Perceiving Smellscapes*

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Abstract:

We perceive smells as perduring complex entities within a distal array. However, Odor Theories' have been recently criticized for their conception of the spatiotemporal nature of olfactory perception and the individuation of distal odors. The paper does not aim to dispute these criticisms. Rather, what will be shown is that Molecular Structure Theory, a refinement of Odor Theory, can be further developed to handle these challenges. The theory is further refined by focusing on distal perception that requires considering the perceptual object as mereologically complex persisting odor against a background scene conceived of as a smellscape.

Keywords:
Smell; Olfaction; Odors; Object of Perception; Olfactory Quality; Distal Perception; Smellscape.

Introduction

There are moments in life when we experience a location not by how things look or sound but based upon the environmental smells[1]. We can all recollect such moments, such as when we first smelled the ocean or the glorious sweetness of the midway at a county fair. Places and times can be experienced by an individual as having a mereologically complex perduring smell. We even revisit locations to re-experience our memory of their smell.[2] These phenomena suggest that olfactory perception is of particular entities within a sensory array external to us - we perceive odors within a smellscape.[3] Using olfaction we perceive mereologically complex perduring smells as locatable within an environment (Young, 2016; Millar 2017)[4], yet the philosophical orthodoxy

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[1] Smell and odor will be interchangeably used as synonyms throughout the paper. By odor I mean the perceived olfactory quality of the chemical stimulus (odorant).
[2] For a review on the tourism of smellscapes see Dann and Jacobson (2003). Also, for an overview and introduction of the use of smellscapes in urban planning see Henshaw (2014).
[3] All claims regarding smells throughout this paper should be understood relativized to only orthonasal smell and not retronasal smell. Claims about smell perception and the olfactory object extrapolated from multisensory flavor perception and taste will not be considered in what follows. For a good discussion of the distinctness of the different olfactory and chemosensory systems cf Smith (2015).
[4] O'Callaghan's (2008, 2016) theory that perceptual objects are the targets of a suite of capacities that form the basis of object perception will be assumed throughout the paper. O'Callaghan's approach is in keeping with the latter half of the papers expansion of MST to explain our perception of odor plumes within a smellscape, which will require a host of perceptual capacity to the exclusion of some sensory systems within the nose as discussed in section 4. Accordingly, perceptual objects are conceived of as complex mereologically structured individuals. His neutral conception allows for an account that can capture not just visual objects of perception, but auditory, tactile, and olfactory objects of perception. However,

has been to deny that smells are perceived or experienced as having a distal location (Lycan, 2000; Batty 2007, 2010, 2014).

Contemporary Odor Theories (Batty, 2007, 2010, 2014; Lycan, 1996, 2000, 2014) argue that smells are the odorous subset of the gaseous effluvia of ordinary objects. Odors identified as gaseous chemical clouds are curious perceptual objects. The clouds boundaries are less truncated than those of ordinary objects identified by vision and touch. The vague nature of odors causes these theorists to consider olfactory perception to be less (or not) objective by comparison to the ideal of visual object perception. While they claim that odors do not synchronically present us with spatial properties, they do not deny that smell is an exteroceptive sense (Richardson, 2013) nor is it claimed that odors are mind dependent objects, rather they claim that odors do not behave in a manner that we expect from our visual counterparts within the same temporal perspective.

Recently, Odor Theories[5] (OT)[6] have been criticized for their claims regarding the aspatial nature of olfactory perception and its lack of distal perception. The theory has been criticized based on its inability to account for the individuation and persistence conditions of smells (Millar, 2017), as well as the distal nature of smells synchronically and diachronically (Aasen, 2018). In the latter case, OT is shown to be inadequate using descriptions of conscious phenomenology, while the former criticism arises from an analysis of gestalt phenomena in combination with perceptual constancies. Rather than dispute these general problems, the paper accepts them, but aims to show how Molecular Structure Theory (MST) refines OT to adequately explain distal olfactory perception. The target of this paper is thus not the central tenet of Odor Theory that we smell odors conceived of as a gaseous cloud of chemicals nor the aforementioned critics, rather it seeks to develop MST to account for distal perception as occurring within smellscapes. The theory on offer expands upon an earlier version of MST (Young, 2016) by considering odor mixtures, as well as how the extended temporal processing time of olfaction must be considered when giving a diachronic construal of olfactory spatial perception. The extended temporal

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contrary to O'Callaghan's (2016) claim that temporal structure is not significant for olfactory object individuation or recognition, the paper shows that the temporal structure must be considered when conceiving of the object of olfactory distal perception in the same way that temporal mereological structure is responsible for determining the objective nature of auditory perceptual objects.

[5] For a further discussion of the differences between the types of Odor Theories cf Young (2019b).

[6] Given the focus on how MST refines OT in a manner that accounts for distal olfactory perception the scope of the paper will be limited to discussion of Odor Theories. Aside from Batty's Abstract account, which must be included for rigor given the target theories, objectivist views will be assumed, and non-objectivist or processes accounts will not be engaged with throughout the paper, as an in-depth analysis of these philosophical accounts of smell and their explanation of distal olfactory perception can be found in Young (2019b). MST shares similarities with the systems level approach of process theory. Both theories advert to the olfactory system's transduction and encoding mechanism in explaining what gives rise to olfactory quality and our ability to recognize smells across token instances. However, process theory's account of smell with its strengths in detailing the systems levels processing that underly olfactory perception in comparison to other philosophical theories of smell has been addressed elsewhere (Young, 2019b). For the purposes of this paper it can be noted that MST has similarly in the past made use of empirical evidence concerning sensory, cortical, and psychological level processing within the olfactory system to explain the multifaceted nature of smells (Young, 2016, footnotes 13-15, p. 10, section 3.1, and (1) & (2) on p. 12). Moreover, the explanatory purchase of endorsing an ontology of processes is discussed in Young (2019b, section 5.3).

perspective provides reason to consider extending the timeframe required for spatial perception given the perspectival relation of the perceiver to the proper perceptible of a given modality.

As a refinement of its predecessors, MST can account for distal olfactory perception of extended persisting objects in the environment that we experience within an array of odors overtime. To support this claim the paper develops over five sections. The first section summarizes the major claims of Batty's and Lycan's version of OT. The second half of the section outlines MST's account of the distal object of olfactory perception. The second section then argues that our perceptual access to the spatial properties of a perceptible object depends upon the temporal transduction rate of each sensory modality, which blocks many of the inferences Odor Theorists make regarding the spatial nature of distal perception. Once it is established that the temporal sequence of olfactory perception is slower than vision, the third section ask us to consider if the spatial dimension might also be expanded.[7] To establish that the perceptible object of a modality should be determined relative to the perspectival relationship between the perceiver and the proper perceptible of each modality, section three, asks us to contemplate two *Wonderland* thought experiments of shrinking and stretching. Since the thought experiments elucidate the nature of the object of distal perception relative to each modality, section four provides an overview of how we might individuate the sense modality of smell using MST. Furthermore, section four shows how individuating the olfactory modality effects our application of the experimental literature in determining the distal nature of olfactory perception. Section five summarizes experimental evidence regarding distal olfactory perception, which suggest that we perceive smells as inhabiting an extended spatiotemporal array. The paper concludes that smelling takes time and as such distal perception need not always meet the strictures of visual object perception nor its temporal processing requirements.

1.1 Odor Theories' Treatments of Distal Olfactory Perception

The previous trend in philosophy of olfaction was to deny that smells are distal entities with spatial properties. Odor Theories generally claim that we do not perceive particular objects, but rather odors dispersed throughout the environment. The two most developed Odor Theories of Batty and Lycan both argue that odors have distal properties, but lack an experience of the smell as being located within external space relative to us.[8] The abstract account is developed by Batty

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[7] Despite extending spatiotemporal processing for olfactory distal object perception, as well as including the need for movement to discern the composition of the odor plume and delimit its extent given the odorants concentration gradients, the paper should not be taken to endorse an enactivist conception of distal olfactory perception. Claiming that movement of the organism or the odor plume plays a constitutive role in enabling diachronic distal perception for olfaction should not be conflated with the stronger claim of enactivists that the tacit deployment of our knowledge of motorsensory contingencies for olfactory perception are essential for our perception of the olfactory quality of an odor. While movement and our ability to encode our own somatosensory information about the plume tactically traversing our face and the inside of our nose plays a role in distal olfaction these are not claimed to be essential components of the olfactory system (see discussion in section 4). Moreover, Enactivism's central tenets are shown to not be upheld in olfactory processes – our tacit deployment of our knowledge regarding motorsensory contingencies are neither necessary or sufficient for our perception of the olfactory quality of an odor (Young, 2017).

[8] Following previous terminological conventions in Young (2016) I will use the term locatedness for the experience of an object as having a fixed determinable location within external space (egocentrically or allocentrically conceived).

over the course of multiple arguments concerning the veridicality of odor perception (2009, 2010c), the individuation of multiple odors within an array (2010a, 2010b, 2011, 2013), and the multiple properties problem (2010a, 2014). According to her theory olfactory perception is not directed upon particulars within a spatial scene, rather our olfactory experiences are of an odor which is a non-spatial non-objective property of environment. The Abstract Theory is primarily constructed to account for the intentional object of olfactory experience using our synchronic phenomenological aspatial experience of smells. However, Batty's focus on the phenomenology of synchronic experiences generates the overarching claim that our smell experiences do not present locatable distal entities with fixed spatial coordinates. While the theory concedes, that olfactory experiences have spatial aspects to them, the abstract account does not attribute spatial properties to odors. The theory provides a strong explanation of the intentional object of olfactory experience synchronically conceived,[9] but does not provide an explanation of the olfactory quality of smells or an account of our distal perception of smells across time (Young, 2016, 2019a-b).

The original OT proposed by Lycan (1996, 2000) claims that odors are not experienced as having spatial properties, such that they are not presented as being at a fixed spatial coordinate. But, he disagrees with Batty's assessment that these are properties of the environment. For Lycan the perceptual object of olfactory experience are odors, which are objective entities composed by a gaseous chemical cloud. Despite endorsing an objectivist perspective, Lycan denies that the odor cloud presents us with spatial properties of the smell. His argument depends upon our agreeing with his account of the synchronic experience of the odor cloud's vague boundaries not presenting us phenomenologically with spatial locatedness. However, even if his claims regarding synchronic experiences are granted, the theory will not do justice to our diachronic perception of mereologically complex odors within an overlapping smellscape. For these situations, Lycan's (2014) layering approach might be of help since our background knowledge and conceptual olfactory resources might enhance the meager nature of synchronic olfactory experience. Nevertheless, without a fuller account of the olfactory quality of an odor and an explanation of how we determine the spatial extent of these distal entities across time, Lycan's theory only provides us with a partial explanation of the distal nature of smells (Young, 2019b).

Odor Theorists' denial of the spatiality of odor perception derives from their narrow synchronic perspective and conclusions derived from our pre-theoretic assumptions about the nature of visual object perception. However, their theoretical starting point of extrapolating from vision does not appreciate the extended timescale of olfactory perception. Furthermore, OT fails to consider that the perspectival relation between the perceiver and perceptible object of a given modality might vary in a non-uniform way across modalities with implication for our conception of the distal object of perception.

1.2. Expanding Molecular Structure Theory

One of the great difficulties in accounting for our perception of naturally occurring smells is explaining how we segregate the turbulent gaseous sea of chemical currents in which we are immersed into distinct smells. MST is superior to its precursor in generating an explanation of

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[9] Aasen (2018) provides descriptions of two interesting situations that might provide reason to doubt even Batty's synchronic conception of olfactory distal perception.

the external object of olfactory perception and what accounts for its olfactory quality[10] (Young, 2016, 2019). According to MST, the distal object of olfactory perception are odors with olfactory qualities that are determined both in terms of the molecular structure of the chemical compounds, as well as the chemical composition of the plume and odorant concentration. What we smell in the environment are complex chemical entities composing the gaseous odor plume that are perceived against a background distal array of other complex chemical mixtures conceived of as a smellscape. The molecular structure forms the basis of using olfactory quality as the means of individuating the odor plumes. The molecular structure of chemical compounds yields individuation conditions for odor plumes and allow us to identify what it is about these external objects that yield their olfactory quality.[11]

Despite the seeming simplicity of the theory whereby the perceptible odor object is primarily identified in light of the molecular structure of chemical compounds, the distal object of olfactory perception is also determined by the gaseous plume. The role of the plume is most clearly demonstrated by the concentration levels of the odorants composing the plume. There must be a sufficient concentration of chemical compounds for the perception of an odor's olfactory quality (Ruth, 1986). Additionally, shifts in the concentration of odorants within a plume yield perceived difference in olfactory quality (Laing et al., 2003). The chemical compounds determine the distal nature of the odor plume given their concentration gradients. Thus, the plume plays a role in the determination of olfactory quality and the spatial extent of the perceptible object of smell.

The initial statement of the theory in Young (2016) was constructed to account for simple smells primarily composed from a single odorant, but as a comprehensive theory it must also account for natural occurring smells that are usually olfactory mixtures composed of multiple types of chemical compounds. Determining the spatial and distal nature of the perceptible odor object requires accounting for the plume structure of a given odor within a turbulent gaseous sea of overlapping chemical currents. But, before this is possible the system must first be able to identify heterogenous mixtures of odorants into unified smells. Odor object identification of complex mixtures is thought to occur based on the olfactory system learning to binds together odorants of different molecular structures to compose the perception of a unified odor object (Wilson and Stevenson, 2006). What was missing from the initial statement of MST was a specification of the perceptible object of olfaction based on the distal nature of the odor plume. What we naturally experience as smells are odor plumes composed from a distinct set of different types of chemical components (odorants) within an array of overlapping chemical currents i.e. a smellscape.

Accounting for the nature of distal olfactory perception requires considering the problem of how we segregate the gaseous plumes of our chemical environment into individual smells both in terms of how the complex chemical mixtures are perceived as unified smells and how we

[10] Olfactory quality is best conceived of in terms of what an odor smells like. Olfactory quality is the proper perceptible of smell according to MST, such that a collection of odorants forming a gaseous cloud will not be elevated to the statues of a smell unless it has a perceptible olfactory quality.

[11] MST is on similar explanatory footing with the process theory of olfaction (Barwich 2015, 2018), since it make use of on-going processing within the olfactory system to segment odorant mixtures into recognizable smells across time. However, MST departs from the process approach, as it accounts for the external objects of perception and what accounts for their perceived quality in terms of the odorants molecular structure, which provides explanatory purchase in the further individuation the sensory processes that transduce the range of molecular structures that olfactory system is sensitive to and that we experience as smells (section 4).

individuate these complex plumes from against the turbulent sea of chemical compounds within our odorous environment. According to MST we can use the olfactory quality, whether of single component or multi-component mixtures, as a means of generating odor identity – an odor is treated as a unitary smell based on the olfactory system representing the molecular structure of the odorant or groups of odorants composing the chemical mixture as an individual type of odor. Identifying the perceptible odor object in terms of its olfactory quality has the added bonus of accounting for concentration as measured by the density of the odorants within the odor plume. To account for how we smell an odorant cloud composed of a group of different chemical compounds as a unitary smell requires considering the distal extended nature of odor plumes, as well as the slow temporal processing of a large spatiotemporally extended perceptual scene.

Smelling odors at a distance requires not merely treating complex odor mixtures as having a particular olfactory quality, but also as mereologically complex persisting entities (Young et al. 2020). To be able to identify and demarcate one grouping of odorants as being of a certain type of smell by comparison to another grouping within a distal array requires the ability to identify and individuate smells generally. Odorant identity can be specified in light of the chemical components yielding a smell, while the intensity and hedonics (including perceived valence) are best treated as properties of the odor identified in light of its olfactory quality. MST must be refined to further consider the role of the olfactory plume in generating the perception of the olfactory quality of complex mixtures, but in doing so the further posit of smellscapes must be included. Perceiving smells as mereologically complex persisting entities requires thinking about the odor environment, which is constantly being segregated into both the background environmental odors, as well as distinct odor plumes with their overlapping and extended distal properties. With this in mind not including the smellscape as part of the perceptual experience of odors even synchronically is a mistake. Our perception of smell always occurs in natural settings within a turbulent gaseous sea of smells.

The idea of smellscapes is certainly not new. 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 of olfactory navigation conceive of smells occurring within a distal sensory array (Gatty, 1983) or more poetically as a mosaic of odor patches (Papi, 1970). However, the canonization of smellscape must be attributed to Porteous's (1985) research that shows 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, Rodaway (1994) examines how olfaction allows interactive navigation through an environment of sensory geographies. Moreover, olfactory perception has been shown in some species to provide navigational accuracy in using odor gradients within a coordinate space to traverse an environment (Wallraff, 2004, 2005, 2013, 2014). MST theoretically evolves by considering distal olfactory perception of extended odor plumes within smellscapes (Young, 2019a). We do not merely perceive odors as synchronic experiences of olfactory qualities. What we perceive using olfaction is an odorant plume against a background distal array of other overlapping smells within a smellscape.

Smellscapes are rather odd things to think about given our visuocentric default mode of theorizing about our experience of reality. However, when theorizing about smells it becomes natural to consider large scale environments with overlapping turbulent gaseous currents that inform us of distal entities of ecological and navigation value to us as organisms. We experience an array of complex smells that can change their properties across time against a background of other odors (Young, 2016; Millar, 2017). To do so we employ background knowledge to generate the composition of olfactory mixtures in terms of their groupings (Wilson and Stevenson 2006). One of the strengths of MST 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 and Mainen, 2008), the concentration rates and ratios between odorants (Cleland et al 2011), 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 plume.[12] 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 (Young, 2019b).[13]

2. Expanding the Spatiotemporal Olfactory Object

Smelling takes time. Our capacity for olfactory object perception is unlike that of vision with its synchronically presented punctate entities within a visual array. Holding our olfactory distal perceptual abilities hostage to the conditions we expect of vision generates the major pitfall of Odor Theories. When considering olfactory perception, it is important to account for both the spatial aspects of distal perception and the temporal characteristics of olfactory processing. If olfactory temporal processing is slow and cannot be determined according to the common timescale of visual object perception, then arguably our ability for spatial olfactory perception should follow suit. Smelling odors within an environment is an extended process. We cannot demarcate odors as occurring at a given place with the same timeframe as vision, rather we locate smells as occurring within an environment against the background of other odors across time.

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 (what it smells likes) 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 or sniff response in accordance with the olfactory valence of the stimulus. 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

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[12] This is not to deny the possibility of representationally generating olfactory qualities that might evolved from the representation of mental qualities derived from the perception of the just-noticeable-differences between odorants (Young, Keller, and Rosenthal, 2014), as there must undoubtedly occur such olfactory experiences (perhaps in instances of olfactory imagery cf Young, 2019c). Rather, the claim is that as an explanatory strategy priority should be given to accounting for the olfactory quality, which is what MST was designed to do in its first iteration (Young, 2016).

[13] It might be objected that MST is at this stage helping itself to experimental research on the internal processes of the olfactory system and not just the stimulus, to which it should be replied yes it is. But, nothing stated about MST suggests that it cannot accommodate and adopt such systems level explanations. Nothing in the previous statement of MST suggests that it is a purely stimulus driven accounts, rather different explanatory strategies might be required to answer the nested issues within the question "what are smells" (Young, 2016, 2019b).

consciously detect the odorant. Identification of olfactory quality and odor valence follows at intervals of approximately 1000 ms and 1100-1200 respectively (reviewed in Olofsson, 2014).[14]

Even a cursory review of the literature suggests that the temporal sequence of olfactory perception is an order of a magnitude slower than that of visual perception. Arguably if temporal processing of the olfactory stimulus is extended then we might need to consider our ability to locate and perceive odors within a distal array as spatiotemporally extended. It would be imprudent to claim that the distal object of olfactory perception is not spatial simply because its boundary conditions are not as truncated as visual objects. After all, we can attest to the ability of demarcating a smell using the concentration gradient of the odor plume.[15] However, locating smells requires changing one's spatiotemporal relation to the odorous object by sniffing, shifting one's position, or attending to the velocity and turbulence of the wind conditions in perceiving the change in the concentration of the odorants. Although olfactory experience can, across time (i.e. diachronically), be aided by moving around, it does not at a particular time (i.e. synchronically) present us with a spatiotemporally-bound entity unlike in the case for visual experience.[16] But, it might be objected that based on the conditions underlying synchronic visual perception we should disallow the temporally extend nature of olfactory perception in generating the distal perception of odors.

However, criticisms of this variety are predicated on the assumption that olfactory experiences can be identified and individuated merely by using phenomenal experience as a guide. Phenomenally, if one compares synchronic visual and olfactory experience it can be admitted that the latter has fewer spatial qualities. Although phenomenological evidence should be accounted for in generating a theory, phenomenology should not be the sole determining factor. Given the divide between synchronic olfactory and visual experiences, perhaps two *Wonderland* thought experiments concerning the perspectival relation of the size of the perceiver relative to the proper perceptible of a given perceptual modality might be employed in adjudicating the issue.

3. *Wonderland* Thought Experiments – Shrinking and Expanding[17]

Odor theories operate under the methodological assumption that synchronic odor perception must be ascertained from the constrains that we extrapolate from our visual experiences (Lycan, 1996, 2000, Batty, 2007, 2009, 2011, 2014, 2015). However, this starting point might be criticized based on its assumption that an uniform account must be given that encompasses what is experienced as a smell across all instances of olfactory perception (Aasen, 2018) and its

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[14] For a discussion of the sniffing sequence in connection with testing the veracity of Enactivism cf Young (2017).

[15] A perfume's silage is an excellent example of the spatial aspect of an odor. In designing a new product, perfume chemists must consider a perfume's silage - the diffusion rate across space of a perfume. Some scents are designed to announce their wearer's presence or to turn the heads of those in a room, while colognes are designed to be noticeable only within a small radius around the wearer.

[16] Despite noting that head movement, sniffing, and motorsensory stimulation play a role in distal olfactory perception, this should not be conflated with the claim that accounting for our perception of smellscapes requires endorsing enactivism. Rather these other sensory systems and motor behavior play a constitutive role. For a discussion of why Actionism cannot account for olfactory perception cf Young (2017).

[17] A similar set of thought experiments focusing on the structural features of smells in relation to other modalities can be found in Myin and Cooke (2011).

assumption that phenomenological reports generated via introspective access can be used as a reliable and valid method for assessing olfactory experience (Young, 2019a). Additionally, employing our synchronic experience of visual objects as a point of comparison has been criticized, because Odor Theorists misrepresent the amount of background knowledge and diachronic movement required even for the perception of visual objects (Aasen, 2018; Young, 2019a). The assumption that visual perceptions automatically presents us, synchronically, with spatially located objects can be challenged, because similar temporally extended processes occur in vision. To see things, one's eyes must be in constant motion through saccadic and micro-saccadic movements. If one's eyes were to stop moving the visual field would shrink and eventually turn a uniform grey, which can be demonstrated by immobilizing one's eyeballs in their sockets or by employing a ganzfeld. This presents a *prima facie* analogy to the role of diachronic movement in olfaction. If sniffing and/or motoric movement is excluded as an enabling condition of olfactory perception, then saccadic eye movements must also be excluded.

The aforementioned criticisms and evidence regarding the extended temporal timescale of olfaction provide reasons for reconsidering the perceptual timescale of olfaction as being extended. Rather than rehashing previous arguments this section attempts to highlight that the object of distal perception might not be uniform across modalities and that extrapolating the individuation conditions for perceptible objects between modalities is questionable. What we conceive of as the object of perception for each modality depends upon the target phenomena that we take as a paradigm for theorizing. The shrinking and stretching thought experiments make us reconsider our pre-theoretic conceptions of distal object perception extrapolated from our introspective reports of visual phenomenology. In what follows the two thought experiments force us to consider what would happen to our pre-theoretic conception of the visual object if the olfactory perspectival relation is taken to constrain perceptual objecthood, while the second example ask us to consider a situation in which we could perceive olfactory objects in the same manner as we do synchronically in vision.[18]

3.1 Perspectival Shrinkage

Assuming that the perceptible odor object is a gaseous plume composed of chemical compounds, then these are large diffuse entities that cannot be fully perceived in the same synchronic timeframe as visual object perception. Demarcating the edges of an odor requires either multiple samples of the stimulus to determine its concentration gradient or movement relative to the edges of the object. Now consider visual objects, these are experienced as three-dimensional

[18] These thought experiments should not require the reader to suspend their knowledge of perceptual science and how the visual and olfactory systems actually work. Rather, the reader is asked to consider the hypothetical cases that could conceivably happen if we maintain our organs of perception but shifted the perspectival relation by increasing or decreasing the observer relative to the size of the perceptible object of a modality. As thought experiments these are meant to manipulate our intuitions generated by our pre-theoretic conceptions that are primarily drawn from introspective reports of the phenomenology we attribute to past visual experiences. With this purpose in mind the thought experiments are not being used to derived conclusions regarding the actual workings of the perceptual modalities or what we should empirically predict, but rather they are only employed to question our phenomenological biases derived primarily from vision. If the reader balks at using conceivability in this manner, they can instead simply consider our visual perception of landscapes, mountain ranges, and redwood trees that cannot be synchronically visually perceived in their entirety and I think the same conclusions would hold in these real-world examples of the shrinking thought experiment.

entities presented to use with a determinable location. But, what if we were to shrink down to the size that we could move about these visual objects in the same way that we can inhabit odor plumes? Presumably we could still perceive them visually - they would still have the same type of refractory properties that our visual system is sensitive to. But, in order to perceive their surfaces and edges as composing mereologically complex visual object against a background we would need to move about. Phenomenologically we would no longer claim to automatically be presented synchronically with a punctate visual object, yet my intuition is that we would still want to say we perceive visual objects distally with spatial properties.

In this situation, we would still see visual objects, but they would be without their phenomenological locatedness synchronically perceived. Holding the perceptible object constant, while shifting our perspectival relation through shrinkage allows one of two possibilities: we conclude that vision is not presenting us with a proper format of distal perception in this scenario; or vision is still perceptual, but with further diachronic exploratory movements built in to allow for objective perception. I myself think the latter is the favorable position in the same way that we can be said to see mountain ranges, vast vistas, or landscapes.

3.2 Perspectival Stretching

Controlling the size of the perspective for vision relative to the olfactory object is quite telling for our intuitions regarding distal perception employing an extended perceptual timeframe together with motorsensory systems or bodily movement to fully perceive the perceptible object. What if we were to shift the perspective in the opposite direction? Consider what would be required to shift the olfactory perceptive to match that of the visual scenario. Assuming that the perceptible objects of olfaction are odor plumes, then to be able to synchronically perceive these entities within a distal scene composed of different particulars and their interrelations would require stretching to a gigantic size. In this instance of olfactory gigantism my intuition is that if we could inhale a large enough sample of the target odor plume and the other odor plumes surrounding it within a single sniff then we would be synchronically presented with an entire distal olfactory smellscape.

What is telling about these *Wonderland* thought experiments is that our phenomenological judgements regarding the underlying conditions for synchronic and diachronic spatial object perception depend upon the default starting perspective. Holding olfaction hostage to visual perception seems tyrannical, but to do the same to vision would be equally oppressive. Rather, the nature of distal perception should be relativized to the perspectival dictates of the modality under consideration. The resultant conclusion would then permit smellscape resolution to be both time and motion dependent. Perhaps phenomenologically we are not synchronically presented with smells with delineated locatedness within a distal array, but that is both expected and unsurprising. Smelling takes time, but when we stop and take the time to smell we are blessed with an experience of a robust smellscape with disperse and overlapping odors generating a nose circus. However, the further question arises how are we specifying the olfactory modality, such that we can identify the perceptible object of olfaction?

4. How Individuating the Olfactory Modality Effects Olfactory Distal Perception

We can individuate the olfactory modality in terms of its proper perceptible qualitative character assessed by measuring judgements of just noticeable differences across a range chemical stimuli

(Young, Keller, and Rosenthal 2014; Keller, 2017). However, more specificity is required in determining the olfactory modality's accuracy conditions for distal perception. Individuating the olfactory modality is no trivial matter, since different aspects of what goes on within the nose will generate different distal abilities for perceiving gaseous clouds.

We pretheoretically identify the perceptual modality of smell using the anatomical organ criteria, which explains why we commonly consider everything that goes on inside of the nose as generating our perception of smells. However, there are at least three distinct systems within the human nose each of which generates different aspects of our distal perceptual ability when it comes to gaseous clouds**.** These three systems are: the trigeminal nerve endings in the nose, the somatosensory system, and the olfactory system (Witt & Hummel, 2006; Sela & Sobel, 2010)

Using trigeminal stimulation, we can locate an odorant within 7-10° of its distal location (von Beksey, 1964). Moreover, using trigeminal stimulation we can demarcate odorant onset between nostrils and the direction from which the odorant is arising, thereby generating the capacity for identifying its distal location (Frasnelli et al, 2009, 2010). If we individuate the olfactory system using the trigeminal nerve together with somatosensory stimulation and olfactory receptor stimulation, we could easily demonstrate that we have distal olfactory perception of objects at fixed spatial coordinates within the environment. However, if we consider only those situations of perceiving stimuli that are pure odorants without any trigeminal component, we lose the capacity for synchronically detecting odor localization, directionality, or odor onset between nostrils. Despite the distal sensitivity that would be gained by including trigeminal stimulation within the olfactory modality it must be excluded, because it is sensitive to the irritant nature of the chemical compounds not to their molecular structure in a manner that yields perception of olfactory quality (Doty, 1995; Hummel, 2000; Hummel & Livermore, 2002; for similar reasons for excluding chemothesis from the olfactory modality using Quality Space Theory cf Keller, 2017). If we identify the perceptible object in accordance with MST using olfactory quality as the determiner of a smell's proper perceptible, then trigeminal stimulation within the nose is not part of the olfactory modality as it does not play an essential role in generating our perception of olfactory quality.

Even discounting the role of the trigeminal stimulation within the nose we might consider the somatosensory systems within each nostril as part of the olfactory modality. Sniffing plays a role in the determination of the onset of a given odorant. Additionally, our sniffing rates play a role in the detection and hedonic responses to smells (cf Oloffson, 2014; Young, 2014), such that some consider sniffing as part of the olfactory percept (Sobel et al, 1999; Bensafi et al, 2004; Mainland and Sobel, 2006). If we include somatosensory stimulation then we cannot tell the difference between odor onset between the nostrils, but we can detect airflow onset, which might be helpful in demarcating the degree of onset of the stimulus across nostrils. However, if we individuate the olfactory object using MST we must exclude somatosensory stimulation within the nostrils from being part of the olfactory modality, because the system is activated by and tracks odorless gaseous plumes. Additionally, it has been argued elsewhere that motorsensory stimulation is not necessary for the perception of olfactory quality (Young, 2017*)*.

By excluding both trigeminal nerve stimulation and somatosensory processes within the nostrils from the olfactory modality, we are left with those transduction processes occurring at the olfactory epithelium and olfactory receptor neurons through odorant encoding at the olfactory bulb and projecting into cortical olfactory processing centers in the piriform cortex and orbital frontal cortex responsible for the unified percept of a complex chemical mixture. Individuating the olfactory modality in this manner places it firmly within the accepted standards of the chemoreceptive sciences. Thus delimited our olfactory capacity for distal perception becomes quite meager. All indications are that the olfactory receptor system cannot localize pure odorant onset between nostrils (Kobal and Hummel 1998; Radil and Wysocki, 1998; Frasnelli et al, 2009, 2010; Kleeman et al, 2009).

Even though binaral rivalry exists such that each nostril has a slightly different smell percept (Zhou and Chen, 2009) this does not yield odor localization. The host of chemoreceptive research indicates that humans cannot use nostril onset to determine olfactory distal perception. However, one spectacular aspect of the olfactory system is its plasticity. Negoias et al (2013) demonstrated that individuals can be trained over time to localized odorants onset within a nostril synchronically. By training subjects overtime they showed that humans can acquire the ability to localize intranasal olfactory stimuli. Their study provides a strong reason to think that we do have the capacity for synchronic odor localization. Individuating the olfactory modality using MST yields the conclusion that we must rule out trigeminal and somatosensory stimulation as part of the modality of smell, thus we are unable under most conditions to detect intranasal stimulus onset. Despite lacking this capacity, a number of studies suggest that olfactory distal perception is possible, but it requires an extended timeframe and exploratory behavior of an extend environment. Thus, individuating the sense of smell using only the olfactory system rules out most cases of synchronic spatial perception, but not diachronic distal perception.[19]

5. Distal Olfactory Perception

Despite our commonsense misconception that we do not distally perceive locatable odors it has been shown that we are both able to track odors across an environment, as well as employ odors to navigate through an environment. However, the ability to locate smells requires changing one's spatiotemporal relation to the odor plume by either sniffing or shifting one's position (Schneirder and Schmidt, 1967). We do not smell a smudge, but rather our experience presents us with a multitude of odorous objects within an extended array. Our experience of odors satisfies the criterion of figure-ground segregation (Wilson and Stevenson 2007; Barnes et al, 2008; Gottfried, 2010; Young 2016; Millar, 2017), which is instrumental in ascertaining the objective nature of perceptual entities. We are continually immersed in a gaseous turbulent sea of chemical compounds that could lead to olfactory experiences. Nonetheless we perceptually detect and individuate separate smells in the environment. Furthermore, we perceive smells as objects within an environment both in terms of our ability for tracking individual smells through an environment, as well as our ability to localize smells diachronically using olfactory spatial memory and navigation. Taken together the evidence surveyed in this section shows the plausibility of claiming that we perceive odors against a background smellscape.

5.1 Olfactory Tracking

[19] It is at this point that Aasen (2018) and I part ways, since she argues using phenomenological descriptions of possible olfactory experiences that we have synchronic olfactory experiences of smells as being at or coming from a direction. However, from the evidence surveyed synchronic olfactory spatial perception of an odor's locatedness and directionality is simply not borne out by the experimental research without expanding the olfactory modality beyond our ability to perceive objects with olfactory qualities .

Porter et al (2007) in an ingenious study showed that using only olfactory cues humans can track an odor across an open field with precision and accuracy. A more recent study showed that in open field environments subjects can localize an odor using just the olfactory system without trigeminal stimulation. Additionally, the ability to locate smells accurately requires the use of both nostrils as the odor stimulus becomes more distant. The use of both nostrils does not make a difference for locating the stimulus at 2 meters or less from the subject. However, beyond 2 meters the use of both nostrils to demarcate the concentration of the plume seems to be of importance in the localization of the smell (Welge-Lussen, 2014). Their results also indicated that regardless of the distance and use of binaral information subjects could accurately localize a smell. Moreover, as the task demands increased the use of both nostrils became of greater importance. While our ability for tracking an individual target odor through an environment is impressive, what is even more sensational is that we can navigate using our sense of smell. Olfactory navigation requires not merely learning to identify a complex chemical mixture as an individual odor and tracking the target from against a background of other smells, but also learning to place odors within an odotopic environmental map.

5.2 Olfactory Navigation

Humans can learn specific locations using olfactory cues such that we have an odor memory system for olfactory spatial representation and using smell can relocated the placement of odors within a spatial environment (Schifferstein et al, 2010). Visually impaired individuals employ olfactory cues in locating an objects proximity or as a point of reference in determining their spatial location within an environment, but not for the purposes of actively sampling and navigating (Koutsoklenis et al, 2011). Additionally, under laboratory conditions it has been observed that we have the ability for olfactory space representations indicating the existence of residual directional smelling abilities for humans (Moessnang et al, 2011).

Moreover, Jacobs (2012) argues that the primary function of olfaction is not for detection or discrimination, but for navigation. He hypothesizes that the function of olfaction is for mapping and navigation based on the relative size and use of the olfactory bulb. His theoretical argument is that the scaling of the olfactory bulb does not obey the same rules as other cortical tissues across species if it were merely evolved for sensory discrimination. Though the evolutionary claim might be dubious, the hypothesis regarding olfactory navigation has been substantiated in a more recent study. Jacobs et al. (2015) demonstrated that we can learn the location of an odor using only olfaction and navigate back to the odor's location using multimodal effects. Thus, they claim that a mechanism long proposed for homing pigeons, the ability to find a location on a map constructed from chemical stimuli, may also be a navigational mechanism used by humans.

Once the time scale of smell perception is taken into account the slow processing speeds of olfactory transduction allow for perceptual experiences of objects with a distal locatedness relative to the perceiver. Not only can we track smells through an environment across time, we also perceive odors as having a dispersed location in an environment relative to its plume. The cumulative evidence from the chemosciences suggests that we need to rethink our intuitive philosophical starting points when theorizing about distal perception. We perceive smells as odor plumes dispersed across a vast area against an array of overlapping gaseous plumes, which we might conceive of as smellscapes.

Conclusion

Smelling objects within an environment takes time. We cannot demarcate odors as occurring at a given location within the same timescale as visual object perception, but we are able to locate smells as occurring within an environment against the background of other odors across time. Noting that the temporal processing of the olfactory stimulus is extended provides motivation for considering our perception of odors as spatially extended. Allowing a spatial expansion of the perceptual scene suggests that perceiving distal odors occurs within 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 vision to olfaction. It certainly becomes dubious if we use the same synchronic conditions of visual experience to generate ramifications for olfactory experience. But, it is a more serious methodological error in relation to diachronic olfactory experience. The shrinking and growing thought experiments suggest that our intuitive theoretical launchpad employing vision to theorize about distal object perception is misguided. Rather, we need to rethink the nature of perceiving at a distance relative to the perceptible object of each modality.

We perceive smells as persisting mereologically complex odors that are distal objects with spatial properties within an olfactory array that might be conceived by analogy to landscapes as smellscapes. What has been shown through-out is that the Molecular Structure Theory of smells provides a comprehensive explanation of the distal nature of odors. As a refinement of Odor Theory, MST embraces the recent onslaught of criticism, as they provide the impetus to expand the theory to properly account for the diachronic nature of olfactory perception and our experience of smells within a distal environmental smellscape.

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