8 The Many Problems of Distal Olfactory Perception

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1. Introduction

The denial of identifying the object of olfactory perception and experience with ordinary objects (Lycan, 1996; Batty, 2010; Young, 2016; Keller, 2017) yields many problems in ascertaining the distal nature of olfactory perception. In everyday life, smells are individuated using our intuitive grasp of ordinary objects, thereby making the emanations of ordinary three-dimensional objects, picked out visually, our most natural conception of the olfactory object. While we are doubtlessly primarily visual creatures, the workings of the visual system, and what we know about it, should not be the sole arbiter on what the proper objects of perception are. Elsewhere, I have argued that that our folk conception of smells is incorrect, since it tacitly assumes an inappropriate conception of the olfactory object that is borrowed from the study of vision (Young, 2016). However, if the objects of olfactory perception and experience are not ordinary objects, then it becomes natural to wonder if smells are even objective entities in the environment.

Despite offering independent theories of olfactory experience and perception, Batty's (2010, 2011, 2014, 2015) and Keller's (2017) non-objectivists theories, which claim that smells should not be considered objective entities within the environment, are predicated upon a similar two-part argument, whose conclusion is that olfaction cannot resolve the multiple properties problem (MPP). The many properties problem is proposed as an explanatory challenged in generating an account of how we can perceive the same types of properties instantiated in different arrangements across a variety of perceptual arrays (Jackson, 1977; Tye, 1989; Clark, 2000; Smith, 2002). Batty and Keller's shared argument might be summarized as follows: olfactory perception and/or experience does not present olfactory objects with fixed spatial locations, such that it cannot generate figure-ground segregation of an odor array, and thus it cannot resolve the MPP. However, the argument depends upon introspective reports of the synchronic phenomenology of distal perception and arguments by analogy from vision. With this methodological access point to olfactory perception and experience, their theories generate a narrow olfactory perspective that limits what might be considered an olfactory object.

By contrast, careful attention to the temporally extend nature of olfactory perception calls into question holding the spatial nature of olfactory objects fixed to the perspectival relation we extrapolate from vision. Expanding our conception of olfactory experience provides an explanation of the distal nature of smells, which is in keeping with molecular structure theory's (MST) identification of the intentional object of olfactory experience with smellscapes (Young, *forthcoming*). The many difficulties in assessing olfaction's distal nature can be accounted for by MST's account of the olfactory object as the molecular structure of chemical compounds within odor plumes (Young, 2016). Thus identified, the objective nature of smell can both generate figure-ground segregation and resolve the MPP.

The chapter unfolds in the following sections. The first section examines the reasons for claiming that olfactory perception is spatially unstructured and our experience of smells has an abstract structure. The second section elucidates the further arguments that olfaction cannot generate figure-ground segregation. The third section assesses the conclusion that olfactory perception and experience cannot solve the MPP. Following the overview of the many problems inherent to distal olfactory perception, MST will be introduced as an alternative perspective that allows for figure-ground segregation and perceiving multiple olfactory objects within an array. The chapter then concludes by replying to the shared argument that olfactory distal perception does not have the requisite resolution to resolve the many properties problem.

2. Spatial Extent

The abstract view, argued for by Batty (2010, 2011, 2014, 2015), is that olfactory experiences present us with an undifferentiated experience of features of an environment. Olfactory properties are not predicated on particulars at determinable locations—our experience of olfactory scenes does not present individual particulars at determinable locations with specifiable spatial properties. To generate such a conclusion, Batty argues that object perception presupposes that perceptible particulars have a spatial location (Batty, 2010) and that we do not experience objects as having a fixed spatial coordinate in olfactory experiences. Her evidence for the lack of spatial resolution derives from an example of smelling a single odor within an environment (Batty, 2011). At a given moment we cannot locate the individual smell with a specifiable determination of the coordinates of the object in egocentric or allocentric space, and thus the best description of the experiential content of these states is that the smell is somewhere hereabouts. From a synchronic perspective, we cannot at a given sniff determine the spatial temporal boundaries of a given smell.

A further piece of evidence that Batty offers is that we lack object individuation resolution when encountering more than one odor. By means of an example, we are asked to consider situations when we cannot distinguish between tokens of different types of smells. For instance, one wakes up to the smudgy experience of coffee and pancakes for breakfast, whereby one cannot distinguish the spatial instantiation of the coffee and pancakes smells as separable entities (Batty, 2010). However, the more telling examples are full cover and miss-a-spot (Batty, 2011). Consider the following two scenarios: you spray an odorant in a room that fully covers a putrid smell, as opposed to the experience of spraying the odorant to cover the putrid smell but you miss a spot. In both of these examples, from a synchronic perspective, it is impossible to tell whether we have an instance of full coverage or miss-a-spot. Thus, given our inability to discriminate the full spatial extent of a smell synchronically, we are meant to conclude that our experiences of smell are not of particular objects with spatial properties.

Moving away from arguments by example from synchronic experience, Keller (2017) provides three separate arguments using evidence from the chemosciences for the conclusion that olfactory perception has no inherent spatial structure. The first is that olfactory experience is spatially unstructured. Our synchronic perceptual experience does not present olfactory qualities with spatial properties. The evidence offered in favor of this claim is that we cannot detect stimulus onset relative to presentation order to each nostril individually. When an odorant is presented to a single nostril we are unable to identify which nostril this is (Kobal & Hummel, 1998; Radil & Wysocki, 1988; Frasnelli et al., 2009, 2010; Kleemann et al., 2009). From this evidence, he concludes that olfactory perception does not yield spatial resolution. While he does allow that trigeminal stimulation yields localization of a distal entity, Keller rightly notes that chemothesis perception should not be considered part of the olfactory perceptual modality. In addition to our inability to localize odor onset binaurally, he notes the lack of spatial coding by olfactory receptors.[1] Olfactory receptor neurons' (ORN) stimulus encoding does not bear an isomorphic mapping relationship between the distal array of objects in the environment and the proximal stimulus as it is transduced at the receptor site.

The second argument made by Keller for the lack of spatial qualities of smell is that we cannot infer from instances of olfactory spatial navigation that the perceptible qualities have spatial characteristics. Since different modalities use different navigational strategies, we cannot infer from the spatial structure of visual navigation that olfactory perception must have spatial structure as well. Furthermore, he argues that even if the spatial structure of the stimuli in the environment can be used for navigation this does not imply that the olfactory qualities themselves contain spatial structure. The olfactory stimuli *simpliciter* are not inherently spatially structured; rather the spatial distribution of the stimuli within the environment facilitates navigation. Underlying this argument is the tacit claim that we cannot infer from the spatial structure of the distal array to the spatial structure of mental qualities. Merely the fact that there is spatial structure in the distal objects does not entail that there is a similar spatial structure within the mental representation thereof.

In summary, Batty and Keller offer four arguments for the conclusion that we do not perceive and/or experience smells as being spatial entities within the environment based on our poor synchronic spatial resolution, our inability to discriminate between and individuate olfactory particulars within an overlapping array, our inability to detect odor onset relative to nostril onset, and the lack of intrinsic spatial properties within the experience of olfactory qualities. Each of these arguments shares the underlying claim that we do not synchronically experience and perceive smells as individual entities with set boundaries and fixed spatial coordinates in the environment.

3. Figure-Ground Segregation

If olfaction does not present perceptible objects at specifiable coordinates in allocentric or egocentric space, it becomes uncertain if olfaction could generate the capacity to segregate one perceptible object from an array of background entities. However, even if olfaction does not have the requisite spatial resolution in synchronic experience, when we consider diachronic olfactory experiences and extended temporal sequences a different conclusion might be warranted. This section will consider the arguments and reasons that Batty and Keller offer against atemporal (synchronic) and temporal (diachronic) figure-ground segregation in olfaction and foreshadow my replies to each argument.

Employing phenomenological descriptions of synchronic olfactory experience concerning the abstract nature of olfactory experiential states, Batty argues that olfaction cannot represent figure-ground segregation, and thus the MPP does not apply to olfaction (2010) or olfaction cannot solve the multiple properties problem (2011). Her argument more explicitly stated is that olfactory properties are not predicated of individual things at determinable locations (2011, 2014); therefore olfaction cannot generate an array of objects that would be necessary for the representation of a perceptible object against a background of other odor objects (2014). While this line of reasoning yields the desired conclusion, it depends upon the questionable accuracy of phenomenological descriptions of olfactory experience relativized to only a synchronic timescale in comparison to vision. Batty (2014) defends the need for synchronic understanding of figure-ground segregation in olfaction to account for those cases of animal models, such as hammerhead sharks, that we presume have synchronic olfactory experiences of distal olfactory objects that are spatially located. But even accounting for these gifted creatures requires slightly extending the timescale of olfactory experience to account for stimulus onset between the nostrils.

Despite reiterating the argument that the capacity for figure-ground segregation is necessary for resolving the multiple properties problem, Batty (2015) considers the sub-capacities of object individuation and recognition that serve as the basis for perceptually grouping objects with their properties. She argues that olfaction can generate recognition without individuation, which explains how it is possible for us to temporally register smells as being of the same type without being able to spatially determine the extent of the odor. Even when considering temporally extend olfactory experiences, she contends that descriptions of these experience still do not generate olfactory object individuation, as they are indeterminate between a feature-based account of olfactory qualities that ascribes odorous properties to the environment and objective theories that propose we smell aspatial odor objects using template matching between past olfactory experiences and the current odorous environment (Wilson & Stevenson, 2006).

However, it is unsurprising that her abstract account will not generate object individuation even in these temporally extended situations, given the great difficulty her account has with synchronic odor object individuation, as has been argued in Young (2016). Moreover, Wilson and Stevenson's theory should be treated as generating an account of the intentional object of olfaction and not addressing the question of how we individuate the external object of olfaction (Young, 2016). When the temporal timescale of olfactory perception is taken into account, and their approach is combined with MST's account of olfactory quality and the external object of olfaction, the claimed ambiguity disappears.

Figure-ground segregation, according to Keller's (2017) conception, requires the representation of the relative position of the stimulus in physical space. However, regardless of the temporal extent of the perceptual experience, he does not think olfaction can achieve figure-ground segregation. He carefully examines three possible scenarios for atemporal figure-ground segregation in olfaction all involving the perception of one component of a complex mixture that is individuated using either differences of intensity, differential familiarity towards the one component, or violations of our expectations concerning one stand-out component of the mixture. He argues by analogy that these are all similar to salience-based attentional allocation in vision, which is not considered adequate for generating figure-ground segregation in vision. Thus, by extension from the visual cases these olfactory examples are not sufficient to generate figure-ground perception. However, given his previous assertion that we cannot simply extrapolate from one capacity in one modality to the structure representation of a capacity in another modality this seems disingenuous. Additionally, his examples might be considered problematic because they all concern components of an odor mixture, which might be considered aspects of a single odor object, rather than what would be required to ideally show figure-ground segregation, which is a particular object against a background array of other olfactory entities.

In connection with just these kinds of worries, Keller considers temporally extended olfactory scenes. He suggests that we consider the background odor to be those smells that have achieved olfactory adaptation and are no longer noticeable, while a new salient smell will be presented as the object of perspectival fixation against this background. Keller argues this olfactory scenario is analogous to the visual example of attending to a banana as it develops spots against the background of the table it is situated upon. Since in the visual case, we do not consider temporal changes as generating figure-ground segregation, then by extension we should accept the same conclusion for olfaction, because he asserts that we should maintain parsimony of what is considered a perceptual object across modalities. What is problematic about his example, aside from being a poor analogy, is the tyranny of holding olfactory perception to the standards of visual perception without some argument that our intuitions derived from vision should be the arbitrator of perceptual objecthood.

4. The Many Properties Problem

As noted in the introduction the many properties problem is proposed as an explanatory problem of accounting for how we can perceive the same types of properties instantiated in different arrangements across a variety of perceptual arrays (Jackson, 1977; Tye, 1989; Clark, 2000; Smith, 2002). Phenomenological appearances suggest that our synchronic visual experiences of the same set of multiple properties across a variety of scenes are rendered by changing the predication of properties to individual objects, which are distinguished based upon their spatial grouping. Yet, it is not clear how this can be accomplished in olfaction given the extended vague boundaries and lack of experiential grouping of smells.

Keller's construal of the olfactory many properties problem centers upon issues concerning the perceptual space rendered by the olfactory system. Since our synchronic experience of olfactory qualities does not demarcate these entities within perceptual space, olfactory perceptual states do not intrinsically represent the spatial mapping of these objects within the environment. Evidence for these claims derives from his original claim regarding the inability to localize the onset of an odor between nostrils. Similarly, Batty (2010, 2011, 2014) claims that olfactory experience does not represent particular odor objects. If olfactory perceptual qualities do not have intrinsic spatial qualities and if our olfactory experiences are not of particulars, then we cannot generate the requisite format for representing many objects and their properties within an environment across multiple presentations in varying arrays.

Assuming that we do not experience smells as particular entities then it becomes impossible to tell which property within a given array would belong to which object. Without the fundamental ability to parse an array of objects it seems impossible to ascribe a property to an individual object so as to generate grouping effects that could represent many properties predicated of different objects within an array (Batty, 2010, 2011, 2014). One way of blocking this theoretical progression is to advert to Carvalho's (2014) argument that to correctly describe some of our phenomenological experience of smells requires reconsidering the abstract view's description of our synchronic olfactory experiences. He asks us to consider the olfactory array of smelling both a red wine and a spicy sausage. Situations such as these require multiple objects for the existential quantification of predicated properties, such that we ascribe the property of spiciness to the sausage and the berry notes to the Beaujolais. In response to Carvalho, Keller argues that at the receptor level there is no predication of olfactory qualities to odorous objects. As the molecular structures impact upon the receptor site there is no segregation of olfactory qualities bound to particular odor objects. However, it is unclear why issues regarding receptor encoding and transduction are being used to adjudicate against certain descriptions of olfactory experiences. We do not extrapolate from the receptor sites in other modalities to their capacity to perceptually segregate individual objects with grouping structure within an array, nor should we expect that the complete correctness conditions of perceptual experiences be sufficiently generated by our understanding of stimulus encoding and transduction at the receptors.

Based on the same reasoning, Keller argues that our ability to segregate an olfactory scene into objects and properties depends upon background knowledge, and thus olfactory perception on its own cannot resolve the MPP. Inferring the correct predication of an olfactory quality to a particular odor object requires accessing past olfactory memories developed from previous interactions with the environment. Keller asserts that nothing about the olfactory experience resolves the issue of whether an individual olfactory quality should be ascribed to any given instance of an odorant cloud. He asked us to consider the situations whereby we order pizza with anchovies, yet the pizza arrived without anchovies, but the deliveryman has the smell of anchovies lingering upon his clothing. In such a situation, it would be incorrect to ascribe the smell of anchovies to the pizza despite anticipatory effects. His argument might work if it could be established that there are no correctness conditions for ascribing olfactory qualities to odor objects within the environment. Perhaps, if we start with ORN receptivity as the determiner of representational content then there is no principled way of individuating olfactory objects and their properties. Yet, as noted earlier when considering other modalities, we do not describe correctness conditions of representational content merely from receptor transduction. Additionally, these kinds of examples might be redescribed as perceptual misrepresentations, in terms of both ascribing a quality to an ordinary object and misattributing the properties in this instance (Young, 2011, 2016).

In considering whether olfaction can synchronically resolve the MPP, Batty (2014) offers an argument against Wilson and Stevenson's (2006) claim that olfactory perception is aspatial, yet attains figure-ground segregation. According to Wilson and Stevenson the intentional object of olfactory experience must correctly be described in terms of template matching. Across multiple token experiences we learn that certain odorants frequently co-occur, such that we develop a prototypical template of what mixtures are associated with a particular type of odor. These template odor objects are meant to be similar to the templates used in visual object mapping. The templates can synchronically be deployed to generate aspatial figure-ground segregation. According to Wilson and Stevenson, within an atemporal olfactory experience we perceive an odor object with a given set of properties using the template against a background of other odor objects using different template structures. However, Batty points out that without spatial mapping, we could alternatively describe these experiences as properties of the environment. Since there is no particular object of which we are predicating the properties but just a sensory template, we could instead ascribe the feature template to the environment based on past experiences. Thus, she argues that these situations are ambiguous between the abstract view and the template approach of the object representational model (ORM) proposed by Wilson and Stevenson. However, as noted in the second section these situations are only ambiguous between the accounts, because ORM merely provides a theory of the intentional object of olfaction; when their theory is combined with MST's account of the olfactory quality and the external object of smell we gain not only the ascription of olfactory qualities to objects in the environment but also figure-ground segregation.

Another issue with the MPP is the diachronic temporal sequence assumed as part of the capacity to delineate where the properties are located relative to the objects within a perceptual array. If we extend the temporal sequence and include cross-modal integration then it is likely that the olfactory system will have the necessary resolution to represent an olfactory array of odors with grouping structure. However, Keller argues that to include these strategies and increase the timescale would cheapen the overall notion of an object, such that nearly all perceptual states would become objective. His argument, charitably interpreted, is that we require a principled reason for considering a perceptible entity an object. Weakening our criteria of objecthood from those that we determined from visual experiences generates a conception of perceptible objects that is too promiscuous.

Batty (2015) considers the issues of diachronic temporal resolution using the following premises: subject-predicate structure is a necessary condition for figure-ground segregation; figure-ground segregation allows grouping objects with properties within a perceptual array. Thus, vision resolves the many properties problems using spatial grouping of objects to which we can then attribute the many properties in their varying distributions across different perceptual arrays. If object individuation is a necessary component of figure-ground segregation, which is necessary for the ability to segregate perceptual arrays into different objects with changeable and repeatable properties, then it is questionable if the olfactory system can resolve these even if we extend the temporal sequence of experience. Considering the first issue of whether the olfactory system can achieve olfactory object individuation, she argues against ORM that the theory at best allows for the individuation of odorous features of an environment, but it does not generate the individuation of a particular object. Thus, we do not individuate objects within the environment, because of the lack of spatiotemporal binding of odorous particulars within the environment.

However, when it comes to the further perceptual capacities of object recognition and grouping, Batty argues that we achieve object recognition and are able to recognize smells in terms of recognizable properties across time. Nonetheless given the abstract view these are still not predicated of objects in the environment. Hypothetically, if olfactory experiences yielded perceptual grouping, such that it could change the orientation of the objects and properties depending upon the perceptual array, then it might be possible to generate the necessary format to resolve the MPP. According to Batty, demonstrating perceptual grouping requires representing multiple situations in which the same objects can be represented with a subset of exchanged properties. On her abstract view, olfactory experience does not achieve individuation or grouping, as demarcating the edges and boundary of the odor object would require diachronic experience and background knowledge. Batty readily admits that the only way to rule out the abstract view is by abstracting away from the olfactory experience *simpliciter* and adverting to aspects of other modalities and cross-model influences. Yet, this is exactly what is required for vision to resolve the many properties problem, thereby yielding a beachhead for my line of reply that these arguments by analogy from vision misrepresent the very nature of visual perception and are prejudiced against olfaction.

5. Molecular Structure Theory and Smellscapes

One of the great difficulties in accounting for our ability to perceive distal olfactory objects is accounting for how we segregate the sea of chemicals enveloping us into distinct smells. Elsewhere it has been argued that MST is superior to the precursor odor theories (Batty, 2007, 2009, 2010; Lycan, 1996, 2000, 2014; Tye, 2000, 2002) in generating an explanation of the external object of olfactory perception and what accounts for olfactory quality and odor individuation (Young, 2016). Moreover, it has been argued that even if we jettison the pretheoretic account of smells as tied to ordinary objects that nonetheless olfactory perception and experience are objective, such that it generates figure-ground segregation,[2] thereby enabling us to perceive mereologically complex perduring olfactory objects (Young, 2016, 2017). According to MST, our experiences represent smells as distal environmental entities with spatial properties, such that what determines the olfactory quality and the spatiotemporal nature of smells is the molecular structures of chemical compounds within the gaseous plume.

The olfactory quality of a given smell, the spatial and temporal boundaries of the distal object, and the intentional object of olfactory experience are determined by the molecular structure of chemical compounds within odor plumes. The chemical compounds determine the distal nature of the token odor plume given their concentration gradients. While the constituent chemical compounds compose the gaseous cloud, the plume also plays a role in the determination of olfactory quality. The interaction between the different kinds of molecular structures within the plume influences olfactory quality (Young, 2016; Young, Escalon, & Mathew, manuscript).

Molecular structure theory jettisons the ordinary object view, while maintaining that we smell mereologically complex particulars that can generate figure-ground segregation. The initial statement of MST (Young, 2016) was primarily constructed to account for simple odor mixtures and monomolecular odorants, but when considering natural environments, we must consider olfactory mixtures composed of multiple types of chemical compounds. Determining the spatial and distal nature of the olfactory object requires accounting for the plume structure of a given odor within a turbulent sea of overlapping chemical currents.

What was missing from the initial statement of MST was a specification of the intentional object of olfactory experience. What we experience as the objects of olfactory experience are odors within a smellscape. The idea of smellscapes is certainly not new, as distal olfactory perception has a long history of debate going back to Plato and Aristotle through to their Medieval Commentators.[3] Additionally, Indian philosophy contains a rich treatment of olfactory navigation, as well as discussions of garden design to elicit a smellscape (for an overview see McHugh, 2012). More recent discussions can be found in Papi (1992), who poetically writes about smells occurring within a distal array as a mosaic of odor patches. Gatty (1983) uses similar terminology when discussing seabirds who use a sensory array of olfactory objects for navigating both at sea and on land. However, the contemporary coinage of smellscape must be attributed to Porteous (1985), who introduces the term to capture the ability to navigate and remember olfactory environments. Porteous's research shows that smells are not randomly distributed; rather localizing smells requires accounting for the odor's current position given its odorous concentration gradient and the wind patterns in the environment. Similarly, Roadaway (1994) examines how olfaction allows interactive navigation through an environment of sensory geographies. Moreover, there are long-standing and ongoing research projects devoted to demonstrating that olfactory perception provides navigational accuracy in using odor gradients within a coordinate space to navigate an environment (Wallraff, 2004, 2005, 2013, 2014). MST theoretically evolves by generating an account of the intentional object as smellscapes where these are by analogy to landscapes large-scale distal arrays (Young, forthcoming).

The overlapping turbulent sea of chemical currents enveloping us generates the environmental smellscape that is the intentional object of olfactory experience. Smellscapes are rather odd things to think about given our visiocentric default mode of theorizing about our experience of reality. However, when theorizing about smells it becomes natural to consider large-scale environments with overlapping currents that inform us of distal entities of ecological and navigation value to us as organisms. We experience a smellscape of complex olfactory objects that can change and shift their properties across time as against a background of other odors. To do so we employ background knowledge to generate the composition of olfactory mixtures in terms of their groupings (Wilson & Stevenson, 2006). One of the strengths of molecular theory is that it can advert to the olfactory system's capacity to encode the molar ratios between the components of a given olfactory mixture (Uchida & Mainen, 2007), the concentration rates and ratios between odorants (Cleland et al., 2012), and overall concentration rates of the key components of complex mixtures (Cleland, 2008; Le Berre et al., 2008; Sinding et al., 2013, 2014). All three of these processes allow for identification and individuation of an odor as having the same olfactory quality despite shifts in the composition of the olfactory plume. Thus, MST has the necessary tools to generate an account of the persistence conditions, the mereological identity conditions, and individuation conditions of an odor in terms of the molecular structure of chemical compounds that compose the complex mixture.

Accounting for the intentional object of olfactory experience requires being sensitive to the timescale of olfactory perception especially in determining the accuracy of our reported experience of smells (Young, 2017). Our capacity for olfactory perception is unlike our alleged visual phenomenology with its synchronically presented punctate entities within an array. Olfactory perception is rather slow. The average sniff lasts 1.6 seconds. During the initial phase of sniffing we modulate the volume of airflow, pressure of airflow, and sampling rates. Additionally, towards the middle to end of a sniff we can detect the presence of an odor, as well as identify its olfactory quality and valence (reviewed in Olofsson, 2014). The sniff sequence can be segmented into multiple stages. The initial sniff onset brings the stimulus into the nasal cavity and lasts 200 ms. Within 150–300 ms of stimulus presentation sniffing is modulated in accordance with the concentration, intensity, and valence of the odorant. Additionally, within 150 ms of sniff onset we modify of sniff response in accordance with the olfactory valence of the stimulus. Furthermore, encoding the olfactory properties of the odor occurs during a 500 ms period following the initial 200 ms of sniff onset. Only after 800 ms of sniff onset do we consciously detect the odorant. Identification of olfactory quality and odor valence follows at intervals of approximately 1000 ms and 1100–1200 ms respectively (reviewed in Olofsson, 2014).

Smelling objects within an environment takes time. We cannot perceive odors as occurring at a given location within a short timescale,[4] but we are able to locate smells as occurring within an environment against the background of other odors across time (Porter, 2007; Welge-Lussen, 2014; Jacobs, Arter, Cook, & Sulloway, 2015). If the temporal processing of the olfactory stimulus is extended then we might need to expand the conditions we think are required for our ability to spatially locate and perceive odors (Young, 2017). Allowing a spatial expansion of the perceptual scene suggests that the intentional object of olfactory perception will have to be of a spatiotemporally extended array that is diachronically perceived.

If the temporal processing speed of olfaction is dissimilar to vision this calls into question extrapolating from the visual perceptual and experiential manifold to olfaction. It certainly becomes dubious if we use the same synchronic conditions of visual experience to generate ramifications for olfactory experience and the object of smell. But it is a more serious methodological error in relation to diachronic olfactory experience given that the very nature of olfactory experience requires movement (Schneider & Schmidt, 1967) to generate the objectification of odor plumes and the segregation of these as against the background of the sea chemicals that envelope us.

An additive strength of molecular structure theory is that it generates a conception of how we perceive particular odors with olfactory properties. The odor's olfactory quality determines object identification and individuation, whereas pleasantness, intensity, and concentration might be considered properties of the odor object. While it is widely agreed that molecular structure determines the olfactory identity of an odor, it is still debatable whether the primary determinate of odor identity is its property of valence or the olfactory quality. In a series of studies, it has been argued that valence is the perceptible property that determines odor identity instead of olfactory quality (Yeshurun & Sobel, 2010). Unlike odor-quality categorization, which is similar in various respects, but varies cross-culturally, there is greater agreement on the categorization and identification of odors using their judged properties of being pleasant or unpleasant (Haddad, Lapid, Harel, & Sobel, 2008; Haddad et al., 2010). Moreover, Sobel's research group generated a computational model of the olfactory object that can predict olfactory valence from chemical structure alone (Snitz et al., 2013). However, recent evidence indicates that the object of olfactory perception is more likely identified by humans in terms of its olfactory quality and not pleasantness (Olofsson, Bowman, Khatibi, & Gottfried, 2012; Gottfried 2010; Olofsson & Gottfried 2013). Additionally, Kumar, Kaur, Auffarth, and Bhondekar (2015) created an alternative computation model using descriptors of qualities and not judgements of valence, as well as measures of chemical structures to predict olfactory quality.

Using olfactory quality as a means of individuating odor objects, we can note that a smell's properties can vary across perceptual instances, including personal variation (Logan, 2014), cultural background (Haddad et al., 2008), and regional background (Cantone et al., 2017). In fact, the molecular features of an odorant are correlated with its perceptual qualities in a manner that allows for separable dimension of quality, pleasantness, and intensity (Keller & Vosshall, 2016). MST generates a means of odor individuation in terms of the olfactory quality, as well as how an odor could have changeable and repeatable properties across encounters. Synchronic perception and experiences of smell may not generate spatial located-ness, yet diachronic olfactory experience has the necessary resolution to resolve the multiple properties problem.

6. Replying to the Many Problems

The issue that motivates all further alleged problems regarding the distal nature of smell follows from the claim that olfactory perception and experience are not object directed. According to MST the vagaries of distal olfactory perception arise from the very nature of what it is that we are perceiving and experiencing. Identifying olfactory particulars using the molecular structure of chemical compounds within plumes generates individuation conditions and the ability to demarcate the distal extent of the olfactory object using its olfactory quality and concentration gradient. Moreover, MST identifies the intentional object of olfactory experience with a smellscape, such that we perceive and experience individual odors as against a background of an environmental array of smells. Thus, the vagaries of the olfactory object are determined not by the nature of the representational experience but by the characteristics of the olfactory object itself. Smells are particulars with abstract boundaries that are extended in both time and space.

Methodologically, descriptive reports derived from phenomenological access to olfactory experience are prejudiced against olfaction, especially if vision is used as the paradigm. For instance, the wrong timescale is assumed given this methodological starting point. Even when handling synchronic olfactory experience, Batty cannot account for the full variety of olfactory experiences that will require the existence and predication of properties to individual objects within the olfactory representational experience (Carvalho, 2014). Even if Keller's reply is correct that in some situations we can misattribute or misrepresent the source of an olfactory experience these cases concern a non-typical causal entity, which does not negate the claim that some olfactory experiences are of multiple objects with separable properties.

A further reason that Keller offers against the ascription of olfactory properties to a particular odor object is based upon a claim that at the receptor level we cannot settle the correct predication of molecular compounds to odor plumes. Yet, it is unclear if this is the appropriate level of description for these phenomena. We do not commonly think that the spatial nature of a perceptible property and/or object is fully evaluable at the receptor level of a given modality. Hence, Keller's evidence regarding the nature of proximal stimulus transduction at the receptor has dubious utility for determining the perceptual and experiential contents of experience.

One of the stronger pieces of evidence provided by Keller against the spatial nature of olfactory experience is that we cannot correctly identify intranasal onset of odorants. Yet, the capacity to distinguish the onset of a smell to a nostril can be trained (Negoias, Aszmann, Cory, & Hummel, 2013). Additionally, there are pragmatic issues regarding the perspectival relation of the object in proximity to the sensory transduction system. The resolution of the olfactory system might require a greater distance of the stimulus from us for the accurate employment of binaural presentation in determining our navigational abilities. As Welge-Lüssen, Looser, Westermann, and Hummel (2014) indicate, the use of nostrils is helpful for navigating and tracking objects only beyond 2 m from the individual.

Despite Keller's argument that we cannot use navigational strategies as a way of demonstrating the spatial characteristics of the stimulus, the aforementioned research suggests that the distance between the individual and the stimulus makes a difference in our strategies of using nostril onset in the orientation towards and tracking of an odorant. Additionally, multiple studies suggest that the olfactory system employs an odotopic map, such that we represent odors as occurring in allocentric space (Schifferstein et al., 2010; Koutsoklenis & Papadopoulos, 2011; Moessnang, Finkelmeyer, Vossen, Schneider, & Habel, 2011). For example, we can learn the placement of odorants using this olfactory map and navigate back to these odors using olfaction (Jacobs et al., 2015). Thus, it is arguably the case that our capacity for olfactory navigation requires further sub-capacities that represent the spatial nature of odors relative to an environment.

Olfactory perception can generate figure-ground segregation (Young, 2016; Millar, 2017), but what is problematic are the visual analogies employed by both Batty and Keller for extrapolating the necessary conditions for figure-ground segregation. The most apparent problem is the overall assumption that the olfactory timescale should be analogous to that of the visual timescale. However, if olfactory perceptual experience is temporarily extended then the very nature of olfactory experience might require an extended array, such as a smellscape. Moreover, the methodology of inferring from our phenomenological reports of visual experience to that of olfaction might be questionable given the under-representation of the background effects and influences that we report in vision. Most philosophers simply assume that upon opening our eyes we are immediately presented with an array of objects with punctuated boundaries as against a background. Yet, there are reasons to doubt the methodology of using introspective access in general, because it is an unreliable mechanism that provides unreliable results (Schwitzgebel, 2008). Moreover, it is arguably the case that there is a multiplicity of introspective mechanisms that draw upon our background knowledge and cross-modal integration (Schwitzgebel, 2012). In particular, these errors can be seen in our accounts of visual experience that pay no heed to visual object perception requiring years of development, cross-modal integration, and a profound amount of information shared from cognitive states. Thus, as a theoretical starting point, introspective reports are questionable as a valid method even for generating an explanation of the intentional objects of visual experience.

The dubious utility of using phenomenological reports of experience gained through introspective access is even more pronounced in application to olfaction. The phenomenological method of assessing the nature of olfactory experience might be both unreliable and invalid as an accurate means of assessing the intentional objects of olfactory experience. The vast majority of olfactory experiences occur in the absence of attention, and thus bring into question if phenomenological reports of consciously aware experiences are a reliable guide to the nature of the representational format of these experiences, given the possible bias of using a suboptimal sample set (Sela & Sobel, 2010). Additionally, it has been argued that olfactory experiences have a phenomenological quality even in the absence of awareness, yet most are surprised to learn that non-conscious olfactory qualities pervasively influence our behavior (Young, 2014), thereby questioning the reliability of our introspective access to the nature of olfactory states. Examples such as these further solidify the dubious nature of using our phenomenological reports of experience in assessing olfaction.

A further difficulty with using visual analogies is the lack of range of examples employed. Considering the synchronic examples of full coverage vs. miss-a-spot, according to MST's account of the olfactory object, we cannot fully perceive the olfactory array or object given this truncated timescale and perspectival relation, and thus the difficulty is attributable to assuming an example that does not account for the extended diachronic nature of olfactory perception. Additionally, it is not an accurate analogy given that if we had two similar visual scenarios in which I am seeing an object, but I have my nose up against it, then I cannot tell whether two feet from my fixation point the wall is painted entirely in the same shade of white or if there is an unpainted spot. Moreover, if we consider a more accurate comparison—that is, of a smellscapes to a landscape—we happily allow that we could not perceive the landscape in its entirety within a synchronic experience. If the correct analogies are made, such as the aforementioned smellscapes to landscapes, which allow for diachronic movement within a temporarily extended perceptual experience, then we would be able to determine if there was full coverage or if we missed a spot.

What becomes most problematic is the claim that background knowledge, cross-modal integration, and a diachronic timescale with exploratory movement cannot be used to generate our capacity to perceive distal objects within a spatial array. If deploying arguments by analogy from vision is a valid strategy then we should allow background knowledge, because our visual capacities require background knowledge and cross-modal integration in developing our ability to both perceive objects[5] and recognize and individuate these objects from against a background with subject-predicate format. The claimed synchronic phenomenology of visual perception and experience misconstrues the actual nature of the visual experience.

Visual object perception is a diachronic process that requires the integration of saccadic eye movements, attentional selection, and the representation of perceptible objects in a sequential fashion. Despite seeming to perceive a uniform manifold our eyes are constantly darting about. Our continuous eye movements provide us with a seemingly fine-grained visual array and hide the blind spot in our visual field caused by the optic nerve exiting the retina. However, at a single instant only our foveal vision represents the full richness of visual experience. Our parafoveal visual field is not colored nor does it represent objects with the full detail that we attribute to our reports of our visual experience.[6] Moreover, even if we extend the visual timescale to include multiple saccades such that we can perceive an entire visual array these complex visual scenes require selective attention to sequentially encode each of the objects (Jia, Liu, Fang, & Luo, 2017), thereby making visual scene processing a diachronic process. In this light it would seem that the perspectival relation between the perceiver and the perceptible object matters in terms of both the distance from the perceiver and the timescale. Moreover, even when people are trained to attend to their saccadic eye movements, they are unable to recognize and report on their eye movement (Clarke, Mahon, Irvine, &

Hunt, 2017), thus further calling into question the veracity of introspective reports on visual phenomenology.

However, even if someone were to object that the aforementioned evidence merely regards sub-personal capacities that do not count towards the determination of the intentional content of experience, it turns out that perceiving the visual scene as composed of individual objects within an array is a learned capacity that depends upon background knowledge. Our capacity for segregating visual objects and tracking them through their changes in place and properties is a complex capacity composed from many different mental processes, including perceptual motor, ongoing visual processing, and cognitive inferences (Pylyshyn, 2003).

Our ability for object perception requires a developmental trajectory making it a learned ability constructed from cross-modal integration. If we argue by analogy from vision then if the visual capacity requires background knowledge, diachronic experiences, and cross-modal integration then we should allow it for olfaction. Charitably it might be replied that phenomenologically we do not report these as part of our phenomenological visual experience. However, the fact that our reports of phenomenological experience regarding vision do not seem to require background conditions only solidifies the previous reasons that suggest the method should be jettisoned.

On the other hand, if as has been argued earlier we should not consider olfactory experiences to be analogous to vision, then we should extend the perceptual and experiential temporal timescale, thereby allowing for the generation of an olfactory smellscape. If the intentional objects of olfactory experiences are smellscapes, then it no longer seems intuitively problematic that we can smell odors as particulars within an array, as well as the juxtapositions of the objects and their properties in different experiential contexts.

7. Conclusion

There are many problems in accounting for distal olfactory perception. The conclusion that olfaction cannot resolve the many properties problem follows from many other alleged problems concerning distal olfactory perception, including: olfaction's lack of synchronic spatial resolution, vagaries in individuating the object of smell, and an inability to segregate smells within an array. However, the strategy employed by both Batty and Keller is unsuccessful, because the visual examples used to argue by analogy to the nature of distal olfactory perception and experience both in their characterization of distal visual perception and the representational character of visual experience are inaccurate and misleading. Furthermore, the methodology of using introspective reports of visual phenomenology is an unreliable means of establishing the spatial nature of perceptual or experiential states. Thus, the tabled arguments by analogy are incorrect, because visual examples do not accurately describe the nature of visual perception and phenomenological reports based on introspective access are unreliable and prone to error. If in vision background conditions and cross-modal cues are required for figure-ground segregation, which is a necessary component for resolving the many properties problem, then these too should be allowed in the situation of olfactory experiences that are diachronically extended. Moreover, claiming that expanding our conception of perceptual objecthood would cheapen the overall notion is tyrannical given that vision itself requires these background conditions and knowledge to generate object recognition and individuation. Additionally, the objection is predicated upon the claim that we require an ideal standard for perceptual objecthood that can be derived from vision. Charitably, it might be replied on their behalf that the transparent phenomenological content of experience in vision is of objects with properties without any seeming phenomenological influence from other modalities. Yet, this goes directly to the heart of the problem, which is the dubious utility of introspecting our phenomenology in generating a theory of the object of olfactory experience and perception. Introspective access of phenomenological content is at best question begging if not epistemically dubious, when applied to olfactory perception and experience. Given these flaws with their shared argument strategy, I suggest that we consider the nature of distal perception and experience as being relative to both (a) the perspectival relation of the perceiver to the proper perceptible and (b) the timescale of perception and background enabling conditions of the perceptible modality.

Molecular structure theory adequately handles both of these by arguing that we need to extend the perceptual array to account for the temporal nature of olfactory experience, as well as include exploratory conditions and background knowledge in generating our perception and experience of smellscapes. The many properties problem is applicable to olfaction, yet resolving how we can perceive smells as individual objects with changing and repeatable properties against a background array requires being sensitive to the many problems inherent in understanding the nature of the olfactory object, how it is individuated, its properties, and the correct spatiotemporal description of the intentional object of olfactory experience as being smellscapes.

Notes

1. For a fuller discussion of the role of trigeminal stimulation and other sensory systems in connection to olfactory perception cf. Young, Keller, and Rosenthal (2014) and Young (2017).
2. Another line of argument for how figure-ground segregation is accomplished in olfactory perception using gestalt principles of grouping can be found in Millar (2017).

3. Plato's theory of smell is contained within two paragraphs of the Timaeus 66d–67a, while Aristotle's theory is developed in *De Anima* and *De Sensu*. Johansen (2006) provides a detailed assessment of the differences between Aristotle's theory in *De Anima* and *De Sensu*. Additionally, for an introduction to the commentators' debate over Plato and Aristotle's theories of olfaction cf. Kemp (1997).
4. The existence of synchronic olfactory spatial perception of an odor's locatedness and directionality is not borne out by experimental research unless we expand the olfactory modality to include trigeminal stimulation (Keller, 2017).
5. Aasen (2018) makes a similar argument for the inclusion of background knowledge and movement in connection to diachronic exploratory movement for both vision and olfaction. However, she allows for synchronic distal olfactory perception using phenomenological descriptions of possible olfactory experiences, which is methodologically suspect for the reasons outlined earlier. Moreover, as noted in the previous footnote the experimental data do not support the existence of synchronic distal olfactory perception of an odor's location or directionality without expanding the olfactory modality to include other systems within the nose that are not sensitive to olfactory quality.
6. For a good, though dated, introduction to these issues with visual perception, as well as further argumentation and empirical evidence, cf. Dennett (1997).

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