Olfactory Objects

Clare Batty
University of Kentucky

1. Introduction

Consider the following visual situation:

(V) There is a baseball cap lying on the driveway. You are looking at it.

Now consider how we might describe an olfactory analogue of (V). It would likely read something like this:

(O) There is a dead rat in the living room. You sniff it.[1]

I take it that, in describing your experience to someone else, you could, and would, describe it in something like the following way:

(D_v) I saw a baseball cap on the driveway.

(D_o) I smelled a dead rat in the living room.[2]

In each case, you report that you perceived some object—in the first case, visually and in the second case, olfactorily. And both (D_v) and (D_o) would be considered accurate. Still, the experiences that (D_v) and (D_o) refer to seem disanalogous in a crucial way. Olfactory experience does not seem overtly object-based. Unlike visual experience, olfactory experience doesn't seem to present individuals that correspond, in any obvious way, to ordinary material objects. We might even go so far as to say that olfactory experience seems disengaged from objects of any kind. It certainly seems to lack a kind of organization that its visual counterpart enjoys.[3] Why, then, do we accept that, not only (D_v) is accurate, but (D_o) as well?

In this chapter, I consider this question in light of an emerging view of olfaction. Recently, some olfactory scientists have begun to question the traditional, feature-centric, way of characterizing olfactory perception. Championed by Wilson and Stevenson (2006, 2007) a new object-based approach to analyzing olfactory perception is emerging as its rival. I argue that this approach is distinctive because it suggests a way of understanding object perception that departs significantly from the reigning visual model. In particular, I argue that it makes available a view according to which object perception can involve something akin to object recognition without object individuation. In stressing that object recognition is, in some cases, more basic than object individuation, such a view forces us to think more deeply about what it means to say that perceptual experience represents objects.

[1] Unfortunately, I take this circumstance from my own personal repertoire.

[2] I take it that you could, and would, if you had the appropriate knowledge of the source of the smell—for instance, if you had already visually located the rat. Otherwise, you would likely describe yourself as having seen or smelled *something*—perhaps a pungent odor (qua emanation) or simply something pungent. These other descriptions work equally well for the contrast this example is meant to set up. I return to these important issues later in the chapter.

[3] Consider Chalmers's claim: "Smell has little in the way of apparent structure and often floats free of any apparent object, remaining a primitive presence in our sensory manifold" (1996, 8).

2. Background

The best way to understand the novelty of Wilson and Stevenson's approach is to consider its origins and, in particular, the kind of approach to explaining olfactory perception it aims to replace. Driving their object-based approach is their dissatisfaction with what they call the traditional Stimulus-Response Model of olfactory processing (from hereon SRM). Olfactory processing begins when odor meets receptor sheet.[4] In humans there are two such patches of tissue, roughly the size of a dime, lying approximately 7cm. within each nostril. Each patch contains three types of cells—olfactory receptor neurons, sustenacular cells and basal cells—and the olfactory glands that produce the olfactory mucosa. Sustenacular cells support those neurons while basal cells differentiate and divide to form new olfactory neurons.[5] Necessary for the generation of an olfactory experience in humans are the receptor neurons themselves.[6] It is now estimated that humans have roughly 300 different types of olfactory receptors, allowing for a remarkable amount of analysis of an odor at the receptor site (Wilson and Stevenson 2006, 2007).[7] According to the SRM, an analysis of olfactory experience involves uncovering how the particular features of a chemical stimulus are represented in experience. In particular, this approach assumes that olfactory experience is analytic—that the various features of a chemical stimulus (i.e., those that trigger receptor excitation) and/or receptor type will map onto features of the resulting experience. The SRM assumes that, in some important sense, olfactory experience can be "broken down" into, or will reflect, those initial features of the stimulus and/or receptor types sensitive to those features.

Wilson and Stevenson (2003, 2006) claim that the SRM, in some guise or another, has shaped much of the history of olfactory research. And, as they note, employing such a model has involved devising classification schemes for the range of olfactory experiences we undergo. That is to say, the approach involves attempting to understand the stimulus and receptor site by first classifying the various phenomenal properties of olfactory experience. In the discussion that follows, I assume, in accordance with the SRM, that these phenomenal properties are intentional insofar as they feature in a characterization of the representational content of olfactory experience. I will say nothing, however, about the nature of the properties represented by those experiences—for example, whether they are physical, dispositional, sui generis properties of the olfactory stimulus, properties of experience, or indeed properties of nothing at all. Given that I will be concerned primarily with the "experience side" of the SRM, what is important is not the nature of the properties represented but rather certain issues about those properties *as they appear to us*.[8]

The earliest classification schemes were what I call *categorical systems* in that they assigned a

[4] By "odor" I mean a collection of volatile molecules, a gaseous emanation given off by a source object. Odors are not ordinary objects; but they are objects nonetheless. "Odor" is sometimes used in property-talk, to denote the distinctive properties presented to one in olfactory experience. I will only use "odor" in object-talk and reserve "smell", in its nominal form, to denote such a property.

[5] Olfactory neurons are distinctive in that they are the only neurons of the adult human that are able to regenerate.

[6] Here "necessary" refers to nomological necessity. I am not claiming that is a matter of logical necessity that the human olfactory system is functionally the way it is.

[7] This is due to the discovery by Buck and Axel (1991) of a large gene family that encodes olfactory G-protein receptors—a discovery for which they received the Nobel Prize in Physiology or Medicine in 2004. The family consists of 1,000 different genes that give rise to an equivalent number of olfactory receptor types. In humans, there are roughly 300 different types of functional genes.

[8] At one point, Wilson and Stevenson refer to these properties as "olfactory qualia" (2006, 11). Given that there is a philosophical use of "qualia" such that qualia are nonintentional properties of experience, I refrain from muddying the waters by taking on their usage.

range of olfactory stimuli to basic categories that reflect the characteristic experiences caused by those stimuli. Put in philosophical terms, stimuli falling under a given category were thought to evoke experiences with common, or at least similar, phenomenal properties. As they stood, such systems were simply a means of grouping, but not ordering, "like with like." The earliest cited system of this kind is Linnaeus's (1756). His system consisted of seven categories used to classify botanical as well as other medicinal materials.[9] It was followed by Zwaardemaker's nine-category system (1895), which, unlike that of Linnaeus, was used to speculate about the physicochemical basis of perceived quality. That is, Zwaardemaker intended his system as a means of asking, and ultimately answering, the question of what physical properties unite all stimuli of a given category.[10]

However, each system proved to be too simple—although, likely due to its more recent publication and its aim to move beyond the classification of specialist materials, Zwaardemaker's has received more critical attention. For example, Titchener (1912) argued that a significant number of stimuli could not be matched under any of Zwaardemaker's nine categories. Similarly, Titchener noted that some of the stimuli that Zwaardemaker had placed under different categories seemed to have more in common with one another than others that he had included under the same category. In general, both systems did not attempt to capture the similarity and difference relations between the various apparent properties evoked by the listed stimuli. Apart from locating stimuli under the same category and, in Zwaardemaker's case, dividing three categories into subgroups,[11] these systems had nothing to say about the relations between apparent olfactory properties. Stimuli were simply filed under single categories without representation of the degree to which they are similar to other stimuli in that category or, as the problems with Zwaardemaker's system show, stimuli in other categories.[12]

In the twentieth century, drawing on recent success in the color domain, categorical systems gave way to the idea of an olfactory *quality space*. The quality space for a given modality is an ordering of the phenomenal properties of that modality. In particular, that ordering forms a system of resemblance relations among those properties. A given phenomenal property for a sensory modality is a location within that modality's quality space. In the olfactory case, these models were anchored by a set of phenomenal primaries—those apparent properties that cannot be matched by a mixture of any other. Commonly referred to as the "odor primaries," these properties were thought of as the olfactory equivalents of the "unique hues."[13] That is to say, it was thought that all other apparent olfactory properties were mixtures of some subset of the odor primaries.[14] I call the systems of

[9] Linnaeus's seven categories were (1) aromatic, (2) fragrant, (3) ambrosial (musk-like), (4) alliaceaous (garlic-like), (5) hircine (goat-like), (6) foul and (7) nauseating. He also proposed a second, related classification scheme in which he grouped these seven categories according to their appeal—that is, pleasant and unpleasant. As Harper et al. (1968) note, this secondary scheme is often overlooked. I also overlook it in the present chapter, as it is unnecessary for understanding the transition from the SRM to Wilson and Stevenson's object-based approach.

[10] Zwaardemaker, a Dutch physiologist, altered Linnaeus's system slightly, adding two more categories: (8) ethereal (e.g., beeswax) and (9) empyreumatic (burnt-like as in, e.g., tobacco smoke or roasted coffee). The first was adopted from Lorry (1784-5) and the second from von Haller (1763).

[11] According to Zwaardemaker, aromatic stimuli could be divided further into those that are (i) camphoraceous, (ii) spicy, (iii) aniseed-like, (iv) citrous, or (v) almond-like. Floral stimuli could be divided into those that are (ii) lilaceous, (iii) vanilla-like, or have (iii) the scents of flowers. Finally, alliaceous stimuli could be divided into those that are (i) garlicky, (ii) cacodylic, or have (iii) the scent of bromine.

[12] As Harper, Bate-Smith and Land (1968) note, Zwaardemaker himself expressed reservations about the categorical system of classification and, in particular, the method of assigning multiple stimuli to a single category.

[13] Here the use of "odor" diverges from my own. See fn. 4.

[14] As it stands, the systems to follow did not have anything analogous to saturation and brightness in the color domain. It might be thought that perceived intensity would be analogous to brightness. However, perceived intensity does not behave as nicely as brightness does in the case of color. In many cases, with changes in intensity of the stimulus come robust changes in perceived quality. So, although it might be an appropriate way of describing changes to the

classification formed in such a way *primary systems*.[15]

The most famous of the primary systems are Henning's (1916) "odor prism,"[16] Crocker and Henderson's (1927) numerical similarity orderings, and Amoore's (1952; 1963; 1970) stereo-chemical theory of olfactory processing. The details of these various models are not important for present purposes. Rather, like Linnaeus's and Zwaardemaker's systems before them, what *is* important is what they have in common.[17] All of these systems aimed to capture the complexity of perceived quality that Zwaardemaker, as well as his critics, worried his system could not. In doing so, like Linnaeus and Zwaardemaker, they each proposed that olfactory experience was largely analytic. In turn, each proposed explicit connections between the "components" of perceived quality and features of the receptor site and/or stimulus. It is reasonable to say, then, that these three primary systems mark the SRM in its most developed form.

Although the SRM made olfactory processing seem neat and tidy, each of the three SRM-inspired systems had problems. For the most part, those problems came in the form of exceptions. In Henning's case, stimuli with a structure that ought to have fallen on a certain plane of the prism were found to fall elsewhere. Some stimuli were even found to fall within the prism; but, according to Henning, none fell within it. All could be classified by their position on the surface of the prism.[18] As Harper et al. (1968) note, Crocker and Henderson's model failed to get consistent results from untrained subjects and raised concerns over its attempt to quantify the contributions that each primary made to the perceived quality of a stimulus. Finally, many grew suspicious of Amoore's hypotheses regarding the relationship between features of the stimulus and receptor type.[19] Moreover, Amoore's contention that there was a mapping between types of anosmia ("smell-blindness," as it were), receptor types, and the odor primaries equally suffered. As the known anosmias grew in number, so did suspicion of modeling olfactory quality space, and indeed the mechanisms of the olfactory system, in accordance with a set of "odor primaries" thought by Amoore to be indicated by those anosmias.[20]

---

concentration of a stimulus, it is questionable whether intensity is an appropriate way of capturing any kind of continuum on which apparent properties might fall. As my primary interest is not in modeling olfactory quality space, I leave this question.

[15] It is important to note that the idea of a primary odor marks a significant assumption on the part of models of this kind. A model that mapped the relations between the phenomenal properties of a modality but lacked primaries would still count as an ordering of those properties and, in doing so, would count as a quality space for that modality.

[16] Again, the use of "odor" here diverges from my own. See fn. 4.

[17] I will, however, provide a few details. According to Henning, there were six olfactory primaries: (i) fragrant, (ii) ethereal or fruity, (iii) resinous, (iv) spicy, (v) putrid, and (vi) burned. Henning plotted these primaries on a geometrical form—the prism. With the primaries occupying the points of the prism, Henning took it that all apparent properties could be plotted on one of the three surface of the prism, at relative distances from the set of primaries that occupied the points of the relevant side. According to Henning, no apparent properties fell within the prism. Like Henning, Crocker and Henderson attempted to improve upon earlier "categorical" systems by mapping the relative similarities and differences between the apparent properties of olfactory stimuli. Their system, however, was unlike Henning's both in that it did not involve a geometrical form and the number of primaries was only four: fragrant, acid, burnt and caprylic. According to Crocker and Henderson, the experience resulting from a given stimulus could be assigned a four-digit number, with each of the four numerals involved (between 1 and 8) representing, in ascending order, the degree to which each of the four primaries (in the order of fragrant, acid, burnt, and caprylic) was represented by that experience. Finally, Amoore, hoped that, just as color-blindness had helped unlock the mystery of the receptors involved in color vision, certain relative inabilities to detect certain odorous compounds known as specific anosmias would do the same for olfaction. Although he was interested in uncovering primaries, and was interested in the quality space to this degree, his was not an attempt to model the entirety of olfactory quality space. For Amoore, uncovering primaries provided a potential way of uncovering the number of receptor types employed by the olfactory system. Compiling a list of common labels used to describe olfactory stimuli in the literature, the most common of these came to denote his seven primaries: (a) ethereal, (b) camphoraceous, (c) musky, (d) floral, (e) minty, (f) pungent and, (g) putrid. Amoore's hypothesis was that the specific anosmias and the seven primaries together suggested seven receptor types.

[18] For a good summary of the problems with Henning's model, see MacDonald (1922).

[19] These problems are well documented. See, for example, Moncrieff (1967).

[20] As Wilson and Stevenson (2006) note, at last count there were upward of seventy specific anosmias.

But, as Wilson and Stevenson (2006) argue, there are more general reasons to give up on primary systems and, in turn, the SRM. The SRM posits that olfactory experience is analytic, that it has various distinguishable components. But olfactory experience doesn't live up to that standard. Olfactory experience is largely synthetic—that is, the various properties of the stimulus produce a largely irreducible experience. Because of this, the various features of the stimulus are not distinguishable at the level of experience—as the SRM would have them. As a way of highlighting this point, Wilson and Stevenson (2006, 2007) draw attention to the fact that much of what we encounter and recognize with our noses is chemical mixtures. For example, the stimulus that gives rise to the "coffee" olfactory experience is such a mixture. Sniffing coffee provides a unique kind of olfactory experience; but it is not one where we are able to discriminate the over 600 volatile compounds that constitute the coffee odor.[21] As Wilson and Stevenson (2003, 2006) note, it is now commonly accepted that even experts are able to distinguish only two or three of the major components that constitute a given odor. Now, to demand that an olfactory experience discriminate every compound that constitutes an odor might be to overstate the success conditions for the SRM. Still, what is clear from Wilson and Stevenson is that while olfactory experience does not entirely fail to be analytic in some cases (i.e., it can be less-than-synthetic), it does not succeed in anything like the way we should expect it to if the SRM is true. As a result, the SRM doesn't succeed in characterizing the nature of olfactory experience. What kind of view would? That's where Wilson and Stevenson's Object Recognition Model comes in.

3. Olfactory Objects

The SRM is a feature-based model of olfactory experience. The views based on it claim that nothing more is needed to characterize a given experience than an inventory of the properties it represents. On the SRM, individual features of the stimulus are represented in olfactory experience in a one-one mapping. Such a mapping is enough, on the SRM, to account for the phenomenology of experience. In contrast to this, Wilson and Stevenson (2003, 2006, 2007) argue that the best way to characterize olfactory experience is not in these "feature-centric" terms, but in terms of the representation of objects. According to their object-based approach, olfactory experience represents not only the properties in the vicinity but also the objects to which those various properties belong. On what I call their Object-Recognition Model of olfactory processing (from hereon ORM), olfactory experience represents "olfactory objects" or, as they sometimes put it, "odor objects."[22]

There is much to learn from Wilson and Stevenson's account of olfactory processing. It offers up a wealth of detail regarding the formation of these odor objects. In what follows, I am concerned with the status of these olfactory objects—and, in particular, with the question of whether it is *objects* that the system represents. As Wilson and Stevenson state it, their main project is to answer the following question: "How does the olfactory system extract an odor object from a complex olfactory scene?" (2006, 22). Unlike Wilson and Stevenson, my primary concern is not with *how* the olfactory

[21] Here I appeal to Wilson and Stevenson's cited source, Maarse 1991, who reports that number as 655. Others, however, have reported upwards of 1,000 volatile compounds.

[22] Although Wilson and Stevenson (2006) suggest that the odorant analysis inherent to the SRM is reinforced by Buck and Axel's discovery of a large gene family that encodes olfactory receptors, they later suggest (2007) that Buck and Axel's focus on the combinatorial nature of receptor sensitivity supports a move to their ORM. See also fn. 7.

system extracts an odor object from a complex olfactory scene.

Still, in order to address *my* question, it is useful to say something more about how they go about answering *theirs*. Consider again what happens when you smell the coffee brewing. A remarkable amount of analysis occurs at the olfactory epithelia. Eight hundred different compounds are brought into the nose and 300 different types of olfactory receptors recognize relevant features of those compounds. But, in most circumstances outside of the lab, our noses are barraged with other molecules than those given off by the coffee. Yet, we are able to smell *coffee*. How does olfactory experience achieve this feat? According to Wilson and Stevenson (2003, 2006, 2007), *learning* and *memory* play a fundamental role in olfactory processing. They claim that, over time, the olfactory system builds up a store of templates in the olfactory cortex of patterns of receptor input. Once stored, these enanble the system to recognize those patterns against variable arrays of receptor excitation. According to Wilson and Stevenson (2003, 2006, 2007), this kind of processing endows us with certain discriminatory abilities—for example, the ability to smell coffee even though there are other smelly things about.[23] I will return to these abilities shortly. For now it is enough to note that when we do smell the coffee in these complex circumstances, rather than being presented with an "array" of discriminable apparent properties each of which can be traced back to features of the coffee stimulus and/or receptor site, as the SRM would have it, we are presented with a "wholistic, unitary percept" (2007, 1821), incapable of being broken down into more than two or three identifiable component features—if at all.[24] According to Wilson and Stevenson (2006, 2007), these unitary percepts are not simply conjunctions of those component features; rather, they are olfactory objects to which olfactory experience attributes certain features. Given that Wilson and Stevenson (2006, 2007) also refer to these objects as "odor objects," it is safe to assume that they take these perceptual objects to correspond to odors—collections of volatile, airborne molecules. In the coffee case, we are presented with what I will call a "coffee object."

The ORM moves beyond thinking of olfactory perception as feature-based and posits the representation of objects in it. That is to say, olfactory perception is a form of object perception and, according to Wilson and Stevenson, "substantial conceptual, if not mechanistic, similarities exist between visual object perception and olfactory perception" (2006, 29). They recognize that, in the case of vision, "perceiving objects…involves the recognition of complex sets of features—objects" (2007, 1821) and that, on the ORM, olfactory perception involves something very similar, namely, "the formation of statistically reliable patterns—objects" (2007, 1821). In other places, they describe these odor objects similarly as "meaningful combination[s] of chemical[s]" (2006, 18), "odor combinations" (2006, 20), "'patterns of stimulation" (2006, 20) and, in more straightforwardly phenomenological terms, "unitary olfactory percepts" (2006, 33) or "synthetic odor objects" (2006, 6). I return to these definitions later and, in particular, how there seem to be two distinct uses of "object" here.

Now: *does* olfactory experience represent objects? In philosophical terms, the claim that

[23] It is important to note that this recognitional capacity does not entail the ability to name or otherwise identify a certain olfactory stimulus. "Successful recognition may or may not be followed by successful identification, in which the name associated with the object is retrieved" (2001, 1). In other words, discrimination (which recognition allows for) must be distinguished from naming and identification. To be sure, out of the ORM falls a natural explanation for why we are able to name and identify certain stimuli much more easily than others (because the templates associated with them are more entrenched). But naming or identification is not necessary for recognition.

[24] These latter cases of "wholly synthetic" olfactory experiences might be thought of as those that present *one* identifiable feature. I turn to this proposal, and the questions it raises about the ORM, shortly.

olfactory experience involves the representation of olfactory objects amounts to a claim about the structure of olfactory experience. In particular, it amounts to the view that olfactory experience has a subject-predicate structure—that is, that, in experience, properties are attributed to individuals.[25] Following Cohen (2004), I refer to those individuals as "sensory individuals." In these terms, on the ORM, when you sniff the coffee brewing, your olfactory experience has a subject-predicate structure. In this case, it involves the attribution of a property, or set of properties to an odor individual—the "coffee-object."[26]

Drawing on empirical theories of vision, philosophers of perception have distinguished two kinds of perceptual phenomena, each of which deserves the label "object perception." They are *object individuation* and *object recognition*. Using vision as a case study, consider each in more detail.[27] Central to object individuation is the *grouping* of perceptual features. It is easiest to understand what grouping is by considering a problem that it enables vision to solve—namely, the Many Properties Problem. The Many Properties Problem is the problem of distinguishing between scenes in which the same properties are instantiated but in different arrangements. It is clear that there is a difference between (1) seeing a red cube to the left of a blue sphere and (2) seeing a blue cube to the left of a red sphere. In each case, the same properties are instantiated. But your visual experience reports on the different arrangements of those properties, and does so by grouping them together to form sensory individuals. In the visual case, these individuals correspond, more or less, with ordinary material objects.[28] In (1), one individual is red and cubical, while another is blue and spherical; in (2) one individual is blue and cubical, while another is red and spherical. Conceiving of the visual system as one that only extracts features from the scene could not account for the difference between (1) and (2). The properties instantiated in each case are the same; the difference lies with the individuals to which these properties are attributed. In the visual case, those individuals typically correspond to ordinary material objects. In representing those objects, visual experience provides information about their *edges* or *boundaries*. It also allows for *figure-ground segregation*, or the ability of a perceiver to discriminate objects from one another as well as a background.

Now object recognition. As it is typically characterized, object recognition draws on object individuation in achieving further object-involving tasks. Again in the visual case, those sensory achievements that fall under the heading "object recognition" are *tracking*, *persistence,* and *amodal completion*. Objects can be tracked across space and time. For example, you can track a ball as it moves through the air toward the goal. If that ball gets a bit muddy over the course of a match, it doesn't appear to you as though a new round object—one with brown patches—has come onto the scene. Rather it appears to you as though the very same object has undergone a change in its properties. That is to say, you perceive the ball to persist through changes in its apparent properties. Finally, if your dog scampers behind a picket fence, you do not see an array of individual objects in between the fence

[25] Given that visual experience has such a structure in the case of illusory as well as hallucinatory experience, read "properties" and "individuals" as "apparent properties" and "apparent individuals," respectively.
[26] Sensory individuals need not correspond to objects. For example, Clark (2000) holds that visual individuals correspond to *places*. In the auditory domain, O'Callaghan (2007, 2008, 2010) argues that its individuals correspond to *events*.
[27] Recently, O'Callaghan has argued that audition achieves both object individuation and object recognition, although it does so temporally rather than spatially. Because the puzzle I started with contrasts olfactory experience with visual experience, I focus on vision.
[28] Examples of exceptions are those sensory individuals that correspond to portions of liquids, individual clouds, and patches of light.

posts. What you see is your dog (or at least an object) behind the posts. That is to say, your dog appears to continue uninterrupted—"complete"—behind other occluding objects.

Far from being isolated phenomena, it would appear that visual object recognition depends on object individuation in a significant way. That is, it would seem that if there is no object individuation, there is no object recognition. What we track are objects. What we visually perceive to survive changes in apparent properties are, again, objects. And what we perceive to continue uninterrupted behind other occluding objects (oops!) are just those—objects! On the visual model, then, object individuation and object recognition can be seen as two *levels* of object perception—with the former the more basic. There might be object individuation without object recognition, as in the case where we are unable to track an object that goes in and out of view at random places. But object recognition without object individuation remains in doubt—at least on initial phenomenological grounds. And that phenomenological benchmark is the main thing to keep in mind when exploring the olfactory case.

Object individuation and object recognition in the visual case form the core of what philosophers of perception have considered object perception. Assume, for the sake of the present argument, that object perception in general can be modeled to some degree or another on the visual case.[29] This assumption is in keeping with Wilson and Stevenson's claim that "substantial conceptual, if not mechanistic, similarities exist between visual object perception and olfactory perception" (2006, 29).[30] If this is right, then olfaction ought to exhibit something like the object individuation and object recognition of vision. Moreover, it should be expected that object individuation forms the basis of object perception.

Drawing on the visual case, and what it is safe to assume about it prima facie, I turn now to the claim that olfactory perception is a form of object perception. In particular, consider the ORM and the view of olfactory experience it espouses. Wilson and Stevenson hold that it is wrong to think of olfactory experience as feature-based, as the SRM would have it. And, in general, their reasons for rejecting the SRM are the same as the reasons for thinking that visual experience is not feature-based. In the case of vision, a feature-based view does not account for perceptual grouping (and, thereby, cannot solve the Many Properties Problem). Now, Wilson and Stevenson do not stress perceptual grouping in their criticism of the SRM. As they stress, olfactory experience is largely synthetic. Still, their criticism of the SRM draws on the fact that, like a feature-based view in the case of vision, it does not capture what experience is like. In the case of olfaction, the SRM posits an "analytic" structure to olfactory representation when in fact, for the most part, it is largely synthetic. Individual features simply aren't represented in the way the SRM posits. What they suggest instead is that, like visual experience, olfactory experience involves objects or, as the philosopher might put it, has a subject-

[29] It might seem suspect to use vision as the model, especially given that philosophers are becoming increasingly wary of doing so—at least as a general rule. But there are some success stories. Drawing on recent work in auditory scene analysis, O'Callaghan (2008), for example, argues that there are auditory analogues of object individuation and object recognition. As will become clear, I make this assumption only as a means of exploring the similarities and differences between the visual case and that prescribed to olfaction by the ORM. As I will argue, the places where the ORM fails to match the visual case—or where one could question that it succeeds in doing so—provide unique insight into the nature of olfactory experience.

[30] Wilson and Stevenson (2006) also claim that olfactory object perception bears similarities to that of the auditory and somatosensory systems. In keeping with the comparison between vision and olfaction that I opened with, and because drawing attention to similarities with vision is Wilson and Stevenson's main concern, I set aside these similarities with other sensory systems.

predicate structure. The "subject" of that relation is, according to Wilson and Stevenson, a "synthetic odor object" (2006, 6).

But it is not simply because olfactory experience is largely synthetic that Wilson and Stevenson claim it represents objects. It is, rather, what it can allegedly achieve as a result of being synthetic that lends favor to the view. According to Wilson and Stevenson, the "defining feature for [perceptual] objecthood" (2007, 1823) is "figure-ground separation" (2007, 1821).[31] Remember that figure-ground segregation is characteristic of the object individuation of vision. And in the visual case, it is achieved spatially. An object is visually perceived to occupy a position in space distinct from other objects as well as a common background. Although Wilson and Stevenson (2006) claim that olfactory experience is aspatial,[32] they claim that it still achieves figure-ground segregation. I hinted at their reasons earlier. We are not creatures of the laboratory; odors are not presented to us in isolation. Day-to-day, at every instant, we are presented with collections of volatile molecules originating from the many objects around us. It is not simply the coffee that is sloughing off such molecules; it is the freshly baked bread, the sour milk, the rubbish in the bin, the cedar of the chopping block, and so on. Just think of how many things around you at any given time are the kinds of things that smell. Your olfactory environment consists of a grand mixture of molecules from a variety of sources. Yet, somehow, when we take in an olfactory scene—literally, through our noses—elements of that scene appear to us as separated from one another. There is coffee and freshly baked bread. There is also sour milk and cedar. Moreover, often certain elements of that scene appear more pronounced than others. It might not even appear as though some present in the scene are, indeed, present at all. So, for example, when you sit at breakfast, the "coffee element" (to remain neutral for a moment between coffee qua object and coffee qua property) might appear more pronounced than the "freshly baked bread" element and the "sour milk" element may not appear to you at all (even though the milk on the table has gone off). Wilson and Stevenson (2006, 2007) characterize this phenomenon of "experiential prominence" as the experience of figure-ground segregation. In the visual case, we know that the apparent figures correspond, for the most part, with ordinary material objects. In the olfactory case, Wilson and Stevenson (2006, 2007) refer to the apparent figures as odor objects and, as I noted earlier, it is fair to assume that they take them to correspond to certain odors—that is, certain collections of volatile molecules in the environment. In terms of the example case, then, they claim that the coffee odor is experienced as distinct from a "noisy" background—one that includes collections of molecules given off by freshly baked bread, sour milk, various bits and pieces in the rubbish, and so on.

Wilson and Stevenson (2003, 2006, 2007) argue that underlying this achievement is their template model of olfactory perception. Olfactory experience isolates target objects in virtue of a "match" between incoming information about the stimulus at the receptor site and stored patterns of receptor input in the olfactory cortex. What this allows for is a kind of filtering of the information generated at the receptor site. On this picture, stable, or "repeated," stimuli are adapted out of the scene, whereas novel, or "newly arrived," stimuli are matched to existing templates and given experiential prominence. (This explains why a person, although initially overpowered by the smell of a bath and body shop, after a moment or two is able to walk around and detect the smells of

[31] According to Wilson and Stevenson (2007), they adopt this definition from Kubovy and Van Valkenburg (2001).
[32] For example, they claim that "odors, unlike visual stimuli, do not intrinsically contain a spatial component, though they may vary in intensity over space as they diffuse from their source" (2006, 44).

individual products.)[33] Their being given such prominence amounts to the representation of an odor object as distinct from a background. Of course, if such a picture is correct, it is likely that a perceiver will have matching templates for more than one odor in the vicinity (the freshly baked bread template, for example) and yet only one odor object (the coffee object, for example) might appear prominent. Wilson and Stevenson (2006) argue that in many cases, it is not the mere comparison between receptor excitation and stored templates that determines what will appear prominent in a given scene. The story is typically much more complex than that. In addition to stressing the importance of memory and learning in olfactory discrimination, the ORM takes into consideration the effects of other influences such as expectation, attention and cross-modal interaction. For example, past experience might constrain a perceiver's expectations with respect to whether a certain odor is present and underlie the template associated with that odor assuming experiential precedence. Similarly, one's current needs, desires or emotions might inform experience. When I get up in the morning, I want coffee. Food, even if freshly baked bread, comes second. As a result, when I wake up, I smell coffee.[34]

At this point, it is helpful to stress a further difference between the SRM and the ORM. Unlike the ORM, the SRM pays little or no attention to the separation of odors in a scene. Of course, the SRM assumes that the coffee odor will result in a distinctive pattern of receptor activation—and that this is discoverable when we consider the inhalation of that odor in isolation. But in anything but exceptional circumstances, we encounter a mix of odors in our environment. And this creates trouble for the SRM. When I smell coffee and newly baked bread in the kitchen, my total receptoral activation is different from when I smell either in isolation. Yet I still smell coffee and I still smell baked bread—not some amalgam of the two. On the SRM, there is no good reason to think that my experience should present my surroundings as such. On the SRM, what I perceive ought to correspond to the total receptor activation at any given moment. To be sure, it ought also to be largely analytic—which, as Wilson and Stevenson note, it is not. But, even so, there is nothing about the SRM which suggests that my experience of coffee and baked bread should be separated, albeit minimally, as it is. The SRM seems caught between the proverbial rock and a hard place. Because it posits that olfactory experience is largely analytic, our olfactory experiences should present arrays of olfactory features—those belonging to the coffee and baked bread stimuli. But they do not. Because they do not, we might ask, Why is it that there is any separation at all? It is not clear that the SRM has the resources with which to answer this question.

Of course, as I said earlier, the ORM's mechanism of template matching provides it a way of answering the question. Indeed, as I noted previously, it is this very question that motivates the ORM. Of course my explanation of that mechanism has simplified and it is important to note that Wilson and Stevenson (2006, 2007) offer up more detail regarding the range of our discriminatory abilities as well as the further top-down mechanisms in place to allow for them. Again, my concern is with the status of their odor objects and less so with how they are generated. For the purposes of the present discussion, it is enough to note that we have these discriminatory abilities in the face of such an overwhelmingly diverse mixtures of molecules at the nose, and that Wilson and Stevenson claim those

[33] Again, I use "smell" in its nominal position to denote an olfactory property.
[34] There is a growing philosophical literature on the issues of cognitive penetrability and cross-modal interaction. For examples of the former, see Lyons (2011), Macpherson (2012), Siegel (2012, 2013å) and Stokes (2012). For examples of the latter, see Macpherson (2011), and O'Callaghan (2012).

discriminations play a definitive role in olfactory object perception by providing for figure-ground segregation.

Before moving on to consider whether they do play this definitive role, it is necessary to consider further accomplishments of the olfactory system that Wilson and Stevenson claim count in favor of the ORM. According to Wilson and Stevenson (2006), the olfactory system can achieve an analogue of visual amodal completion. They argue that degraded or partial input at the receptor site and/or olfactory bulb can be completed at the level of experience.[35] Just as one does not receive visual information about some parts of a dog sitting behind a picket fence, one does not receive olfactory information about all of the components of an odor stimulus. And, in turn, like one sees that there is a dog (or at least an object) behind the fence, as opposed to an array of individual objects located between the fence posts, one smells that there is certain odor object present as opposed to, or in addition to, some other. As Wilson and Stevenson (2003, 2006, 2007) stress, this is common given that there are typically many odors present in the environment at any given time—"overlapped" in space, as we might think of them—and this inevitably leads to partial, or degraded, input at the receptor site. This situation is further compounded because, given the kinds of objects they are, odors are dispersed through the atmosphere and may be more concentrated in some locations (such as at the source) than others. To be sure, sometimes a change in the intensity of an odor stimulus makes for a wholesale change in perceived quality. For example, at lower concentrations, methyl heptinoate smells like violets while, at high concentration, it smells foul.[36] Of course, with the knowledge of this variation, one may be able to recognize methyl heptinoate as being the same thing, from lower to higher concentrations. At other times, however, there is no such stark difference with changes in intensity. We simply perceive it to be the same thing.[37] In terms of the ORM, these achievements of discrimination and perceptual constancy allow for the perceived persistence of an olfactory object as well as, it would seem, for the ability to track an object through space (in this case an odor), as when we search for its source. Wilson and Stevenson (2003, 2006, 2007) argue that underlying these achievements of completion and constancy in the face of fluctuations in concentration and/or other odorant "noise" is the template model of the ORM. To return to a previous example, if the pattern of excitation associated with the "coffee" template is incomplete, or degraded, at the receptor and/or olfactory bulb levels (as it will be in many cases), the "coffee" template is nevertheless able to "lock onto" the existing pattern of excitation, generating the kind of experience one has when the input is complete—namely, the "coffee" kind of experience.

In total, the phenomena that Wilson and Stevenson cite that bear resemblance to aspects of visual object perception are *figure-ground segregation*, *amodal completion* and arguably, *tracking,* and *persistence*. Figure-ground segregation falls within the domain of object individuation. Amodal completion, tracking, and persistence fall within the domain of object recognition. The next step is to

[35] Among the evidence that Wilson and Stevenson (2003) cite is a series of experiments conducted by Slotnick et al. (1997). In these experiments, rats with parts of the olfactory bulb removed are nevertheless able to perform a series of detection and discriminatory tasks as well as, or nearly as well as, normal rats. What Wilson and Stevenson take this ability to show is that olfactory perception is not wholly determined by the excitation at the receptor site or the output of the olfactory bulb. Further top-down influences play a significant, if not central, role in olfactory discrimination. The template model of the ORM, they argue, is the most plausible way of accounting for these further influences.

[36] See Gross-Isseroff and Lancet (1988).

[37] Here I intend to remain vague regarding the question of whether, on the ORM, you smell the same *kind* of thing or the same *particular* of a certain kind. I revisit these issues in my conclusion—although I do not, in this chapter, intend to settle the issue.

consider whether they are similar enough to do the same kind of theoretical work as their visual counterparts and, if they are not, whether this matters for object perception.

4. Olfactory Objects?

When assessing the ORM, it is important to distinguish two questions:

(i) *Does olfactory experience achieve object individuation?*

(ii) *Does olfactory experience represent objects?*

I begin with (i).

Up until now, I have been assuming what I have called the visual model of perception. On that model, object individuation and object recognition form the core of object perception, with object individuation forming the basis of object recognition. There might be object individuation without object recognition. But object recognition without object individuation remains doubtful. Vision achieves figure-ground segregation at the level of object individuation.[38] Figure-ground segregation is an effect of what is characteristic of object individuation in the visual case—namely, the perceptual grouping of visual properties—and that grouping is done spatially. Due to the perceptual grouping of visual properties, visual experience provides information about the edges and boundaries of sensory individuals and allows for figure-ground segregation. The fact that vision achieves such grouping and, in turn, makes these further accomplishments rules out the view that visual experience is feature-based.

Now compare the olfactory case to the visual one. Recall that Wilson and Stevenson claim that olfactory experience is aspatial. Despite this, they also claim that, like the visual case, olfaction achieves figure-ground segregation and that, unlike what I have suggested in the visual case, this achievement is their "defining feature [of perceptual] objecthood" (2007, 1823). As I suggested, the traditional visual model takes perceptual grouping as the central feature of object individuation—the basic level of object perception. Wilson and Stevenson do not say anything about perceptual grouping—a point I return to shortly. Still, it achieves aspatial figure-ground segregation and that it does so forms the basis of their claim that olfactory experience represents objects. In terms of the visual model, then, object perception, for Wilson and Stevenson, is achieved at the level of object individuation and their answer to (i), *"Does olfactory experience achieve object individuation?*", is "yes." In particular, the answer to the following question is "yes":

(i') *Does olfactory experience achieve figure-ground segregation?*

The trouble is, the answer to (i') is underdetermined by the data.

This is because what Wilson and Stevenson say about figure-ground segregation at this level does not rule out a feature-based view. But if segregation constitutes the "defining feature [of perceptual] objecthood," then such a view should be rendered a nonoption. In order to see that this is so, consider again the coffee case. Wilson and Stevenson do not deny that, in being presented with the coffee object, we are presented with a distinctive property or, in the case of those less-than-synthetic experiences, a distinctive set of properties. For the sake of simplicity, assume the coffee experience is

[38] As O'Callaghan (2008) notes, figure-ground segregation needn't be achieved spatially. He argues that, in the auditory domain, it is achieved temporally.

wholly synthetic; I will return to less-than-synthetic experiences in a moment. When we sniff around the coffee, we are presented with what we can call the "coffee smell." Now suppose that the right view of such an experience is one according to which your experience attributes a property to an object. If that is true, then there must be a way of rejecting the view according to which your olfactory experience simply registers the instantiation of a property (i.e., the coffee smell) in the vicinity. Given its reliance on analytic processing, it is doubtful that the SRM can provide such a view; as Wilson and Stevenson stress, it must project that there is no presentation of *a* coffee smell per se. But consider the following version of a feature-based view: in the coffee case, your olfactory experience reports "it is coffee-smelling here" where, just as we do not attribute heat to the referent of "it" in the sentence "it is hot in here," your experience does not attribute the coffee smell to anything at all.[39] Is it possible to rule out *this* view?

It isn't clear that we have the materials with which to adjudicate. Both the ORM and this feature-based view will grant that a distinctive property (the coffee smell) is presented to you in experience. Each can also grant that the property appears to stand out from the other properties instantiated in a scene. Of course, each will tell a different story about how that experiential prominence comes about. I have rehearsed ORM's story, in terms of template matching, earlier. And it would seem that feature-based views are no less equipped for telling their own story—at least prima facie. A feature-based view might claim that it is a matter of attention and/or expectation. Or, as the ORM does, a feature-based view might appeal to mechanisms of learning and memory. For example, a certain olfactory property in one's environment might be "novel" to the system and so appear more prominently in the scene. Or the story might appeal to both types of influence. In any case, there are options. In sum, it would seem that a feature-based view could grant all of the perceptual phenomena that the ORM cites in favor of an object-based view—and yet remain a feature-based view.

As a result, something more needs to be said about how to rule out feature-based views like this. Earlier, I hinted that there seem to be two uses of "object" at work in Wilson and Stevenson. I will now say something more about this. At certain points of their discussion, Wilson and Stevenson speak of olfactory objects as the patterns of receptoral activity that are encoded as templates and stored in long-term memory. For example, they speak of olfactory objects as "statistically reliable patterns" and "patterns of stimulation." At other points of their discussion, they speak of such objects as the experiential output of template matching, as "unitary olfactory percepts" (2006, 33) or "synthetic odor objects" (2006, 6). It is important to note that responding to present worries about ruling out feature-based views requires more that simply drawing attention to the fact that there exist such patterns of excitation at the receptoral level, nor to the fact that such patterns are stored in long-term memory to expedite later olfactory discrimination. What is at issue is whether these patterns and combinations show up, at the level of experience, as perceptual objects. The question is whether the experiential output of template matching—the "unitary olfactory percepts" or "synthetic odor objects"—ought to be characterized in object-based terms. And, again, it isn't clear that there are the materials to adjudicate between that kind of view and one that characterizes olfactory experience merely in terms of apparent properties—at least if we are relying on observations of experiential

[39] I must thank Austen Clark for raising this point to me in a Symposium on Non-Visual Perception at the 2010 Pacific APA. In the published version of his comments, Clark (2011) gives other examples, some arguably feature-based, some individual-based, but not object-based. For the sake of space I consider only this of his examples.

prominence to decide it.

A clearer answer might be in the offing if "object individuation" of the original (i) is taken to refer to something more central to visual object individuation—namely, perceptual grouping. Earlier I argued that central to object individuation in vision is perceptual grouping. Because visual experience groups properties, it represents edges and boundaries and achieves figure-ground segregation. Following the visual case closely, it is plausible to think that if olfactory experience achieves perceptual grouping, it will do so in such a way that it provides a distinction between figure and ground—something that Wilson and Stevenson claim is central to olfactory object perception. A natural next question, then, is this:

(i'') *Does olfactory experience achieve perceptual grouping?*

But, even in the case of (i''), the answer is uncertain.

I do not doubt that Wilson and Stevenson would have what they need to rule out a feature-based view if olfactory experience achieved something akin to the perceptual grouping that occurs in vision. But it remains unclear that they *do* have it. Remember that olfactory experience is largely synthetic. As a result, olfactory experience doesn't have the wealth of perceptual ingredients that visual experience has to work with. And this fact about the nature of olfactory experience raises initial questions about the claim that olfactory experience achieves anything like the perceptual grouping that vision achieves.

But it is not as if olfactory experience has *no* ingredients to work with. After all, as Wilson and Stevenson claim, olfactory experience is "*largely* synthetic" (my emphasis), allowing, in some cases, for us to distinguish two or three features of an odorant stimulus. Perhaps olfactory experience achieves "minimal grouping." Unfortunately, as I noted earlier, Wilson and Stevenson do not say much about these cases and I have no particular example to draw on. Still, it is possible to project what would go some way toward settling the issue. Suppose that a certain odor, O_1, has the discriminable features, f_1 and f_2 and that another odor, O_2, has the discriminable features, f_3 and f_4. In each case, a combination of features is instantiated: $(f_1 + f_2)$, in the case of O_1, and $(f_3 + f_4)$, in the case of O_2. If further combinations of these features were possible—namely, one or more of $(f_1 + f_3)$, $(f_1 + f_4)$, $(f_2 + f_3)$, and $(f_2 + f_4)$— then the idea that olfactory experience can achieve perceptual grouping (and, indeed, solve the Many Properties Problem in certain cases) would make sense. Unlike vision, this grouping would not be achieved along spatial lines—something that would fit nicely with Wilson and Stevenson's claim that olfactory experience is aspatial. Still, it would seem to be perceptual grouping nonetheless.[40]

Still, even if such cases were actual, they would likely form only a small subset of our stock of olfactory experiences. Again, as Wilson and Stevenson stress, olfactory experience is "largely synthetic" and their focus is on arguing that those experiences that *are* synthetic are also object-based. If it turned out that some, less-than-synthetic olfactory experiences achieve perceptual grouping, then so much the better for the view that, in general, olfactory experience is object-based. But it remains that the experiences that do not achieve that much are their chief concern. And it is those experiences that Wilson and Stevenson claim are also object-based.

So far I have argued that it is unclear whether olfactory experience achieves object individuation in the way that Wilson and Stevenson claim is definitive of perceptual objecthood—

[40] I must thank Fiona Macpherson for helping me see these points about perceptual grouping.

namely, with aspatial figure-ground segregation. In response to (i'), what they say about segregation does not distinguish their object-based view from a feature-based one (and I gave an example of just such a view). The answer to (i'), then, is underdetermined. Then, with (ii'), I drew attention to the possibility that individuation might be achieved with perceptual grouping. Again it is unclear how to answer the question. At best we do not yet know whether olfactory experience achieves grouping; at worst, it does not. What is the next step?

There is at least one more version of (i) to consider:

(i''') *Does olfactory experience report on the edges and boundaries of objects?*

Arguably it does when we put the appropriate amount of work into it. Consider what you typically do when you experience a bad smell in your home and do not have an idea of what it might be (as it is typical to say). You walk around and notice fluctuations in the intensity of the smell. In the hope of cornering its source, you determine where the smell is instantiated in the area around you and where it is not. You also use your other senses (typically your eyes) to latch onto that source. Arguably in such a case, your olfactory experience reports on the edges and boundaries of the odor that the source gives off. You know, for example, not to investigate the bedroom any further when you are no longer greeted with the stench when you enter. Of course, once you have found the source, you typically give up your attempts to trace the boundaries of the odor it gives off and get down to the task at hand—getting rid of that source. But, the point is that you *could* trace those boundaries further and, in doing so, get an idea of the layout of the odor's expanse. And, when you do, arguably your experience, extended through time as events are, presents not a part of a particular odor but the entirety of one. And it does so *in space*.

What this example suggests is that we can have object individuation in olfactory experience. We track odors and, as a result, are able to experience them as extended through space. As Wilson and Stevenson stress, sometimes performing such investigative tasks will be complicated, given the mix of odors in our environment and differences in their intensities relative to one another and to the location of their parts. As I pointed out at the end of the previous section, familiarity with certain of the odors in our environment would seem to ease our navigation of the olfactory scene, allowing for tracking and persistence. This achievement of navigation, Wilson and Stevenson would presumably argue, can be explained by their template model of olfactory processing. Remember that, according to Wilson and Stevenson, the olfactory system is able to recognize patterns of receptor input allowing the system to lend experiential prominence to matched patterns. It does so by enacting stored templates of previous receptor input. A subject is able to smell the coffee odor despite the fact that her environment consists of a variety of such odors. She is also able to smell the coffee odor despite degradation of the stimulus or receptor input, or despite fluctuations in the concentration of that odor. Given the complexity—the confusion, it might be said—of our olfactory environment, these are particularly notable achievements.

Let me stress now that what aids us in these complex circumstances and, in turn, allows for the kind of object individuation I drew attention to earlier is not simply a type of discrimination but a type of *recognition*. But what does this recognition amount to? The recognition of properties, as a feature-based view would have it? Or the recognition of objects?

Clearly Wilson and Stevenson would claim that it is the latter and, as they see it, this

recognition is necessarily informed by figure-ground segregation—a phenomenon in the province of object individuation. Remember that, for Wilson and Stevenson, figure-ground segregation is the defining feature of perceptual objecthood. For Wilson and Stevenson, then, object recognition involves object individuation. This is in keeping with the visual model, a model of object perception that grants object individuation a defining role. But there is another way to understand the ORM—a "remodeled" ORM. The remodeled ORM places less emphasis on figure-ground segregation—indeed on object individuation. In doing so, it allows for object recognition to play a driving role in object perception. That it can do so, the remodeled ORM argues, is especially evident in cases in which object individuation is arguably absent. Unlike what the visual model supposes, the remodeled ORM allows that, in the olfactory case, instances of object recognition need not involve object individuation. Moreover, in circumstances of tracking and tracing boundaries, object recognition might drive object individuation. And I take it that it is this kind of role for object recognition that, at root, Wilson and Stevenson want to stress with the ORM—a role that allows us, in certain common circumstances, to rule out feature-based views at the level of object recognition alone. In terms of my previous two questions, then, a remodeled ORM shows that we might have, in certain circumstances, an answer of "no" to all of the variations of (i), *Does olfactory experience achieve object individuation?* and an answer of "yes" to (ii), *Does olfactory experience represent objects?* Despite loosening the ties of what has been the prevailing model of object perception in philosophy—namely, the visual model—it is a position that comes naturally to us. Let me say more.

At least two things are natural to think about olfactory perception. First, as I highlighted in the introduction, the natural position is that we smell *things*—not simply properties. As I stated it then, it is natural to think that we smell ordinary material objects (source objects); but, despite the fact that we typically appeal to material objects in reporting what we smell, I hold that it is equally natural—perhaps more natural—to think that we smell odors. Odors are objects—just not ordinary ones, we might say. And we think of ourselves as smelling material objects by smelling the odors they give off. This indirectness makes olfactory perception unlike visual perception. But we do hold them to be alike insofar as each involves the perception of objects—ordinary ones and unordinary ones, in the case of olfaction. Second, we do not think of olfaction as acting in isolation. When we take it that we smell a certain kind of thing, we do so because we have had previous experience with those kinds of things—as the sources of smells or as the emanations given off by those source things. Sometimes we may have located those sources using our olfactory tracking skills in conjunction with (in most cases, I take it) our eyes. At other times we may have simply been told that a certain object (or kind of object) is the source of an odor (or kind of odor). In any case, we are armed with a robust network of background beliefs about our olfactory environment and the kinds of objects that feature in them. Given this network of beliefs, we come to think of our olfactory experiences as those in which we smell objects (odors and ordinary objects), and not simply properties distinctive of their kind. The natural view of olfactory perception—one according to which we smell objects—has it as importantly experience-based.

A story about how beliefs about objects manifest in particular cases likely has the following form. When you are first presented with a particular smell, you gather beliefs about its source. To see how you might do so, it is easiest to think of that smell as a novel one and as appearing to you in a

relatively uncomplex scene—that is, one that is not comprised of a variety of odors. What do you do in such a circumstance? As I said, you look for its source, likely by gathering information about the instantiation of the smell. At the source, the smell will be more concentrated, allowing the filtering out of any other olfactory stimuli. In this way, a distinctive olfactory property becomes, at the level of belief, locked onto a specific source object. Armed with this information about that property, you may also track its odor, gathering beliefs about the spatial presentation of the odor it gives off. In any case, as a result of gathering beliefs about its source, you also gather beliefs about the kind of odor it puts forth into the atmosphere. "Dead rats give off an odor like *this*," you might say, where "this" refers to that odor's distinctive smell (i.e., some property or combination of properties).

When you next run into that distinctive smell, those beliefs about the kind of odor it belongs to and that odor's source are put into use. Indeed, in many cases, it is as though previous experiences help us discriminate—latch onto—a certain smell at a later date. But, most crucially, you are not merely poised to believe on the basis of your current experience that there are certain properties instantiated in your environment; rather, you are poised to believe that there are objects in your environment with that property. Faced with the dead rat smell in the living room again, I wouldn't simply come to believe that there is a distinctively distasteful property around, even if I had not located the source or traced the boundaries of the odor to which it belongs—that is, even if my experience arguably doesn't achieve object individuation.[41] Rather, I would come to believe that there is a smelly object (odor and/or ordinary object) of a certain kind (the dead rat kind) in my environment. In these circumstances, the natural view is that the content of my experience reflects these beliefs. On the natural view, that content is not simply, as the feature-based view I considered earlier might have it, "it smells pungent." Rather, we think of it as something like "the odor in this room is pungent" or "there is a rat around and it smells pungent." And it is fair to say that we would so even if such an experience was not informed by the contribution of any current investigation—that is, moving about, tracing the boundaries of the odor, or finding its source. It is the recognition of what was formerly experienced, together with what presently is, that determines the content of my experience.

On the natural view, then, the content of olfactory experience is shaped by influences other than those strictly olfactory and, despite any failure to accomplish object individuation in a given case, it is still able to represent objects. The content of an experience is often characterized as the way the world appears to a subject when she has that experience. Now, the notion of "the way the world appears" is often one that is used intuitively. But one way to characterize "that way"—and indeed a characterization that is suggested by the olfactory case itself—is to ask what the subject is justified in believing on the basis of that experience. If that characterization is adopted, it is natural to say that, given earlier experiences, I am not only presently justified in believing that there are certain properties instantiated before me, but also that those properties belong to objects. If we never moved about, never used any other modality than olfaction, never gained beliefs on the basis of doing so, then perhaps we would be unable to rule out a feature-based view. But we do. And we gain beliefs about objects on the basis of doing so.

How does the ORM fit into to this story? According to what I have been calling the natural

[41] Luckily it has not happened again.

view of olfactory perception, olfactory experience represents objects and can do so despite, in certain circumstances, failing to achieve anything like object individuation. The ORM can explain how it is able to do so. For reasons I gave earlier, I take it that it is best to deemphasize Wilson and Stevenson's emphasis on figure-ground segregation for the olfactory case and focus instead on what is truly unique about the ORM—namely, its emphasis on the importance of object recognition as forming the basis, in many cases, of olfactory object perception. It is this that makes the ORM truly distinctive—and important for theorizing about olfaction and sensory perception in general. On the remodeled ORM it is in virtue of olfactory object recognition that we are able to latch onto relevant odors in our environments and enjoy much more complex representations of objects—of odors and, in virtue of those, of ordinary objects. Driving this ability to latch onto certain odors in our environment is learning and memory—in particular, the matching of stored templates. The experiential prominence that results from such a match can be seen, as the natural view would have it, as the representation of an object—just not one in which object individuation need play a fundamental role. As I argued, if the emphasis is placed on figure-ground segregation, then it is difficult to see how experiential prominence provides the basis for a rejection of a feature-based view. If we restrict Wilson and Stevenson's emphasis on figure-ground segregation and place even greater emphasis on top-down influences on olfactory content (what they refer to throughout as learning and memory), it becomes easier to see how the ORM can go about rejecting those views. As a consideration of the natural view has shown us, it is just those kinds of influences that allow, in many cases, for our ability to describe ourselves as smelling objects. If our descriptions of our experiences are correct, then the ORM provides a framework with which to account for their correctness. This is because the ORM makes a available a way of ruling out feature-based views not merely at the level of individuation, as when we trace the boundaries of an odor in a relatively uncomplex scene, but also, in more complex scenes, at the level of object recognition alone. It is *this*—more than the ability to meet any parameters of the visual model—that should be stressed when we praise the novelty of this emerging approach to theorizing about olfaction.

5. Hats and Rats

Let me now say something more about the examples I began with. Recall that in the introduction I described two perceptual situations. In (V), there is a baseball cap lying on the driveway. You are looking at it. In (O), there is a dead rat in the living room. You sniff it. I claimed that, in each case, a certain description of the circumstances would be considered accurate. In (V), the following description of your situation would be considered accurate:

(D_v) I saw a baseball cap on the driveway.

And, in (O), the following description of your situation would be considered accurate:

(D_o) I smelled a dead rat in the living room.

Now, it might be argued that the way that I described (O) implies that you have located the rat, even that you see it. After all, I claimed "you sniff *it*." This characterization, together with the visual situation it is drawn from, naturally brings with it the suggestion that you, the perceiver, have located the rat. In this case, it is easy to see why we regard (D_o) as true. But I do not want to focus on that kind

of circumstance. The variant of the case that I want to focus on is the one in which the rat smell is not novel (you have experienced it before) and you have not located any rat or indeed traced its odor. You are simply standing there, struck with the smell. Arguably these are the kinds of experiences that Wilson and Stevenson are appealing to when they describe olfactory experience as aspatial. In such a case, (D_o) also seems accurate. But, as I indicated at the outset, it does so even though the experience it describes seems disanalogous to the visual experience that (D_v) describes. I then asked, How can that be explained?

The ORM, as I have formulated it, provides a particularly nice explanation. For the remainder of the chapter, let (O) be a case in which you have not located the rat or traced its odor, but its smell is not a novel one. As I claimed, the description (D_o) seems to accurately describe the experience you have in (O). But (O) is also a situation in which olfactory experience achieves none of the things that vision does at the level of individuation. It is for this reason, I take it, that we are apt to regard the experiences that (D_v) and (D_o) describe as importantly disanalogous. In (V), your experience achieves object individuation; in (O), it does not. And it is because it does not that we regard the experience involved in (O) as failing to be overtly object-based. "Overtly object-based," I maintain, refers to the kind of perceptual organization achieved at the level of object individuation. If we think of object perception as requiring object individuation, as I think philosophers are prone to do when we take the visual model seriously, then we are bound to think that cases in which there is no such individuation are cases where there is no object perception.

But, as consideration of the ORM has shown us, this assumption does not capture all cases of olfactory experience. And what this suggests is that what it is about visual experience that makes it the case that (D_v) is true might be different from what it is about olfactory experience that makes (D_o) true. In the case of (D_v), what explains its truth is arguably the fact that your visual experience achieves object individuation and, in virtue of that, is capable of object recognition. The case of (D_o) is different. As I have described it, (O) is not a situation in which anything like object individuation is achieved. Yet, it is one in which you recognize the smell of rat given your previous (unfortunate) experience with such a smell. Because you are disposed to believe that there is a rat around or that the odor you smell is the rat odor—that is, you are disposed to believe certain things about objects in your vicinity—your experience in such a situation arguably represents objects. After all, if we take seriously the view that the content of an experience is just the way that things appear to you when having an experience, and that "way" can in turned be cashed out in terms of what you are disposed to believe on the basis of that experience, then the content of your experience in (O) must appeal to rat odors, rats, or both.

Now, clearly there is more to be said about the view of object representation that the remodeled ORM espouses. One question I did not deal with is whether, in those olfactory experiences in which it claims there is object recognition without individuation, a subject's experience represents particular objects as opposed to, or perhaps in addition to, kinds of objects. What I have said on behalf of Wilson and Stevenson suggests that it can at least do the latter; but what about the former? As I have presented the ORM, the answer to this question remains open. And answering it is a natural next step. But in general, in making available a view according to which objection perception can involve recognition without individuation, the ORM highlights interesting issues about the nature of object

perception in general—issues that are much more difficult to isolate if we let the visual congest us.

Acknowledgements: I must thank the editors of this volume for a wealth of helpful comments along the way. In addition, I must thank an audience at the University of Glasgow for their comments on and help with some of the issues presented in this chapter as well as Tim Sundell for reading earlier drafts of it. All helped me improve the paper greatly.

Works Cited

Amoore, J. E. 1952. "The Stereochemical Specificities of Human Olfactory Receptors." *Perfume and Essential Oil Record* 43: 321-330.

Amoore, J. E. 1963. "The Stereochemical Theory of Olfaction." *Nature* 198: 271-272.

Amoore, J. E. 1970. *Molecular Basis of Odor*. Springfield, IL: Thomas.

Buck, L. and R. Axel. 1991. "A Novel Multigene Family May Encode Odorant Receptors: A Molecular Basis for Odor Recognition." Cell 85 175-187

Chalmers, D. J. 1996. *The Conscious Mind*. New York: Oxford University Press.

Clark, A. 2000. *A Theory of Sentience*. New York: Oxford University Press.

Clark, A. 2011. "Vicissitudes of Non-Visual Objects: Comments on Macpherson, O'Callaghan, and Batty." *Philosophical Studies* 153: 175-181.

Cohen, J. 2004. "Objects, Places, and Perception." *Philosophical Psychology* 17: 471-495.

Crocker, E. C. and L. F. Henderson. 1927. "Analysis and Classification of Odours." *American Perfumery and Essential Oil Review* 22: 325-356.

Gross-Isseroff, R. and D. Lancet. 1988. "Concentration-Dependent Changes of Perceived Odor." *Chemical Senses* 13: 191–204.

Harper, R., E. C. Bate-Smith, and D. G. Land. 1968. *Odour Description and Odour Classification*. New York: American Elsevier.

Henning, H. 1916. *Der Geruch*. Leipzig: Barth.

Kubovy, M. and D. Van Valkenburg. 2001. "Auditory and Visual Objects." *Cognition* 80: 97-126.

Linnaeus, C. 1756. "Odores Medicamentorum." *Amoenitates Academicae* 3: 183-201.

Lyons, J. 2011. "Circularity, Reliability, and the Cognitive Penetrability of Perception." *Philsophical Issues* 21: 289-311.

Maarse, H. 1991. *Volatile Compounds in Foods and Beverages*. New York: Marcel Dekker.

MacDonald, M. K. 1922. "An Experimental Study of Henning's System of Olfactory Qualities." *American Journal of Psychology* 33: 535-553.

Macpherson, F. 2011. "Cross-Modal Experiences." *Proceedings of the Aristotelian Society* 111: 429–468.

Macpherson, F. 2012. "Cognitive Penetration of Colour Experience: Rethinking the Issue in Light of an Indirect Mechanism." *Philosophy and Phenomenological Research* 84: 24–62.

Moncrieff, J.W. 1967. *The Chemical Senses,* 2nd edition. London: Leonard Hill Books.

O'Callaghan, C. 2007. *Sounds: A Philosophical Theory*. New York: Oxford University Press.

O'Callaghan, C. 2008. "Object Perception: Vision and Audition." *Philosophy Compass* 3: 803-829.

O'Callaghan, C. 2010. "Sounds and Events." In C. O' Callaghan and M. Nudds (Eds.), *Sounds and Perception: New Philosophical Essays*, 26–49. New York: Oxford University Press.

O'Callaghan, C. 2012. "Perception and Multimodality." In E. Margolis, R. Samuels & S. Stich (Eds.), *Oxford Handbook of Philosophy of Cognitive Science*, 73–91. New York: Oxford University Press.

Siegel, S. 2012. "Cognitive Penetrability and Perceptual Justification." *Noûs* 46: 201–222.

Siegel, S. 2013. "The Epistemic Impact of the Etiology of Experience." *Philosophical Studies* 162: 697–722.

Slotnick, B.M., G. A. Bell, H. Panhuber and D. G. Laing. 1997. "Detection and Discrimination of Propionic Acid after Removal of Its 2-DG Identified Major Focus in the Olfactory Bulb: A Psychophysical Analysis." *Brain Research* 762: 89-96.

Stokes, D. 2012. "Perceiving and Desiring: A New Look at the Cognitive Penetrability of Experience." *Philosophical Studies* 158: 472-492.

Titchener, E. B. 1912. *A Textbook of Psychology*. New York: MacMillan.

Wilson, D. A. and R. J. Stevenson. 2003. "Olfactory Perceptual Learning: The Critical Role of Memory in Odor Discrimination." *Neuroscience and Biobehavioral Reviews* 27: 307-328.

Wilson, D. A. and R. J. Stevenson. 2006. *Learning to Smell: Olfactory Perception from Neurobiology to Behavior*. Baltimore: Johns Hopkins University Press.

Wilson, D. A. and R. J. Stevenson. 2007. "Odour Perception: An Object-Recognition Approach." *Perception* 36: 1821-1833.

Zwaardemaker, H. 1895. *Die Physiologie Des Geruchs*. Leipzig: Engelmann.