our visual perceptions in that they don't seem to present us with items with clear, sharply distinguished edges. Thus, it is not immediately clear whether olfaction could allow the perception of discrete objects, and as we shall see, there is little consensus on this issue.

Moreover, there are a number of potential complications in arguing in favour of olfactory objecthood. For example, an initial problem is to decide what sort of objects we could perceive via olfaction. As discussed in chapter 1, most researchers of olfaction endorse what has been called the 'odour view' (Richardson, 2018). This is the view that it is odours, and not source objects, that are immediately perceived through the sense of smell (e.g. see Lycan, 1996; Batty, 2010a; Richardson, 2013; Young, 2016 for discussion). There are two main reasons for this. First, we can smell a rose scent, for example, without having to be in the direct vicinity of a rose, and a rose scent may persist after the rose itself is removed or destroyed. It is also possible to give rise to a rose scent artificially — say, through a rose-scented air freshener. It would be strange to say that our perceptions in such cases are non-veridical because of the lack of an actual rose. Thus, the most common view among those who endorse an object-based account is the immediate objects that

we perceive through olfaction are *odours,* rather than source objects. It is sometimes added that we can still indirectly perceive the source objects *via* the perception of the odour (Lycan, 1996; see also Cavedon-Taylor, 2018 for a review of these issues). While the issue of whether source objects are represented in olfactory perception is important in determining the *intentional* objects of olfaction, here my concern is whether we immediately perceive odours as *objects* in a phenomenological sense (to be spelled out in section 3.2). My claim is that for odours to count as objects in this sense, they must be perceived as discrete entities, which instantiate properties and survive shifts in perspective. I remain neutral on the question of whether olfaction may also involve an indirect representation of source objects and take these issues to be orthogonal to the discussion here. For the purposes of this chapter I assume that the odour view is correct (though for some challenges to this position see Aasen, 2018). This assumption is shared in the key literature that I discuss throughout this chapter (e.g. Lycan, 1996; 2000; Wilson & Stevenson, 2003; 2006; 2007; Batty, 2010a; 2011; 2014a; 2014b; Carvalho, 2014). While this isn't the primary purpose of the arguments here, this chapter also provides a further reason for endorsing the odour view. Namely, as will become clear, it is *odours* rather than the source objects that are subject to olfactory figure-ground effects and constancies.

A second, related complication is that even if we agree that it is odours rather than source objects that we directly perceive through olfaction, there is some debate on the nature of these odours. For the purposes of this thesis, I follow philosophers such as Lycan (1996)

and Roberts (2015) in taking an odour to be a molecular cloud of volatile particles, which may instantiate olfactory properties such as smokiness, sweetness, and so forth. I shall not discuss the nature of odours further (see Cavedon-Taylor, 2018 for an in-depth discussion), but it is worth noting that not all parties in the debates about olfaction share the same idea of what an odour is.

The theorists that I discuss in detail in this chapter all endorse world-directed accounts of olfaction. However, this is itself somewhat controversial and some philosophers have claimed that our olfactory experiences may be merely sensational; i.e. olfaction only makes us aware of properties of our own experiences rather than properties of, or objects in, the world. One clear example of this comes from a brief but suggestive remark from Peacocke: 'a sensation of…[smell] may have no representational content of any sort, though of course the sensation will be of a distinctive kind' (1983, p. 5). As we saw in chapter 2, Burge also argues that the chemical senses are non-perceptual. Others have claimed that the phenomenology of olfaction is in accordance with the sensation-based view, even if the sensation-based view is inaccurate for other reasons (e.g. Lycan, 1996). With a sensation-based view, we do not perceive objects or worldly features in the case of olfaction because sensations are not world-directed.[42] Most researchers, however, seem keen to accommodate olfaction in world-directed accounts of perception, rejecting

[42] As noted in 1.1.4 if olfaction is not perceptual, the sensorimotor approach may not apply since it purports to be a theory of *perceptual* experience.

the sensation-based view.[43] There have been several different world-directed approaches to olfaction.

The first world-directed approach to smell is the *feature-based* view. Those that endorse this approach concede that olfaction is world-directed but claim that what we olfactorily perceive are not *objects* but only *properties* or *features* (see Matthen's brief discussion of olfaction in 2005, pp. 284–285 for such an account). We don't smell the fruitiness, smokiness and maltiness of a coffee as bound together, but instead simply perceive these properties, free of any object. Matthen says that smells, 'have, at best, a *primitive* — that is, an undifferentiating — feature-location structure — every smell of which I am aware is simply here' (p. 284). He adds that olfactory content 'does not come in object-attribute form' (*ibid.*). This sort of feature-based approach has also traditionally been dominant within olfactory science, where the primary goal has been to understand olfaction by identifying how different features of a chemical stimulus are represented in olfactory experience.[44] However, the tides are turning in the olfactory sciences and an object-based approach to olfaction, advocated by Wilson and Stevenson (2006; 2007), has recently gained in popularity. Wilson and Stevenson (2006) argue that an object-based approach can make sense of a growing body of data from neurobiology and psychology. In particular, they think an object-based approach better accounts for the behavioural

[43] Here I use the term 'world-directed' to refer to any theory of perception that takes worldly entities to be accessible or represented through our experience. This would cover relationalism (such as the direct realism often attributed to the sensorimotor approach) as well as varieties of representationalism. I intend my discussion in this chapter to be neutral between these different approaches.
[44] See Wilson and Stevenson (2006) for an in-depth discussion of this model of olfactory experience.

evidence and for the need to perceive biologically salient groups of odorants amid changing olfactory stimulation (p. 1892).

Among the object-based approaches to olfaction, there are wide ranging views. First is the abstract view, endorsed by Batty (2010a; 2011). This view is similar to that of Matthen (2005), but allows for a weak, *existentially quantified* form of olfactory objecthood. For Batty, olfactory experience only ever involves the representation that there is *something or other* in one's vicinity, instantiating olfactory properties. She argues that we never attribute olfactory properties to *particular* objects, and there cannot be any object individuation in the case of olfaction. A coffee smell and a lemon smell perceived concurrently won't be experienced as individuated objects but simply properties instantiated by something or other 'here'. In this chapter, I argue in favour of a much stronger notion of olfactory objecthood — one in which smelling does allow us to parse the olfactory world into individuated objects. We perceive *particular* (rather than existentially quantified) olfactory objects.

Lycan (1996; 2000) also endorses a weak variety of olfactory objecthood. For Lycan, there are olfactory objects in the sense that our olfactory experience represents odours — and an odour is 'a vaporous emanation, a diffusing collection of molecules typically given off from a definite physical source… they are public physical entities available for sensing by anyone who happens, fortunately or unfortunately, by' (1996, p. 91). Like Batty, however, he does not allow for the representation of discrete objects in experience. His account is

based upon the idea that taking olfaction to represent odours — public physical entities — allows us to best account for the olfactory correctness conditions discussed above; an experience of a rose smell is veridical just in case there is a rose odour in one's vicinity, regardless of whether there is also a rose nearby. Yet he thinks that this sort of world-directed object perception is not apparent on phenomenological grounds. In fact, he thinks that 'phenomenally speaking, a smell is just a modification of our consciousness, a qualitative condition or quale… in us, lingering uselessly in the mind without representing anything' (1996, p. 90). In what follows, I argue in favour of a kind of *phenomenological* objecthood in olfaction — we perceive odour objects that exhibit figure-ground segregation and perceptual constancies.

Both the feature-based and weaker object-based approaches are largely motivated by the apparent paucity of spatial information associated with olfactory experiences, as compared to other senses. Vision — which is taken to provide the paradigmatic example of object perception — allows us to differentiate objects and understand their spatial relations with one another and to our own bodies. We see objects as spatially extended and bounded entities, arrayed within the visual field. In contrast, among theorists on all sides of the debate regarding olfactory objects, there is a common suspicion that olfactory perception is aspatial (e.g. Lycan, 2000; Wilson & Stevenson, 2006) or spatially undifferentiated (Matthen, 2005; Batty, 2011; 2014b; Carvalho, 2014). Carvalho (2014) and Wilson and Stevenson (2006) agree that smell is aspatial, but think that it is possible to perceive individuated objects in a non-spatial manner, while theorists such as Batty

(2010a; 2010c) and Matthen (2005) treat spatial differentiation as a prerequisite for object individuation. This idea that spatiality is key to object individuation is quite intuitive given the primacy of vision within perceptual research; in vision, we segregate objects based on spatial locations and their spatially situated edges. Thus, if olfaction fails to be adequately spatially differentiated, this may give prima facie credence to a feature-based or a weak object-based approach (although as we shall see, there are legitimate non-spatial types of figure-ground segregation).

Some such as Carvalho (2014) and Wilson and Stevenson (2003; 2006; 2007) offer stronger accounts of object perception, taking olfactory experience to present to us particular odour objects individuated on the basis of their chemical structure. While my own view is more closely aligned with these approaches, both Carvalho and Wilson and Stevenson agree with Batty and Lycan that olfaction does not allow for spatial discrimination of odours, and as we shall see, their arguments for the individuation of odours are alone insufficient to counter Batty's objections. In what follows, I argue that odours can be individuated both in an aspatial manner based on Gestalt grouping principles and in a spatial manner when we take into account the role of bodily movement and tactile stimulation for olfactory phenomenology.

Finally, there have also been criticisms that target the whole dispute between the different object-based and feature-based approaches. Theorists such as Cooke and Myin (2011) and Barwich (2014) argue in favour of more *process-driven* approaches, accusing

philosophers such as Batty and Lycan of taking the phenomenal character of perceptions to be in some way independent of the processes that give rise to these experiences, a view that Barwich and Cooke and Myin call the *Independence Thesis*. Allegedly, those guilty of endorsing this thesis tend to assume that sensory perceptions can be understood as static, autonomous units, whose properties may or may not be correlated to the properties of physical objects. Barwich (2014) argues that we can understand olfaction without recourse to perceptual objects or properties of objects, paying attention instead to olfactory processes. This thesis does not address such views in detail, but in section 3.3.2 I illustrate how we can take insights from such approaches, while still endorsing an object-based account.

In what follows, I oppose the feature-based views and the weaker object-based views of Batty and Lycan and argue that there are perceptual objects in olfaction in a robust sense. Olfaction allows the perception of *particular* objects, rather than merely an existentially quantified *something or other* in one's vicinity. I begin by providing necessary and sufficient conditions for this robust phenomenological sense of objecthood before showing that these criteria are fulfilled in olfactory perception.

3.2 Necessary and sufficient conditions for objecthood

This section argues that figure-ground segregation and perceptual constancies are each necessary for the perception of particular (rather than merely existentially quantified) objects, and that they are jointly sufficient. As mentioned above, discrete objects exhibit

boundaries and are able to survive changes in our own perspective, as they move and (to some extent) over time. These phenomenological features of perception involve abilities to discern the boundaries of objects (this falls under the category of *object individuation*) and to recognise objects across different viewing conditions and in different contexts (abilities that are central to *object recognition* in ways I discuss below in 3.2.2). Whether these abilities are accounted for in one's theory of objecthood is a useful test for determining whether we have adequate phenomenological criteria for object perception. Regardless of whether one endorses the sensorimotor approach outlined in the previous chapters, the phenomenology of experience ought not be wholly disconnected from the skills involved in perception.

Figure-ground segregation is the defining feature of the ability to perceive boundaries (object individuation), while perceptual constancies allow perceived objects to appear invariant across different perspectives and amid changes (underpinning various object recognition abilities). First, let us consider figure-ground segregation.

3.2.1 Figure-ground segregation

'Figure-ground segregation' refers to our ability to distinguish figures from backgrounds. This figure-ground structure is central to our visual experiences: we perceive, for example, houses against a background of the sky, and books against the background of a desk. We are unable to take in a whole detailed scene at once due to the limitations of our perceptual access to the world, so we attend to a particular figure or set of figures at a

given time, relegating everything else to background. We perceive these backgrounds as relatively undifferentiated and less determinate than the figures themselves.

It has been suggested by Kubovy and Van Valkenburg (2001) that susceptibility to figure-ground segregation is the defining feature of perceptual objects; it is both necessary and sufficient for the perception of objects (p. 102). Those features of the world that become *figures* for us are perceptual objects. A number of other researchers have agreed that figure-ground segregation is central to the perception of particular objects, and have used this criterion to argue both for (e.g. Wilson & Stevenson, 2007; Carvalho, 2014) and against (e.g. Batty, 2011; 2014b) the idea that olfactory experience could allow for objects in this sense. Part of Kubovy and Van Valkenburg's motivation for taking figure-ground separation to be the defining feature of objecthood is to provide a non-visuocentric account of perceptual objects. Research suggests that figure-ground segregation is exhibited in non-visual types of sense perception, such as auditory experience. For example, audition researcher Bregman claims that hearing involves the parsing of auditory scenes into distinct auditory streams (1990) — which can be understood as a kind of boundary allocation — and studies show that listeners are unable to pay attention to more than one sound stream at a time, which is also indicative of figure-ground segregation. One such study by Bregman and Campbell (1971) found that perceivers were unable to judge the order of sounds presented in a repetitive cycle where these sounds were experienced as two distinct streams. Participants were presented with three high-pitched sounds (ABC) and three low-pitched sounds (123) in the order A–1–B–2–C–3.

However, the majority of participants experienced the order as either A–B–C–1–2–3 or 1–2–3–A–B–C as they were only able to pay attention to one stream at a time; one stream at a time is experienced as a figure against a background. As I discuss in section 3.3.1, this suggests that figure-ground segregation need not be a spatial feature of perception and can be applied to non-visual senses such as audition.

Kubovy and Van Valkenburg are right to avoid a visuocentric notion of perceptual objecthood given important similarities in how we perceive the world through different senses — e.g. both vision and audition involve figure-ground segregation, Gestalt grouping principles, and so forth. Figure-ground segregation is at the heart of 'object individuation', and a successful phenomenological account of object perception should highlight the importance of this capacity. Figure-ground segregation allows us to make sense of the idea that perceptual objects are discrete and have *boundaries*. In fact, figure-ground segregation is both necessary and sufficient for the exhibition in experience of boundaries (which, as suggested by the auditory case above, need not be spatial): if there is figure-ground segregation, there must be boundaries allowing the separation of the figure from background. Likewise, if we perceive something as having boundaries, this entails that we perceive it as segregated from everything else around it. Boundedness and figure-ground segregation are two sides of the same coin. Boundedness (and thus, figure-ground segregation) is certainly necessary for a robust sense of perceptual objecthood that goes beyond the mere representation that there is something or other with olfactory properties in one's vicinity, but it is less clear that it is also sufficient. For full-blown

perceptual objecthood we also need to recognise the object as persisting through change, which as we shall see, is crucial for object recognition. As mentioned, the standard notion of perceptual objecthood involves the idea that these entities can — at least to some degree — survive shifts in our own perspective, movements of the objects themselves and certain changes over time. I do not think that figure-ground segregation alone gives us this.

Here are two cases in which it seems that figure-ground segregation applies, but where there isn't full-blown object perception. First, imagine the experience of standing under a railway bridge, looking up at its underside as the train passes by overhead.[45] You perceive flashes of light through the gaps between the tracks as the carriages pass by. These flashes of light stand out to us against a background of the environment under the bridge. However, these flashes do not seem to be perceived as perceptual objects, but merely as differences in lighting that jump out in our experience. I do not think we ought to include these flashes as examples of perceptual objects, because if we were to do so, our notion would be extremely weak and wouldn't correspond with any normal usage of the term 'object'. The notion of objecthood that I am interested in here is one that involves both object individuation and object recognition abilities — the two sets of skills considered to be at the heart of object perception. Perceiving the flashes doesn't appear to involve object recognition abilities such as tracking, amodal completion or the perception of them

[45] With thanks to Alistair Isaac (personal communication) for providing this example.

as persistent. Thus, nor does it involve perceptual constancies — the flashes aren't perceived as invariant across changes in perspective, but they are merely transient figures that capture our attention.

A second example in which there seems to be figure-ground segregation without perceptual objecthood is the experience of an after-image following the perception of a bright light. After-images appear segregated from everything else we experience, allowing for figure-ground segregation. However, they don't present themselves to us as objects in the world, but instead seem overlaid on our visual field, lacking phenomenal objectivity. They continue to appear to us in whichever direction we look. Hence, we do not perceive after-images as invariant amid changing sensory stimulation, because no matter how one's perspective varies, after-images do not provide different sensory input.

Figure-ground segregation is thus not sufficient for perceptual objecthood; there are counter-examples to such a theory. Kubovy and Van Valkenburg's criterion for perceptual objecthood (susceptibility to figure-ground segregation alone) is too weak to capture an important aspect of the perception of objects — the perceived entity's ability to survive changes of perspective and in the object itself. Adding the criterion of the exhibition of constancies provides a more robust and useful notion of objecthood, which better encapsulates what is generally meant by the term, i.e. something that persists, which we can track, and so forth. Recall O'Callaghan's assertion that 'objects perceptibly persist and survive changes' (2016, p. 1273). Now we turn to the second criterion for perceptual

objecthood: the exhibition of perceptual constancies.

3.2.2 Perceptual constancies

Contra Kubovy and Van Valkenburg (2001), in my view the exhibition of *perceptual constancies* is also necessary for the perception of objects. Perceptual constancies are the invariances we perceive amid changing sensory stimulation. For example, I can perceive the invariant size of an object even if my perspective changes, giving rise to a duality to the experience. Consider Peacocke's (1983, p. 12) well-known example of seeing two trees of exactly the same size, one of which is further away than the other. There is a sense in which one of the trees *looks bigger* in that it takes up more space in the visual field, but there is another clear sense in which the trees are perceived as the same size. The perceiver sees the observer-independent size of the trees. Similarly, Noë (2004, p. 78) observes that although a plate, in *some sense*, looks elliptical from an angle, the viewer also perceives the objective roundness of the plate. In fact, these observer independent properties are generally much easier to attend to than perspective-dependent appearances; when I look at a plate, it takes some effort to notice the elliptical appearance. A novice artist may struggle to recreate the lines and angles required for an accurate drawing of the plate, and may simply draw it as a round circle. We are able to detect patterns and invariances as our perspective on the world shifts. Perceptual constancies are a requirement for coherent object perception. Part of what it is to perceive an object is to recognise it as the same object from different perspectives. Without such an ability, our perceptions would be extremely confusing — as soon as we

moved our eyes, the world around us would appear to change.

Object recognition encompasses a range of skills that are closely connected to these perceptual constancies. It includes capacities to recognise invariance amid change along with semantic categorisation. It involves the ability to recognise tokens of the same type (for example, one might see two tomatoes and recognise a kind of sameness among them) and also the ability to perceive objects as the same token object from one moment to the next. Thus, skills such as tracking, etc. are taken as object recognition abilities. This aspect of object perception has been emphasised by a number of olfaction researchers (e.g. Wilson & Stevenson, 2003; 2006; 2007; Batty, 2010a). Batty's abstract view takes there to be something akin to object recognition in the case of olfaction, even though there is no object individuation.

Perceptual constancies underpin various object recogition abilities such as tracking, perceiving an object as persistent, and amodal completion. They are needed to perceive an object as maintaining its identity moment to moment, or to categorise objects as belonging to a particular type. Consider an example of tracking an object: I watch a car driving down the street. As I do so, the shape of the car projected onto my retina continually changes as it moves past and different aspects of the car come into view. Despite all of these dramatic perspectival changes, I do not perceive the car itself as changing shape or the colour of the car as changing when the sun reflects off different parts of it. I perceive the car as an invariant three-dimensional object of a particular colour

moving in a particular direction. Without these constancy effects, it is not clear that we could track the object amid the flux of changing appearances. Likewise, it seems that these constancies are crucial in perceiving the object as persisting over time. I perceive the car as remaining the same object over time, even as my eyes move and I walk around, and as I see different aspects of the object.

Amodal completion can be construed as a variety of perceptual constancy (as suggested in the previous chapter). In vision, amodal completion is the perception of an object as complete even though it is not entirely visible. As in the previous cases, this seems to involve an ability to go beyond the immediate sensory evidence to perceive the overall shape of an object. We are presented with a world of whole, invariant objects rather than simply the facing sides of objects with which we are in direct sensory contact. Noë (2006b) notes that when one looks at a tomato, although one is only in direct sensory contact with its facing side, 'The visual experience of the tomato, when one takes it at face value, presents itself to one precisely as a *visual experience as of a whole tomato*' (p. 413, italics in original). This is a case of amodal completion, and one that, according to Noë, depends upon our expectancies regarding how different aspects of the tomato would come into view if we were to change our perspective; our grasp of constancies enables the perception of whole objects despite the limitations of our perspectives. Burge (2010, p. 417) notes that in both tracking cases and amodal completion cases we 'perceptually anticipate' that which is not strictly speaking present to our senses. This also suggests a commonality with the constancy cases discussed above. Just as we can perceive the round

shape of the plate even though this involves a kind of extrapolation from the immediate sensory evidence, we are able to perceive the tomato as whole even though we cannot strictly speaking see all of it at once. Thus, amodal completion is plausibly a special case of our ability to perceive constant aspects of the world — the object is perceived as having an invariant, complete shape despite our sensory limitations. As we saw in 2.2.2 and will be reiterated in 3.3.3, something similar applies in the case of olfaction.

While perceptual constancies are closely connected to object recognition, there are some aspects of object recognition that I am hesitant to include as necessary for object perception. For example, object recognition is often also taken to involve implicit object memories — the ability to recognise (at least implicitly) that an object is of the same type as a previously experienced object. While object memories are able to influence the way we categorise objects and seemingly can even influence figure-ground assignments (e.g. Peterson & Gibson, 1994; see chapter 6 for discussion), raising interesting questions about how object recognition and object individuation are interlinked, this aspect of object recognition does not itself appear to be necessary for the perception of objects. After all, if this were the case, it would not be possible to perceive novel objects of which the subject has no prior memories. Thus, it is the perceptual constancies that underpin object recognition abilities that are necessary for the perception of objects, rather than (all aspects of) object recognition itself. Perceptual constancies are required for achieving the initial perception of a coherent object along with feats of recognition such as tracking, persistence, and amodal completion.

Perceptual constancies have been observed across other modalities and are intimately tied to the notion of perceptual objects across the senses. Researchers have, for example, found various constancies exhibited in auditory perception. It has been observed that the perception of sound streams involves the phenomenon of *timbre constancy* (e.g. Bregman, 1990; Isaac, 2017). Bregman points out:

> A friend's voice has the same perceived timbre in a quiet room as at a cocktail party. Yet at the party, the set of frequency components arising from that voice is mixed at the listener's ear with frequency components from other sources. The total spectrum of energy that reaches the ear may be significantly different in different environments. (1990, p. 2)

We recognise invariance of timbre even though there is also a sense in which we hear something quite different in a cocktail party and in a quiet room. Another example is highlighted by Matthen (2010), who, drawing on the work of neuroscientist and musician Daniel J. Levitin (2006), notes that melodies retain their identity even if they are played in a different key. We recognise the sameness of the melodies amid changes. Thus, Matthen takes them to be analogous to the three-dimensional objects we perceive through vision and describes them as a type of auditory object.

Such perceptual constancies are a necessary condition for object perception. As noted, without such constancies, we would not be able to recognise an object as persisting amid change. We would merely experience a barrage of changing sensations rather than coherent objects. Thus, if it turns out that olfactory experience does not exhibit such constancies, smell cannot involve the perception of objects in a robust phenomenological

sense. However, perceptual constancies alone are not sufficient for the perception of objects as there are types of perceptual constancies that apply to *properties*, which may not be instantiated by a particular perceived object. In particular, colour constancy may occur in cases where we do not perceive an object. One such case is provided by Kennedy (2007), who suggests that where someone is engulfed in fog, although their experience presents to them a uniform, undifferentiated colour, there may still be cases of colour constancy.

> The blue as it is presented to me in a Ganzfeld fog could seem a bit thicker or smoother while still appearing to be the same color. In this sort of case, the color character of my experience changes, but I still seem to be aware of the same color. One's experience in a color-constancy Ganzfeld-case would have a significant phenomenological similarity to one's experience of an object's color as constant (p. 315).

The experience of the fog doesn't present itself as of an object, and doesn't exhibit figure-ground segregation, but it can still involve perceptual constancies.

If a perception involves both boundaries (figure-ground segregation) and constancies, this will be a case of full-blown object perception in a phenomenological sense. The joint exhibition of these features in perception ensures that the putative object is perceived as discrete and bounded, and that it can survive changes in one's perspective and movements of the object itself. This is a much stronger notion of objecthood than the non-phenomenological notion offered by Lycan and the weak existentially quantified variety offered by Batty, allowing for the perception of particular objects rather than merely some-or-other undifferentiated object. Using these conditions enables a robust,

non-visuocentric notion of perceptual objecthood, which avoids the counterexamples faced by Kubovy and Van Valkenburg's (2001) theory. Thus, plausibly susceptibility to figure-ground segregation and perceptual constancies are *jointly sufficient* for the perception of particular objects, as well as individually necessary. If I am right, then demonstrating that these features of perception are exhibited in olfaction would show there to be *olfactory objects* in a robust sense.

3.3 Does olfaction fulfil the criteria for perceptual objecthood?

Here I argue that olfactory experiences often exhibit both figure-ground segregation and perceptual constancies — and thus, we perceive discrete objects through olfaction. As we have seen, figure-ground segregation and perceptual constancies are each necessary for this kind of perceptual objecthood, and so, if either is missing from olfactory experience, this would show that we do not perceive olfactory objects in a robust phenomenological sense. If there are perceptual constancies but not figure-ground segregation, this would allow for Batty's weak abstract variety of object, but not allow the perception of particular objects.

This section begins by looking at whether there is a figure-ground structure to olfactory experience. I argue that there can be a type of non-spatial figure-ground segregation in olfaction (3.3.1), based on the Gestalt grouping principles, which have been used to provide evidence for perceptual grouping and segregation in vision and audition. Secondly, I argue that there is also a form of spatial figure-ground segregation that applies

in the case of smell (3.3.2). Section 3.3.3 focuses on perceptual constancies, which are also required for full-blown objecthood. I recap the empirical research and evidence from olfactory phenomenology (also briefly discussed in 2.2.2), which suggest that there are least two types of perceptual constancy exhibited in olfactory experience, and thus, that olfaction does involve perceptual objects.

3.3.1 Figure-ground segregation in olfaction: an aspatial notion based on Gestalt principles

While there has been research into audition suggesting that figure-ground segregation can occur in a temporal, rather than spatial, manner (Bregman, 1990), the phenomenon is often still described in explicitly spatial terms. For example, Batty (2014b) asserts, 'In those types of experience in which we think of figure-ground segregation as achieved—vision, audition and touch, for example—we do so on the basis of the richness of its spatial representation' (p. 10). Visual experience provides a paradigmatic example of this kind of rich spatiality, presenting us with clearly bounded, spatially arrayed objects that we distinguish from each other and from the background. Olfaction doesn't ostensibly do this and as mentioned above, many researchers consider olfaction to be aspatial or spatially undifferentiated (Lycan, 2000; Matthen, 2005; Wilson & Stevenson, 2006; Batty, 2011; 2014b). It therefore remains highly controversial whether olfaction achieves figure-ground segregation.

Researchers that have argued in favour of olfactory figure-ground segregation include

Wilson and Stevenson (2006; 2007), Carvalho (2014) and Young (2016). Wilson and Stevenson (2006; 2007) and Carvalho (2014) have broadly similar accounts of olfactory figure-ground segregation. They suggest that we should understand figure-ground segregation in smell as being an ability to perceive an individual odour against a background of other odorants. Carvalho says: 'for one of these odors to be experienced as such, as the odor that it is, the olfactory system needs to be able to extract a very complex blend against a background of irrelevant odorants and competing olfactory objects' (2014, p. 63). For example, intuitively, when I walk into a coffee shop, I can perceive a unified coffee odour despite there also being a complex blend of odorants from cleaning products, food, perfume and so forth. We perceive the coffee as a 'unitary percept' (Wilson & Stevenson, 2006), which then stands out against the other odorants in the air. Batty takes these sorts of arguments to rely on the idea that the coffee odour has 'experiential prominence' (2014a; 2014b) and argues that her own approach is equally well-placed to explain the experiential prominence of the coffee smell.

Recall, Batty believes that olfactory experience is just too 'smudgy' to involve bounded, discrete objects. Rather than particular objects, olfactory experience only allows the perception of olfactory properties instantiated by some-or-other object 'here' in one's vicinity. She takes 'here' to be an undifferentiated location, claiming that we do not distinguish where the smell is instantiated from where it is not (2010a, p. 9). The content of olfactory experience is thus indexical (in that odours are experienced as 'here') and abstract in the sense that rather than representing particular objects they simply

represent 'that there is something or other here with certain properties' (Batty, 2011, p. 170). She takes olfactory experience itself to be silent on which odour instantiates which olfactory property (since she denies there is object individuation in olfaction). If one can smell coffee and perfume, for Batty the experience will merely report that it smells perfumey and coffee-like here (see 2010, p. 534; 2011, pp. 166–167). If certain aspects of one's experience are especially prominent (say the coffee smell sticks out to the perceiver over the perfume smell), for Batty, this will be a case of experiential prominence, which need not be understood as a kind of figure-ground segregation. This could merely be a case of certain properties being experienced as more prominent than other properties of some-or-other object, and this could be explained in terms of attention/expectation, or the mechanisms of learning and memory, without the need to attribute figure-ground effects and discrete objects to the experience (2014a, p. 237). Thus, Batty claims that her abstract view is, prima facie, equally well equipped to explain our olfactory experiences.

If Batty is right, how ought we decide whether olfactory perception involves figure-ground segregation? It appears that relying upon experiential prominence, as Wilson and Stevenson (2006; 2007) and Carvalho (2014) do, will alone not suffice to establish this. As mentioned, much of the motivation for object-talk in perception is the interesting set of commonalities among our perceptual processes and the entities we perceive as grouped. The Gestalt psychologists uncovered a range of principles that govern when we perceive stimulus features as bounded and discrete (and thus exhibiting figure-ground segregation). These principles may be useful in determining whether figure-ground

segregation is exhibited in the olfactory case because if they apply, this would suggest that groupings and segregations analogous to those in the other senses are occurring. A robust notion of olfactory figure-ground segregation ought to bear a resemblance to the way separations of figure and ground occur in the other senses, especially as people's intuitions on this point seem to differ a great deal.

The Gestalt psychologists placed phenomenal experience at the heart of their approach to the mind. They believed that we do not first experience disjointed sensations, but rather an organised field of structured wholes, segregated from their fields, and sought to uncover stimulus features that determine how the perceptual field is organised. Recall that Wertheimer (1923/1938) outlined aspects of a stimulus that influence perceptual organisation, giving rise to a range of grouping principles such as similarity, proximity, common fate and good form (the law of Prägnanz). For example, in the case of the principle of similarity: items that are similar in colour, shape, texture, etc. are more likely to be visually grouped. The Gestalt psychologists found that these grouping principles exerted a significant influence on the way that people perceive visual displays (e.g. Wertheimer, 1923/1938), and it has been found that all of these principles are also applicable to auditory perception (e.g. Bregman, 1990).

If olfaction only allowed the perception of nebulous properties (Matthen, 2005) or merely the weak sense of existentially quantified objecthood advocated by Batty, olfactory experience would not involve structured wholes segregated from their surroundings. If,

however, the Gestalt principles of perceptual organisation apply to the objects/features we perceive through smell, this would be a good reason for describing olfaction as exhibiting figure-ground segregation. It would demonstrate clear similarities to the pre-established notions of visual and auditory figure-ground segregation and would suggest that perceptual organisation in olfaction occurs in ways analogous to the other senses. In fact, there is evidence that, even disregarding any potential spatial import in olfactory experience, several of these principles apply.[46]

Principle of Similarity: The principle of similarity states that we tend to group similar aspects of a stimulus together. There are some issues in assessing how we are to determine whether items are *similar,* but generally it is assumed that parts of a stimulus that, for example, share the same colour or shape are more similar (at least in these respects) than those that don't (see fig 1.2). For example, in the case of vision, two red dots are more likely to be grouped into a structured whole than a red and a blue dot. These sorts of specific cases of similarity are taken to be instantiations of a broader

[46] Other Gestalt principles may well also apply in the olfactory case, but there is limited research in this area. The principle of common fate says that we are more likely to perceive elements that move together as being grouped. Bregman (1990, p. 249), however, suggested that this principle can be expanded to include elements that *change* together in proportional and synchronous ways. He says that would show this principle to be applicable to audition, in cases where, for example, two frequency components changed synchronously by proportional amounts and were therefore likely to be perceived as grouped. Olfactory experiences, like auditory ones, rely heavily on the temporal extension, unfolding over time in important ways. It would be interesting to see if something analogous occurs in the case of smell. It is plausible that experiencing odours as changing in a synchronous manner would result in a greater likelihood of grouping, but as far as I am aware there is no research exploring this issue. The applicability of at least some of the principles does, nevertheless, add empirical support to the view that olfaction involves figure-ground segregation.

principle of similarity.[47] There is evidence that something analogous is applicable in the case of olfaction. Research shows that mixtures of similarly smelling components are more likely to be perceived as having unified, novel olfactory qualities than mixtures of dissimilar components. In cases where the components smell dissimilar it is generally easier to individuate them and perceive them as separate than in the cases where the individual odorants smell similar (Wiltrout, Dogra, & Linster, 2003; see Young, 2016 for further discussion). This seems to be an instance of perceptual grouping based on similarity and lends weight to the idea that figure-ground segregation occurs in olfaction.

Principle of Proximity: Another of the Gestalt Principles is the law of proximity, which states that elements that are closer together are more likely to be perceived as grouped (see fig 1.3). Generally, in the visual case, this is simply measured by manipulating distances between aspects of the input image. For example, studies show that dots that are clustered closely together are more likely to be perceived as grouped together into a unified figure (e.g. Compton & Logan, 1993). In audition, Bregman (1990) suggests that

[47] These kinds of simple visual examples have the potential to be misleading. In the case of grouping together dots, the individual dots may *themselves* be perceived as figures against a background in some cases (presumably based in part on further grouping principles), but they are also often perceptually combined into larger perceived objects. Thus, it may be ambiguous whether we perceive an individual dot as a figure against a background or the larger grouping of dots as a figure (perhaps like cases of bi-stable figure-ground perception such as Rubin's 'vase-or-face' image, which can be perceived according to two distinct figure-ground interpretations; see Fig. 6.1). In many cases, however, there isn't such an ambiguity. Plausibly, part of the reason we perceive a tomato as a unified, bounded object is because of the similar shades of red across different parts of it. In such cases we don't perceive one patch of the tomato as itself a figure against a background, even though it may be possible to attend to one patch of it. Likewise, in the case of olfactory grouping by similarity, the perception is of a unified odour, and even if it may be possible in some instances to attend to different aspects of the odour, these aspects don't seem to be segregated from the whole. Thanks to an anonymous reviewer of the paper on which this chapter is based for prompting clarification on this issue.

an analogue of this is separation in time (p. 19). One manifestation of this principle in audition is that concurrent onset of sounds provides a good indication that they are members of the same stream, while different start times can signal different streams (O'Callaghan, 2008, p. 822). Separation in time seems to also be relevant in the olfactory case, as there is evidence suggesting that (as in audition) concurrent onset of olfactory stimuli increases the chance of our perceiving them as belonging together. Studies show that in multimodal flavour-smell interactions, simultaneous onset makes them more likely to be integrated (Pfeiffer, Hollowood, Hort, & Taylor, 2005; Stevenson, 2014). While this hasn't been directly tested in the non-multisensory olfactory case, it is very plausible that something similar would apply. I take this to be indirect evidence of the law of proximity applying in the case of olfaction.

Principle of Prägnanz/*Good Form*: Finally, it is worth considering the principle of good form or 'Prägnanz' — an overarching Gestalt principle that is often said to encompass the other grouping principles. This states that we are more likely perceptually group together assemblies of parts that are coherent, balanced, simple, and so forth. We generally group together elements into the simplest and most internally coherent figures that are compatible with the available sensory information. Intuitively, *good form* is something that can be achieved in the olfactory domain. Perfumery provides an example of this and suggests that good form aids in the grouping of odours. Perfume manufacturers seek to develop well-balanced fragrances, combining top, middle and base notes to obtain a *perfume accord.* An accord is a blend of notes that produces a harmonious odour, in which

the notes lose their individual identity and are perceived as unified. Perfume accords are plausibly bounded and segregated from other scents, and good form seems to be an important factor in achieving this. The balance, harmony and internal coherence exhibited by these accords is crucial to the perception of a unified scent.

These examples highlight that several of the Gestalt principles apply in the case of olfaction, influencing whether we perceive olfactory features as unified and discrete. This doesn't look like mere experiential prominence but rather, olfactory experience seems to be organised in ways analogous to in the other senses. Thus, there is good reason to apply the notion of figure-ground segregation to olfactory perception. Importantly, if the evidence I have provided does indicate that the several of the Gestalt principles apply to smell (thus providing evidence for figure-ground segregation), they seem to apply in a non-spatial manner. In the next section, I argue that in addition to this type of figure-ground segregation, olfaction also exhibits a form of *spatial* figure-ground segregation.

3.3.2 Figure-ground segregation and the spatiality of olfaction

We have seen that there are reasons to think that, as in the auditory case, there is a non-spatial form of figure-ground segregation in olfaction. However, some researchers have rejected the idea of non-spatial figure-ground segregation, suggesting that the notion should be reserved for instances of spatial discrimination (which is usually thought to preclude olfaction). Batty (2014b) argues that we need a spatial account of figure-ground segregation in order to make interesting comparisons between human and non-human

olfactory perceptions. In particular, it is clear that some animals have a *directional* sense of smell. Batty notes that the hammerhead shark's sense of smell enables it to immediately turn in the direction of the source of a blood odour (p. 10). Moreover, its nasal cavities are far apart, giving it a stereo sense of smell. According to Batty, the shark's sense of smell can rightly be said to involve a kind of (spatial) figure-ground segregation, while ours cannot. She says, 'If we are to account for the difference between us and the hammerhead, then, we require the spatial notion of figure-ground segregation' (*ibid.)*. This ability to immediately detect the direction from which the blood arrives is, she claims, analogous to our ability to detect the location of a sound in audition (*ibid.*).

Batty's argument is primarily pragmatic; it is based on the alleged utility of reserving the term 'figure-ground segregation' for spatial types of perception. Extending the term to non-spatial cases, she thinks, threatens its usefulness in accounting for differences between varied types of perception (such as human olfaction and that of the shark). As we have seen, Bregman (1990) and others have claimed that there are important notions of figure-ground segregation that aren't reliant on spatial features, allowing us, for example, to make sense of how we perceive distinct sound streams. While audition does, as Batty notes, enable us to spatially locate objects and events in the environment, it also appears to be governed by a myriad of Gestalt grouping principles that are heavily reliant on temporal and non-spatial features. These principles provide evidence of non-spatial figure-ground effects in audition. Furthermore, we have seen that at least some of these Gestalt principles apply to olfaction also. Nevertheless, even if one were to reserve the

notion of figure-ground segregation for spatial cases, we will see that it can still apply to olfactory experience. Thus, here I also disagree with Wilson and Stevenson (2006; 2007) and Carvalho (2014), who think only non-spatial figure-ground segregation occurs in olfaction, and others such as Lycan (2000) and Matthen (2005) who reject any kind of figure-ground segregation in olfaction. In what follows, I respond to Batty and argue that spatial olfactory figure-ground segregation is at least sometimes achieved. To see that olfaction does provide us with spatial information, we need to first understand that bodily activity is required for olfactory experience and that tactile inputs can give rise to olfactory phenomenology (see also discussion in chapter 2).

A clear sense in which olfaction involves (a minimal kind of) bodily movement is through the act of sniffing. Empirical research demonstrates that the act of inhalation is necessary to have any olfactory experience whatsoever. Proetz (1941) highlighted the necessity of airflow through the nostrils by pouring a solution of eau de cologne into the nostrils of his students, noting that this did not give rise to an olfactory perception: 'Although it obviously reaches his olfactory area he will not detect the odor' (p. 366). Further evidence for the necessity of the inhalation comes from Bocca, Antonelli, & Mosciaro (1965), who intravenously injected odorants into subjects. Odorants were delivered to the epithelium via the blood stream, but subjects did not perceive any odour except for when they sniffed and breathed normally through the nose. Thus, the act of inhalation is crucial for olfactory experience, with some taking the sniff to be 'as integral to olfactory perception as the eye movement is to visual perception' (Mainland & Sobel, 2006, p. 1). In addition, evidence

suggests that multiple sniffs are needed to differentiate odours (Mainland & Sobel, 2006). Thus, we ought to acknowledge the role of this kind of temporally extended olfactory exploration in considering whether figure-ground segregation is achieved.

Active sniffing also appears to offer us more spatial information than has generally been supposed. A conservative endorsement of spatiality in olfactory experience comes from Richardson (2013). She argues that the act of sniffing causes us to perceive smell in an *exteroceptive* manner: we perceive odours as being brought *into* the nose from the *outside*. In this way, smell differs from bodily sensations like pain, for example. Richardson doesn't think that distance and direction are represented in olfactory experiences, claiming that they are more akin to the tactile experience of a breeze blowing against your face: 'One is not aware of some distance that the air that touches your face has travelled. But nevertheless, it does seem as if the breeze is coming to the body from somewhere beyond it—from without' (p. 411). Although Richardson may be correct that distance is not represented in such cases, I think the analogy highlights (contra Richardson) that we *can* learn about direction from air blowing into your face. Wind might hit my left cheek, but not my right cheek, giving me information about which direction it is coming from. Something similar might hold in certain cases of olfaction.

In fact, Roberts (2015) uses this line of thought — and a similar example — in arguing in favour of spatial content in olfaction. He asserts:

> Firstly, consider that some odours arrive on the breeze, and are experienced as such. Directional ventilation can add a dimension of spatial content that is missing in olfactory encounters with static air, permitting the subject to smell where an odour is coming from. A scent that is carried by a current that is felt upon the left hand side of one's face can, plausibly, be perceptually localised to that direction… (p. 9)

The example of odours carried on a breeze seems to show that there can be directional content in olfaction (for further arguments in favour of directional content in olfactory experience see Aasen, 2018). This goes beyond the exteroceptivity that Richardson highlights, illustrating the beginnings of a more robust account of spatiality in olfaction.

As well as the case of odours arriving on a breeze, empirical studies indicate that we can gain some directional information through smelling by stimulation of the trigeminal nerve (Kobal, Van Toller, & Hummel, 1989) — a nerve involved in activity such as chewing and responsible for (what are usually considered to be) tactile and pain sensations in the face. Participants can discern whether odours are on the left or right if they involve elements such as cooling, warmth or pressure sensations. It might be protested that these directional experiences aren't truly olfactory, given the involvement of trigeminal or, (as in the breeze case) other types of tactile stimulation. However, as Roberts (*ibid.*) points out, it seems to be a mistake to think that there is ever 'pure olfaction' devoid of input from the other senses (p. 19, fn. 17; see also Richardson, 2013, section 6.3). As we have seen, plausibly the act of smelling *always* involves bodily movement in the form of the sniff,[48] which like the experience of a breeze hitting us, involves a degree of tactile

[48] Though see Young (2017) for arguments to the contrary.

stimulation. If we agree with Richardson that our olfactory experiences are exteroceptive, this seems to crucially involve the experience of the inhalation of air through the nostrils. This exteroceptivity is a vital aspect of olfactory phenomenology, but one that depends upon tactile input.

Likewise, many smells rely on trigeminal stimulation for their perceived quality. For example, the *cool* scent of menthol, the *pungency* of ammonia and the *acridity* of burning rubber are all reliant on trigeminal stimulation. Yet these do seem to be features of odours, we detect them by sniffing, and they seem to present themselves as olfactory properties. Our experiences of these properties seem to undermine the idea that we can neatly carve off olfactory phenomenology from tactile phenomenology. It might be thought that considering anosmia, where patients have lost their sense of smell, would allow us to isolate the trigeminal from the olfactory aspects of experience. However, in fact this doesn't provide a clear way to separate the two because anosmia also comes with a decrease in trigeminal sensitivity (Hummel, et al., 1996), illustrating the tight connection between olfactory and trigeminal stimulation in smell. Trigeminal stimulation is ubiquitous in our normal olfactory experiences and the vast majority of odorants also stimulate the trigeminal nerve (e.g. Wysocki et al., 2003).

There have also been interesting experiments demonstrating that humans have a capacity for tracking odour trails. Porter, et al. (2007) show that we are in fact able to track odour trails using smell alone (participants were blindfolded, given sound-blocking earmuffs

etc.).[49] Accuracy dropped significantly when the subjects had one nostril taped up, and when a device was used to combine airflow so both nostrils received the same information. This suggests that our bilateral nostrils play a role in the spatial information derived from olfaction: 'Here we find that mammals performing a scent-tracking task, freely able to move their nose and sample the olfactory environment in real time, reap added benefit from sampling via their two spatially offset nostrils' (p. 29).[50] They conclude that we are able to spatially localise odorants. In this case, it is very plausible that the subjects experience the scent trail as a figure against a background — a case of olfactory figure-ground segregation that is achieved spatially. Whether we move our bodies to seek out the scents that we inhale, or whether the air is brought to us on a breeze, we can garner spatial information from olfaction.

Now we are in a position to re-consider Batty's (2014b) shark example. Batty infers a spatial type of perception from the shark's abilities, taking hammerhead sharks to have a

[49] Again, some researchers are likely to argue that this isn't an example of 'pure' olfaction. Lycan, who, as I have mentioned, claims olfaction is aspatial, would disagree with this account of spatial content in olfaction because he thinks that spatial information derived from sniffing while moving our heads or bodies wouldn't count as spatial content from *olfaction itself* (personal communication). His focus is only on whether there is spatial content in smell when we don't move around (i.e. synchronic perception). However, once we recognise that some bodily movement is a requirement for having any olfactory experience whatsoever, it is a small step to accept that ordinary olfactory experience involves exploratory sniffing. We move our heads towards roses to smell them, we move away from bad smells, we lift the coffee cup towards our noses to smell its odour, and so forth.

[50] Based on this research, a possible experiment to test the role of sensorimotor understanding in olfaction would be reverse the olfactory input received by each nostril, in much the same way that experiments involving reversing goggles are used to support the sensorimotor approach for vision. If olfaction were then noticeably distorted for the subject, the sensorimotor approach would predict an adaptation of their olfactory experience and associated behavioural dispositions as they became attuned to the new sensorimotor contingencies.

directional sense of smell because they have the ability to immediately turn in the direction of the source of a blood odour, for example (p. 10), as well as noting that their offset nostrils allow stereo smell. Yet Batty's 'abstract' account of human olfaction requires that we assess the phenomenology of a motionless perceiver. She says: 'If we bracket information gained from movement and any other sensory modality, and consider olfactory experience at-a-time, then we see that any locatedness of these properties—other than simply "here"—goes as well' (2010a, p. 9). As we have seen, the idea that olfactory properties are simply instantiated 'here' is central to her account, highlighting that she believes that bracketing off movement and information from the other senses is the correct approach to understanding human olfaction. Batty says, '[I]t would be strange to conclude that the hammerhead's olfactory experiences are to be evaluated according to one notion of figure-ground segregation, while ours are not' (2014b, p. 10). However, human scent tracking also involves differential stimulation of the nostrils and Porter, et al.'s research seems to suggest clear similarities in the perceptual abilities of humans and sharks. Participants in the study moved their heads in such a way as to follow the odour trail, from which we can infer the sort of spatial phenomenology that Batty claims is the preserve of non-human animals. Thus, there doesn't seem to be a reason to accept evidence for figure-ground segregation from a shark's abilities but not from those of a human. If the hammerhead shark's sense of smell is said to involve figure-ground segregation, it seems that (at least) in certain circumstances human olfaction does so too.

In fact, a key role of olfaction is to spatially localise the sources of odours, and exploratory

sniffing also allows us to track the direction from which some odours arrive. We don't only perceive odours as exteroceptive through olfaction but can also learn about direction and other spatial features of odours, which may assist us in segregating them. Thus, contra researchers like Batty (2011; 2014b), Lycan (2000) and Matthen (2005) it appears that we do have spatial discriminatory abilities in olfaction. By adopting this approach to olfaction, we can also take insights from the *process-based* accounts of olfaction (mentioned in section 3.1) while retaining a robust notion of objecthood. Barwich (2014) says that we ought to reject the notion of perceptual objects because researchers treat them as static units of analysis, independent of perceptual processes (p. 264). However, with the proposed approach we can see that perceptual objects are *crucially dependent upon* perceptual processes. Without bodily activity like sniffing, plausibly we cannot perceive objects at all, and moving our heads and bodies can give us rich spatial information about odours, allowing us to spatially segregate them from complex mixtures of odorants in the air.

The preceding discussion's emphasis on the role of tactile and trigeminal stimulation in olfactory phenomenology opens up questions about whether we ought to take olfactory experience to be multisensory (perhaps akin to how flavour perception is often understood). These kinds of questions will be covered in detail in chapter 5. For now, some brief remarks suffice. In my view, there are three main ways to construe olfaction here: (a) as a multisensory type of perception involving olfactory, tactile and trigeminal sense modalities, (b) as a unisensory type of perception, which takes the tactile/trigeminal

involvement to merely influence olfaction rather than forming part of the olfactory experience itself, or (c) as a unimodal type of perception that takes the tactile and trigeminal involvement to form a constitutive part of a unified olfactory sense modality/perceptual modality. How this question is answered will depend on the way in which the senses are individuated.[51] There have been wide-ranging approaches to this issue. Traditionally, most of these accounts have based individuation on either the phenomenal character of a sense experience, types of receptors, the sense organ involved or the representational content of the experience (Macpherson, 2011b). Others have suggested we individuate the senses in accordance with types of perceptual activity (e.g. Matthen, 2014) or societal convention (Nudds, 2004). These different strategies for individuating the senses result in different answers to the question of whether olfactory experience is multisensory (see chapter 5 for further discussion).

With the account I have put forward, odours are presented to us as spatiotemporally extended entities. Even though they have less clearly specified spatial boundaries than the objects presented in, say, vision, they do allow spatial differentiation when we actively engage in the activity of smelling. There is evidence that figure-ground segregation applies in olfaction: it is possible to discriminate odours both on the basis of non-spatial and spatial factors. Batty (2014b) argues against the presentation of particular objects in

[51] See Macpherson (2011a) for an introduction to different approaches to individuating the senses and see Richardson (2013) for discussion of the exteroceptivity of olfaction and its implications for the debate on individuating the senses.

olfaction because of the alleged lack of figure-ground segregation, so a key argument in favour of the abstract view fails. Similar considerations would hold against the feature-based view prevalent in the olfactory sciences; we have seen that there is good reason to think that olfaction involves the experience of discrete structured wholes, rather than disjointed properties. However, to assess whether there are olfactory objects, we must also determine whether olfaction involves perceptual constancies.

3.3.3 Olfactory constancies

In the previous sections, I discussed two ways in which figure-ground segregation is exhibited in olfaction. We saw that figure-ground segregation alone, however, is not sufficient for the exhibition of particular objects in experience. Perceptual constancies must also be exhibited in olfactory experiences for olfaction to meet the criteria for the perception of particular objects. For robust object perception, I have claimed, we require more than a mere moment-by-moment individuation of odours; we also need these odours to retain their identity across change (involving object recognition capacities). In chapter 2, I argued contra researchers such as Burge (2009; 2010) that there are constancies in our flavour and smell experiences, allowing for the experienced duality to perceptual experience posited by the sensorimotor approach. Not only do such constancies vindicate this aspect of how the sensorimotor approach construes phenomenology, but when alongside figure-ground segregation, they also fulfil the criteria for perceptual objecthood. Let us briefly recap this evidence.

Firstly, amodal completion occurs in olfaction; we perceptually 'fill in' chemical substances. We are able to perceive odours *as the odour-type that they are*, even if they are corrupted or missing elements due to poor perceptual conditions (Barnes, Hofacer, Zaman, Rennaker, & Wilson, 2008; see Carvalho, 2014 for a discussion of this type of constancy). We perceive a coffee odour as a coherent whole, which retains its identity, even if the precise odorants that stimulate the nasal cavity don't include all 600 chemical elements that typify a coffee odour. We recognise it as a *coffee odour* even if the particular compounds that we are in contact with vary. It is thought that this is a result of object recognition processes (Stevenson, 2011, p. 1892). This is analogous to the sort of visual object recognition that allows us to see objects as complete, even though we only have direct sensory contact with their facing sides and in cases where they are partially occluded.

A second type of perceptual constancy in olfaction relates to intensity. The size of sniff that one takes has a significant effect on the neural response of the olfactory nerve but does not result in significant changes to the apparent intensity of an odour (Teghtsoonian & Teghtsoonian, 1982). We seem able to perceive an invariant feature of an odour — its intensity — even though our perspectives on the world change. This appears to be related to an awareness of how one's own sniffing activity influences the olfactory stimuli that reaches the olfactory epithelium. Crucially, when the changes to airflow rate are not controlled by the subject, there is no such constancy effect and there is a perceived change to odour intensity, highlighting again the importance of bodily activity (here, in

terms of the effect of effort expended when sniffing) in olfactory perception (Hahn, Scherer, & Mozell, 1994). Olfaction involves constancies, just like the other sensory modalities.

As we have already seen in the previous chapters and section 3.2.2 here, in the cases of perceptual constancy exhibited in visual experience, there is generally a kind of duality to the phenomenology of the experience. There is a sense in which one tree looks smaller than the other, and the plate looks elliptical, but in another more robust sense, the trees look the same size and the plate looks round. Could something like this apply to the olfactory constancies discussed above? In the case of intensity constancy, it is clear to me that it does. There is a sense in which if I take a big sniff of coffee and a small sniff of coffee, I can notice that there is, in a way, a different intensity to the experience, but at the same time I perceive the coffee odour as having an invariant intensity. Likewise, there is a case for something like this applying to olfactory phenomenology regarding amodal completion. This type of constancy is analogous to the visual case of seeing an object as complete even though we only see its facing side, or it is partially occluded by something. In the visual case, there is a sense in which the object appears as a whole object even though in another sense we recognise that we only see part of it. Plausibly in the case of olfaction, one could recognise that not all of the properties typical of the coffee odour are apparent at once (picking out, say, the fruitiness and yet needing to move closer to coffee cup to pick out the chocolate notes), and yet still also recognise the coffee odour as complete and unified in another sense. As suggested in chapter 2, an expert coffee taster

would likely be better at picking out these perspective-dependent olfactory properties, just as an experienced artist is better able to pick out the angles and shapes apparent from a perspective. The unified coffee odour — like the objective shape of the plate — is generally easier to pick out than the particular properties apparent at each moment.

If we accept the role of tactile stimulation and bodily movement in olfactory phenomenology, we can see that olfaction involves both figure-ground segregation and perceptual constancies, and thus fulfils the criteria I laid out for a robust type of perceptual objecthood. This object-based approach improves upon the abstract and feature-based approaches, which usually rely on the claim that olfaction is aspatial and can't exhibit figure-ground effects. With my suggested approach, we can appreciate the important ways in which olfaction is similar to other varieties of perception, providing us with rich information about the world.

3.4 Conclusion

In this chapter I argued that olfaction allows the perception of discrete objects in the form of odours. Figure-ground segregation and perceptual constancies are the hallmarks of the perception of particular objects, providing individually necessary and jointly sufficient conditions. We saw that there is empirical evidence that the Gestalt principles of similarity, proximity and good form apply in the case of olfaction, suggesting that there is a non-spatial variety of figure-ground segregation exhibited by smell. Additionally, however, we saw that olfaction involves a second, *spatial* type of figure-ground

segregation and odours can be experienced in a spatial manner. The figure-ground structure and spatiality of olfactory experience is especially evident when we pay attention to the role of tactile stimulation and bodily movement in olfactory experience. Furthermore, there is empirical and phenomenological evidence of perceptual constancies in olfaction, which together with figure-ground segregation, fulfils the criteria for a robust kind of perceptual objecthood that goes beyond the weak, abstract notion of objecthood or the perception of nebulous features.

Olfaction may have seemed to present a challenge for the sensorimotor approach since it doesn't appear to allow for the immediate perception of physical objects in the environment. We now have a notion of *perceptual objecthood*, and it is these more diffuse odour objects that we access through olfaction. The sensorimotor approach says that our skilful sensorimotor attunement allows for the experience of perceptually present wholes — and here these wholes are understood as *perceptual objects*. The approach set out in this chapter, drawing upon Gestalt psychology, thus both removes an imposing obstacle for a sensorimotor approach to the chemical senses and can help to flesh out the idea of perceptual presence (see also section 1.1.3 and chapter 2). Moreover, it also provided a methodology for reflecting on the difficult-to-grasp phenomenology of olfaction. In the next chapter, I ask whether we should likewise extend these object concepts to *flavour* perception.

4. Extending object concepts to flavour perception

4.0 Introduction

This chapter argues that flavour perception, like olfaction, allows for the experience of discrete perceptual objects. I survey the empirical and phenomenological evidence for flavour fulfilling the conditions on objecthood. Some unique challenges emerge, with researchers questioning whether anything could constitute a 'background' (which may be required for figure-ground assignments) in flavour experience.

This is how we shall proceed. In 4.1, I explore initial motivations for applying object concepts in the case of flavour perception and investigate what (if anything) the immediate perceptual objects of flavour perception would be. We have seen that the relevant objects of olfaction are *odours* rather than everyday objects like roses and rubbish bins. Here I argue that there are analogous reasons to take the immediate objects of flavour perception to be *flavours* rather than everyday objects like bananas and chocolates. In 4.2 I consider whether flavour experiences exhibit figure-ground effects — a necessary condition on object perception. I argue that the phenomenon of *oral referral* provides persuasive evidence for perceptual grouping and figure-ground segregation in flavour perception. Congruent olfactory and gustatory stimuli are generally experienced together as gestalt, spatially located flavours rather than distinct sensations. I also respond to a worry that there isn't anything that could count as the relevant *background* in many typical tasting experiences. Finally, in 4.3 I explore the ways in which bodily

activity and implicit sensorimotor expectancies are involved in the perception of flavour objects as objective aspects of the world. Skill-laden bodily movement gives rise to perceptual constancies in flavour. This allows us to access overarching, objective flavours even in imperfect perceptual conditions and through limitations to our immediate sensory stimulation.

4.1 Putative flavour objects

Flavour perception is underpinned by a wide variety of stimuli and sensory processes (for detailed overviews, see Delwiche, 2004; Spence, Smith, & Auvray, 2014; Smith, 2015a). It involves the tongue-based gustatory system, retronasal olfaction, and tactile and trigeminal somatosensation. The gustatory system enables the detection of the five 'basic' tastes — sweet, sour, bitter, salty and umami.[52] Retronasal olfaction involves volatile molecules rising up through the nasopharynx via the mouth, and in combination with the 'basic' tastes, this allows for the perception of flavours such as 'chocolate' or 'banana'. Psychophysical research has suggested that odours that have previously been identified orthonasally are not automatically identifiable retronasally (Rozin, 1982). Flavour appears

[52] Some researchers have suggested that *fat* (Gilbertson, Fontenot, Liu, Zhang, & Monroe, 1997) and *metallic* are additional basic tastes, with some arguing that there may be twenty or more such tastes (e.g. see Stuckey, 2012, Ch. 13). However, this is controversial because, for example, fat may serve as a flavourant, which merely modulates other taste qualities (see e.g. Mattes, 2010 for discussion) and metallic taste experiences are partly due to olfactory stimulation (e.g. Hettinger, Myers, & Frank, 1990). Others are sceptical of the concept of basic tastes, and question whether the term meaningfully refers to anything at all (Delwiche, 1996; Erickson, 2008; Spence, Smith, & Auvray, 2014).

to be phenomenologically distinct from a mere conjunction of olfactory and gustatory stimuli.

Tactile and trigeminal somatosensation also play a significant role in flavour perception. Many ingredients trigger trigeminal stimulation, which involves the kind of chemical irritation and nociception evident when we eat hot chillies, menthol, wasabi and spices. This trigeminal sensation is an integral part of many flavour experiences, from spicy curry to minty chewing gum. Tactile somatosensory cues in the mouth provide information regarding food texture. For example, it is tactile stimulation that is responsible for our perception of chewiness (e.g. see Delwiche, 2004) and the experience of the astringency of a tannic red wine (Breslin, Gilmore, Beauchamp, & Green, 1993). Tastants also induce thermal sensations on the tongue. The temperature of a meal can make the food taste better or worse (the majority of people wouldn't enjoy warm lemonade or lager, or most varieties of soup served cold), and temperature often accentuates other aspects of flavour (see Lemon, 2017 for a review of the ways temperature modulates taste). One study showed that increasing the serving temperature of Cheddar cheese augmented its perceived sourness (Drake, Yates, & Gerard, 2005). Similarly, perceived sweetness tends to increase as a food or drink is warmed, as is exemplified in the cloying sweetness of melted ice cream (Green & Frankmann, 1988).

Despite the varied sensory processes that underpin flavour perception, we seemingly experience unified overall flavours (see also chapter 2). Rather than merely experiencing

transient sensations, flavour plausibly involves a kind of perceptual grouping. For example, the experience of eating a tomato seems to give rise to a singular tomato flavour, and we can recognise other instances of this *type* of flavour when we eat other tomatoes (or tomato soup, ketchup, etc.). This provides a prima facie motivation for using object concepts in the case of flavour. Small and Green (2011, Section 36.1) assert that, in the case of flavour, 'though the resulting perception depends on inputs from multiple sensory modalities, it is experienced as a unitary percept of a food or beverage', which they describe as a 'coherent "flavour object"'. According to Auvray and Spence, '[T]he act of eating allows the different qualities of an object to be combined into a whole percept' (2008, p. 1027). Delwiche (2004) asserts, '[W]hen eating or drinking, or even smoking … it is the gestalt (or whole) of this overall experience that is of interest to those eating, drinking, and cooking...' (p. 137). These alleged gestalts or unitary percepts offer an initial motivation for believing that flavour perception involves individuated perceptual objects. It is plausible that we experience unified flavour objects that instantiate properties such as sweetness, tanginess, and 'citrusyness'. However, as we have seen, there are constraints upon the notion of objecthood; to count as perceptual objects, these flavour experiences must involve figure-ground assignments, allowing for object individuation, and perceptual constancies, allowing for object recognition.

Before investigating whether flavour perception meets these criteria in 4.2, let us consider what (if anything) the immediate perceptual objects would be in the case of flavour. We have seen that in olfaction, the relevant perceptual objects are *odours* (see discussion of

the 'odour view' in chapters 1 and 3). Recall, there were a number of reasons for this. As has been discussed by various researchers (e.g. see Lycan, 1996; Batty, 2010a; Richardson, 2013; Young, 2016), taking the relevant perceptual objects to be odours makes best sense of olfactory accuracy conditions. For example, odours can be produced artificially. If someone detects an artificial rose odour, it doesn't seem that their perception is non-veridical because of the lack of an actual rose. They accurately perceive the rose *odour*. Additionally, odours can perdure temporally even in the absence of a source object. The odour of mouldy food may remain even when the mouldy food has been disposed of or destroyed. Again, there is nothing non-veridical about perceiving the odour, despite the absence of the original source object.[53] A further reason for endorsing the odour view should have become apparent throughout the previous chapter: it is *odours* rather than source objects that are subject to olfactory figure-ground effects and constancies.

By analogy with the olfactory case, there are two key candidates for perceptual objects in flavour perception. One possibility is that these objects are *everyday objects* — tomatoes, bananas, chocolate bars. Another possibility is that they are *flavours* within the food. There are reasons to endorse this second option. Although these parallels have not yet (to the best of my knowledge) been addressed in the literature, a number of the same considerations apply to flavour perception as they do to olfaction. First, akin to the

[53] What *would* be non-veridical would be the perception of a mouldy food odour when there is no such odour or experiencing the odour as having different properties to those that it actually has. For discussion of non-veridical experience in the chemical senses see 7.2.1.

argument regarding artificial odours, many flavours can be produced artificially. Just as smelling an artificial rose odour is not a non-veridical experience, tasting an artificial flavour isn't non-veridical either. Isoamyl acetate is a compound that is found naturally in bananas. However, it is also produced synthetically and confers a banana-like flavour. If someone consumes isoamyl acetate and perceives a banana flavour, it doesn't seem that they are having a non-veridical experience despite a lack of actual bananas. Rather, the subject would seem to be accurately perceiving a banana *flavour.*[54]

Secondly, there are also parallels to the argument regarding odours persisting in the absence of a source object. Although it is less immediately apparent than in the olfactory case, flavours too can persist in the absence of an everyday object. Much of the perception of flavour occurs after swallowing, when volatile molecules are released into the throat and reach the olfactory epithelium retronasally. Directly paralleling the orthonasal olfactory case, these volatile chemicals are separate from the everyday objects that give rise to them. Volatile molecules are not ordinary objects like bananas and chocolates, and they are no longer detectable through other senses such as vision or touch. If such an argument shows that odours, and not source objects, are the perceptual objects of olfaction (as in e.g. Batty, 2010a; Richardson, 2013; Young, 2016), the same reasoning must be extended to flavour perception. Moreover, in the case of flavour,

[54] This idea seems increasingly pertinent as imitation meats and dairy replacement products become more popular and more closely resemble the items they are based upon. If a veggie burger accurately replicates the taste of beef, the taster isn't wrong to perceive a beef-like flavour, even if the burger is actually made from soy protein. The manufacturers have likely gone to great lengths to replicate a specific taste.

questions arise as to whether an everyday food object even retains its identity once the tasting process has begun. Food is transformed through chewing into a soft bolus and eventually as more saliva is added, a more fluid mash (see Shepherd, 2016, chapter 5). It isn't clear whether the ordinary object's identity is retained through these transformations, and it is only through such changes that we fully experience flavour. If the volatile molecules and the transformed substances that allow for flavour perception are not ordinary objects, then ordinary physical objects cannot be the immediate object of flavour perception.

For analogous reasons to the olfactory case, we must conclude that everyday objects like bananas and chocolate bars are not the immediate objects of flavour perception; it isn't everyday objects that are perceptually parcelled up into discrete objects via the activity of tasting. Instead, flavours can perdure over time, even as the everyday object is transformed and/or swallowed. Few have presented realist approaches to flavour, but Smith (e.g. 2007, 2013b) is a notable exception. With his proposed account, tastes are objective features of food and beverages that can be uncovered through perceptual exploration. According to Smith, 'The term flavour does not describe a construct of the brain, but it is a technical term used to describe the sapid and odourous properties of a solid or liquid, including properties of its temperature and texture, as well as the power to irritate the trigeminal nerve' (2013b, p. 310). I am in agreement with Smith's account of flavours as objective aspects of the world to be discovered, and in what follows I offer arguments in favour of such an approach. However, with my proposed account, I add that

flavours are not only *properties* of food and wine, but also discrete property-bearing *perceptual objects* in their own right (much like sounds and smells). The act of tasting involves parsing the perceptual landscape into discrete flavours.

Also analogous to the olfactory case, this is not to say that we couldn't also, more indirectly perceive foods and beverages *through* the act of perceiving flavours (see Lycan, 1996 for the application of such an approach to olfaction). A layered approach to perceptual representation is compatible with the account set out here. However, if the act of tasting allows us to immediately experience perceptual objects at all, these perceptual objects (which pop out as figures and exhibit constancies) are *flavours.*

4.2 Figure-ground segregation and perceptual grouping in flavour

Figure-ground segregation is a necessary condition of perceptual objecthood. It is how objects are perceptually individuated from one another and elucidates the notion of an object's *boundaries* in a non-visuocentric manner. Do flavour experiences exhibit these kinds of figure-ground effects? This issue has received little attention in the literature (however, see discussions in Stevenson, 2014, p. 1373; Spence & Youssef, 2016; Roque, Auvray, & Lafraire, 2018, pp. 4–5). Here I suggest that, as in the olfactory case, there is evidence of Gestalt grouping principles applying to flavour perception. However, flavour perception presents some unique difficulties as it has been argued that there is nothing that could count as a *background* against which flavour objects are perceived.

Intuitively, we can detect and individuate different flavours through the act of tasting. Here I suggest that the phenomenon of *oral referral* provides evidence of figure-ground effects. Oral referral is the apparent *mislocalisation* of olfactory stimuli to the oral cavity (see Spence, 2016 for overview). Much of our experience of flavour is underpinned by retronasal olfaction, where volatile molecules released from the food are pumped towards the olfactory epithelium throughout the savouring process. Yet, we don't experience these sensations in our noses, but rather in our mouths — where the food is. And as noted above, the experience of flavour involves a blending of retronasal olfactory, somatosensory and gustatory tongue-based sensations, resulting in a unified flavour experience spatially located in the mouth. The spatiality of this experience leaves room for a kind of spatial figure-ground segregation in flavour perception. The spatial boundaries of flavours may be less clear than in visual case, but we need not hold the chemical senses to visuo-centric standards.

As regards the blending of somatosensory and gustatory sensations, researchers have argued that the common location in the mouth and the common timing of the sensations is likely sufficient for binding them together (see Stevenson, 2012). More controversial is the question of which factors modulate the oral referral of *olfactory* stimuli to the mouth (for reviews see Stevenson, 2012; Spence, 2016). Traditionally, the prevailing hypothesis was that oral somatosensory stimulation induces the referral of the olfactory stimulation to the mouth (Murphy & Cain, 1980; Rozin, 1982), but later studies have conflicted with these results (Lim & Johnson, 2011; Lim & Johnson, 2012). Other researchers suggest that

temporal synchrony plays an important role, as is typically the case in cross-modal binding across the senses (see Stevenson, 2012). Von Békésy (1964) presented evidence to support this claim, which demonstrated that the onset times of stimuli alters the perceived location of the flavour. According to this research, manipulating the onset times of the odour/taste components of a mixture can change the perceived spatial location of the resultant percept. The mixture is perceived as being on the tip of the nose if the olfactory stimuli precede the gustatory stimuli, but it is perceived as being in the mouth if stimuli are presented simultaneously. More research is required here, however, since these results have not been replicated and few methodological details of this study were given.

More recently, research into oral referral has demonstrated convincingly that the *congruence* of the olfactory and gustatory stimuli plays an important role in modulating oral referral (Lim & Johnson, 2011; Lim & Johnson, 2012). Congruent combinations of stimuli are defined as those that commonly appear alongside one another, and are highly associated with one another (2012, p. 516). In the first round of experiments (2011), Lim and Johnson, used a pipette to place a tastant onto subjects' tongues as they inhaled an odorant retronasally.[55] Congruent combinations, such as a vanilla odorant experienced alongside a sweet taste solution or a soy sauce odorant with a salty taste solution, gave rise to more cases of oral referral than incongruent combinations (vanilla with salt or soy

[55] Retronasal olfaction was achieved by inhaling through a straw and exhaling through the nose.

sauce with sweet). Giving a subject a *tasteless* liquid along with an odorant didn't have an effect on whether there would be a referral when compared to retronasally inhaling an odour alone without the accompanying liquid. Comparable results were found in further studies (2012) that aimed to replicate more normal tasting conditions by giving subjects a gelatine disc, which either contained a tastant or was flavourless, rather than pipetting a liquid. Tasteless discs experienced along with odorants showed no more referral than cases in which an odorant was inhaled by itself without the disc. These studies suggest, contra Murphy and Cain (1980) and Rozin (1982), that oral somatosensory stimulation in and of itself doesn't induce oral referral. Rather, the congruence of odorants and tastants makes it more likely that a unified, spatially located flavour will be perceived.

Several studies also emphasise the role of cross-modal congruency in the enhancement of stimuli. In particular, odours like strawberry or vanilla that are congruent with sweet tastants are known to enhance the perceived sweetness (Frank & Byram, 1988; Frank, Shaffer, & Smith, 1991). The combination of a strawberry odour and a sucrose solution is perceived as sweeter than a sucrose solution alone.[56] It has also been suggested that congruency may aid in the detection of stimuli. Weak tastes and smells might alone each be subthreshold for detection but can be sensed together if they are congruent (Dalton, Doolittle, Nagata, & Breslin, 2000; Breslin, Doolittle, & Dalton, 2001; however, see Delwiche & Heffelfinger, 2005 for conflicting results). This further confirms that taste and

[56] Conversely, such 'sweet' odours can also reduce the perceived sourness of tastants like citric acid (Stevenson, Prescott, & Boakes, 1999).

smell are integrated in the congruent cases (see also chapter 5 for how related evidence supports *multisensory objects*).

The overarching principle of Prägnanz or good form says that harmoniously connected elements are more likely to be grouped together, and this appears to occur with the integration of retronasal olfactory and gustatory stimulation. Oral referral and taste enhancement show that *congruent* stimuli tend to be perceptually grouped, and this congruence intuitively exemplifies a kind of harmonious connection or prägnanz.[57] Interestingly, which combinations of stimuli count as congruent appears to be culturally relative. In Western society, almond odours are generally most associated with sweet tastes, while in Japan they are associated with umami. This is reflected in which tastes are enhanced by almond odours for Western and Japanese subjects (Breslin, Doolittle, & Dalton, 2001).[58] Which items are meaningfully related may differ among perceivers (see chapter 6 for detailed discussion of how learning and memories can impact object perception).

Even aside from oral referral and sweetness enhancement, there is an intuitive sense in which the principle of Prägnanz applies. It is phenomenologically evident that foods and beverages can be composed in harmonious ways, resulting in a more cohesive flavour experience. In a well-balanced wine, the tannins, acidity, sweetness, and alcohol are all

[57] See also Spence & Youssef (2016) for a related discussion of how the phenomenon of *emergence* occurs in flavour perception.
[58] A number of researchers have taken odour-taste congruency to arise from associative learning (see Small & Prescott, 2005 for review).

incorporated in such a way that no one component stands out. This allows for a more coherent, gestalt flavour. This would seem to be a plausible manifestation of the principle of Prägnanz, suggesting that grouping occurs in flavour perception, as with the other senses.

The principle of Prägnanz is an overarching principle under which the other Gestalt principles are subsumed. More specific grouping principles such as the principles of similarity and proximity also seem applicable. The principle of similarity states that elements tend to be grouped together if they are similar to each other. The congruence of odours and tastes has been expressed in terms of the *perceived similarity* of stimuli, since odours are often experienced as having taste-like qualities (e.g. Stevenson & Boakes, 2004). For example, odours like strawberry and vanilla are often described as 'sweet', even though strictly speaking sweetness is a gustatory property. If we understand congruence in terms of similarity, grouping into a spatially located, unified percept (i.e. oral referral) can be said to be more likely where stimuli are more perceptually similar to one another.

The Gestalt law of proximity tells us that sensations that are (spatially or temporally) proximate are more likely to be grouped together into a single percept. As mentioned above, with regard to the *gustatory* and *tactile* aspects of flavour, both the common location in the mouth and the common timing of stimulation likely play a role in the experience of them as bound together (Stevenson, 2012). This suggests that both spatial

and temporal versions of the Gestalt law of proximity are in operation. Moreover, while there is not sufficient empirical research to draw conclusive results, temporal synchrony (along with the congruence of the relevant stimuli) may also modulate the referral of *olfactory* stimuli (as in, e.g. von Békésy, 1964; see also Pfeiffer, Hollowood, Hort, & Taylor 2005 for further suggestive support). The way that gustatory and olfactory stimuli temporally unfold plausibly impacts whether such stimuli are grouped into a unified flavour.

On the basis of the above discussion, various Gestalt principles guide groupings in flavour perception. This provides evidence — as in the olfactory case — that figure-ground segregation occurs in flavour perception. The unified and spatially located flavours that we experience are plausibly individuated figures.

4.2.1 A potential problem

Despite the evidence for grouping and segregation in flavour perception, there is a potential problem. Flavour perception may not allow for figure-ground segregation due to lacking a suitable *background*. If so, flavour perception fails to meet the criteria for perceptual objecthood.

Stevenson (2014, p. 1373) argues that flavour perception (unlike olfaction, in his view) fails to exhibit figure-ground segregation. He thinks that in vision, audition and orthonasal olfaction it is evident that there is both a *figure* and a *background*. For example, we smell

the coffee odour against the background of cakes and air-freshener. Yet in Stevenson's view, there is no readily apparent background in the case of flavour perception. He considers whether eating multiple foods together in a meal might allow for figure-ground segregation, suggesting that it is possible that 'the combinations placed in the mouth all reflect several viable flavor objects that can each be perceived individually, with the others forming the background (e.g., with a mouthful of pheasant, roasted parsnip, and leek; the "pheasant" object with the "parsnip and leek" background)' (p. 1373). However, he quickly rejects this idea because meals with multiple ingredients 'may not represent the type of diet that the flavor system evolved to deal with (i.e., relatively few food types eaten to repletion…. It would appear then that there may be no background to experience a flavor object "against."' (p. 1373).[59] When tasting a tomato, is there a background to this experience?

Stevenson also points out that a primary reason for perceiving objects is to enable the rapid detection and identification of complex environmental information (p. 1374). Yet, we generally identify foods through vision and orthonasal olfaction prior to tasting them, and thus, we have little need to detect or identify objects through flavour perception. Experiencing perceptual objects through flavour may carry an unnecessary cognitive cost. This worry may, at first glance, carry a contentious assumption that we experience the

[59] Here I won't address the evolutionary aspects of Stevenson's worries in detail. However, it is worth noting that object perception in flavour could have simply occurred through a happy accident, without a need for a clear evolutionary rationale. In any case, there is still a legitimate concern about whether flavours are usually experienced against a background.

same perceptual objects via these different senses. While odours can carry information about source objects, the immediate perceptual object is the odour (the tomato odour), and the immediate perceptual object of vision is the everyday object (the tomato). In the previous section, I argued that for similar reasons to the olfactory case, we ought to regard the immediate objects of flavour perception to be *flavours*. However, the argument remains that there may be no added benefit to experiencing flavours as individuated perceptual objects (rather than, say, ephemeral sensations or disjointed properties) if sufficient ecological information has already been obtained prior to tasting.

In response to this concern, it is worth noting that even if foods are identified before tasting them, it may still be useful to perceive gestalt, individuated flavour objects. One reason for this is that we can be mistaken about what the food in question is or what its properties are. Similar-looking foods may have very different properties, which can be revealed through flavour perception. For example, poisonous Canadian moonseed berries closely resemble edible wild grapes in appearance and would be difficult to distinguish by sight. However, the moonseed berries reportedly taste very bad (e.g. Tyler, 1980, p. 119), which would provide a valuable clue that they ought not to be eaten. Specific aspects of flavour are likely to serve further functions. For example, tasting is very useful for assessing whether a food has gone off or is fresh (see Roque, Auvray, & Lafraire, 2018 for discussion of the functions of freshness perception). Even if a food is identified before tasting, we can still learn ecologically important information about it through the perception of flavours.

Stevenson's question about whether there is anything that could serve as a background against which we perceive perceptual objects in flavour perception is potentially more serious. If flavours do not involve figure-ground segregation, then such experiences will fail the criteria for perceptual objecthood.

As an initial point in favour of flavour exhibiting a figure-ground structure, Stevenson's own example of tasting different ingredients in a dish (2014, p. 1373) is quite a plausible case of figure-ground segregation, even though he himself ultimately rejects it. Intuitively, we can segregate flavours from one another when tasting complex combinations of food and pick out the flavour of one food. Plausibly our attention selects a putative flavour object and everything else is relegated to background. As in vision, we can shift our attention, altering what counts as figure and what counts as background. One might focus on the pheasant with the leek and parsnip as background, but then shift their attention to the parsnip flavour, shifting the pheasant to background along with the leek. The background will be relatively homogenous, less determinate and perceived as in some sense 'behind' the figure. There is a worry about this kind of example, however. We don't always eat foods with multiple ingredients. This raises a phenomenological issue for accounts of figure-ground segregation in flavour. If someone tastes a single food by itself, there isn't an obvious background to the figure like there is in the multi-ingredient case. The flavour of a tomato seems unified, but it isn't prima facie clear that there is a background to the experience if it is the only thing being tasted.

However, in response to the worry about tasting a single flavour alone, it isn't clear that there needs to be another flavour or set of flavours for figure-ground segregation to occur. In fact, placing these kinds of restraints upon figure-ground segregation would rule out many paradigmatic instances of figure-ground segregation across the senses. A clear palate — an absence of stimuli — may also be able to serve as a background. There is a precedent for this as researchers, focusing on other sense modalities, have endorsed the idea that we can in fact perceive absences[60] and that such absences can serve as backgrounds to perceptual objects. Martin (1993) uses the example of a visual perception of a Polo mint to highlight this:

> One experiences not only the white parts of the mint, but also the hole in the middle and the area around its outer edge. In order to see the mint as a ring-shape, one needs to distinguish the figure from the ground, but the ground here need be no more than the empty space around the object. (p. 214).

Similarly, Gurwitsch (1964/2010) asserts that auditory stillness is 'the experience of an auditory background *par excellence* out of which sounds emerge and into which they relapse' (p. 109). With such an account, being in a silent room and hearing a sudden bang, would be a paradigmatic case of figure-ground segregation. He takes this kind of auditory example to be analogous to the visual case of illuminated points arising out of a background of darkness. Similarly, we may perceive a single odour in an otherwise odour-free environment. Figure-ground segregation is a necessary condition on objecthood, and

[60] For positive accounts of absence perception in vision see also Richardson, 2010; Soteriou, 2011. For discussion of absence perception in olfaction see Roberts, 2015; Todd, 2018. See Mac Cumhaill, 2017 for discussion of whether empty space can serve as a background in tactile perception.

it would be counter-intuitive for sounds and odours to only count as perceptual objects when occurring alongside other sounds and odours. Likewise, an account of objecthood shouldn't exclude visible figures that happen to be emerging from darkness rather than being in a fully illuminated setting. The same can be said of the perception of flavours. To avoid arbitrary constraints upon perceptual objecthood, we must concede that a clear palate, an odour-free environment, a silent room, and empty space or darkness can serve as backgrounds in experience. Figures must be contrasted with something, but they can be contrasted with emptiness.

The problems posed by Stevenson (2014) for figure-ground segregation in flavour perception are unconvincing. The worry about flavours lacking a relevant *background* can be extended to many paradigmatic examples of figure-ground segregation in vision and audition, suggesting it isn't a genuine problem at all. A flavour can pop out in experience both against other flavours and against a clear palate. They are perceived as unified individuals, which exhibit many of the usual hallmarks of figure-ground segregation. Many distinct types of stimuli are grouped together into spatially located flavour gestalts through oral referral mechanisms, and we have seen that a number of Gestalt grouping principles plausibly apply in flavour perception. Proximity and similarity of stimuli makes it more likely that odours and tastes will be unified into a gestalt flavour. Likewise, harmonious combinations of ingredients are also more likely to result in this kind of unified and spatially situated flavour experience, manifesting the law of Prägnanz.

4.3 Sensorimotor activity and perceptual constancies in flavour

With the sensorimotor approach, perceptual experience is constituted by a skilful attunement to sensorimotor contingencies. Through this attunement we can perceive invariant, objective aspects of the environment. Perceptual objects are more than mere transient sensations; they are objective entities we can access amid changing sensory stimulation. As argued in the previous chapter, perceptual constancies are a necessary condition on perceptual objecthood. We have seen that they underpin various object recognition abilities, which are generally taken to be a crucial aspect of object perception. Perceiving constant properties of objects allows for object categorisation, reidentification of the objects in changing conditions, amodal completion, and perceiving them as persisting through time. Building on the discussion in 2.2.2, I argue that sensorimotor activity enables us to uncover constancies in flavour perception, and that thus, flavours fulfil the criteria (figure-ground segregation and constancies) for perceptual objecthood.

Across the senses, we often experience properties as constant despite variations in perceptual conditions and amid sensory changes. According to the sensorimotor approach, this is due to an understanding of how one's bodily movements induce the variations in sensory stimulation that we come to perceive the invariant properties of things. Various types of perceptual constancy are evident in flavour perception, providing reason to treat flavours as objective, non-perspectival aspects of the world.

4.3.1 Flavour constancy amid gappy and changing stimulation

Tasting food involves highly complex bodily activity, involving the manipulation of the jaw, tongue, lips, cheeks and muscles in the neck. Such oral movements are crucial in the release of flavour compounds from foods (for reviews see Salles, et al., 2010; Foster, et al., 2011). For example, the perception of almost all flavour and mouth-feel attributes requires a degree of tongue movement (de Wijk, Engelen, & Prinz, 2003). Retronasal olfaction also involves complex bodily activity, and it has been suggested that mouth movements enable retronasal olfaction in a manner analogous to how the sniff enables orthonasal olfaction (Burdach & Doty, 1987). As one engages in the dynamic process of tasting, the border between the soft palate and the tongue (velum-tongue border) alternately opens and closes. When it opens, retronasal olfaction can occur. Less solid foods (and beverages) result in the velum-tongue border opening less, but also induce a higher rate of swallowing which then instigates an aroma burst to the olfactory epithelium. Retronasal olfaction is under a degree of voluntary control and can be deliberately augmented with certain types of activity. For example, wine-tasters are able to keep open the velum-tongue border to boost the stimuli that reach the olfactory epithelium (Salles, et al., 2010). This is achievable by taking only a small amount of wine into the mouth and deliberately inhaling air through the lips and/or by bending the head forwards while inhaling so liquid doesn't flow into the pharynx.

Retronasal stimulation occurs when the velum-tongue border is open, but this border is only open periodically (Salles, et al., 2010). It usually opens when food is first placed in the mouth (Buettner, Beer, Hannig, Settles, & Schieberle, 2002), but it is generally closed when chewing and swallowing, for example. So, one might expect flavour experience to be punctuated with gaps, where we only experience gustatory and tactile stimulation and not the richer flavours (tomato, chocolate, etc.) of things. However, we do not experience such lapses. This is comparable to the way we don't generally notice the lack of visual stimulation when we blink or experience continuous perturbations as our eyes saccade. We see the stable world before us, and likewise we taste the stable flavour of tomato. With the sensorimotor approach, this is unsurprising: visual perception occurs *through* such bodily activity, rather than despite it (see O'Regan & Noë, 2001b, p. 92). Similarly, it is through the periodic opening and shutting of the velum-tongue border as we chew and swallow food that we experience flavours; it is part of the normal machinery we use to sample and explore flavours.

We are subject to a wide variety of different types of sensory stimulation as we engage in the activity of tasting, but we rarely notice corresponding variations in flavour. As noted, we generally seem to perceive a flavour in a gestalt manner; it pops out against other flavours (or a clear palate) and is experienced as unified. We perceive the flavour of, say, tomato as in some sense unchanged throughout the process of eating, and in different circumstances. According to the sensorimotor approach, this is explained by our attunement to the way that bodily activity induces sensory changes. We are sensitive to

how tongue movements, chewing and swallowing induce give us access to different aspects of flavours. Exhalation after swallowing gives rise to significant retronasal stimulation, for example. It is because of an implicit understanding of how to induce different ephemeral sensations that we are able to experience the whole overarching flavour. We never access all parts of a tomato flavour at once, just as we don't visually access all parts of a tomato at once. Yet all parts of the perceptual object are *accessible* (through wide-ranging tasting activity), and it is because of this that we experience these objects as complete and real parts of the world to be discovered.

As discussed in chapter 2, another example is that we experience the *intensity* of flavours as constant, despite there also being a perspectival sense in which flavour intensity varies. Theunissen and Kroeze (1996) found that although mouth movements impact the amount of sensory stimulation induced by tasting, the rate of these movements does not affect the perceived intensity of the flavour (although as argued in chapter 2, I think there is still a sense in which we can also experience the varying perspectival intensity levels). They suggest that this phenomenon may be analogous to how the intensity of a sniff does not affect the perceived intensity of the odour (Teghtsoonian & Teghtsoonian, 1982; see chapter 3). These results are consonant with the sensorimotor approach, which would predict that when mouth movements are under the control of the subject, properties of the perceptual object(s) would be experienced as relatively constant. We recognise how our own bodily activity induces certain kinds of sensory changes, and don't attribute those

changes to the object itself. In the case of tasting, we have implicit expectancies about how increased mouth movement will result in an increase of sensory stimulation.

4.3.2 Expectations and constancies

Perception is a skill and, according to the sensorimotor approach, it requires implicit sensorimotor understanding of how bodily activity will alter the kinds of sensory stimulation we receive. With this ability, one can perceive unified flavour objects of particular intensities, and so on. As we saw in section 4.2, congruent combinations of olfactory and gustatory stimuli are more likely to be perceived as unified and spatially located in the mouth. These combinations are familiar and mimic common food sources (for example, a citral aroma with sucrose and citric acid was said to taste like a lemon gelatin dessert) (Lim & Johnson, 2012). A sensorimotor approach can explain this in terms of a subject's implicit sensorimotor expectations. In the case of congruent, familiar combinations, the subject has already developed an attunement to how the stimuli unfold through the act of tasting. This enables the experience of a unified flavour in the mouth. This attunement is plausibly disrupted, on the other hand, when incongruent stimuli are presented. In the incongruent case, it is more likely that the subject will merely experience an array of disjointed sensations.

As also discussed in chapter 2, manipulating a subject's expectations can also cause interesting constancy-based effects. Anything that we know about a food or beverage, based on visual and olfactory cues for example, can shape our flavour expectations (for a

review of the role of expectations in flavour perception see Piqueras-Fiszman & Spence, 2015). Woods et al. (2010) showed that an expectation that two samples of drink are the same — inferred from the two (different) drinks being poured from the same jug — results in the samples being perceived as more similar. An expectation of homogenous taste can result in a kind of flavour constancy. We don't get much information about a drink's flavour from a single sip, but our background knowledge facilitates the perception of a unified flavour despite our sensory limitations. Researchers have further suggested that expectations that arise from the first sip or bite of a food also serve to induce a kind of perceptual constancy (Dijksterhuis, Boucon, & Le Berre, 2014).[61] These kinds of expectations would seem to be on a continuum with sensorimotor expectations, influencing our attunement to sensorimotor contingencies and our ability to perceptually interact with objects in the world.

One the basis of the evidence surveyed, flavours are experienced as constant amid gappy and changing sensory stimulation. Perceptual constancies are necessary for objecthood and are tied to our experience of objects as *perceptually present*: they are experienced as whole, worldly entities even though our sensory contact with them is limited. The phenomenology of perceptual experience outstrips current sensory contact with perceived objects. We experience a tomato as round even though we don't immediately

[61] This study found that a salty first bite of a food resulted in increased salt perception of the remainder of the tasting experience. Understanding flavour constancies may have important implications for consumers' health (by allowing for salt-reduction, for example).

see the back of it. Likewise, we experience a flavour as a unified gestalt, even though we only access certain aspects of a flavour at any one time and sensory stimulation is gappy. Tomato flavours, like tomatoes, are experienced as constant and perceptually present objects because of our attunement to the way our activity induces different kinds of sensory stimulation. Because of these constancies we experience coherent flavours that can be recognised and reidentified in future.

This chapter argued that flavours pop out in experience as unified perceptual objects. Gestalt grouping principles apply to flavour perception, providing evidence that tasting involves the same kinds of spontaneous perceptual groupings and segregations seen across the sense modalities. Thus, there are empirical and phenomenological reasons for taking flavours to be experienced as *figures*, and I further argued these figures may be perceived against the background of either other flavours or a clear palate. We also saw that flavour perception involves the experience of whole, perceptually present entities amid gappy and transient sensory stimulation. Constancies in flavour perception appear to operate in analogous ways to visual constancies. To the extent that the sensorimotor approach provides a good explanation of our ability to perceive whole, constant entities amid change in vision, it also does so in flavour perception.

Flavours fulfil the criteria for perceptual objecthood, and we ought to take them to be objective aspects of the world to be uncovered. In the next chapter, I explore whether the chemical senses are involved in *multisensory* object perception.

5. Flavour, smell and multisensory objects

5.0 Introduction

In the previous chapters, we saw that there is good reason to apply object concepts to both smell and flavour perception. Views diverge, however, about whether the chemical senses allow for *multisensory perceptual objects*. It is often held that there is something peculiarly multisensory about flavour perception. Yet it remains controversial whether it really involves multiple distinct sense modalities rather than a single, unified flavour sense. Likewise, standpoints conflict about whether retronasal and orthonasal olfaction constitute two separate senses of smell and how we should understand the relationship between flavour and smell and between these senses and other senses like vision and audition. The account of perceptual objecthood outlined in the previous chapters sets certain constraints on which perceptual episodes can be deemed to involve perceptual objects. It thus provides the tools to answer these questions about multisensory objecthood in the chemical senses.

Three main questions will be addressed in this chapter. (1) First, it is often claimed that flavour encompasses a variety of different senses such as taste, touch and smell, and as seen in the previous chapters, smell also involves tactile and trigeminal stimulation. Thus, the question arises as to whether flavour and smell are multisensory modes of perception. As we shall see, the answer to this question depends on one's approach to individuating the senses. (2) Secondly, there are close connections between flavour and (orthonasal)

smell, so we might also wonder whether these senses are able to jointly pick out unified flavour-smell objects. I shall give a positive answer to this question. (3) Thirdly, research also indicates that our flavour and smell experiences can be impacted by other senses such as vision and audition. Do these other senses perceptually combine with the chemical senses to allow for overarching multisensory perceptual objects? As we shall see, it is implausible that they do combine in this manner.

5.1 Individuating the chemical senses

Generally, we experience the world through multiple senses. I currently see a scene full of tables, chairs, people and coffee cups, while hearing chattering voices and instrumental music, and smelling coffee. This experience may not involve truly *multisensory* perception of objects, however; it may merely be an assortment of co-conscious perceptual episodes through different sense modalities. The question of whether any given perceptual episode is multisensory (rather than merely the conjunction of experiences through different senses) cannot be answered without committing to some method of individuating the senses (see also Richardson, 2013). Without knowing how to distinguish one sense from another, we would have no principled way of determining whether one or multiple senses are involved. This is particularly pronounced in relation to the chemical senses where there is little agreement about how many senses are involved in any given experience.

While we tend to have clear intuitions regarding, say, *vision* being a single type of sense,

distinct from other senses such as audition,[62] things aren't so clear in relation to the chemical senses. Researchers disagree about whether flavour constitutes a single sense, and the idea that flavour is partly down to the sense of smell has arguably also reached folk understandings of the senses.[63] It is well known, for example, that having a blocked nose impairs our ability to taste foods properly.

Flavour perception involves a variety of different sensory inputs — gustatory, olfactory, tactile and trigeminal. Without the combination of retronasal olfaction and the stimulation of taste receptors in the mouth, we cannot experience flavours like orange, chocolate or tomato. This is accompanied by tactile stimulation in the mouth and very often has a trigeminal component. Thus, it seems quite natural to deem flavour perception multisensory, and this is the orthodoxy in research into the chemical senses. Yet, other researchers instead consider flavour perception to be a singular modality encompassing both olfactory and gustatory processes. French gastronome Brillat-Savarin asserts, 'I am not only convinced that there is no full act of tasting without the participation of the sense of smell, but I am also tempted to believe that smell and taste form a single sense, of which the mouth is the laboratory and the nose is the chimney' (Brillat-Savarin, 1835/2009). In more recent times, Gibson (1966/1983) and those influenced by his approach, such as Auvray and Spence (2008) and Matthen (2014),[64] have

[62] Although, see Fulkerson (2014) for reasons to doubt whether even vision is clearly classifiable as a single sense modality.
[63] See Nudds' (2004) and MacPherson (2011a) for debate about whether folk conceptions of the senses are changing and/or changeable on the basis of empirical evidence.
[64] Smith (2013a, p. 734) and Spence, Smith, and Auvray (2014, p. 31) also offer discussions of this idea.

suggested we can treat flavour as a single perceptual system over and above any component sensory processing. As Gibson states (and is repeated by Auvray and Spence, 2008, p. 1022), 'Smelling and tasting however, need not be defined by receptors and nerves. They can be defined by their functions in use…' (p. 136). As we shall see, the sensorimotor approach, which is heavily influenced by Gibson, also advocates this kind of method of individuating the chemical senses.

We saw in chapter 3 that (orthonasal) smell, much like flavour, involves multiple distinct types of sensory stimulation. Tactile and trigeminal stimulation play an important role in our olfactory experiences. Richardson (2013) has highlighted that olfactory perception involves an experience of bringing in odours from the outside; smell is experienced in an exteroceptive manner. This essentially involves the tactile component of air stimulating the nostrils. Many odours rely upon trigeminal stimulation for their perceived quality (e.g. menthol, ammonia, etc; see Wysocki, 2003). Thus, if we are to treat flavour as the product of multiple senses, we ought to say the same about the sense of smell. If we take both flavour and smell to necessarily involve multiple senses, then it is trivially true that all perceptual objects experienced through these senses are multisensory.

Further questions arise about whether taste constitutes a separate sense modality to flavour, or whether we ought to construe *taste* as simply an element of flavour (as argued by, e.g., Spence, Smith, & Auvray, 2014), and about whether we ought to take there to be two distinct senses of smell. There are both orthonasal and retronasal pathways to the

olfactory epithelium, so it has been claimed that olfaction is a 'dual sensory modality' (Rozin, 1982). This idea is further supported by evidence of differing neural responses depending on the route by which olfactory receptors are stimulated (Small, Gerber, Mak, & Hummel, 2005). However, one might instead think both belong to a unified sense of smell since they are simply different pathways to the same olfactory receptor cells. Alternatively, it could be argued that retronasal olfaction merely serves as part of the sense of flavour, rather than being any aspect of the sense of smell.

Determining whether a given object perceived through the chemical senses is *multisensory* requires some kind of answer to these questions, and the answers that one gives will depend on how the senses are individuated. There are many possible methods of individuating the senses (see Macpherson, 2011a for a useful overview). For example, the most common traditional approaches aim to individuate the senses on the basis of one (or more) of the following: the experience's phenomenal character, its representational content,[65] the kind of proximal stimulus involved, or the type of sense organ involved (Grice, 1962/2011; Macpherson, 2011a). The core distinction between seeing and smelling for example, may be pinned on: (a) differences in how visual and olfactory experiences qualitatively feel; (b) the fact that seeing represents physical objects that instantiate colours, shapes and other visibly perceived properties, and smelling

[65] See Mizrahi (2017) for an application of such a strategy to the sense of taste. She argues in favour of using the 'proper object' of each sense — those items only perceptible to one unique sense — to individuate the senses. See my brief discussion of *sensibilia* in 5.4 for a potential initial challenge to such an approach.

represents odours with olfactory qualities like pungency and smokiness; (c) the fact that the proximal stimulus of sight is electromagnetic waves of between 380 and 750 nanometres, while the proximal stimulus of olfaction is volatile particles; (d) the relevant sense organs being the eye and the nose respectively. Each of these approaches seems to capture an intuitive difference between the senses.

However, each strategy may run into issues in accounting for certain problem cases such as non-human animal senses. For example, the vision (or at least what we think of as being vision) of non-human animals can involve receptivity to different wavelengths from human vision. Birds and bees are sensitive to UV light, so restricting the proximal stimuli for vision to only electromagnetic energy between 380 and 750 nanometres does not allow for types of non-human vision. But defining vision in terms of receptivity to *all* types of electromagnetic energy would include senses that do *not* appear to be visual. For example, pit vipers possess small pits below their eyes, which allow them to detect infrared electromagnetic radiation. Although both the pits and their eyes detect electromagnetic energy, neuroethologists generally take the pits to be involved in thermal imaging rather than vision (see Gray, 2005 for discussion of this case). Approaches that rely on differences between sense organs face similar issues (do the pit vipers' pits count as eyes?). It is difficult to specify precisely what ought to count as the relevant organs for each sense, and plausibly creatures that are very different physiologically from humans can still see, smell, hear, etc. A bee seems to be able to see, but its compound eyes are very different from human eyes.

These approaches all shift the taxonomic debate from the question of how the senses should be individuated to questions of how other phenomena should be individuated. What counts as the proximal stimulus of each sense? What counts as the unique smell-like phenomenal character distinctive of olfaction? What constitutes the relevant sense organs? What are the perceptual contents distinctive of each sense? At some point, it seems, an answer to these questions must be stipulated, but ideally, they should be stipulated in a non-arbitrary way that accords with our everyday understanding of the senses and serves one's explanatory interests.

One approach, which seems to do good job of capturing both everyday intuitions and a scientific understanding of the senses, is to treat flavour and smell as unified perceptual systems that can cut across different receptor types. With this approach, the emphasis is shifted towards how the senses are used in our engagement with the world. This kind of understanding of the chemical senses is in line with the sensorimotor approach, as well as other active accounts such as, for example, Gibson's (1966/1983) ecological approach and Matthen's (2014) account,[66] and is the approach I follow throughout this chapter. Such approaches take the senses to be essentially active and allow for individuation of the senses on the basis of particular types of bodily engagement with the world. For Gibson,

[66] For my purposes here, nothing hinges on the specifics of how these active approaches to individuating the senses differ from one another since they arrive at the same answers about how we should individuate the chemical senses. The sensorimotor approach is broadly Gibsonian in its approach for individuating the senses (e.g. see Noë, 2002). Sensorimotor theorists generally advocate distinguishing them according to the different patterns of sensorimotor contingency associated with each sense (e.g. O'Regan & Noë, 2001a, p. 943; Noë, 2002). In order to perceive through a given sense modality one must have an attunement to these regularities.

'The active senses cannot simply be the initiator of signals in nerve fibers or messages to the brain; instead they are analogous to tentacles and feelers' (1966/1983, p. 5). Noë asserts that 'what differentiates the sensory modalities are the different patterns of activity that constitutes [*sic*] their exercise' (2002, p. 65).[67] We see by moving our eyes and heads, we touch by running our hands over surfaces, we smell through sniffing and moving our heads and bodies in response to odours, we actively taste through jaw, cheek and tongue movements, etc; we *use* the senses to explore the environment; they aren't mere recipients of information.

These approaches appear to do a good job of accounting for the differences between the senses that the traditional approaches focused on. According to the sensorimotor account, our attunement to the (counterfactual) sensory effects of interactions with the world can explain the *phenomenal character* of perceptual experience (e.g. see Hurley & Noë, 2003). However, even if one does not agree with the claim that phenomenal character is *constituted* by sensorimotor engagement, it is hard to deny that one's engagement with the world at least causally impacts phenomenal character in important ways. Types of bodily interaction with the world are also informative with regard to the *content* of perceptual experience, since perceptual content is at least partially explained by those features of the world that we perceptually engage with. If olfaction represents

[67] Noë also argues that this amounts to the same thing as individuating them on the basis of each sense's 'corresponding appearance-structures' (p. 65) but this claim adds unneeded controversy for this chapter's purposes, so I shall not discuss this idea further.

odours, this is presumably because we engage with odours through the sense of smell. Our bodily engagement with the world crucially involves us making use of the *sense organs* related to each sense, and the *proximal stimuli* that are associated with each sense are induced by our bodily interaction with the environment.

With this method for individuating the chemical senses, flavour perception can be treated as a unified sense modality, distinguished from other senses because of the patterns of bodily activity involved in tasting. All of the distinct types of stimulation are induced through the unified activity of tasting. As Matthen says of flavour perception, activities like chewing, savouring, moving food around, swallowing constitute a *system* (2014, p. 11). Orthonasal olfaction too is to be understood as a single sense modality because it is to be individuated on the basis of smelling activity rather than types of stimulus/receptor. Retronasal olfaction would most likely be considered merely a part of the sense of flavour rather than its own sense modality, since (to the best of my knowledge) we don't engage in any kind of distinctive retronasal smelling activity that isn't simply a part of tasting. It is through the processes of chewing, savouring, swallowing, etc. that retronasal olfaction occurs.[68] Similarly, with this kind of approach it appears that *taste* doesn't constitute

[68] One potential problem with taking retronasal olfaction to simply be an aspect of flavour is that in certain experimental conditions, we can be made to experience retronasal olfactory stimulation as being of a smell rather than a flavour (e.g. see Smith, 2015a for discussion of this). These are artificial conditions involving pumping an odour to the olfactory epithelium using a specially made device, rather than normal olfactory conditions. This is akin to how in certain experimental conditions it may be possible to experience something approaching *basic tastes* (sweet, sour, etc.) in isolation, but this doesn't generally occur in natural tasting conditions (if at all) (see e.g. Spence, Smith, & Auvray, 2014). Usually these tastes are experienced simply as aspects of flavours. I don't think we ought to individuate the senses on the basis of these unusual lab-based sensory experiences, but the fact that in experimental conditions retronasal olfaction can be experienced in this way does highlight the important connections between flavour and smell.

separate sense modality to flavour because it doesn't involve its own types of bodily engagment with the world.

Treating the senses as perceptual systems, individuated on the basis of bodily activity, need not be assumed to be the sole, true method of individuating the senses. There may be multiple useful methods for doing this depending upon one's explanatory interests (see Fulkerson, 2014). It may be helpful to sometimes examine underlying stimuli involved in flavour (i.e., gustatory, retronasal olfactory, tactile, trigeminal) or smell, while at other times it may be more helpful to look at the way we engage with the world through tasting and smelling. Matthen (2014), for example, argues that there are two key ways to look at the senses, one of which emphasises the 'carriers and recipients of information', while the other understands the senses as perceptual systems (p. 24). Treating the senses as perceptual systems will serve our interests here.

It is trivially true that if all the sensory processes (retronasal olfactory, gustatory, tactile and trigeminal) that underlie flavour and smell experiences are taken to be individual senses, then all flavour and olfactory objects are multisensory. A more interesting question is whether flavour and smell could still be involved in the experience of multisensory objects if we understand the senses as perceptual systems, and whether flavour and (orthonasal) olfaction could together be involved in the perception of unified flavour-odour objects. Thus, for the purposes of the rest of this chapter, I take the senses to be these kinds of perceptual systems.

5.2 From unisensory to multisensory perceptual objects

As argued in the previous chapters, we experience a world of discrete particulars referred to as 'perceptual objects'. Both odours (chapter 3) and flavours (chapter 4) can be experienced as perceptual objects. They are perceived as individuated items that instantiate properties such as smokiness and pungency, sweetness and creaminess, and are able to survive perspectival shifts. The individuation of these objects is understood through the notion of *figure-ground segregation* — the way we pick out an object as a unified *figure* against everything else around it. Figure-ground segregation appears to apply across the senses, with evidence of it applying to smell (chapter 3), flavour (chapter 4), audition (Bregman, 1990), and touch (Gallace & Spence, 2011; Mac Cumhaill, 2017), as well as in the paradigmatic case of vision. As we have also seen, different senses involve different types of grouping and figure-ground segregation, but all appear to be governed by the Gestalt principles first set out by Wertheimer (1923/1938). These principles offer insights into the ways we spontaneously perceive certain environmental features as unified into structured wholes, individuated from everything else in the environment.

There has been an increase of interest into whether perceptual objects can be *multisensory* (recent examples include Kubovy & Schutz, 2010; Deroy, Chen, & Spence, 2014; Green, 2018; and O'Callaghan's body of work, including 2008, 2014, 2016, 2017). The type of multisensory object under discussion here are perceptual objects that are perceived in a unified manner by multiple senses. This captures an intuitive understanding

of what it means for an experience of an object to be multisensory, but as we shall see, surprisingly few types of perception meet this criterion. For an object to be perceived through more than one sense modality, these senses ought to concur with one another about the identity of the object (object recognition) and about where the boundaries of the object lie (object individuation). If they do not concur with regard to the boundaries of the object, there must be multiple sets of perceived boundaries, and thus multiple perceptual objects (since, with the notion of objecthood we are working with, it is the boundaries of objects that individuate them from one another). More generally, if contradictory properties are attributed to objects by different senses, they cannot be involved in the perception of a single, unified object.

There are prima facie reasons to endorse multisensory perceptual objects. First, it might seem phenomenologically evident that we *can* in fact perceive objects in a multisensory way. Consider the experience of eating a freshly cooked veggie burger. Ostensibly, when someone eats the burger, they hear it sizzling, and see, touch, taste and smell it. The experience does not feel disjointed; it seems quite plausible that the senses are jointly engaged in perceiving something. Perhaps then, there is phenomenological reason to endorse a notion of multisensory objecthood.

Secondly, the senses interact with each other, and these interactions often produce interesting cross-modal effects. Perhaps the best-known examples of this are audio-visual

cases like the McGurk and ventriloquism effects,[69] but such phenomena occur across the senses. Vision and audition are known to interact with our experiences in the chemical senses. For example, whether or not we experience congruent colour cues[70] can profoundly alter our ability to recognise odours and flavours (DuBose, Cardello, & Maller, 1980; see Spence, Levitan, Shanker, & Zamprini, 2010 for a review), as well as impacting the perceived intensity of flavour and the enjoyment we derive from food (Wheatley, 1973).

Audition plays an important role too. Whether it is the 'snap, crackle and pop' of breakfast cereal, the sizzling of a burger, the fizz of a carbonated drink, or the satisfying *'glou-glou'* sound of wine being poured or swallowed,[71] sound seems integral to the experience of these foods and beverages. Studies show that auditory feedback can modulate our flavour experiences. Zampini and Spence (2004) conducted an experiment in which participants were asked to eat Pringles while being played real-time auditory feedback of their own

[69] The McGurk effect involves visual dominance over auditory information: visual perception of lip movements can alter one's auditory perception of phonemes. When dubbed over a video of a speaker making the lip movements associated with the phoneme /ga/, the sound /ba/ is heard instead as /da/ by most subjects (McGurk & Macdonald, 1976). Similarly, in the case of the ventriloquism effect precise covariation of visual and auditory stimuli result in the auditory stimuli being perceived as located closer to the visual stimuli. Seeing movement of the ventriloquist's dummy's mouth results in a perception of the sound as emanating from the dummy's mouth rather than that of the ventriloquist.

[70] What counts as being a 'congruent' colour depends upon which products we are exposed to. A study, which asked subjects to predict the flavours of different coloured liquids, found that young adults in the UK associated bright blue drinks with a raspberry flavour (Shankar, Levitan, & Spence, 2010), probably due to products such as Gatorade using the blue-raspberry flavour. Young people in Taiwan instead associated the colour with a mint flavour. See chapter 6 for discussion of how prior experience shapes perceptual organisation.

[71] The term 'glou-glou' is attributed to Molière's 1966 play *The Doctor in Spite of Himself* (see Shepherd, 2012 for discussion.)

crunching sounds through headphones. Altering the volume/frequency composition of these sounds modified the participants' perceptions of how stale or fresh the crisps tasted. The Pringles were perceived as 'both crisper and fresher when either the overall sound level was increased, or when just the high frequency sounds… were selectively amplified' (p. 1). More recently, similar results have been found in a study looking at the perceived hardness and crispness of apples (Demattè, et al., 2014). Cross-modal associations between odour quality and auditory pitch have also been documented. In studies of cross-modal matching, subjects arranged fragrances in sequence to match various sounds of different pitches. Subjects shared a common interpretation of which odours 'matched' a particular pitch, suggesting that they drew interesting associations between smells and sounds (Belkin, Martin, Kemp, & Gilbert, 1997). Are experiences of, say, seeing and smelling something or tasting and hearing crunchy food instances of multisensory object perception?

Prima facie, these kinds of effects may be thought to serve as empirical evidence for multisensory perceptual objecthood. The fact that visual feedback influences auditory perception (as in the McGurk and ventriloquism cases) may be suggestive of multisensory audio-visual objecthood. If this is so, then the fact that senses like audition and vision can influence our flavour perceptions is also suggestive of multisensory objecthood, allowing for, say, audition and flavour to engage in jointly perceiving a crunchy apple. However, there is also an important challenge for multisensory objecthood known as the 'diversity problem'.

5.2.1 A challenge: The diversity problem

Despite the apparent reasons for endorsing various instances of multisensory objecthood, there is an immediate challenge for putative multisensory objects. Namely, there are important differences in what we can perceive via each of the sense modalities. The different senses allow us to perceive a very diverse range of properties and objects, and the objects accessible by each sense are not necessarily accessible by the others. For example, odours cannot be seen and are very different from the sources of these odours that are often visible. A rose odour is a molecular cloud of volatile particles; the rose itself is, of course, a physical, everyday object that one can see and touch. Some further hold that odours should be understood as 'sensibilia' — ephemeral non-ordinary entities that are only perceptible through a single sense modality (Richardson, 2018). Similar issues apply to flavours and sound streams. Auditory objects in the form of sound streams are of a very different kind to the visible objects that give rise to the sounds (violins, bells, radios). These facts about what we perceive through each sense modality present a challenge for multisensory objecthood known as the 'diversity' problem (see O'Callaghan, 2016; Green, 2018). There is such variation between what each of the senses allows us to perceive that it is difficult to see how they could work together to pick out a unified multisensory object.

Moreover, we have seen that it is through figure-ground segregation that we experience objects as unified particulars, separated from their fields. Different sense-modalities, such

as flavour, smell, vision and audition, segregate their respective objects in different ways from their grounds, which adds further difficulty for notions of multisensory objecthood. For example, whereas vision uses primarily spatial properties, audition uses frequency, timbre, and temporal properties. Flavour and smell involve groupings and segregation on the basis of properties of the relevant chemical substances. Because of such differences, these senses appear to all specify different types of object boundaries, and correspondingly, the perceptual objects of each of these senses differ. In the case of the chemical senses, as we have seen, the immediate objects of these senses are not ordinary physical objects but rather flavours and odours. Since it is through figure-ground segregation that objects are perceived as distinct from one another, unless the very same figures are picked out by multiple senses, there cannot be a single, unified multisensory perceptual object.

This seems relatively unproblematic for certain instances of putative multisensory objecthood. For example, visuo-tactile cases of objecthood seem quite plausible because the perceived objects of both of these senses are ordinary, physical objects. Moreover, the boundaries of these objects are plausibly specified in a spatial manner through both vision and touch.[72] As we shall see in section 5.3.2, these kinds of multisensory visuo-tactile objects can also remain unified amid shifts and changes in one's interpretation of the stimulus. However, the diversity problem presents a serious difficulty for other

[72] Though, see Richardson (2014) for discussion of a view according to which vision and touch do not converge even on spatial properties.

putative types of multisensory object. The perceptual objects perceived through the chemical senses are *flavours* and *odours*, which are not accessible through other senses such as vision, and they are individuated in different ways to, say, physical objects.

One potential solution, allowing for a kind of multisensory objecthood, is that there can be *overarching* perceptual objects that group together discrete unisensory perceptual objects. This overarching object may exhibit figure-ground effects that are specified in a multisensory manner. For example, consider O'Callaghan's (2016) approach, according to which events experienced through multiple senses can constitute extended event-like perceptual objects. He argues that 'one can bimodally perceive a common whole with some parts accessible to one but not both senses' (2016, p. 1271) and '[f]or instance, just as something may visually appear at once to be both red and round, or to have a red part and a green part, something may multimodally perceptually appear at once to be both bright and loud, or to have a red part and a rough part' (2014, p. 73). Focusing largely on audio-visual cases, he argues that sounds aren't perceptually distinct from events such as wheels screeching, hands clapping and so forth. Through hearing sounds, you can hear their sources. Auditory objects are individual parts of broader, mereologically complex, event-like objects, which include both sounds and ordinary objects such as wheels:

> Audio-visual perception sometimes not only converges upon a common object but also identifies a shared perceptible object as such… Audio-visual perception thus reveals a temporally extended, event-like individual with visible bodies as participants and sound streams as parts. The multisensory perceptual object is the broader, encompassing happening—the hands' clapping, the wheels' screeching, the tuba's soloing—that you perceive audio-visually (2016, pp. 1283–1284).

This suggestion has prima facie phenomenological appeal: watching and hearing wheels screeching doesn't seem disjointed. We perceive the sounds as emanating from the visible wheels on the tarmac, and we might therefore take this experience to be of a unified perceptual object, which has the auditory stream as one part. When we see and hear wheels screeching, we see the movement of the wheels, which results in the sound-stream emanating from them. This chapter does not discuss whether this approach ultimately succeeds in accounting for audio-visual perception. However, I assess whether it allows other kinds of multisensory objecthood involving the chemical senses, such as olfactory-visual objects. In what follows I argue that even with this kind of overarching objecthood, the constituent unisensory objects must be closely connected enough that they allow for unified figure-ground segregation.

O'Callaghan's suggested approach opens the possibility that odours emanating from a source object could constitute an extended event-like object that includes both the visually perceived physical object and the olfactorily perceived odour. When we see garlic being fried, we are seeing the event that results in the odour emanating from the garlic. Initial intuitions are likely to clash about whether seeing garlic frying in a pan and smelling its odour should count as a multisensory perceptual object. Perhaps this approach would also allow for perceptual grouping together of flavours and odours, where we engage in a temporally extended tasting and smelling activities.

For these kinds of events to constitute *perceptual objects* (in the sense I have argued for),

they must fulfil certain criteria. As we saw in chapter 3, such happenings must be experienced as unified and individuated from everything else (i.e. they must exhibit figure-ground segregation) and must exhibit constancies, surviving perceptual shifts and changes. The constituent unisensory objects must be sufficiently closely connected to count as being involved in a kind of overarching object. It isn't immediately clear whether happenings like garlic odours emanating from a pan (or cases like both seeing and hearing wheels screeching) could jointly exhibit figure-ground segregation. If they do not, these happenings cannot be considered multisensory perceptual objects.

5.3 Two types of evidence for multisensory objecthood

To aid us in uncovering whether various perceptual episodes involve multisensory perceptual objects, in 5.3.1 and 5.3.2 I outline two kinds of evidence for multisensory objecthood. As we saw in the previous chapters, the operation of Gestalt grouping principles provides a source of evidence for figure-ground segregation. In section 5.3.1 I look at whether such principles could also provide evidence for multisensory figure-ground assignments (and ipso facto, multisensory objecthood). In section 5.3.2 I argue that there is another potential source of evidence for multisensory objects in the form of multisensory Gestalt shifts. This sort of evidence spans the requirement for unified figure-ground segregation and for constancies, depending upon the kind of Gestalt shift at hand. Either way, a unified multisensory object perception ought not to allow contradictory properties to be attributed to the object. If contradictory properties (whether these

properties relate to the boundaries of the object, or to the overall identity of the object) are attributed, there are multiple perceptual objects rather than a single unified multisensory object. It is a necessary condition on multisensory objecthood that the different senses do not attribute contradictory properties to the putative object. Whereas, if multiple senses are involved jointly in Gestalt shifts, this demonstrates that the senses are concurring with one another about an object's boundaries (as specified through object individuation) and/or identity (object recognition). The senses being jointly susceptible to Gestalt shifts is *sufficient* (but not necessary) for objecthood.

As we shall see, these kinds of evidence provide support for multisensory flavour-smell objects. However, they do not provide support for other types of putative multisensory objecthood, such as olfactory-visual or auditory-flavour objects.

5.3.1 The grouping principles

The Gestalt grouping principles can provide evidence of figure-ground effects and perceptual objecthood, and are especially useful in cases where we lack the kinds of clear intuitions we have in, say, the visual case.[73] If we could show that Gestalt grouping principles also apply in a multisensory manner, this would provide evidence for multisensory figure-ground segregation and multisensory perceptual objects. These principles describe the situations in which it is more likely that features of the

[73] See also Green (2018), who has recently presented an approach to perceptual objecthood that draws heavily upon these grouping principles.

environment will be grouped together, but individually each of these principles is defeasible. Each of these principles exemplifies an aspect of the overarching law of Prägnanz; overall, perceptual organisation tends to towards that which is most simple, harmonious, etc. Grouping and segregation operate differently (albeit utilising analogous Gestalt principles) in different senses. The features of the environment upon which these groupings are based, and the structure of perceptual objects differ greatly in different sense modalities.

We have seen that the principle of *similarity* plausibly applies to flavour and smell perception, as well as other senses such as vision and audition. There are, however, issues with the idea that properties perceived through one sense could be *similar* to properties perceived through another sense.[74] We may visually group features together because of their similar colours, or auditorily group together sounds with similar frequencies, but could we also group visual and auditory properties on the basis of similarity? Is the sound of a guitar phenomenally similar to the sight of a guitar? Intuitively, it doesn't make much sense to talk about an auditory property being *similar* to a visual property. Likewise, it doesn't seem prima facie plausible that, say, visually perceived colours can be *similar* to flavours or odours (even if they impact our olfactory/gustatory experience in interesting ways, as highlighted in Spence, Levitan, Shanker, & Zamprini, 2010). Nor, intuitively, can

[74] Well-known philosophical issues with the concept of similarity (e.g. Goodman, 1972) are beyond the scope of my discussion here. This thesis assumes we have an intuitive grasp of certain things being more similar to one another than other things.

auditorily perceived sounds be similar to flavours or odours.

One possibility is that we draw synaesthetic-type associations between such properties, and perhaps this constitutes a kind of cross-modal similarity. There is evidence of implicit associations between flavours/tastes and pitch. Sweet and sour tastes are associated with high-pitched sounds, while umami and bitter tastes are associated with low-pitched sounds (Crisinel & Spence, 2010). Such associations are also evident in other senses, such as audio-visual cases. Pitch and visually perceived size are implicitly associated, with high-pitched sounds associated with smallness and low-pitched sounds associated with largeness (e.g. Gallace & Spence, 2006). However, whether these kinds of associations can be considered evidence of *similarity* between the properties perceived through different senses is unclear. Moreover, even if they did suggest a kind of similarity between such properties, evidence would also be required that these properties are grouped together on the basis of this perceived similarity. Although this may be an interesting question for further research, I am inclined to find it implausible that such properties can really be *similar* to one another, and we currently lack empirical evidence in favour of such a view. In fact, as we saw in 5.1, the intuitive *dissimilarities* between our experiences in different senses forms the basis of various approaches to individuating the senses (e.g. see Grice's, 1962/2011 approach).

A notable exception to the intuitive dissimilarities between our experiences across the senses is provided by the flavour-smell case (and this is reflected in it being less obvious

how these senses should be individuated). There is research suggesting that we *can* find odours and flavours to be similar to one another. In the last chapter, I highlighted empirical evidence of similarity-based grouping in flavour perception. Much of this research turns out to also be applicable here because not only does such grouping occur when *retronasal* olfactory stimulation occurs alongside tasting (i.e. components of unisensory flavour), but also when *orthonasal olfaction* is combined with tasting. Orthonasal olfaction (as we saw 5.1) is a separate sense modality from taste/flavour, even if retronasal olfaction is taken to simply be an aspect of flavour perception.

Subjects are inclined to describe certain odours using terms such as 'sweet' and 'sour' that are generally attributed to the gustatory systems (e.g. Harper, Land, Griffiths, & Bate-Smith, 1968; Burdach, Kroeze, & Koster, 1984). For example, strawberry and vanilla odours are consistently described as 'sweet'. Related research shows that we have a tendency to conflate these kinds of 'sweet' odours and sweet tastes in our memory (Stevenson & Oaten, 2010), further evidencing genuine phenomenological similarities between odours and flavours. Studies have also uncovered the phenomenon of *sweetness enhancement* (Frank & Byram, 1988; Frank, Shaffer, & Smith, 1991). Combining 'sweet' smells with a sweet tastant (sucrose solution), enhance the perceived sweetness of the tastant as compared to the experience of the tastant alone. Sweetness enhancement occurs whether the odours are presented *retronasally* or *orthonasally*, and thus serves as evidence for similarity-based grouping both in unisensory flavour perception and multisensory flavour-smell perception. The fact that sweet smells have an additive effect

on the perceived sweetness of the tastant again supports a phenomenological similarity between the olfactory and gustatory properties and suggests a kind of perceptual grouping. The sweetness of the smell seems to be *combined* perceptually with the sweetness of the tastant. This evidence in combination suggests that the connections between taste and smell go beyond mere synaesthetic associations. Although it is ultimately an empirical question, it seems unlikely that a high-pitched sound would be conflated in memory with a sour taste, for example. The links between taste and smell are tighter.

As we saw in the flavour case, looking to the thresholds for perceiving stimuli also provides evidence of perceptual groupings on the basis of similarity. Weak tastes and smells may individually be subthreshold for detection but jointly detectable if they are congruent (Dalton, Doolittle, Nagata, & Breslin, 2000; Breslin, Doolittle, & Dalton, 2001).[75] The 'congruent' tastes and odours are again combinations like strawberry and sucrose, and given the evidence presented above (and discussed in the previous chapter), we can understand this congruence in terms of *perceived similarity*.[76] People are inclined to describe these sorts of stimuli in the same way and even conflate them in their memory. The fact that individually sub-threshold stimuli can be experienced together if they are

[75] Though see also Delwiche & Heffelfinger (2005), which provides conflicting results.

[76] This differs from other types of 'congruent' properties, such as the way that congruent colour cues can help us to identify odours flavours and alter our enjoyment of the food (Spence, Levitan, Shanker, & Zamprini, 2010). In the colour case, we lack evidence suggesting the colours are *similar* to the odours/flavours.

perceptually similar again suggests a kind of grouping together of the similar tastes and smells. They are only detectable at all if experienced together.

Using the same paradigm of looking to whether stimuli are sub-threshold individually but perceptible together, there is also evidence of grouping by (temporal) proximity. *Simultaneous onset* — as well as the aforementioned congruence — of these taste and smell stimuli makes it more likely that sub-threshold stimuli will become perceptible (Pfeiffer, Hollowood, Hort, & Taylor, 2005; Stevenson, 2014). Simultaneous onset can be construed as a temporal analogue of the principle of proximity. It plays a role, for example, in auditory groupings (see O'Callaghan, 2008, p. 822). It seems Gestalt grouping principles can operate across flavour and smell experience, evidencing a kind of multisensory figure-ground segregation. Plausibly, the temporally extended experience of tasting and smelling can *at times* constitute the experience of a unified multisensory object, which has the unisensory olfactory and flavour objects as closely connected parts. This is to say that, although odours and flavours are distinct (with different *spatial* boundaries, etc.) it may be that they are sometimes sufficiently phenomenologically connected to allow for an overarching unified perceptual object.

One might worry here that the fact that odours are experienced as existing in external space while flavours are experienced in the mouth is a problem for the idea that they can, at times, be experienced as unified. Their different spatial characters might seem counter to them exhibiting unified boundaries. However, as argued in 3.3.1, the operation of the

Gestalt principles need not be based upon spatial properties, and odours can be picked out in a *non-spatial* manner. In the same way, plausibly odours and flavours can be grouped together into an overarching flavour-smell object on the basis of non-spatial forms of similarity, proximity and so forth (while perhaps the component unisensory objects are still individuated from one another in another sense, in part, on the basis of their spatial properties).

Looking towards the other senses, it might initially seem that the principle of proximity could also apply to cases such as visual interactions with smell or flavour. For example, perhaps the proximity of odours to their visually perceived source objects might allow for some kind of proximity-based multisensory grouping. If I see and smell garlic frying in a pan, the garlic odour may be in close proximity to the pieces of garlic from which the odour emanates. However, much of the time odours simply *aren't* near to their source objects. As we have seen, odours are able to persist even if the source object has been moved or destroyed, and this was one of the motivations for taking odours, and not source objects, to be the immediate objects of olfactory experience. More generally, it is hard to see how perceptual objects that are segregated from their grounds in extremely different ways could also involve a kind of overarching figure-ground segregation that unites the two sets of very different boundaries. It is often difficult to discern the spatial properties of odours, and usually they are instead individuated on the basis of non-spatial properties, unlike vision. It doesn't appear that these grouping principles are applicable to interactions between vision and olfaction.

It is perhaps more plausible that auditory interactions with flavour allow for a kind of grouping by temporal variants of the principles of proximity or common fate (things that follow the same trajectory are likely to be grouped). As we saw in 5.2, real-time auditory feedback of subjects' own crunching sounds through headphones can alter one's flavour experiences, making Pringles taste more fresh or more stale (Zampini & Spence, 2004). The way these sounds unfold at the same time as the flavour could conceivably allow for grouping by proximity/common fate. Both flavour and sound unfold over time, making temporal variants of the grouping principles more likely. However, it's not clear that the way flavour unfolds really maps onto the way that the sounds unfold. Much of the flavour unfolds *after* the period of audible crunching, for example. After swallowing, there is an aroma burst where volatile molecules arrive at the olfactory epithelium retronasally (e.g. see Shepherd, 2016).

Again, the operation of other Gestalt grouping principles is simply implausible in the auditory-flavour case. These auditory and flavour properties aren't perceived as *similar* to one another, for example. The grouping principles are all supposed to work together in order to attain the maximally prägnant interpretation of the scene/stimulus (see also Green, 2018), and thus it seems unlikely that the mere fact these phenomena occur in close temporal proximity and that both unfold over time would be sufficient to override the notable *dissimilarities* between the properties perceived.

Unlike in the flavour-smell case, it seems we currently lack robust evidence to suggest

that episodes of perception such as both *seeing* and *smelling* frying garlic, or *hearing* and *tasting* the crunchy Pringles, involve multisensory grouping. The fact that an experience in one sense is modulated by an experience in another is insufficient for *grouping* between these senses.[77] I now move onto a second type of evidence for multisensory grouping/segregation: multisensory Gestalt shifts.

5.3.2 Multisensory Gestalt shifts

The senses involved in multisensory object perception ought not to attribute contradictory properties to the object perceived. If they are involved in the multisensory perception of the same unified object, the senses ought to concur with one another about the identity of the object (since, as seen in chapter 3, object recognition is a key aspect of perceptual objecthood) and the boundaries of the object (object individuation). If they attribute contradictory properties to the object, it doesn't look like these senses are really involved in the perception of a single, unified object at all. This section proposes that Gestalt shifts can provide additional evidence for multisensory object perception, demonstrating that multiple senses are concurring with one another in their interpretation of an object. I argue that they provide robust evidence for multisensory objecthood in the case of visuo-tactile perception and provide some further minimal

[77] There may be borderline cases where it isn't clear if they should be classified as instances of grouping and figure-ground effects. For example, there may be cases where there are multiple equally prägnant interpretations of a scene. In such cases, whether there is a unified overarching perceptual object tying together unisensory objects may simply be indeterminate.

evidence for objecthood in the flavour-smell case.

One way to assess whether object perception is occurring in a multisensory way is to look at whether the senses involved concur with one another the about the identity and the boundaries of the object. It can be difficult to assess whether this is the case, but it becomes clearer if the perceived boundaries/properties of the object suddenly and dramatically change. If the senses remain in agreement with one another amid such shifts and changes, this is good evidence for multisensory object perception. A particularly clear example of changing object boundaries and/or changing object identities comes from cases of bistable (or multistable) ambiguous figures, where one's interpretation of the stimulus spontaneously shifts. An example of such multistability targeting the boundaries (as specified by figure-ground assignments) of the object is the Necker Cube (Fig. 5.1); interpretations of the object boundaries flip back and forth. An example of the *identity* of the object changing is the duck-rabbit (Fig. 5.2); the same stimulus is perceived variously as two different types of object. Although the most well-known examples of multistability are visual cases, similar effects have been observed in audition (Warren & Gregory, 1958; Bregman & Campbell, 1971; O'Leary & Rhodes, 1984; Bregman, 1990) and touch (e.g. Harrar and Harris, 2007; Carter, Konkle, Wang, Hayward, & Moore, 2008). As we shall see below, there is more limited evidence for multistability in the chemical senses.

The above cases are unisensory but let us now consider whether they could occur in a *multisensory* case. If a perceived object is subject to this kind of 'Gestalt shift' in one sense

modality but not the other(s), then the senses must be dividing up the world in differing ways. If multisensory objecthood involves perceptually picking out a single, unified figure in the environment, the object's key traits (its boundaries, identity, etc.) ought to be interpreted in a unified way. Where there is an ambiguity about the interpretation of the object, this ambiguity should subsist in all the senses involved, and when interpretations of the object change, these changes should occur across the senses.

While there has been little research looking at whether Gestalt shifts can be multisensory, there have been a few studies into bimodal versions of ambiguous figures like the Necker cube. Research into the bimodal Necker Cube involves giving subjects a three-dimensional wire cube, rather than the familiar two-dimensional picture of a cube's frame (Shopland & Gregory, 1964; Purves & Andrews, 1997; Ando & Ashida, 2003; Bruno, Jacomuzzi, Bertamini, & Meyer, 2006; Bertamini, Masala, Meyer, & Bruno, 2010; Bruno, 2017).

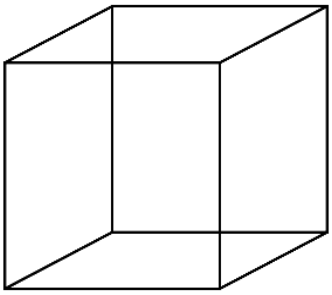


Fig. 5.1. Necker Cube

Interpretations of which is the cube's facing side spontaneously change.

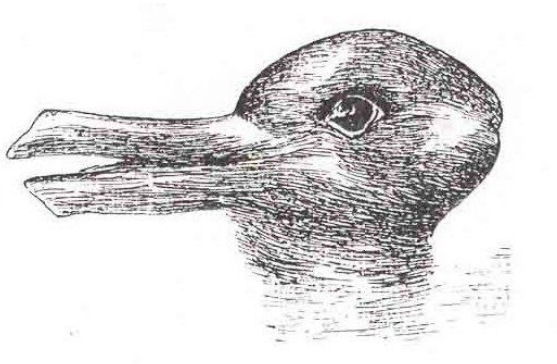


Fig. 5.2. Duck-rabbit (Jastrow, 1899)

The stimulus can be interpreted either as a duck or a rabbit.

Surprisingly, visual reversals can still occur when viewing these three-dimensional cubes, even when subjects are also exploring the cubes haptically. With the three-dimensional version of the Necker cube, when a subject makes figure-ground assignments in a veridical manner, the shape is accurately perceived as a cube. However, when figure-ground reversals occur the shape instead appears to be a 'truncated pyramid' — a pyramid with the top sliced off — pointing towards the viewer. This is because, when the Gestalt shift occurs, the viewer's perception of depth is non-veridical. The distal faces of the cube instead appear to be proximal and thus look smaller than the faces that appear (incorrectly) to be further away.

One fascinating observation from these studies is that when a perceiver experiences the 'truncated pyramid' interpretation, this generally results in them feeling as though their wrists are pointing at impossible angles or that the cube has somehow lost its rigidity (Bruno, Jacomuzzi, Bertamini, & Meyer, 2006, p. 2; Bruno, 2017). Bruno (2017) asserts:

> The resulting experience is striking: at times, the object will seem to undergo nonrigid deformations; at other times, we will have the impression that our wrists are bent at impossible angles, *consistent with the visually reversed shape* instead of the haptically felt one (p. 784, emphasis mine).

The perceiver's tactile experience somehow conforms to the illusory 'truncated pyramid' interpretation of the object. This suggests that the haptic and visual stimulation are unified into a single multisensory percept exhibiting a unified interpretation of the object. The senses concur with one another about whether the perception is of a cube or a truncated pyramid, even if this results in the feeling that one's hands are in an impossible

position. Thus, it is very plausible that touch and vision can engage in unified object perceptions. This should be unsurprising since both senses appear to give us access to everyday physical objects, and they both engage in a spatial variant of figure-ground segregation.[78]

Gestalt shifts may serve as a useful test for multisensory objecthood, but they aren't *necessary* for multisensory objecthood. This is because most perception is not ambiguous in the way that the Necker cube is. Most of the time, there is a veridical way to perceive the world, and we are generally successful in this. Suppose we see and touch a normal solid cube. Generally, a question will not arise about the correct way to interpret the shape of the object. This lack of perceptual ambiguity should not affect whether the object is perceived in a multisensory manner. Thus, while Gestalt shifts can be a useful test for whether a perceived object should be considered multisensory, they are not a necessary condition on multisensory objecthood.

[78] Another possible case of multisensory Gestalt switches comes from the Rubber Hand illusion. The rubber hand illusion most commonly involves occluding the subject's hand from view and stroking it, while a visible rubber hand is stroked in synchrony with the real hand (Botvinik & Cohen, 1998). According to a popular interpretation of the phenomenon, subjects begin to incorporate the rubber hand into their own body-image and start to feel that the rubber hand is their own — an effect that seems to be simultaneously visual and proproprioceptive/tactile. The shift in one's proprioceptive and tactile experience is in accordance with the visual experience of seeing the rubber hand being stroked. Plausibly, there is a kind of figure-ground segregation occurring here where subjects visually experience the non-occluded (rubber) hand as a figure with a particular spatial location and the proprioceptively felt hand is picked out at the same location. The proprioceptively and tactually felt location of the hand accord with the visual experience. Interestingly, the visual experience is so dominant in rubber-hand effects, most subjects experience a proprioceptive shift even when the rubber hand is stroked out of sync with the real hand, and some experience it without any stroking at all (Valenzuela Moguillansky, O'Regan, & Petitmengin, 2013). This is another good candidate for multisensory objecthood.

Do analogous Gestalt shifts occur in olfaction and/or flavour perception? In a recent review article Spence and Youssef (2016) consider the (at present, rather limited) evidence for this multistability in the chemical senses. One case that they discuss relates to a dish — beetroot and orange jelly — created by renowned chef Heston Blumenthal to be served at his Fat Duck restaurant. Half of the jelly is purple and half is orange, which leads diners to suppose that the purple half will be beetroot flavoured and the orange half will be orange flavoured. In fact, the colours are reversed. Often, when diners first taste the jelly, they do not notice the discrepancy and perceive the orange half as orange flavoured and the purple half as beetroot. After multiple tastes, or after a hint from the waiter, they experience a perceptual shift towards the veridical flavours of the jelly. Blumenthal (2008, p. 237) states of the jelly, 'I had always hoped to create a dish that didn't just surprise diners but made them flip between different sensory perceptions, jogging the brain into new attractor states.' Neither Spence and Youssef nor Blumenthal state whether this flip also occurs in one's olfactory experience of the jelly. However, presumably if the diner veridically perceived the orange smell of the purple jelly and beetroot smell of the orange jelly, they would be alerted to the trickery before even tasting the dish. Thus, plausibly the switch occurs across flavour and smell. This could constitute a Gestalt shift that occurs in a multisensory manner across flavour and smell. If it did turn out that, counter-intuitively, the perceiver veridically perceived the orange and the beetroot through the sense of smell, but still muddled up the two through tasting, this would suggest a lack of multisensory unity. This is because they would seemingly be

attributing contradictory properties to the putative flavour-smell object.

Even if one agrees with my suspicion that the shift would occur in both flavour and smell, one might object to the claim that this experience is a kind of Gestalt shift. This is because, as Spence and Youssef (p. 4) point out, it isn't clear that the beetroot and orange jelly allows the taster to flip back to the original interpretation of the food once they have uncovered the discrepancy between the colour and the flavour. Thus, this case doesn't seem analogous to the examples of multistability discussed above. The evidence for multisensory objecthood is stronger in cases where the senses' interpretation of an object jointly flips back and forth. This is because if the Gestalt shifts keep occurring, there is less of a chance that the joint interpretative shift was just a coincidence or simply down to something (e.g. a piece of information) happening to alter our unisensory perceptions across multiple senses. A singular interpretative shift serves as more minimal evidence in favour of multisensory objecthood. What would be required for more robust evidence here would be a substance with ambiguous olfactory and gustatory interpretations. If our interpretation of the stimuli flipped back and forth together through both flavour and smell, this would provide strong evidence of multisensory grouping.

Unfortunately, there may not be examples of flavours and smells that continue to evoke spontaneous shifts in interpretation like the Necker cube. There are cases of ambiguous odours, such as benzaldehyde — a scent that smells like almond or cherry. However, according to Spence and Youseff (2016, p. 4), while subjects are generally able to

recognise both interpretations of the benzaldehyde odour, they tend to settle on one interpretation and don't experience spontaneous shifts in their perception. Thus, we lack evidence that these ambiguous odours result in multistability. Spence and Youseff suggest that the chemical senses may not allow for multistable perceptual shifts because they provide less rich bottom-up contributions to perception or because our flavour and smell perceptions involve slower attentional shifts than in the other senses (p. 4). They also note that the lack of evidence for multistability in flavour and smell perception may simply be down to a dearth of research into the chemical senses. Further studies are needed, but for now at least, this line of evidence only provides minimal support for flavour-smell objects.

Nevertheless, based on the minimal suggestive evidence from the jelly case and the more robust evidence from Gestalt grouping principles, there are plausible grounds to think flavour and smell can be involved in the unified perception of multisensory flavour-odour objects. Although flavours are distinct from odours, there still seems to be a continuity between the chemical substances experienced through each of these senses (see Mizrahi, 2014 for an approach that emphasises this kind of continuity), and that this can be reflected in a kind of multisensory perceptual objecthood. Flavour perception involves odours perceived retronasally, and thus a similar kind of stimulus is involved in both flavour and smell. There are grounds for thinking that at least sometimes these senses jointly pick out a single odorous, flavoursome chemical substance. On the other hand, we

lack good grounds for taking visual and auditory interactions with the chemical senses to be constitutive of multisensory objects.

5.4 A chemical variant of Molyneux's question

The issues so far discussed in this chapter are closely related to Molyneux's question — a long-standing problem of perception, referenced by John Locke (1689/1979, book 2, chapter ix). Molyneux's question is the question of whether one born blind but who had regained their vision might be able to visually recognise a cube, which they had only identified through touch previously. Many people find it quite plausible that they could do so. Studies looking at congenital cataract patients find that, in fact, such subjects *cannot* recognise a cube that had previously only been perceived through touch (Held, et al., 2011). However, this may not be due to a lack of connection between vision and touch, but rather because such patients only have a limited capacity for visual 3D form perception immediately following surgery (Schwenkler, 2012). Moreover, the sensory deprivation involved in blindness from birth may cause perceptual deficits even following the removal of the cataracts.[79] And so the debate continues.

Regardless, there is a question as to why it even seems *plausible* that Molyneux's question could be answered in the affirmative, whereas similar scenarios involving the other senses

[79] And with a sensorimotor approach, the subject must master new sensorimotor contingencies to perceive via a new sense modality, regardless of any connection between the objects picked out by each sense. Noë (2004) has argued that congenital cataract patients are 'experientially blind' (pp. 3–11) following the removal of cataracts because they haven't yet developed the requisite sensorimotor understanding.

do not. The reason that one might think a previously blind subject could recognise the cube is because features such as the shape and size of the cube (which specify the object's boundaries) can be recognised through both vision and touch.[80] It seems highly unlikely, on the other hand, that one could visually recognise a lemon, which one had only *smelled* or *tasted* before. This is precisely because olfactory and flavour objects are picked out in different ways than visual objects, and the perceptual objects themselves are different from the visually perceived objects (odours and flavours rather than lemons). We currently also seem to lack evidence for an overarching perceptual object that combines the unisensory visual and olfactory/flavour objects. The different object types don't seem to bear sufficient connection to one another in how they are individuated to exhibit a unified kind of figure-ground segregation.

What ought we say about a chemical variant of the question, where we ask whether someone could recognise by taste something only ever smelled before, or by smell something only ever tasted before? Plausibly, they could successfully recognise the flavour or smell. Often things do taste how you would expect them to taste based on their smell. There is empirical evidence to vindicate this suspicion. A study by Pierce and Halpern (1996) shows people are good at identifying odorants retronasally, when they

[80] It is controversial whether vision and touch do converge on such properties. For example, see Richardson (2014) for discussion of a view she attributes to Berkeley and Broad ('the Berkeley-Broad view'), which takes the spatial fields of vision and touch to be importantly and wholly distinct. Although a full exploration of such views is beyond the scope of this chapter, the evidence from three-dimensional Necker cubes may go some way to counteract this kind of position.

have only been trained to recognise them orthonasally.[81] This supports a positive answer to a flavour/smell version of Molyneux' question: a subject who had only ever smelled something's odour before would be likely to also recognise its flavour. And these two unisensory types of perceptual object (flavours and smells) can be experienced together as a kind of multisensory flavour-smell object.

In some instances, things *don't* taste as we would expect from their smell. People sometimes express surprise that something doesn't taste how they would expect from its smell. Some people profess to enjoy the taste of certain types of cheese but to dislike the smell, and to like the smell of coffee but not the taste. These kinds of instances might constitute examples of a failure of perceptual grouping. But the fact that such *failures* occur further serves to highlight that there are also successes: often our flavour and smell experiences are unified.[82]

More work is required to determine how pervasive this kind of unification is. Although this thesis will not explore this issue further, the foregoing discussion may have implications for debates that take odours to be *sensibilia* — ephemeral entities that are

[81] However, it isn't clear from this study whether the participants had ever had any prior retronasal exposure to such stimuli, so this evidence does not *conclusively* show that we can recognise through flavour things only previously experienced through smell.

[82] This is analogous to various audio-visual cases highlighted by O'Callaghan (2017, p. 163). He has argued that a source of support for putative cases of multisensory grouping is to look at the phenomenological distinction between cases where the grouping succeeds and where it fails. Badly dubbed films are jarring and seem to result in wholly separate auditory and visual experiences, and a bad ventriloquist will result in our seeing the dummy's mouth moving as separate from the sound stream (and we might instead perceive the sound stream as being intimately connected with the ventriloquist's own mouth movements). According to O'Callaghan, what accounts for these phenomenological differences is the shift from a single multisensory object to multiple unisensory objects.

not ordinary objects and are only perceptible through a single sense modality (Richardson, 2018; see also Mac Cumhaill, 2018) — or more broadly take odours to be the 'proper objects' of olfaction. Odours are, according to such accounts, only perceptible through the sense of smell. Physical three-dimensional objects, on the other hand, do not appear to bear this kind of intimate connection with a single modality, since they are perceptible through both vision and touch, for example. However, if we are sometimes able to perceive a joint perceptual object through both flavour and smell, this may make their object more akin to the physical objects jointly detectable through vision and touch. Odorous, flavoursome substances may sometimes be experienced as a unified, single worldly entity. Whether this kind of joint perception challenges — or at least softens — notions of odours (and flavours) as sensibilia/proper objects would be worthwhile avenue for future investigation.

5.5 Conclusion

In this chapter I have argued that with some approaches to individuating the senses is it trivially true that flavour and smell objects are multisensory, but with another method of individuating them (whereby we treat the senses as perceptual systems), things are not so obvious. To help determine whether multiple senses are jointly involved in picking out a unified perceptual object, I proposed two different types of evidence: the application of the Gestalt grouping principles and multisensory Gestalt shifts. We saw that the first type of evidence, based on Gestalt grouping principles, supports unified multisensory flavour-

smell objects. Certain grouping principles seem to apply across flavours and smells. For example, I argued that there are genuine phenomenological *similarities* across odours and flavours (odours may be perceived as similarly 'sweet' or 'sour' to a flavour, for example), and there appears to be grouping in accordance with such similarities. Although further research about multistability in the chemical senses is needed, this chapter also outlined some suggestive evidence of multisensory Gestalt shifts across the flavour and smell. Such shifts indicate that these senses can engage in a unified interpretation of a perceptual object's identity and/or boundaries.

The evidence discussed in this chapter provides good reason to endorse the idea that, at least sometimes, there can be unified flavour-smell objects. Although generally the spatial boundaries of odours and flavours differ, in some instances because of the phenomenological similarities and close connections between these senses and their objects, flavour and smell can jointly pick out a unified flavour-smell object. This reflects the non-spatial manner in which the Gestalt principles can apply. However, we currently lack good evidence for certain other kinds of multisensory perceptual objecthood, such as single objects picked out by vision or audition in conjunction with flavour or smell.

6. Memory and the chemical senses

6.0 Introduction

In the previous chapters, through the application of aspects of Gestalt psychology, we have seen how we ought to understand the *perceptual objects* that we access through our sensorimotor engagement. The sensorimotor approach set out in this thesis also emphasises the *developmental* nature of perception. Perception is a skill to be learned, involving a kind of embodied know-how, which enables us to pick out unified perceptual objects segregated from their backgrounds. However, thus far we haven't explored in any detail how, in the course of this perceptual learning, prior experience shapes perceptual consciousness. This chapter will take a closer look at the role of previous experience and memory in perception, examining how familiarity with object-types impacts flavour and smell experiences.

This chapter has two distinct but thematically related objectives. First, I explore the relationship between two central components of perceptual object experiences: object individuation and (an aspect of) object recognition. The element of object recognition that I discuss here is known as *implicit object memory.* Drawing on empirical evidence relating to both vision and chemical senses, I argue that this form of memory can impact object individuation (understood through figure-ground segregation), which is generally considered to be a very early aspect of perceptual processing. I further argue that the sensorimotor approach to perception can help to defuse an a priori argument against the

claim that object memories can influence object individuation. According to this argument, it is logically required that to implicitly recognise an object, we must first be able to discern which parts of the visual field belong together as figures and which bits are background. Such an argument, however, relies on assumptions about implicit object memory that need not be endorsed.

Second, I explore another kind of memory involved in flavour and smell experiences — autobiographical memory. Flavours and smells tend to give rise to especially rich and emotional memories of one's past. This is known as the 'Proust Phenomenon'. The autobiographical memories of the Proust phenomenon are a narrative variety of memory; they involve the construction and reconstruction of personally significant stories. I draw on Velleman's (2003) account of narrative explanation here, according to which the intelligibility distinctive of narratives derives from the emotional trajectories (or 'cadences') central to them. I argue that the especially affective nature of olfactory and gustatory objects makes them particularly well-placed to serve as catalysts for these emotional trajectories at the heart of autobiographical memory. Just as certain triggers can reactivate procedural skills, certain triggers can reactivate emotional, interoceptive patterns. The arguments of this chapter suggest that the line between procedural memory and 'cognitive' forms of memory can be softened.

6.1 Does prior experience play a role in object individuation?

To what extent does prior experience of perceptual objects shape our future encounters

with such items? I argued in chapter 3 that perceptual constancies underpin various object recognition abilities (such as tracking, perceiving an object as persistent, and amodal completion), which are to be understood in terms of one's sensorimotor understanding. Here I focus on a different aspect of object recognition: implicit object memory, which is a familiarity with an object/object-type, without the requirement that the subject consciously remembers the object.[83] As we shall see, evidence suggests implicit object memories often influence figure-ground assignments. This is especially pertinent in flavour and smell perception, where it is hard to make figure-ground distinctions without familiarity with the relevant odours/flavours.

Two opposing approaches to the role of object memories in perception have emerged. Each is supported by differing empirical evidence and assumptions about perception. The first has been referred to as the 'figure-ground first' (FGF) approach (I follow Peterson & Skow Grant's, 2003 terminology here), according to which object memories cannot play a role in figure-ground assignments. With this approach, figure-ground segregation must precede higher level processing, occurring in a serial, feedforward manner (e.g., Marr, 1982; Kosslyn, 1987; Craft, Schütze, Niebur, & von der Heydt, 2007; Palmer & Rock, 1994). This has been the dominant approach in cognitive science. Kosslyn (1987, p. 148) says: '[H]igh-level visual processing in perception occurs after bottom-up figure/ ground

[83] As we shall see in the following discussion, the motivation for focusing on implicit object memories rather than conscious object memories is that exposure to particular object types can impact perceptual abilities even without any *conscious* recognition of the object.

segregation and parsing (which is done purely on the basis of stimulus properties)'. Stimulus properties alone, such as those upon which the classical Gestalt grouping principles are based, are said to be responsible for our figure-ground assignments. There are empirical reasons (to be discussed below) that Marr and others assumed that figure-ground segregation occurs early and access to object memories only occurs at a later stage. As section 6.1.2 will discuss, there is also an argument that takes the FGF approach to be true a priori.

The other approach — which I shall call the 'memory affects figure-ground' (MAFG) approach — instead argues that implicit object memory (or 'familiarity')[84] can affect figure-ground segregation. This second approach has been notably defended by Peterson and colleagues (Peterson, Harvey, & Weidenbacher, 1991; Peterson & Gibson, 1994; Peterson, de Gelder, Rapcsak, Gerhardstein, & Bachoud-Lévi, 2000; Peterson & Skow Grant, 2003). However, this idea that familiarity affects perceptual organisation isn't new. Rubin found that when viewers of an ambiguous figure-ground display (such as his famous vase, Fig. 6.1) look at the same display again, they have a tendency to perceive the same region as a figure again — a phenomenon he referred to as 'figural after-effects' (Rubin, 1915, Section 2; see also Peterson, 1999 for discussion).[85] Moreover, Wertheimer — who

[84] I use the terms 'implicit object memory' and 'familiarity' with objects interchangeably here. However, the term 'familiarity' shouldn't be taken to imply a conscious feeling of familiarity (see the distinction between explicit and object recognition below).

[85] Rubin's findings were criticised and various subsequent studies failed to replicate them (e.g. see Rock & Kremen, 1957) but as Peterson (1999) points out, such studies greatly differed in their design from Rubin's original study. Moreover, other research *did* replicate Rubin's findings (e.g. Gottschaldt, 1929/1938).

first set out the Gestalt grouping principles — suggested that past experience is one of the factors in perceptual grouping:

> Another factor affecting whether a certain grouping and segregation will result is familiarity or 'past experience.' In its simplest formulation, this principle asserts that if AB is familiar, and C is familiar, but BC is not; if they happen to be associated with something else (spoken names, etc.); or if AB/C is familiar, but A/BC is not; then there is the tendency for ABC to result in the familiar, frequently experienced, learned, trained pattern AB/C. (Wertheimer, 1923/1938, p. 160)

However, despite Rubin's and Wertheimer's observations, evidence taken from Gestalt psychology might also appear to reinforce the FGF approach. Typically, the Gestalt approach has emphasised the role of the classical grouping principles without consideration of past experience (see Wagemans, et al., 2012 for discussion). This is

Fig. 6.1. Rubin's Vase (adapted from Rubin, 1915, image 3)

Depending on one's figure-ground assignments, this image can be interpreted either as a white vase or as two black faces.

because, in the case of novel shapes, figure-ground assignments can seemingly be explained through these classical Gestalt cues alone. The Gestalt psychologists found that regions that were symmetrical, enclosed, convex, etc. are more likely to be perceived as figures, and are more likely to be grouped together with aspects of the scene that are similar to them, in close proximity, exhibit common motion, etc. Moreover, familiar figures can often be hidden within images (much like those in fig 1.1.a that hide a hexagon), and they will not be picked out over novel figures that conform to a more prägnant organisation (see Metzger, 1936/2006, p. 17, fig. 20, where the familiar numeral 4 is hidden within an image). The Gestalt principles can be understood as providing bottom-up heuristics for organising the perceptual field.

More contemporary studies have also been taken to favour the FGF approach (by Marr, 1982, for example). Warrington and Taylor (1973) found that a patient with a form of 'apperceptive' visual agnosia performed poorly at object and shape identification tasks (thus, seemingly lacking object memory), but was still able to segregate figure and ground correctly. This was taken as evidence in favour of the assumption that vision operates in a serial hierarchical manner, with figure-ground segregation occurring at an early stage prior to the accessing of object memories (Marr, 1982). According to the FGF approach, figure-ground assignments are not penetrable by 'higher' processes such as memory, and memories of objects are only accessed after figure-ground segregation has occurred. This has been the dominant approach in cognitive science.

The trouble with this kind of evidence for the FGF approach is that it stems from the faulty assumption that since there are *some* instances in which figure-ground segregation occurs without being influenced by object memory, it must always do so (see Peterson's 1999 critique of Marr). Taking the Gestalt principles to favour the FGF approach requires a jump from the claim that Gestalt principles can (sometimes) explain figure-ground effects without object memories playing a role, to the claim that object memories can *never* play a role in figure-ground segregation. Likewise, the evidence from Warrington and Taylor can on its own, at best, only show that in a particular case involving a subject with visual agnosia, object memory isn't playing a role in figure-ground assignments.

The MAFG approach is consistent with there being some cases where object memory plays no role in object individuation. Since the FGF approach says that it is *impossible* for object memory to play a role in figure-ground assignments, an alternative view need only argue that in *some* cases memory plays a role. This is the approach of Peterson and colleagues. In keeping with Wertheimer's original statements about the role of familiarity in perceptual organisation, they argue that object memory acts only as another defeasible cue for figure-ground assignment (Peterson & Gibson, 1994; Peterson & Skow Grant, 2003). Like the other cues, it can (ceteris paribus) make it more likely that certain aspects of the world will be grouped together as a unified *figure*, but it need not always be in operation. It neither dominates nor is dominated by the classical grouping principles of Gestalt psychology, and in the case of novel shapes where the subject does not have prior experience with that object-type, the classical cues alone can plausibly explain figure-

ground assignments (although, as 6.1.1 discusses, object memory is an especially important cue in the case of the chemical senses).

However, Peterson and colleagues don't merely wish to show that the evidence from agnosia and Gestalt psychology (which had been taken to support FGF) is *consistent* with MAFG. They wish to further demonstrate that in many cases, even those involving agnosia like the case highlighted by Warrington and Taylor, implicit object memory actually *does* play a role. Thus, they take a different line of enquiry and tease apart the notions of *explicit* and *implicit* object memories. Their research provides evidence of *implicit* object memories influencing figure-ground assignments even where the subject lacks *explicit* object memories.

Peterson and Skow Grant (2003) point out that Warrington and Taylor's study relied on naming tasks, which tested *explicit object memory*, rather than implicit familiarity. What was shown was that agnosic subjects didn't consciously recognise the objects and they were unable to successfully name them, i.e. involving 'conscious recognition and identification' (*ibid.*, p. 3), but they could still separate figure from ground in a normal manner. They argue that the kind of explicit object memory tested by the naming task differs from *implicit object memory*, which does not require a conscious awareness of one's familiarity with an object-type. The distinction between these forms of memory is vindicated elsewhere, for example in studies showing that conscious familiarity is impacted by medication that does not generally affect implicit perceptual memory

(Weingartner, Eckardt, Molchan, & Sunderland, 1992; see also Yonelinas, 2002, pp. 482–484 for discussion of other functional distinctions between these forms of memory).

In behavioural studies, it was shown that subjects are more likely to perceive familiar regions as being figures (Peterson, Harvey, & Weidenbacher, 1991). Importantly, Peterson and colleagues (2000) highlight cases where this holds even though subjects lack explicit object recognition abilities. They developed a study involving displays, similar to Rubin vases (Fig. 6.1), with a black shape in the centre and white shapes at the sides. The white shapes at the side depicted parts of well-known objects, such as face profiles or guitars, but they presented these displays at differing orientations (normal orientation or upside-down). They tested a visual agnosic, A.D., and discovered that although she was unable to consciously identify the well-known shapes presented, she (like non-agnosic subjects) was still more likely to perceive these 'familiar' shapes as figures when presented at their usual, more recognisable orientation. This occurred even though the traditional Gestalt cues such as convexity, symmetry, similarity and proximity remained the same whether the displays were in an upright or upside-down orientation. This suggests implicit object memories can play a role in perceptual grouping, even if the subject does not explicitly remember having encountered the object-type before. Regardless of conscious recognition, subjects' figure-ground assignments can be affected by implicit familiarity.

Peterson and colleagues' (2000) research appears to show that familiarity with objects at least sometimes plays a role in figure-ground assignments, contra the FGF approach.

Moreover, it suggests the relevant sort of memory involved in figure-ground assignments is — or at least can be — of an implicit non-declarative form.[86]

Fig. 6.2. The Dalmatian

The well-known photograph of a Dalmatian by R. C. James. It is very difficult to locate the dog on first viewing of the image.

Moving beyond the simple shapes used in Peterson's research towards more complex ambiguous images provides more obvious cases where familiarity influences figure-ground segregation. Consider the famous Dalmatian image by R. C. James (Fig. 6.2). To see the dog in the image in the first instance, plausibly one must have encountered dogs

[86] There is also evidence suggesting that conscious declarative memory of shapes is not *sufficient* for this pattern of figure-ground effects. Telling a subject that the orientation of the display has changed — and the subject being well-aware of what the upside-down shape depicts — does not increase the likelihood of them perceiving this region as a figure (Peterson, Harvey, & Weidenbacher, 1991; Peterson & Gibson, 1994).

before (without some level of familiarity with dogs it is unlikely one would be able to see the hidden figure), and even then, it is difficult to pick out the Dalmatian initially. And when one has seen this figure once, it is almost impossible not to pick it out again in future encounters, thus suggesting that one develops a memory of this specific stimulus. This effect appears to hold even in cases where subjects deny conscious recollection of their prior experience with such an image, suggesting again that *implicit* object memory is playing the crucial role here (Mitchell, 2006). This is a clear instance where figure-ground assignments are influenced by prior experience.[87]

Proponents of FGF may deny that our interpretation of such images is a purely visual activity. Marr (1982, p. 101) says that the Dalmatian image relies upon complex top-down factors (such as memory) rather than just 'straightforward visual skills'. However, the assumption that such instances of perception — confounded by top-down influences — are clearly separable from those cases that only involve straightforward visual skills already requires a reliance upon the kind of serial model of vision advocated by Marr.

[87] As an addendum to this, certain cross-cultural studies provide additional support for the MAFG approach. Such research provides support for the claim that familiarity (or lack thereof) can play a role in whether perceptual grouping is successful and can alter the kinds of figure-ground assignments that are made. The Pirahã, a remote Amazonian tribe with limited access to modern media, are less able to recognise two-toned images reduced to just black and white (akin to the Dalmatian image, fig 6.2) than English-speaking controls, even in the presence of the original photo from which the two-tone image was adapted (Yoon, et al., 2014). Subjects are unable to perceptually group the images into meaningful figures, perhaps because of their lack of familiarity with these types of black and white photographic images. Thus, in this case, lack of familiarity results in a failure to segregate into meaningful figure and ground. See also Stachoň and colleagues (2019) for discussion of how cultural differences impact figure-ground assignments in the reading of reference maps. Other research suggests that figure-ground assignments can be treated as a skill built on prior experience. For example, video game players are better at picking out visual targets in a cluttered field than non-gamers (Achtman, Green, & Bavelier, 2008)

Without this assumption (and in light of the evidence from Peterson suggesting that implicit object memory can influence figure-ground assignments even in the 'simple' cases), it doesn't appear than the Dalmatian case can simply be dismissed as not straightforwardly visual. In previous chapters I advocated extending object concepts to the chemical senses, and here we will see that the FGF approach is especially empirically implausible as an account of such non-visual perceptual objects.

6.1.1 Further support for MAFG: familiarity and the chemical senses

Consideration of the chemical senses provides support for the MAFG approach (or at least suggests that it is the correct approach for the chemical senses). Familiarity plays an especially important role in our figure-ground assignments in these senses. While there may be some limited cases where a perceiver does not have prior experience with an object in these senses, it is difficult to individuate wholly novel flavour and smell objects. Most of the empirical research surveyed in this section relates to olfaction, but because of the close connections between olfaction and flavour perception (see chapter 5), much of it plausibly also applies to flavour.

Implicit (rather than explicit) object memory is the norm in olfactory experience as often odours aren't explicitly noticed in the first place, and there are relatively few instances where *explicit* object memory is required. For those who don't regularly engage in activities like wine-tasting, explicit olfactory object memory is likely to be largely restricted to cases such as cooking and gas leak detection (Köster, Møller, & Mojet, 2014). Yet

implicit familiarity with odours has a dramatic impact on our abilities to individuate them. For example, subjects who work at perfume retail outlets (Hummel, Guel, & Delank, 2004) perform better than controls in odour discrimination tasks. Moreover, subjects are poor at distinguishing novel odours from one another (i.e. olfactory object individuation). However, they quickly improve after repeated exposure to these odours (Jehl, Royet, & Holley, 1995). Thus, we can see that olfactory familiarity greatly improves individuation abilities, presenting a challenge for FGF approaches. It is particularly difficult to individuate odours on the basis of stimulus properties alone (which is not to say it is impossible, as discussed in chapter 3). Thus, prior experience seems to play a particularly important role for olfaction.

Although prior experience generally makes us better at olfactory figure-ground segregation, it can also make certain figure-ground distinctions more challenging or alter how odours and flavours are individuated in interesting ways. This is evidenced by the effects of odour-pairings. Studies show that if subjects are presented with combinations of novel odours, the individual odours subsequently often seem more similar to one another (and, thus, harder to discriminate). If cherry and mushroom odours are paired, mushrooms are subsequently experienced as smelling more like cherries, and vice versa. And it becomes harder to discriminate between these odours (Stevenson, 2001; Case, Stevenson, & Dempsey, 2004; Wilson & Stevenson, 2007). This suggests that prior experiences can make it harder to individuate perceptual objects and/or alter the figure-ground assignments that one makes.

Olfactory experience is often more analogous to difficult-to-segregate, ambiguous visual cases like the Dalmatian dog image (Fig. 6.2; see Wilson & Stevenson, 2006, pp. 113–114, who draw this kind of comparison) than it is to perceptions of simpler visual images. The Dalmatian image involves a lot of confusing background 'noise' and the Dalmatian doesn't have clearly demarcated edges. Thus, seeing the dog as a figure segregated from the background in the first place requires a degree of understanding about the shape of a dog, how it would look across different perspectives and so forth. Similarly, olfaction usually involves picking figures out from a background of wide-ranging odours and the edges of odours are not clearly specified. Plausibly experience of odours in different contexts, against different background odorants etc., enables us to develop the ability to segregate them efficiently and consistently. Similarly, once we have mastered the skills relevant in allowing us to individuate and recognise odour objects, we become much more adept at perceiving these objects again.

Object memory thus plays an especially important role in successful figure-ground segregation in the chemical senses. It is harder to individuate olfactory objects on the basis of stimulus properties alone and individuation is often facilitated by acquired familiarity. The classical Gestalt cues do at times allow for novel figure-ground assignments. Through extended smelling and savouring activity, we can individuate flavour and smell objects through classical Gestalt principles (see chapters 3 and 4 for further discussion). However, in comparison to visual perception of novel objects, this environmental exploration is likely to be even more protracted. While the presence and

strength of odours can often be determined in a single sniff, perceptual grouping and object individuation often requires multiple sniffs (see Mainland & Sobel, 2006), which occur about 1.6 seconds apart. We can perceive odours as spatially extended and located (allowing for spatial figure-ground segregation), but this is a time-consuming process. We generally don't *synchronically* (i.e. at a single time) experience odours being at a determinable distal location but can do so *diachronically* (across time) as we engage with the perceptual landscape (see Young, 2016).[88] Successfully perceiving novel odours as individuated objects is often rather difficult and slow. Plausibly, the same holds in the case of flavour perception. As argued in chapter 2, flavours often follow temporally extended trajectories and seem equally elusive (see also Smith, 2015b).

Implicit object memory is required for quick and easy olfactory figure-ground segregation (and likely this applies to flavour perception too). There thus appears to be an especially tight link between object memories and the chemical senses. Olfactory figure-ground segregation is hard to achieve without prior experience and thus looking to the chemical senses seems to lend further support to the MAFG approach.

6.1.2 Defusing the a priori argument

However, even though the evidence surveyed above makes the FGF approach empirically implausible, especially when applied to the chemical senses, there remains another kind

[88] Although see Aasen, 2018 for phenomenological reasons to think we can sometimes experience the spatial extension of odours, and their being at a distance, even synchronically.

of argument in favour of this approach. There is an a priori worry about object memory influencing figure-ground assignments. According to this argument, to *recognise* an object, we must first be able to discern which parts of the visual field belong together as figures and which bits are background. Rock and co-authors have expressed such a worry. Rock and Kremen (1957, p. 23) state:

> There is a logical reason, however, why past experience should not determine form perception as here defined. Insofar as past experience with specific shapes is preserved via memory traces, to say that such past experience can determine form is to say that the relevant trace can enter into the process which organizes the percept. But we assume that ordinarily the relevant trace is aroused after the form is perceived, that it is selected in some way by virtue of the similarity of the present perceptual process to the trace and that this leads to recognition.

And more recently Palmer and Rock (1994, p. 517) similarly argue:

> The major difficulty we see … is that object recognition seems logically to imply a comparison between the shape of the object candidate and the shapes of known object types. This, in turn, seems logically to require that figure-ground organization occur prior to object recognition, because a contour imparts shape only to the region on its figural side; the ground is seen to extend uniformly behind the figural region. Such considerations lead us to believe that some distinction between figure and ground processing must occur prior to object recognition. The logic appears airtight.

This kind of argument is premised on the idea that object memory involves matching up a current target object (i.e. already picked out as a segregated individual) with object-representations stored as memories. For a current object to be subject to comparison, it must have undergone figure-ground segregation (otherwise it would not be a discrete perceptual object in the first place). Thus, according to Rock and colleagues' line of argument, the MAFG approach is false since it says that, at least in some cases, the target

object is *not* segregated prior to the operation of object memory.

Peterson and Gibson's (1994) solution to this kind of worry is to take there to be some early partial edge detection (which does not constitute full-blown figure-ground segregation) that allows for the accessing of object memories. Such a solution concedes that there is initial perceptual organisation prior to the activation of implicit object memories but alleges that this organisation does not count as figure-ground segregation. This kind of approach allows one to hold onto the premise that implicit object recognition requires a comparison between something currently represented and stored object memories. Yet, it says that the items that are subject to comparison are not individuated figures but merely partial edges. The applicability of such a suggestion to the chemical senses is unknown (especially since it's unclear whether the notion of 'partial edges' makes sense in these domains). However, regardless of this, one could perhaps avoid the a priori worry in a similar way by simply arguing that *some kind* of rudimentary chemical information (which does not itself constitute figure-ground segregation) can be compared with stored flavour and smell object representations.

It is unclear, though, whether Peterson's approach really succeeds in avoiding reliance upon figure-ground segregation prior to object recognition. Palmer and Rock (1994) find Peterson and Gibson's solution to be inadequate because they think that if edges are to serve the role required by the proposed solution, they must actually be the boundaries of a figure. This is because edges alone do not have shape: 'they merely impart shape to the

regions they bound.' (p. 517) Edges alone are shapeless and thus don't impart sufficient information to allow for comparison with remembered objects. They thus think that Peterson and Gibson are sneaking the notion of figure-ground segregation back into their account. The challenge is to find early perceptual information that is sufficiently informative to allow for matching up with object-representations, but which is also sufficiently *uninformative* that it doesn't yet involve figure-ground segregation. Although this thesis does not offer a full investigation of whether such an approach can succeed, I agree with Palmer and Rock that there is a tension within this strategy.

Regardless of whether Peterson and Gibson's proposed solution can succeed, there is a different kind of response available to the proponent of MAFG. With this suggested approach, the a priori worry does not arise. Rather than searching for a kind of early perceptual information that treads the delicate line between too informative (i.e. already involving figure-ground segregation) and not informative enough (to allow for matching up with object representations), one can instead question the notion of implicit object memory that the a priori argument is premised upon. Rock and colleagues take object recognition to be a process of comparing current perceptual representations with those stored in memory. This idea follows the traditional hierarchical representation-based models of researchers such as Marr (1982) and Biederman (1987). According to such approaches, context-neutral representations of objects are stored in the brain and when one encounters further objects, the current perceptual representation is matched up to those stored in memory.

As we have seen, the kind of memory of interest to MAFG is an *implicit* form of object memory. It thus requires no conscious awareness of one's own familiarity with an object-type; it need not be accompanied by conscious episodic memory (recollection of events of the personal past) or semantic memory (recollection of facts or propositions). This implicit form of memory is generally evidenced simply by alterations to behavioural and perceptual engagement with the world owing to prior experience (as in priming tasks, for example).[89] Much like the other well-known form of implicit memory, *procedural* memory (the type of long-term memory responsible for bodily skills such as riding a bike and playing the piano, i.e. *know-how*), a subject's prior experience shapes their future behaviours and/or perceptions. As with procedural memory, it isn't clear that implicit object memory constitutes *know-that*. It may instead be explicable in terms of a kind of bodily *know-how*. Subjects learn how to perceptually engage with certain object-types, without necessarily remembering any prior encounters with such objects.

Many researchers have taken there to be no explanatory need to understand procedural memory in terms of the retrieval of stored contents (e.g. Schacter & Tulving, 1994; Tulving, 2000; Sutton & Williamson, 2014; Michaelian, 2015). Tulving (2000) takes the application of such concepts to procedural skills to be 'awkward at best and silly at worst' (2000, p. 38). However, usually these researchers draw a sharp distinction between such

[89] The orthodoxy is to treat priming as non-declarative, but as still a cognitive form of memory based on the retrieval of stored contents (Schacter & Tulving, 1994; Tulving, 2000; Michaelian, 2015). The view expressed here can be seen as diverging from this assumption.

behavioural skills and 'cognitive' forms of memory, which are to be understood in terms of the retrieval of stored contents (e.g. Schacter & Tulving, 1994; Tulving, 2000; Michaelian, 2015). Meanwhile, other researchers have questioned the notion of memory traces and/or rejected memory as grounded in stored internal representations altogether (e.g. see Moyal-Sharrock, 2013; Myin & Zahidi, 2015; Hutto & Myin, 2017; Hutto & Peeters, 2018), instead advocating that we treat memories as embodied capacities. Although here I do not commit to a wholesale rejection of internal representations in memory, implicit object memories are a good candidate for a more embodied treatment. With the developmental style of sensorimotor approach set out in this thesis (see chapters 1 and 2), prior experience allows for mastery of the relevant sensorimotor contingencies and hones worldly interaction. Through these modifications to a subject's perceptual engagement with the world, their figure-ground assignments can plausibly be altered (as per the MAFG approach). There need not be a comparison between a target object and remembered object for this to occur (which is not to claim that the relevant worldly interactions are not guided by neural representations).

This approach can defuse the a priori argument. If perception is treated as a bodily skill that can be refined through prior experience, there is no logical problem stemming from a need to match current perceptual representations with stored object representations. Comparison between perceptual representations is not how implicit object memory is to be understood. It is instead to be understood in terms of a subject's mastery of the relevant object-related sensorimotor contingencies. Prior experience with objects allows

for this mastery, honing one's perceptual engagement with the world.

This approach not only allows for the defusal of the a priori argument but is also empirically tractable. Empirical support for such an approach to implicit object memory includes studies in both robotic systems and humans. Such research has suggested that object recognition can be understood in terms of the mastery of object-related sensorimotor contingencies (see Engel, Maye, Kurthen, & König, 2013 for a review of relevant empirical evidence). For example, researchers have developed models in robotic systems, where the activation of sensorimotor contingencies allows the system to recognise and distinguish object-classes (Maye & Engel, 2011).[90]

With the sensorimotor framework set out in this thesis and with the preceding discussion in mind, plausibly the form of implicit object memory discussed here consists in sensorimotor understanding. This is consonant with the emphasis on familiarity and prior experience by sensorimotor theorists (see chapter 2's discussion of the developmental type of sensorimotor account, especially section 2.3). For example, Noë asserts:

> …we can only expand our experiential repertoire piecemeal, by nudging forward holding hands with what is familiar. For the most part, we are simply incapable of new sights, new sounds, new experiences. What we can perceive is limited to what we understand. (2006a, p. 31)

The preceding discussion supports this kind of assertion and allows for the added claim

[90] See also Kietzmann, Geuter, & König (2011) for research into the role of eye movement in *conscious* object recognition.

from MAFG that familiarity is often involved even in supposedly simple perceptual processes like figure-ground segregation.[91] With this suggested approach, the distinction is softened between this implicit form of object memory and so-called *procedural* memory — the form of long-term memory, responsible for bodily skills such as riding a bike and playing the piano. Both can be understood as bodily skills shaped by prior experience. It also suggests that Gestalt principles are particularly important for the perception of novel objects, which involves more protracted sensorimotor engagement with the environment. Based on this discussion, it appears that Gestalt principles may serve as heuristics for guiding this initial sensorimotor engagement. As the subject begins their perceptual engagement with the environment, stimulus features (that are, for example, similar and proximal/dissimilar and far apart) allow for initial expectations about which parts of the world belong together and which are distinct.

6.2 Familiarity and affect in the chemical senses

Along with prior experience come affective associations. The chemical senses are often taken to be especially affective, which may be related to the particularly important role that object memory plays in flavour and smell. Having looked at how prior experience can

[91] It shouldn't, however, be inferred from this that with the sensorimotor approach it is impossible to perceive novel objects. As argued in chapter 2, the exercise of sensorimotor understanding *either* involves current bodily coupling with the environment *or* an attunement to how counterfactual bodily interaction with the world would induce sensory changes. Some types of perception — such as some types of temporally extended perception — appear to require the former, involving protracted engagement with the environment. Perceiving novel objects plausibly also requires this kind of more extended coupling with the environment to allow for the development of new sensorimotor understanding.

influence the way the perceptual field is parcelled up into discrete entities, here I shall explore how familiarity also shapes the affective valence of perceptual objects. This in turn will help to explain the so-called 'Proust phenomenon' — the capacity of flavours and smells to induce particularly rich autobiographical memories, which will be the topic of discussion in subsection 6.2.1.

Flavour and smell experiences have a pronounced hedonic character and are closely connected to emotion and mood. The chemical senses generally give rise to more visceral affective reactions than the other senses, often provoking an 'escape response' (i.e. a heightened motivation to escape the situation), rather than just a negative affective experience (Asmus & Bell, 1999). Moreover, hedonic valence (pleasantness/ unpleasantness) tends to dominate olfactory experiences (e.g. Zald and Pardo, 1997; Khan et al., 2007). These aspects of the chemical senses are so pronounced that some take flavour and smell to be *intrinsically* valenced (e.g. Todd, 2018). With Todd's approach, the affective aspects of flavour and smell experiences cannot be phenomenologically separated out from an objective flavour. This, he argues, is not the case in other perceptual experiences such as auditory experience of sound, where the unpleasantness of a sound is largely determined by factors such as volume, timbre and pitch (p. 287). The valence of flavours and smells, on the other hand, are not reducible to such dimensions. This conclusion may also be supported by multidimensional scaling techniques, which have been used to argue that valence is the most important factor in odour assessment (Haddad, et al., 2008). When rating similarity, sounds are likely to be ordered from low to

high pitch, smells are likely to be ordered (at least in part) in accordance with their pleasantness or unpleasantness.

The significance of valence in the chemical senses is reflected in brain structures common to emotion and odour processing (for a review see Soudry, et al., 2011). Much of our emotional and olfactory processing occurs in limbic brain regions, such as the amygdala and hippocampus. The amygdala is crucial for emotional processing and is known to be especially involved in the detection of threat (Whalen, et al., 2004). It receives strong input from the primary olfactory cortex, and the connections between the amygdala and the primary olfactory cortex are bidirectional (Zald & Pardo, 1997). No other sensory system is so directly and dynamically connected with the parts of the brain responsible for emotional processing.

There is reason to believe that implicit object memories of the sort set out in the previous sections play an important role in the highly valenced nature of flavours and smells. Plausibly, prior experience results in various affective associations, which impact future perceptual experience. This is supported by research showing that subjects tend to rate *unfamiliar* odours as neither pleasant nor unpleasant (Keller & Vosshall, 2016), suggesting that prior experience plays a role in the affective value of olfactory perceptions. Thus, one's previous encounters can play a role in not only the successful individuation of flavours and smells (as argued in the previous section) but also in their affective valence.

Further evidence shows that in the case of the chemical senses, we not only associate

perceptual objects with connected scenarios, contexts and feelings, but also the common *sources* of those odours and flavours. This is reflected in people's preferences. One's like or dislike of a particular odour appears to be predicted by the average preferences for *all* of the source-objects associated with that odour, weighted by how closely these associated objects match the relevant test odours (Schloss, Goldberger, Palmer, & Levitan, 2015).[92] An apple odour is not just associated with apples, but also scented soap, sweets, etc., and according to this research, how positively valenced an apple-odour perception is will depend upon how positive or negative all these associations are. These associations will vary greatly between individuals. The smell of burning wood may be associated with campfires, but could also be associated with burning buildings, and the valenced nature of the percept is correlated with the weighted average of these positive and negative associations. Again, this would appear to support the idea that the associations based on prior experience play a role in the valenced nature of olfactory perceptions. Subjects' preferences for certain odours are based upon the valences of prior odour-related experiences. Although humans tend to rely most heavily on visual and verbal communication as we navigate throughout the world, the chemical senses remain associated with our survival. The perceptual objects of the chemical senses are highly linked with things such as food consumption (Fallon & Rozin, 1983), disease and hazard avoidance (Curtis & Biran, 2001), reproduction, and social preferences (Li, Moallem,

[92] The idea that preferences for stimuli are predicted by one's preferences for the things associated with those stimuli has also been shown to apply for colour preferences (Palmer & Schloss, 2010) and the model has had reasonable success in predicting visual texture preferences (Stephens & Hoffman, 2016).

Paller, & Gottfried, 2007). Such factors, along with the difficulty in perceiving individuated flavours and smells without prior experience (and the consequent affective associations), may go some way to explaining why they are so affectively charged.

One way to cash out the idea that prior experience results in the affective valence of a perceived object is provided by Barrett and Bar (2009) and Lebrecht and colleagues (2012). According to such an approach, prior reactions to perceptual objects allow for implicit expectations regarding the value of objects when we encounter them again. It is plausible in the case of the chemical senses that the highly valenced nature of these perceptions is (at least in part) due to the kinds of associations we have with tastes and smells. The affective value of objects is understood in an embodied manner consistent with the sensorimotor approach. When faced with a pleasant or unpleasant sight, smell, taste, texture or sound we undergo a range of interoceptive, affective sensations such as changes to muscle tension, stomach motility, breathing, heart rate, etc. (Barrett & Bar, 2009). The sensorimotor approach encourages us to view these bodily changes as parts of sensorimotor loops. A mastery of object-related sensorimotor contingencies may also involve an attunement to the kinds of interoceptive sensations these objects may induce. Objects may be perceptibly valenced in virtue of such expectancies.[93]

[93] Although beyond the scope of this thesis, this can plausibly help to explain the motivational character of our perceptions — because of the affective valence of perceptual objects, they are able to solicit various actions from us. For example, if a flavour is perceived as disgusting it will likely result in very different action tendencies (spitting out, throwing food away, etc.) than flavour perceived as delicious (eating more, savouring, etc.).

With this understanding of the affective valence of perceptual objects, connections can also be drawn between such perceptual experiences and the memories that are sometimes triggered by such perceptions. It is a well-known piece of folk wisdom that the chemical senses are especially effective at prompting rich and emotional memories of the past, as was famously described by Marcel Proust.[94] Many people find the ability of the chemical senses to induce memories to be a very salient aspect of the phenomenology surrounding tasting and smelling. Thus, it is worth considering whether the approach set out in this thesis can offer something of value to our understanding of this phenomenon. In the final section of this chapter I shall offer a discussion of how an embodied sensorimotor approach can be informative about the links between the chemical senses and emotional autobiographical memories.

6.2.1 The Proust phenomenon

We have seen that flavours and smells are often especially strongly valenced, carrying a range of affective associations. Moreover, we have seen that with the suggested sensorimotor approach, the distinction between some forms of cognitive memory and procedural memory can be softened. Here, with both of these ideas in mind, I shall argue that even a seemingly paradigmatic example of declarative (expressible verbally), cognitive memory — autobiographical memory — may also not be so sharply

[94] The phenomenon has been depicted more recently in the popular 2007 Pixar film *Ratatouille*, where the taste of ratatouille mentally transported an unsentimental restaurant critic back to his childhood.

distinguishable from procedural forms of memory. This reframing of autobiographical memories can help to explain the phenomenology of the so-called 'Proust phenomenon — the capacity of the chemical senses to trigger particularly rich autobiographical memories.

In his novel *In Search of Lost Time,* Marcel Proust describes a character recalling highly vivid and emotional childhood memories after smelling and tasting a madeleine biscuit soaked in tea.

> No sooner had the warm liquid mixed with the crumbs touched my palate than a shudder ran through me and I stopped, intent upon the extraordinary thing that was happening to me. An exquisite pleasure had invaded my senses, something isolated, detached, with no suggestion of its origin. And at once the vicissitudes of life had become indifferent to me, its disasters innocuous, its brevity illusory — this new sensation having had on me the effect which love has of filling me with a precious essence; or rather this essence was not in me it was me. ... Whence did it come? What did it mean? How could I seize and apprehend it? ... And suddenly the memory revealed itself. The taste was that of the little piece of madeleine which on Sunday mornings at Combray (because on those mornings I did not go out before mass), when I went to say good morning to her in her bedroom, my aunt Léonie used to give me, dipping it first in her own cup of tea or tisane. The sight of the little madeleine had recalled nothing to my mind before I tasted it… (Proust, 1913/1992, pp. 60–63)

This literary work has attracted the interest of psychologists and neuroscientists as it seems to capture a special link that the chemical senses have with autobiographical, affective memories, which has been dubbed the *Proust phenomenon.* Autobiographical memory is most commonly taken to involve a combination of episodic and semantic forms of memory (both themselves generally taken to be cognitive, declarative forms of memory, involving the retrieval of stored contents), and involves a recollection of events

from one's own life or has some kind of personal significance.[95] Unlike the implicit forms of memory discussed in 6.1, autobiographical memory is considered a type of *explicit* declarative memory. Consistent with Proust's descriptions, empirical research shows that the chemical senses are especially effective triggers for vivid autobiographical memories (de Bruijn & Bender, 2018). Such memories are significantly more likely to involve a feeling of being 'brought back' in time than those that are prompted visually (Herz & Schooler, 2002, p. 30) and they are particularly emotional, as measured both by self-reports and heart-rate responses (Herz & Cupchik, 1992; Herz & Cupchik, 1995; Chu & Downes, 2001; Herz & Schooler, 2002; Willander & Larsson, 2007). They also tend to relate to earlier experiences, often involving the first decade of one's life (Chu & Downes, 2001).[96]

Not only are the memories of the Proust phenomenon markedly vivid and emotional, but they are importantly narrative-involving. One reason for treating such memories as inherently narrative-involving is that phenomenologically, autobiographical memories do usually appear to take the form of words or stories, as is exemplified by Proust's narrator. They involve reliving or recounting stories from one's life. A number of researchers (e.g. Nelson, 1988; Nelson & Fivush, 2004; Hoerl, 2007; Fivush, 2011; Hutto, 2017; Hutto & Myin, 2017) have also offered good empirical reasons to take autobiographical memory

[95] Autobiographical memory has been defined in different ways. Some take it to include all types of self-related information (e.g. Brewer, 1986), while others restrict it to memories with particular significance (e.g. Nelson, 1993). I shall not adjudicate the merits of each definition here.

[96] More generally, smells serve as particularly effective memory prompts after long delays. This was highlighted by a study of how the distinctive smell of the Jorvik Viking Centre in York, UK can (more effectively than non-relevant control odorants) prompt memories of the centre six years later (Aggleton & Waskett, 1999).

to be a kind of socio-culturally acquired narrative skill, involving a learned ability to reconstruct stories from one's past.[97] With such a view, narratives provide a kind of cognitive framework for autobiographical memory, and this is something that is developed in childhood and further refined through our lives (for detailed discussion see Hoerl, 2007; Hutto & Myin, 2017).

Why should the chemical senses be so well-suited for triggering emotional narrative memories of this sort? A phenomenologically satisfying account of why this should be the case requires some exploration of the connections between affective perceptions and the dynamics of emotional autobiographical memories. Proust-style memories feel as though they follow quite naturally from the affective nature of the percepts that trigger them, which I shall suggest can be explained with an embodied approach to emotional memories.

An account that accurately captures the phenomenology of how Proustian memories unfold is provided by Velleman's (2003) approach to narrative understanding. For Velleman, narrative understanding is emotional understanding. It is assumed that emotions exhibit intentionality — a directedness at objects, events or states of affairs — and because of this they are capable of imparting meaning. Our understanding of stories

[97] Although narratives can purport to convey the truth, they need not actually do so and may be more closely related to — for example — our sense of self and our well-being. This approach coheres with the growing consensus that memory is not simply stored in a relatively inactive form in the brain before being retrieved, but inherently involves construction and reconstruction (e.g. see Nelson, 1993; Schacter, 1996; Conway & Pleydell-Pearce, 2000; Schacter & Addis, 2007; Sutton & Williamson, 2014).

(including, he thinks, those by which we understand our own lives) comes from the *emotional cadences* to which they give rise — their distinctive patterns of emotional arousal and resolution. Stories can be analysed as having beginnings, middles and ends and each of these stages, and their relationship to one another, are intelligible in virtue of their emotional structure. The ups and downs of narratives are *felt*. For example, Velleman (*ibid.,* p. 16) suggests that a horror story might be understood emotionally in terms of initial puzzlement that gives way to horror, which finally gives way to relief. Such cadences are not just random emotions pieced together, but instead follow distinctive trajectories that we learn through our own engagement with the world and through the stories that we become familiar with.

Since William James (1884) proposed that emotions can be understood in terms of perceptions of physiological changes, many researchers have taken emotions to be importantly embodied, crucially involving an affective bodily component. Along these lines, Velleman takes emotional cadences to be visceral and embodied, stored 'in experiential, proprioceptive, and kinesthetic memory–as we might say, in the muscle-memory of the heart' (p. 19). Thus, they can be understood, at least in part, in an embodied, enactive way consonant with the sensorimotor approach (particularly where sensorimotor loops are taken to extend to interoceptive sensations as suggested in 6.2). Moreover, as we saw in chapter 2, sensorimotor understanding can extend to the grasp of trajectories. We can be attuned to the way that flavours and smells (and pieces of music, etc.) unfold over time in accordance with definite patterns. By the same token, our

skilful sensorimotor engagement with the world is likely continuous with related tools we use to understand the world, such as our grasp of how narratives unfold. While there is not scope in this chapter to explore the viability of Velleman's approach to narratives more generally,[98] the account seems apt as a description of how Proustian memories feel. Thus, there are phenomenological reasons for thinking Velleman's account can assist us in our understanding of how the chemical senses trigger memories.

The emotional manner in which memories triggered by flavours and smells unfold does appear to be characterised by distinctive emotional patterns. When we have a sense of being teleported back in time, remembering various events of our lives (which may or may not be directly and saliently causally related to one another), these events seem connected to one another emotionally. In *In Search of Lost* Time, there is not an obvious causal link (at best, there are only complex and tangential causal connections) between the narrator's Aunt Léonie dipping a madeleine in lime-flower tea and the subsequently recounted events, places and people in Combray, but there are salient emotional links between such events for Proust's narrator. Moreover, Velleman highlights that certain emotional happenings seem to naturally follow from others: 'some episodes set off an emotional tick to which subsequent episodes can provide the answering tock' (p. 20), capturing the way a remembered event seems to naturally give way to another. If

[98] For critiques of such an approach as definitional of narrative understanding, see Carroll, 2007; Currie, 2008. For discussions of how this approach can inform us about agency and mental time travel, see Hardt, 2017; Ward, 2019.

autobiographical memories have this form, then percepts imbued with emotional or affective content would seem well-placed to serve as the initial 'tick' that then prompts the rest of an emotional trajectory. Since olfaction and flavour perception are especially affectively-charged they are likewise particularly powerful catalysts for instigating such trajectories. The experience of tasting a madeleine or a spoonful of ratatouille may be highly affectively valenced — perhaps inducing 'an exquisite pleasure' (Proust, 1913/1992, p. 60) — and this gives way to the unfolding of an emotional cadence.

As discussed in 6.1, researchers have often drawn a clear divide between bodily procedural skills and 'cognitive' forms of memory involving the retrieval of stored contents (e.g. Schacter & Tulving, 1994; Tulving, 2000; Michaelian, 2015). However, taking there to be such a sharp distinction in the case of emotional autobiographical memories (a 'cognitive' type of memory) conflicts with the embodied manner in which these autobiographical memories unfold. If the suggested account is correct, emotional/affective experience can prime us to continue the rest of the embodied, affective cadence of an autobiographical memory. Familiar patterns of bodily response are initiated when prompted. With this approach to the Proust phenomenon, perceptions of odours and flavours can allow for a reinitiation of affective, interoceptive processes (giving rise to an emotional cadence) in a similar manner to how *procedural* memories allow for reinitiation of particular rehearsed bodily skills. Thus, as we saw with regards implict object memories above, there may again be scope to question the strict line drawn between cognitive and procedural forms of memory.

A piano player might implicitly know how to continue a piece of music after the first couple of notes. Or when someone remembers a speech, a sentence or two can serve as a prompt from which rest of the speech will flow. Similarly, a particular affective state induced by smelling or tasting may trigger the rest of a more extended affective cadence, which we implicitly recognise as following on naturally from this state. As noted above, Velleman (2003), describes our grasp of such trajectories in terms of the 'muscle-memory of the heart' (p. 19), and perhaps we ought to take his analogy with (a form of) procedural memory seriously.

While much more work will be required to fully understand autobiographical memory and how it connects to perception and emotion, Velleman's embodied approach to narrative understanding is helpful in capturing the phenomenology of Proustian memories. Moreover, although autobiographical memory is beyond the immediate purview of the sensorimotor approach, the preceding discussion shows how the sensorimotor approach to perceptual experience can be tied into broader discussions about the phenomenology of experience.

6.3 Conclusion

Perceptual experience (as understood through the proposed sensorimotor account) relies on past experience, which can shape perception through alterations to even supposedly early processes like object individuation as well as inducing affective associations. This can

in turn help us to understand why perceptual experience might trigger emotional memories.

This chapter argued that familiarity with objects can influence the way the perceptual field is parcelled up into discrete entities. This is pertinent in the case of the chemical senses where individuating wholly novel objects is generally particularly tricky and time-consuming. With the approach set out, the distinction between cognitive forms of memory and procedural bodily memories is softened: implicit object memories can be construed as part of our embodied attunement to sensorimotor contingencies. This chapter further argued that the kinds of prior experiences that allow for implicit object memories can also foster affective associations. Since prior experience is even more central to olfactory and flavour perception than it is to vision, we can expect fewer (if any) instances of hedonically neutral flavours and smells. Finally, I argued that treating flavours and smells as especially affectively valenced can help to explain why they serve as effective catalysts for emotional, narratively driven memories. Drawing on Velleman's account of narrative understanding, I argued that the affective valence of perceptual objects can serve as a kind of prompt for the rest of an affective cadence characteristic of a narrative trajectory. This again suggests that the line between bodily procedural memories and cognitive memories may not be clear cut.

7. Conclusion

7.1 Summary

This thesis has explored whether the sensorimotor approach — supplemented by ideas from Gestalt psychology — can be extended to flavour and smell. I argued that flavour and smell do not present a problem for a sensorimotor approach and presented a positive account of how we should conceive of flavour and smell experiences within this framework. The main amendment to the sensorimotor approach throughout the thesis was to argue that it is *perceptual objects*, understood as discrete particulars involving figure-ground segregation and perceptual constancies, rather than just ordinary physical objects that we gain access to through sensorimotor engagement. Sensorimotor skills allow perceivers to gain access to these *perceptual objects*, which not only include three-dimensional physical objects but more diffuse entities like odours and flavours. This helps sensorimotor enactivism to achieve its aim of offering a general account of perception across the senses.

The previous chapters have provided reason to both question the orthodoxy about the chemical senses and to rethink what kind of sensorimotor approach (if any) should be endorsed. If these senses allow for the experience of discrete perceptual objects, involving figure-ground assignments and perceptual constancies, this challenges the notions of flavour and smell as primitive and informationally impoverished. I also challenged the pervasive assumption that olfaction is aspatial; once we take into account

the role of bodily movement over time, it is clear that odours are experienced as spatiotemporally extended entities. Considerations of the chemical senses also helps to shape the sensorimotor approach: it lends weight to the conception of sensorimotor understanding as a kind of know-how rather than a cognitive know-that. There is reason to think that even babies may have primitive olfactory and gustatory abilities, and thus, sensorimotor understanding cannot be an intellectual skill. The shift to *perceptual objects* also alters how we are to conceive of our engagement with the world (see discussion in 7.2.2).

Chapter 1 introduced the sensorimotor framework and the Gestalt grouping principles. The grouping principles, and the notion of perceptual objecthood developed in subsequent chapters, offer a framework for understanding perception in a modality-neutral manner. The distinctions between visual objects tend to map onto the well-understood divisions between ordinary three-dimensional objects. This is not the case for the chemical senses. Thus, grasping the perceptual organisation afforded by these senses requires a more careful phenomenological investigation. Through the subsequent chapters we found that, like vision, the chemical senses partition the world into discrete entities that exhibit constancies, but unlike with vision, these entities are not ordinary physical objects. If sensorimotor enactivism is to be extended to the chemical senses, sensorimotor engagement must not only allow for access to physical objects and their properties.

Chapter 2 tackled two arguments against the extension of the sensorimotor approach to flavour and smell. These arguments were (1) that flavour and smell experiences are possible without bodily activity and (2) these experiences lack the perceptual duality proposed by the sensorimotor approach. We saw that the first argument only targets a specific interpretation of the sensorimotor account. To avoid this worry, the sensorimotor theorist can advocate a (developmental) notion of sensorimotor skill whereby the subject is attuned to how bodily movements would *counterfactually* induce sensory changes. I argued that the second argument is false because flavour and smell perceptions do allow for the kind of perceptual duality proposed by sensorimotor theorists. This provides support for the claim that perception is based on an attunement to sensory change.

Chapters 3 and 4 drew upon Gestalt psychology to offer a novel account of the notion of *perceptual objecthood,* allowing for a more modality-neutral construal of sensorimotor enactivism. I argued that figure-ground segregation and perceptual constancies are individually necessary and jointly sufficient for perceptual objects. Smell and flavour experiences fulfil these criteria. Through sensorimotor engagement we perceive odours and flavours as individuated perceptual objects that survive shifts and change. With the suggested approach, sensorimotor enactivism involves access to *perceptual objects* rather than just ordinary physical objects. It is these perceptual objects that exhibit 'perceptual presence' — experienced completeness despite the limitations of our sensory access to the world.

Chapter 5 asked whether flavour and smell can be involved in *multisensory* perceptual objects. There is reason to think these senses can perceptually combine with one another into unified flavour-smell objects, but that it is implausible that they can combine with the perceptions of other senses in this way. I offered two different ways of assessing whether multiple senses are jointly picking out a unified object: (1) we can look at the application of the Gestalt grouping principles across the senses, and (2) look at whether the different senses concur with one another about the putative multisensory object's properties. If they attribute contradictory properties to the object, these senses are not really involved in the perception of a single object, whereas if the senses interpret an object in the same way across shifts and changes, this provides evidence that they are jointly picking out a single perceptual object.

Finally, chapter 6 looked at the role of prior experience and memory in flavour and smell perception, focusing on *implicit object memory* and *autobiographical memory*. I argued that implicit object memory can impact figure-ground assignments — a claim that has been opposed in traditional approaches to cognitive science. While recent empirical evidence has supported this approach (particularly when looking beyond vision towards the chemical senses), there is an argument that it is logically impossible for object memories to precede figure-ground segregation. Cashing out implicit object memory in an embodied manner, whereby it is treated as a mastery of object-related sensorimotor contingencies, offers a solution to this challenge. We also saw how prior experience can result in an object-type carrying affective associations, which may play a role in the

notably affective nature of the chemical senses. Flavours and smell perceptions are more dependent on prior experience than, say, vision, and thus they are likely to carry affective associations on this basis. Drawing upon the valenced nature of flavour and smell, I finally offered an approach to the 'Proust phenomenon' — their ability to trigger rich autobiographical memories.

Chapter 6 also offered some clarification on the relationship between sensorimotor skills and Gestalt principles. In cases where one has not already developed an attunement to the relevant sensorimotor contingencies, perception involves a more protracted sensorimotor interaction with the environment. The Gestalt principles are particularly important in these instances of novel object perception, and plausibly act as heuristics for guiding this initial sensorimotor interaction. As one engages with the world, these principles are informative about which parts of the environment belong together and which are separate entities.

The discussions in this thesis have further implications and open a number of different avenues for research. Here I shall highlight two areas worthy of future investigation.

7.2 Areas for development and future enquiry

7.2.1 Illusions in the chemical senses

While some take olfactory illusions to be pervasive (Stevenson, 2011), others argue that they are not possible at all (Batty, 2014b). Traditionally, illusions are taken to be cases

where we are perceptually mistaken with regard to some property of an existent object, whereas hallucinations are cases where one perceives something that is not really there. An example of a visual illusion is a blue sweatshirt appearing green in certain lighting conditions. An example of a hallucination is the experience of a sweatshirt that isn't really there. The approach set out in this thesis can inform us about the possibility of illusions in the chemical senses and may be informative about the sorts of illusions that can be expected.

Accounts that deny the perception of discrete perceptual objects through the chemical senses cannot allow for illusions or hallucinations, as traditionally understood. This is because these types of non-veridical experience are defined in terms of objects: illusions are misperceptions of an object's properties and hallucinations are experiences of non-existent objects. Thus, feature-based approaches (e.g. Matthen, 2005) and weaker object-based accounts (e.g. Batty, 2010a; 2010c; 2011; 2014a; 2014b) do not allow for these types of non-veridical experiences (as traditionally construed) in the chemical senses. According to Batty's 'abstract' account, olfactory experience only ever involves the representation that there is *something or other* in one's vicinity (an existentially quantified type of object), instantiating olfactory properties. Consequently, she denies the possibility of olfactory illusions; we cannot misperceive a *particular* object's properties through the sense of smell since we don't experience discrete property-bearing objects at all (Batty,

2010c; 2014b).[99] She thinks this accords with our pre-philosophical understanding of olfaction because '[t]he notion of an olfactory illusion is not something that resonates with us' (2010c, p. 12). However, contra Batty, I have argued that we perceive discrete property-bearing particulars through flavour and smell. With this approach, the possibility remains open of illusions and hallucinations in flavour and smell. There is no immediate reason to assume we cannot misperceive properties of existing perceptual objects in olfaction and flavour and/or hallucinate flavour and smell objects.

As a starting point for investigating this issue, Stevenson (2011) presents a useful review of the empirical literature regarding putative olfactory illusions. However, while Batty rules out olfactory illusions altogether, Stevenson is too permissive. He argues that there are two categories of olfactory illusions: 'same stimulus – different percept' and 'different stimulus – same percept'. As an example of the former, he talks about how odours can be perceived differently through the orthonasal and retronasal routes (p. 1890) and the latter encompasses cases such as intensity constancy, where taking a bigger sniff of an odour does not induce a more intense percept despite a difference to the stimulation of

[99] However, as Batty (2014b) and Macpherson and Batty (2016) point out, by tweaking the traditional definitions of hallucinations and illusions, different kinds of non-veridical experiences can be acknowledged. Although Batty (2014b) rules out olfactory illusions, she does suggest that smell could allow for a kind of *property* hallucination (2014b). We might perceive properties — not instantiated by anything in particular — that aren't really there. Elsewhere Macpherson and Batty (2016) propose a new taxonomy of hallucinations and illusions to accommodate 'pure property' experiences. They suggest there may be property illusions as well as hallucinations. For example, one might misperceive an olfactory property (e.g. smokiness), as more intense than it really is. While there may be benefits to a new taxonomy of illusions and hallucinations, an implication of the approach in this thesis is that we need not redefine illusion and hallucination to accommodate the chemical senses. Even within the constraints of traditional accounts of non-veridical experiences, flavour and smell illusions and hallucinations are possible.

the olfactory epithelium (p. 1892). He gives a number of further examples of each alleged type of olfactory illusion. However, not all the cases can rightly be classified as illusions. Although as I shall discuss below, constancies when *misapplied* (or applied atypically) can result in illusions, intensity constancy appears to be a case of perceptual constancies operating *correctly*. It informs us about the properties of the odour. Changing one's bodily behaviour should not change the perceived properties of the distal object itself. Just as moving one's head towards a sound source doesn't make it seem that the sound itself has become louder, or moving toward a visually perceived object doesn't make it seem that the object itself is getting bigger, taking a bigger sniff of an odour doesn't make it seem that the smell has become stronger. It also isn't clear that differences in how odours are experienced through orthonasal and retronasal routes should be considered illusory, since retronasal olfaction may be best understood as a part of *flavour* perception rather than smell perception (see discussion in 5.1). Thus, more work is needed to determine which of the examples highlighted by Stevenson should count as illusions.

The account of perceptual objecthood set out in this thesis may prove informative about the kinds of illusions that could occur in flavour and smell. I have argued that perceptual objects crucially involve constancies and figure-ground assignments and across the other senses, there are illusions that relate to these features of objecthood. So, examining these aspects of perception might provide some examples of illusions in the chemical senses.

According to a popular account (e.g. see Gregory, 1963; Day, 1972; Ramachandran & Rogers-Ramachandran, 2006), a large class of illusions are based upon perceptual constancy mechanisms. Such illusions involve a misapplication (or atypical/surprising application) of these constancies. Consider the Ponzo illusion (Fig. 7.1). To most observers, the two horizontal lines appear to be different sizes despite being of equal length. A prominent explanation says this is due to a misapplication of size constancy due to depth cues stemming from the converging lines (Gregory, 1963; Ramachandran & Rogers-Ramachandran, 2006). The Müller-Lyer effect is also often taken to be based (at least in part) upon a misapplication of constancies, whether size constancy (Gregory, 1963) or shape constancy (Nanay, 2009). Other visual illusions rely upon the application of colour constancy in atypical settings (i.e. when looking at a picture of an object rather than a real three-dimensional object). It is taken to be surprising that two patches of an image are the same colour when they appear different due to the apparent lighting conditions within the picture.

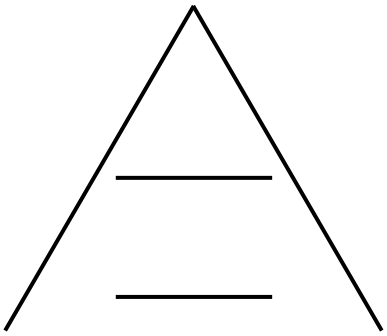


Fig. 7.1. The Ponzo illusion

The upper horizontal line appears larger than the lower line, but they are the same size.

There are also illusions based upon atypical figure-ground segregation and perceptual groupings. For example, the double beep experiment provides a multisensory example of such figure-ground assignments. Auditory stimuli can influence the amount of flashes that one visually perceives (Shams, Kamitani, & Shimojo, 2000), and thus the figure-ground assignments that are visually made. Hearing two beeps in quick succession often causes the perceiver to report seeing two flashes, rather than the single flash that actually occurred. The auditory stimuli result in altered visual figure-ground effects: the subject perceives two successive figures rather than a single unified figure. Another example is provided by an illusion known as the 'auditory gap transfer' illusion (see Nakajima, 2006 for review). In this illusion an ascending-frequency auditory glide of 1,500 milliseconds with a brief temporal gap in the middle is crossed with a shorter (500 millisecond) descending-frequency glide. The gap is misperceived as occurring in the shorter, descending glide. Nakajima (2006, p. 323) suggests that 'if an onset and an offset are close to each other in a subjective space corresponding to time and frequency, they are likely to be connected.' The shorter glide begins later than the longer glide, and so its onset is more temporally proximate to the gap. This application of the Gestalt principle of proximity here results in a non-veridical experience.

Flavour and smell perceptions exhibit constancies and figure-ground segregation. It is thus prima facie possible for these features of objecthood to occur in atypical or surprising ways in these senses, as in the visual and auditory examples above. Looking for such applications of constancies and grouping/segregations may help to reveal illusions in

these senses. Revisiting studies discussed in the previous chapters provides a couple of initial plausible examples.

The first candidate illusion is provided by the study by Woods and colleagues (2010), which was discussed in chapters 2 and 4. In this study, subjects perceived drink samples as being more similar to one another than they really were. Their expectations were manipulated by the two distinct drink samples appearing to be poured from the same jug. This may be a case of a misapplied constancies allowing for the misperception of a perceptual object's properties. Secondly, we have seen that perceiving novel odours paired together can impact one's subsequent perceptions of the individual component odours. They tend to appear more similar to one another than is typical and subjects' abilities to distinguish the odours are impaired. For example, as discussed in chapter 6, when cherry and mushroom odours are paired, mushrooms are subsequently experienced as smelling more like cherries (Wilson & Stevenson, 2007). This effect is plausibly related to perceptual constancies, but it also makes it harder to segregate the odours, thus impacting figure-ground assignments. If the odours are experienced as grouped together rather than two separate odour objects, this may constitute an illusion due to atypical grouping/segregation.

While I have only provided a couple of brief examples of potential flavour and smell illusions here, this would appear to be a fruitful avenue for further investigation. More work is needed to provide suitable constraints on what should count as illusions and

hallucinations in these senses. An additional question is why, if there are flavour and smell illusions, they are not usually phenomenologically obvious to us.

7.2.2 Direct realism

The sensorimotor approach is often construed as a kind of direct realism; through sensorimotor engagement, we gain direct and unmediated access worldly objects (e.g. Noë, 2004, p. 163; 2008; 2009; Beaton, 2016). That it plausibly offers an empirically tractable type of direct realism may be taken as an advantage of the approach. In the foregoing chapters, I shifted the emphasis from physical objects to *perceptual objects*, which better encompasses perceptions across the non-visual modalities. This may impact claims about direct realism because perceptual objects are individuated according to the subject's own figure-ground assignments. Endorsing this notion of perceptual objecthood may thus give the impression that we do not directly perceive the mind-independent world, but instead only experience perceiver-dependent entities. Moreover, the focus on the chemical senses puts further pressure on a direct realist interpretation of the sensorimotor approach because there is wide-ranging variation in what people can detect through these senses. Here I can only offer some initial remarks about these issues. However, with further research, the approach in this thesis may prove informative about whether direct realism is viable and, if so, which kind should be endorsed.

Perceptual objects are parts of the world, as experienced by a subject. The perceiver parses the world into distinct figures and as we have seen at various junctures, perceptual

organisation can vary among perceivers. Perceptual organisation tends towards the most prägnant interpretation, but this can be influenced by one's prior experiences (see chapter 6) and one's cultural background (see 4.2). For example, which flavour combinations are considered congruent varies in different cultures. In Western countries, almond is usually considered congruent with sweet tastes, whereas in Japan it is instead most associated with umami (Breslin, Doolittle, & Dalton, 2001). As argued in chapter 4, such differences plausibly reflect differences in what flavour combinations are considered to exhibit the most harmonious, prägnant form. And this has implications for perceptual organisation. Two perceivers could in principle organise the same stimuli in highly divergent ways, putting tension on the claim that we directly perceive a mind-independent world.

I think that one can (and should) hold that the perceiver is still gaining direct access to an observer-independent world, but that exactly how the world is parcelled up is to some extent perceiver-dependent. Through the sense of smell, we access odours — real environmental entities — but which collections of molecules are grouped together is, in part, dependent upon the interests and prior experiences of the perceiver. Someone who has only ever experienced cherries and mushrooms in combination will be less likely to experience them as discrete perceptual objects (see discussion in 6.1.1; also Wilson & Stevenson, 2007). Likewise, we might, in some sense, access the same world as a cat or an ant, but the way this world is perceptually divided into meaningful entities will differ greatly. This conflicts with one kind of direct realism that says that perceptual

phenomenology is constitutively and *completely* determined by the mind-independent world (see Beck, 2019 for discussion and critique of this kind of approach). However, other types of direct realism can allow certain perceiver-dependent factors (along with the perceiver-independent ones) to play a role in perceptual phenomenology. Thus, perceiver-dependent variations in figure-ground assignments need not be taken to conflict with the direct perception of a perceiver-independent world.[100] This suggestion does, however, require more investigation.

Direct realism about flavour and smell is put under particular pressure due to variation in what individuals experience through these senses. It is well known that so-called 'supertasters' are genetically disposed to perceive certain foods, such as Brussel Sprouts and some artificial sweeteners, to be unacceptably bitter.[101] There is also variation in the abilities to detect many other tastes, such as umami and sourness, and smells (for reviews see Garcia-Bailo, Toguri, Eny, & El-Sohemy, 2009; Spence, 2019). Moreover, various flavours seem qualitatively different to different people. Coriander, for example, is notoriously polarising. It tastes soapy or dirty to a portion of the population and fragrantly herbal to others, which is said to be based, at least in part, on genetic variation in olfactory

[100] If fleshed out in a suitable manner, this approach could also help to offer a direct-realism-friendly account of the kinds of illusions discussed in 7.1. The perceiver-independent world can sometimes be perceptually parcelled up in atypical and surprising ways. For example, the auditory gap transfer illusion discussed in 7.1 can be understood in terms of directly accessing real, mind-independent sounds, but which are grouped together in an atypical manner.

[101] Variations in bitter taste detection have long been established through research into compounds such as phenylthiocarbamide (PTC). Such variations were first discovered in 1931 when researcher Arthur Fox was pouring PTC, a powder, into a bottle and some of it flew into the air of the lab. His colleague complained about its bitter taste, but Fox was unable to detect it, prompting him to research responses to the chemical (Fox, 1932).

receptors (Eriksson, et al., 2012). Such individual differences in flavour and smell perception may present a problem for the idea that we are accessing objective parts of the world through these senses.

As an initial response, where the differences are solely down to different thresholds for detection of taste or smells, this is not particularly threatening for the direct realist. In these cases, subjects who do not detect the properties can be construed as simply failing to perceptually access an existent property. Cases where there are substantial qualitative differences to the experiences of different perceivers may be more challenging. One response is to downplay such variation. Notable defender of taste realism Barry Smith argues that talk of individual variation in tastes is overblown: 'Milk that has soured tastes disgusting to all, and a banana could not taste like an orange to some people without there being something wrong with such people or with the banana' (2013a, p. 734). Another kind of response to these kinds of differences would be emphasise that there are multiple real flavours and smells and/or flavour and smell properties, and only some of which are experienced by any one perceiver. Speaking of wine, Smith says:

> Of course, you cannot be sure that someone else will detect the same tastes you do. But there is every reason to think tastes are there to be detected. We draw each other's attention to what we have noticed in a wine. 'Do you get the pear?' we may say when tasting a white Burgundy, or 'Fig?' when tasting a Rhône (2007, p. 45).

Perhaps something similar can be said of the coriander case. Unlike the wine case, it doesn't seem that one can draw attention to the soapy taste if the perceiver is not

genetically disposed to perceive it as such. Nevertheless, it may be that both the soapy and herbal coriander flavours are really there. The soapy flavour of coriander is simply not detectable by some perceivers and the fragrant herbal flavour is perhaps not detectable to others, just as the bitter taste of sweeteners may not be perceptible to non-super-tasters. Allen (2016) offers a direct realist account of colour perception and argues that the same object can have multiple mind-independent colours. Future research should further explore whether this kind of argument is satisfactory when applied to the chemical senses.

The chemical senses remain under-explored and there is still much work to be done in exploring how what is empirically known about them impacts philosophical debates about perception. I hope this thesis has provided an informative contribution to this burgeoning field.

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