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Olfactory Objecthood

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Abstract

In the contemporary analytic discussions concerning human olfactory perception, it is commonly claimed that (1) olfactory experiences are representations having content and (2) olfactory experiences represent odours, like coffee odour or vanilla odour. However, despite these common assumptions, there seems to be an ontological controversy between two views: the first states that odours are perceptually represented as features and the second states that they are represented as objects. In this paper, I aim to systematically address the "feature or object" status of represented odours by concerning whether odours are represented (a) as subjects of properties, (b) as mereological wholes, and (c) entities persisting in a way characteristic for objects. I argue that olfactorily represented odours constitute a sui generis category and cannot be easily classified as objects or features. Such investigations constitute a step in establishing whether various human modalities are unified by organising the environment according to the same categories.

Keywords Perception · Olfaction · Vision · Ontology · Objects · Identity · Mereology

Analytic papers concerning olfactory experiences commonly start with the statement that olfaction has received significantly less philosophical attention than vision. While this is certainly true, in recent years philosophers have formulated a significant number of alternative accounts of olfactory content. These accounts share two characteristics. First, olfactory experiences are interpreted as representational (Batty 2009; Lycan 2014), i.e. they are not only "modifications of consciousness" but also represent the environment as being a certain way. Second, olfactory experiences represent odours, like coffee odour or vanilla odour (e.g., Batty 2010b). Despite these two common assumptions, authors disagree on how to properly characterise olfactory content. For example, it is claimed that olfaction represents odours as instantiated by surrounding space (Batty 2010c), or as instantiated by entities that are sources

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of odours, like an onion odour instantiated by an onion (see Batty 2011; Lycan 2000; Mizrahi 2014 for a discussion). On the other hand, it is postulated that odours are represented not as features of some entities, but rather as objects which themselves possess features and have mereological structure (Carvalho 2014, Young 2016). More generally, there seems to be an ontological controversy between two views: the first states that odours should be characterised as features and the second states that they should be interpreted as objects.

The above ontological question has two aspects. First, one may want a clear outline of the ontology of odours understood as physical entities that are represented in olfactory experiences. In the philosophical literature one can find several competing answers, for instance that physical odours are chemical structures (Young 2016) or stuffs (Mizrahi 2014). The second aspect, which is investigated in this paper, concerns not what the physical odours are but how they are presented in olfactory experiences. It is possible that these two ontological questions have different answers. For instance, it may be the case that physical odours are objects but they are represented as features in usual, human olfactory experiences. In other words, the first aspect concerns the objective ontology of odours while the second aspect is about ontological characteristics presented in perceptual experiences. Of course, this is not to state that these aspects are completely unrelated. In particular, if one believes that olfactory experiences are usually accurate, then the objective ontology of odours cannot significantly deviate from ontological characteristics ascribed to odours by olfaction (see Mizrahi 2014 for an application of this strategy). However, in this paper I do not make any assumptions about the accuracy of olfactory representations; I focus on the second ontological aspect concerning the odours as they are represented in human olfactory experiences.

The considered ontological controversy is a difficult one, not only because of the internal complexity of the "olfactory content" debate, but also because in philosophical works there are various, competing notions of what it means to be an object. To apply the notion of object to experiences associated with different modalities, one has to use a concept that is sufficiently general to abstract from contingent differences between modalities but which still captures important intuitions about being an object. The most common general characteristics of perceptual objecthood proposed within the philosophy of perception are (1) being a subject of properties (Cohen 2010), (2) having a mereological structure (O'Callaghan 2016), and (3) being able to persist through time despite significant qualitative changes (Scholl 2007). The usual path of reasoning is to start from considerations concerning visual experiences, as it is very plausible that such experiences present entities as having characteristics (1)–(3), and then show that these characteristics are also satisfied in case of other modalities. In particular, it has been extensively argued that human audition represents sounds as objects due to the fact that sounds are represented as being the subject of properties such as pitch and loudness, complex sounds are represented as having temporal parts, and sounds are represented as persisting through varieties of changes (see Matthen, 2010; O'Callaghan 2008). In this paper, I apply an analogous strategy to systematically address the object-status of odours by investigating whether odours are represented (a) as subjects understood as entities instantiating properties, (b) as mereological wholes and (c) as entities persisting through qualitative changes.

The paper starts by explicating the ontological problem I aim to address and presenting the general notion of perceptual objecthood (section 1). Subsequently, by using the notion of perceptual objecthood, I compare visual and olfactory experiences

by investigating whether they represent objects and odours as (I) subjects of properties (section 2), (II) mereological wholes (section 3), and (III) persisting entities (section 4). Relying on the results of this analysis (section 5), I argue that while odours are represented as subjects and as mereological wholes, they are not represented as persisting in a way that is characteristic of objects.

1 Ontology and Experiences

My goal in this paper is to analyse, by applying ontological notions, how odours are represented in usual, human olfactory experiences. In particular, I want to investigate whether odours are olfactorily represented as objects.[1] This is not the same as analysing what physical odours actually are. For instance, let's assume that physical odours are identical to some chemical mixtures that are able to influence olfactory receptors. In this case, it may be that there is a chemical mixture in the surrounding that is represented as a vanilla odour. In such an example an odour may be represented as having different ontological characteristics than it really has. For instance, the chemical mixture has a complex mereological structure composed of various molecules, but the represented vanilla odour seems partless and uniform.

In olfaction-related philosophical literature, the above distinction is sometimes expressed as a difference between external and intentional objects. According to Young (2016: 521), external objects are "entities or stimuli external to us that we sense using the olfactory system" while intentional ones are those "that we represent our experience as being of when we introspectively report on the phenomenological content of olfactory perception". In case of Young (see also Carvalho, 2014 for a similar approach), odours understood as external objects of olfaction are chemical structures. However, chemical structures are not intentional objects of olfaction as we do not represent odours as chemical structures. In fact, relying solely on the phenomenological content of olfactory experiences, we may never come to the scientific idea that things like chemical structures exist at all. According to Young's proposals, we rather represent odours as objects that can be distinguished from ground and have spatial as well as mereological properties (Young 2016, see also Stevenson and Wilson 2007). Alternatively, it is proposed that odours are represented as stuffs because, contrary to Young, they are not experienced as having any part-structure (Mizrahi 2014), or are represented not as objects but as properties (Batty 2010a, see also Keller 2016: 85 who agrees with Batty but generally does not believe that the main function of olfaction is to represent entities in the environment).

Despite the above examples of applying ontological categories to odours, it may be doubted whether it is justified to talk about ontology when we consider how odours are represented by human olfaction. Usually, ontological concepts are used in discussions about the nature of objective reality, but here they are applied to issues connected, not with reality per se, but with the way in which olfaction presents it. However, I believe that this application is justified, because in perceptual experiences entities are presented as having some ontological characteristics. Perceptual experiences do not present the surrounding as chaotic but as organised according to certain rules, and many of these rules are suited to

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[1] I assume that representing the environment is an important function of human olfaction. For alternative approaches see Barwich 2014; Castro and Seeley 2014.

being described using ontological notions. For instance, entities may be perceptually experienced as having a part-structure that allows for the application of mereological concepts, or they may be experienced as persisting through time, such that the rules of their persistence may be analysed by referring to ontological considerations about identity criterions (see Scholl 2007). Further, philosophers have already used ontological concepts in investigations concerning the way in which perception represents the environment. For instance, it has been argued that sounds are auditorily experienced as having temporal parts (Matthen 2010), and that multimodal experiences present entities as having mereological structure (O'Callaghan 2016). Here, an analogous strategy is applied to problems related to the object-status of olfactorily represented odours. It should be noted that the above approach does not assume the existence of some additional, mind-dependent odours distinct from physical odours; a standard representational framework is used, according to which physical odours have some ontological characteristics and they are also represented as having some ontological characteristics. These represented characteristics may, but do not have to, match the actual ones (for instance, it is possible that odours are not objects, but are perceptually represented as objects).

In investigating whether odours are represented as objects, I use a general, ontological notion of objects according to which they are persisting entities with mereological structure and the subjects of properties. Such a notion has been already proposed by philosophers of perception as one that may describe perceptual objects of different modalities (O'Callaghan 2016), and has been applied in order to show that human audition represents sounds as objects (Matthen 2010; Nudds 2010; O'Callaghan 2008). An advantage of using such a general notion is that it abstracts from contingent differences in the capacities of various human perceptual modalities. For instance, it does not assume that representing something as an object requires certain abilities to represent space or to make figure/ground discriminations. Instead, it allows that different modalities can succeed in representing object-related characteristics by using their specific means.

The applied notion of object describes perceptual objecthood using three characteristics. According to the first, objects are subjects of properties. In philosophical works, it is often claimed that there is an asymmetry of instantiation between entities characterised as subjects and entities characterised as properties: subjects instantiate properties but not vice versa (see Clark 2004; Matthen 2004 for discussion of this in the context of vision).[2] Using the classical example, it seems that Socrates is a subject instantiating the property of "being wise", but "being wise" does not instantiate Socrates. In section 3, I introduce a notion of "primary subjects", i.e. subjects that themselves are not properties of some other entities. I argue that being a primary subject is a characteristic of both visually experienced objects and olfactorily experienced odours.[3]

The second characteristic describes objects as mereologically complex entities, i.e. having a part-structure. According to usual characterizations (Casati and Varzi 1999), the parthood relation is reflexive (i.e., everything is a part of itself), asymmetric (i.e., if x is a part of y then y is not a part of x, unless x is identical to y), and transitive (i.e., if x is a part of

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[2] Later, I use the term "property" to name entities which, unlike subjects, are instantiated by something, and the term "feature" to name entities such as colours and shapes. Because of this it cannot be automatically inferred that features are properties.

[3] By "visually experienced objects" and "olfactorily experienced odours" I mean objects and odours considered with respect to how they are represented by vision or olfaction.

y and y is a part of z, then also x is a part of z). A fundamental distinction separates atomic entities that have only one part, identical to themselves, and complex entities that also have "proper parts" which are not identical to the whole entity they constitute.

Finally, the third characteristic concerns diachronic identity conditions. Such identity conditions determine what is necessary and sufficient for an entity x existing at some moment t_k and an entity y existing at some later moment t_m to be identical. While nearly every type of entity has some abilities to persist, there is a specific way of persisting that is characteristic of objects (see Hirsch, 1982 for classical metaphysical investigations and Scholl 2007; O'Callaghan 2008 for considerations regarding perception). First, objects can change many of their properties over time without becoming a numerically different object. In other words, many of their properties are contingent for their diachronic identity. Second, despite robust abilities to change properties, the diachronic sameness of objects requires the occurrence of certain continuity relations. For instance, in order to preserve numeric identity objects can move only in a spatiotemporally continuous fashion or their qualitative changes have to be gradual.

In the subsequent sections I consider whether human olfaction represents odours as having the above three characteristics. In particular, in each case I start by showing that a discussed characteristic is represented in the case of visual experiences of objects. This also allows me to specify how each of the formal, ontological characteristics can be interpreted such that they can be applied in the perceptual context. Further, I discuss whether the considered characteristic is also represented in the case of olfactory experiences of odours.

2 Subjects and Properties

The first characteristic of perceptual objecthood concerns a distinction between subjects and properties: according to this distinction, objects are subjects and not properties. There is a strong intuition that in the case of human vision objects are represented as subjects while features are represented as properties. It is a red square that possesses a shade of red and squareness, but not the other way round. However, it less obvious how we can understand this asymmetry in the context of perceptual experiences. For instance, it is not an asymmetry of existential dependence: features are always visually represented as instantiated by something (by an object, or sometimes by a place, see Clark 2004); and conversely, objects are not visually represented as featureless. In addition, it is not an asymmetry of uniqueness: a feature may be visually represented as instantiated by many objects, for example we may perceive several objects of the same shade of red, and a single object is represented as having many features.

2.1 Vision and Primary Subjects

I propose that the intuitive subject/property asymmetry should be explicated by referring to the unificatory role of visually represented objects. It is widely accepted that human vision is able to resolve the so-called Many Properties problem, i.e. it can distinguish between situations of perceiving different arrangements of the same elements (Clark 2004). For example, a person can easily visually differentiate between a presentation of (1) a red square and a green triangle, and a presentation of (2) a red triangle and a green square. In

both cases the represented elements are the same: two objects, redness, greenness, triangularity, and squareness, but they are combined differently. Hence, many authors postulate that visual content cannot be characterised as a list of elements, as a single list would serve both of the above situations. On the contrary, content should be described in terms of objects connected with features through an instantiation-like relation (Clark 2004; Cohen 2004; Keane 2008; Matthen 2004).

While the Many Properties problem is solved by combining objects with features, the two types of elements do not play the same role. In particular, there is an asymmetry of unification: a single object unifies many features into a perceptual unit, but a single feature does not unify many objects into such a unit. If redness and squareness are combined with the same object, then a red square is represented. It is a perceptual unit that is crucial for the perceptual organisation of a visual scene on which further visual processes operate. In particular, a red square (1) can be easily attentively selected, which allows for a detailed analysis of its features and spatial structure (Scholl 2001; Qiu and von der Heydt 2005); (2) can be tracked and re-identified despite its movement and changes in features (Pylyshyn 2007; Scholl 2007); and (3) may be combined with other units to become a part of a larger whole (Xu and Singh 2002).

However, a feature does not usually create a perceptual unit from several objects. In particular, spatially disjoint figures are not typically represented as composing a perceptual unit even if they share a feature. For example, if a red square is represented as located on the left side of the visual field and a green square as located on the right side, these two figures do not compose a single perceptual unit despite their both being combined with squareness. The limited unificatory power of features is demonstrated by the fact that perceptual mechanisms cannot operate on disjoint objects sharing a feature in the same way that they can operate on a single object with several features. First, it is much harder to simultaneously focus attention on two objects with a common feature than to focus attention on a single object possessing several features (Alvarez and Scholl 2005; Scholl 2001). This shows that attentional mechanisms do not usually treat several disjoint objects as composing a single perceptual unit. The second point concerns mechanisms of visual tracking. While it is very easy to track changes concerning a single object with several features, it is much harder to do so when a task involves tracking several objects, even if they share some features. In such cases re-identification errors occur and changes in features are often difficult to spot (Pylyshyn 2007: 37). Such results suggest that tracking mechanisms have difficulty treating several disjoint objects as a single perceptual unit and efficiently representing changes concerning its properties.

Because of the above difference, the intuitive subject/property asymmetry between visually represented objects and visually represented features may be grounded in the unificatory role of objects in creating perceptual units. However, this postulate needs further specification. First, it seems that visually represented features can also play a unificatory role for other features. For example, a particular shade of red unifies its features like those describing its brightness and saturation. Second, it is not universally true that features cannot unify objects into perceptual units, since several nearby objects may be represented as a single perceptual group if they share features such as colour or shape. Third, some philosophers of perception claim that at least in certain cases the unificatory role in solving the Many Properties problem is served not by objects but by places (Clark 2004).

Nevertheless, these observations do not undermine the special unificatory role of visually represented objects. First, while features may unify other features into some type of perceptual units, they themselves, in order to solve the Many Properties Problem, must be unified into perceptual units by objects. This is not the case with objects that unify features without a need to be themselves unified into another perceptual unit. Second, while a feature like colour may unify objects into a perceptual group, such a grouping process operates on pre-formed perceptual units: figures in which features, with colour among them, are unified by objects. Third, while I argue that objects are subjects in relation to features, I do not claim that they are the only elements visually represented as subjects. It is possible that there are also other entities, for instance places, with the characteristics of subjects.

We may express the crucial difference by stating that objects are *primary subjects*, as they create perceptual units without themselves being constituents of perceptual units unified by something else. On the other hand, features create perceptual units only by being constituents of units already unified by something else (mainly objects or places). Because of this asymmetry they may be characterised, when they constitute a perceptual unit together with objects, as *properties* of objects.

The above considerations show that objects are visually represented as *primary subjects* of features. Now, we can ask whether odours are also olfactorily represented as *primary subjects*.

2.2 Odours as Subjects

The first question that should be asked is whether olfaction, like vision, is able to solve the Many Properties problem. Some authors claim that human olfaction has no ability to solve this problem, mainly due to the rudimentary spatial aspect of olfactory experiences. Probably the best-known argument against olfactory abilities to solve the Many Properties problem is the air freshener example provided by Clare Batty (see 2010abc; 2011 for variants, all focusing on the spatial character of vision and olfaction). Let's imagine that someone tries to cover a cigarette odour with an air freshener odour and as a result has a perceptual experience in which two odours are represented. Visually, one can perceive two objects in many ways, for example the first object on the left of the second one, or vice versa, or one partially overlapping another. However, there seems to be no such variation in olfactory experiences: when we perceive cigarette and air freshener odours we do not discern between a situations in which the cigarette odour is to the right or left of an air freshener odour. Furthermore, as argued by Keller (2016: 75–77), olfaction cannot solve the Many Properties problem by attributing features to sources of odours. This is because the information available to the olfactory mechanism does not allow us to precisely individuate sources. For instance, an experience presenting an onion odour and a pepperoni odour does not allow us to decide whether there is a single source-item, for instance a pizza with both onion and pepperoni, or two source-items each with features related to one of the presented odours.

While the above arguments may be accurate, they focus too strongly on the contingent way in which the Many Properties problem is solved by vision. The core ability to solve the Many Properties problem lies in discriminating situations that contain varying arrangements of the same elements. Vision, due to its rich capability for spatial discrimination, may discern between situations where the same objects are situated in varying positions, and it may be the case that olfaction, due to its limitations

in representing space, cannot make analogous discriminations in the case of odours. However, it does not follow that there are no other cases of the Many Properties problem in which olfaction can succeed (see Carvalho 2014 for a similar observation).

Batty acknowledges that an alternative option is to resolve the Many Properties Problem without using spatial locations or referring to odour-sources, but instead by solely recombining the represented features. However, she does not believe such cases are likely to happen (Batty 2010a, 2014). For instance, it may be proposed that an experience of an acidic coffee smell and a sweet lily smell results from an olfactory binding in which coffee odour is combined with acidity and lily odour with sweetness, while the alternative option would be to bind coffee with sweetness and lily with acidity. Nevertheless, it may be doubted whether this is a genuine example of resolving the Many Properties problem. It seems that lily odour entails sweetness and not acidity. In consequence, there are not two alternative ways to combine the represented elements and so no binding is in fact required.

However, the above criticism of the non-spatial resolution of the Many Properties problem neglects the variety of features that can be olfactorily represented. In particular, olfaction does not only represent features like sweetness or sourness,[4] but also features such as higher or lower intensities (Morton 2000), hedonic features (Castro and Seeley 2014) and trigeminal features, like irritating or cooling (Laska et al. 1997). While trigeminal features are processed by distinct physiological mechanisms than other features of odorants, I believe that there are good reasons for treating at least some trigeminal mechanisms as parts of olfactory modality. First, there does not have to be a separate perceptual modality for each mechanism processing sensory data; a perceptual modality may encompass many mechanisms unified by a common purpose of obtaining data about some aspect of the environment (see Keeley 2002 for general picture and Auvray, Spence 2008 for a specific case regarding flavour perception). From this perspective, some trigeminal mechanisms constitute a modality which provides information about the properties of odours. Second, the functioning of trigeminal mechanisms is not merely some peripheral and insignificant part of odour perception. The majority of odours activate trigeminal mechanisms (see Millar 2017), and it is believed that trigeminal data processing is crucial in the ability to track odours (Young et al. 2014).

Given the above observations, let's consider a rather unfortunate case in which one experiences high-intensity cigarette odour and low-intensity onion odour, both as quite irritating. It is plausible that this situation can be olfactorily distinguished from another in which the same elements are represented but the intensities are reversed: low-intensity cigarette odour and high-intensity onion odour, both as quite irritating. If such situations can be olfactorily distinguished, then as in standard descriptions of the Many Properties problem, the olfactory content cannot be characterised as a list of elements: cigarette odour, onion odour, low-intensity, high-intensity, and irritating, because such a list applies to both situations. The content should be described in terms of odours-intensities-trigeminal features combinations. In fact, the intensity-features seem to be particularly well suited to constructing olfactory examples of the Many Properties problem. This is evidenced through cases of anosmia, where people can perceive

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[4] It is believed that the olfactory system gains the ability to represent such gustatory-like features by virtue of learned correlations between properties of gustatory and olfactory stimuli (e.g. vanilla odour seems to be sweet because it often accompanies sweet food, see Small and Prescott 2005).

intensities of odours without representing their qualitative character (Morton 2000). It suggests that the intensity-features and qualitative-features of odours are represented separately and that the task of the perceptual system is to unify them within a more complex representation. Other plausible examples involve hedonic features that may change with experience and trigeminal features that, as stated earlier, are processed by a different physiological mechanism to the one that processes features like sweetness.

The above example of solving the Many Properties problem in olfaction reveals an asymmetry of unification between odours and other elements of olfactory content. A combination of an odour with features seems to form a perceptual unit and in both of the above situations two such units can be distinguished: one corresponding to the onion odour with its features and the other to the cigarette odour with its features. As shown earlier in the discussion concerning vision, an important characteristic of perceptual units is that they may be chosen and further processed by attentional mechanisms. In the case of olfaction, the neuroscientific data gathered in fMRI studies show that there are specific neural regions that preferentially respond when people attend the presented odours (Zelano et al. 2005). Furthermore, similar odours may overshadow each other such that it is harder for the attentional mechanism to distinguish between them (Young 2016: 523–524). It seems that similarly to the case of vision, in olfaction odours form perceptual units can be attentively chosen if only their qualities allow us to distinguish them from the "ground" constituted by other represented odours (Gottfried 2010: 638). Another relevant characteristic of visual perceptual units is that they may be tracked through time despite movement and qualitative changes. This is also true of olfactorily represented odours that can tracked despite modifications in their features, for instance, as they change in intensity (Richardson 2013). As shown in experimental research, human olfactory tracking abilities are sufficient to localize odour-sources in natural environments without relying on data from other senses (Porter et al. 2007). The above characteristics of olfactorily represented odours suggest that, similarly to visually represented objects, they constitute perceptual units.

On the other hand, the reverse does not hold, as onion and cigarette odours do not form a single perceptual unit unified by a trigeminal feature despite the fact that they are both irritating. Analogously to other olfactory features, the fact that two represented odours have a common feature of "being sweet" or "being unpleasant" does not seem to cause them to form a perceptual unit. This intuitive conviction is supported by the presence of figure/ground discrimination in olfaction. It is claimed that cases of representing two odours are situations in which one odour is discriminated against the background constituted by another (Gottfried 2010; Young 2016). However, figure/ground discrimination phenomena occur not within one, but between two competing perceptual units.[5] Hence, one cannot simultaneously attentively select two odours "unified" by a common feature, since focusing on one odour causes the second odour to be perceived as an unattended ground. Analogously, tracking one odour to recognise changes in its features leaves the second odour unattended and it is likely that changes in its features will not be registered. This suggests that when two odours are represented, then each one, together with its features, constitutes a separate perceptual unit.

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[5] Some authors claim that the relation between simultaneously experienced odours should not be characterized as a distinction between a figure and a ground because, in contrast to the case of vision, such odours do not stand in appropriate spatial relations (Keller 2016: 72–75). However, this does not change the presented argument, as it requires only that odours compete for attentional resources no matter whether this competition is be characterized as a figure/ground discrimination or not.

2.3 Odours as Primary Subjects

Taking into account the above observations, odours presented in olfactory experiences can be characterised as the subject of features analogously to visually represented objects. However, one may doubt whether odours satisfy conditions for being *primary subjects*. Such a status is controversial, as some authors state that olfaction represents odours as instantiated by the space around us, or by entities that are sources of odours (see Batty 2010c for discussion). This may justify a claim that while odours bind features into perceptual units, they themselves are constituents of units unified by something else.

If an entity is a subject of odours, then it should have the ability to be combined with more than one odour simultaneously and, at least in usual circumstances, unify these odours into a perceptual unit. According to the first idea, such a role can be served by olfactorily represented places. Within the philosophical literature concerning olfaction, there are competing accounts concerning the human olfactory ability to represent space. Minimally, it is claimed that odours are represented as something external to us, which does not necessarily mean that they are represented as having any spatial characteristics (Richardson 2013). According to a different position, all odours are olfactorily represented as located in the same, poorly specified, "somewhere around" region (Batty 2010c). However, some authors believe that human olfaction has a greater developed ability to represent the spatial characteristics of odours. In particular, if we consider not only synchronic, but also diachronic olfactory experiences arising from exploratory behaviours involving bodily movements and odour tracking, then olfactorily experienced odours should be characterised as being spatially extended (O'Callaghan 2016), or as coming from some direction and distance (Aasen 2018).

All the above positions, except the first one, which only characterises odours as external but not spatial, are consistent with the idea that two odours may be represented as simultaneously located at the same place. Depending on a theory, they may be represented as located in the same "somewhere around" region, as encompassing the same extended region of space, or as positioned in the same direction. If such a common place is a subject of odours, then in a typical olfactory experience representing two co-located odours, a single perceptual unit composed of both odours unified by a place is represented.

However, despite the possibility that two odours may be represented as having the same spatial location, I believe that the idea of "odours instantiated by space" is unjustified, because places do not usually unify olfactorily represented odours into perceptual units. As stated earlier, when human olfaction represents two odours simultaneously, then one of them is represented as an olfactory "figure", distinguished from a ground constituted by the second odour (Batty 2010a; Gottfried 2010; Young 2016). Hence, odours are unlikely to be represented as a single perceptual unit, even if they are represented as located at the same place, because in ordinary circumstances, attentive processing of one odour causes the second one to obtain only a rudimentary representation of an olfactory ground. In consequence, the presence of figure/ground discrimination phenomena shows that in typical olfactory experiences, odours are treated as separate, competing units even when having the same localisation.

According to the second option, olfactorily represented odours are not *primary subjects,* because they are properties of odour-sources. For example, in an experience presenting an onion odour it is not only the odour and its features that are presented, but also the item—an onion—which is a source of the considered odour. Analogously, as in

the case of places, if odour-sources were represented as subjects of odours, then they could be represented as simultaneously related to more than one odour, and they should unify these odours into a perceptual unit. However, to present two odours as having the same source simultaneously, human olfaction must be able to identify the source of the first odour with the source of the second, and it is unlikely that human olfaction has such representational ability.

To represent sources, information about them must be inferred from data provided by interactions between olfactory mechanisms and odorants, because in olfactory experiences odour-sources are not presented directly; rather, their presence is inferred from information concerning odours. However, information about sources that can be inferred from detected odours is quite limited (see Keller 2016: 75–77 for a similar observation). First, it is difficult to establish the number of sources (e.g. whether an onion odour emanates from a single onion or from several onions). Second, even if human olfaction is able to represent odours as being spatially extended or positioned in some direction, this information is usually not sufficient to establish the exact location of a source, because the represented location of an odour may be different from the location of a source. For instance, a cigarette odour may be represented as extending over some area, while the source of this odour, a cigarette, occupies a much smaller fragment, or may even be no longer present in the area encompassed by the odour. Some data suggest that people can determine the location of an odour-source by tracking changes of intensity and spatial characteristics of an odour over time (Porter et al. 2007). However, it is unclear whether within a tracking process, two odours can be tracked simultaneously, and whether the locations of these odours can be compared. Further, such extensive tracking does not occur in all olfactory experiences, so in many experiences odours are represented without being attributed to spatially located sources. Third, there is uncertainty about the source's type. For instance, an onion odour may be caused by an onion or by a packet of onion-flavoured crisps. It also unclear whether a source is a whole individual odour or a proper part of it. In consequence, in many typical cases of representing odours, there is not enough data to establish whether two experienced odours have the same source.

The above considerations show that olfaction represents odours as *primary subjects*, in the analogous way that vision represents objects. In the subsequent sections, I judge whether odours are also represented as having the two remaining characteristics of objects.

3 Mereology of Vision and Olfaction

According to the second characteristic of perceptual objecthood, objects are entities with a mereological structure. In the previous section, I expressed an intuition that objects are visually represented as subjects of features. I believe that there is an equally strong intuition that they are also represented as having parts.

Simple visually represented objects may become parts of more complex ones, particularly when they are spatially connected (Palmer and Rock 1994). For example, it is likely that when two squares connected by sides, one red and one green, are represented, then a more complex, rectangular figure composed of these two squares is also represented. Components of this figure have features that are different from the features of the whole: they differ in shape, size, and colour as they are wholly green or

wholly red, which is not the case in the complex figure. Furthermore, simpler objects still maintain their status of two separate objects after being combined into a more complex entity. In the above example we can focus attention on each of the two squares or track changes in their features independently of one another. Generally speaking, there exist complex visually represented objects, whose components are simpler visually represented objects with differing features to the whole they compose.

Relying on the above observations we may state that objects are visually represented as having a mereological structure due to being represented as having fragments that themselves are visually represented as objects. Given this, it can be asked whether odours are also represented as having such fragments, i.e. fragments which themselves are represented as odours. If it is the case, then olfaction too is able to represent odours as mereologically complex entities.

There are reasons to doubt whether human olfaction has such representational abilities (in particular, see Mizrahi 2014). First, it seems that, in contrast to visual experiences, olfactory experiences represent space in a rudimentary fashion and do not allow us to distinguish between various potential spatial parts of an odour. Second, it is claimed that human olfactory perception lacks exploratory behaviours that in the case of vision are associated with part-perception, like changing the viewpoint from which an object is observed in order to recognise its structure. Third, the structure of olfactorily represented odours seems to lack the qualitative borders that allow us to distinguish parts in the case of visually represented objects. Furthermore, it is commonly claimed that olfactory perception is more 'synthetic' than 'analytic' (e.g., Barwich 2014; Wilson and Stevenson 2003), or using different terminology, that odours are mainly processed in a 'configural' and not in an 'elemental' fashion (Barkat et al. 2012; Howard and Gottfried, 2014). This means that the structural complexities of mixtures causing olfactory experiences are not presented by olfaction, as odours are represented as homogenous entities. An example from the psychological literature is the lemon odour, which does not seem to have any internal structure (Lawless 1997: 141–142).

The above arguments may be weakened by noticing the presence of diachronic aspects of olfactory perception. For instance, authors such as Aasen (2018), O'Callaghan (2016), and Roberts (2015) believe that by virtue of olfactory interactions with the environment, such as sniffing (see Young 2017), we experience odours as extended in space and located in a certain direction. In consequence, it may be proposed that in contrary to Mizrahi (2014), human olfaction represents odours as having spatial structure composed of distinct fragments which can be explored over time.

On the other hand, one may be sceptical about the strength of the link between representing spatial characteristics of odours and representing that they have part-structure. First, from the perspective of formal ontology, it is consistent to postulate entities which are spatially extended while not having any proper parts (so-called *extended simples*, see McDaniel 2007). Second, according to psychological models of part perception, not every experienced spatial fragment of an entity is also represented as one of its parts (e.g., Hoffman and Richards 1984; Xu and Singh 2002). To represent spatial parthood, a perceptual system also has to represent some edges or other qualitative discontinuities which give the ability to distinguish a fragment from the rest of an entity. Hence we may not simply infer from the fact that odours are represented as encompassing many locations in various directions, that they are

represented as having spatial part-structure. I do not attempt to resolve the above controversy. Instead, below I argue that many odours are represented as having mereological structure by developing a novel argumentation which does not rely on the assumptions regarding the way that human olfaction represents space.[6]

Despite the significant presence of synthetic/configural aspects of odour perception, it is also widely accepted that olfactory perception has important analytic/elemental aspects (e.g. Coureaud et al. 2014; Howard and Gottfried 2014; Laing and Jinks 2001; Wilson and Sullivan 2011; Witrout et al. 2003; Thomas-Danugin et al., 2014). While complex odours are not usually represented merely as sets of simpler odours, often some simpler odours are still distinguishable within a complex odour. As an illustration, let's consider a complex perfume in which one may distinguish some components, like a cherry note and a woody note. Relying on phenomenal character of olfactory experiences, it seems plausible to accept that such a perfume is not represented simply as a combination of the distinguished components.

Such represented components of complex odours may be plausibly interpreted as their parts, because they satisfy the general characterisation of perceptual parts described earlier. Parts of visually represented objects are those of their fragments that themselves are visually represented as objects by virtue of properties that allow them to be differentiated from other fragments of an object, or from the whole object itself. Analogously, in the olfactory context, parts of olfactorily represented odours are fragments that are themselves olfactorily represented as odours by virtue of properties that allow them to be differentiated from other fragments of an odour, or from the whole complex odour itself.

Olfactory components, like the cherry note of a perfume, are themselves represented as odours. This is because they are experienced as having properties usually associated with odours like intensity, qualitative properties like sourness, and hedonic properties (Castro and Seeley 2014; Laska et al. 1997; Morton, 2000). In addition, the olfactory mechanism categorizes them as instances of odour categories, for example as a flowery or a woody odour (Batty 2014; Wilson and Stevenson 2003).

Such components can also be interpreted as fragments of complex olfactorily represented odours. In the case of visual experiences, fragments of presented objects are spatially smaller than the whole objects. This does not seem to be true about olfactory components of complex odours. However, it can be argued that they are fragments by virtue of being "qualitatively smaller". This is because while all qualitative properties of a component contribute to the overall qualitative character of the complex odour, not all qualitative properties of a complex odour contribute to the qualitative character of a component. For example, if a perfume has a woody note and a cherry note, then these notes contribute to the overall qualitative character of a perfume. However, I believe that the phenomenal character of olfactory experiences suggests that while the considered perfume is partially woody, this woody characteristic does not constitute the qualitative character of the cherry component. In other words, if an odour is represented as having both cherry and woody components, then there is something

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[6] One additional idea, which is worth mentioning but cannot be properly developed within the scope of this paper, is to investigate whether odours are experienced as having temporal proper parts existing at successive moments (for such considerations regarding audition see O'Callaghan 2008; Matthen 2010).

cherry-like within this odour but there is probably nothing wood-like in its cherry component.

Finally, similarly to the case of visual parts, olfactory components are distinguished in virtue of possessing properties that differentiate them from other components, or from the complex odour itself. For instance, our example cherry component can be distinguished within a complex perfume because it is sweeter or less musky than the whole complex odour.

As has already been suggested, olfactory parts are not exactly the same as visual parts. In particular, olfactory parts do not seem to be spatial parts. First, they are not represented as fragments of odours by virtue of being localised within a sub-region of a location in which a whole odour is located. Second, they are not distinguished as a result of perceiving spatial borders separating them from other components of an odour. Third, the mereological structure of odours is not discovered through spatial-exploratory behaviours (like changing the spatial perspective from which an odour is experienced); but new components of an odour may be discovered by focusing attention and also due to learning (Barkat et al. 2012). However, the spatial properties of parts do not seem to be essential for perceptual parthood, but are rather associated with the particular way in which human vision represents space. For instance, philosophers of perception claim that sounds are represented as having temporal, but not spatial parts (O'Callaghan 2008). And in the case of olfaction, despite the lack of spatial characteristics, the components of complex odours display the crucial characteristics of perceptual parts: they themselves are represented as odours, they are represented as fragments of odours, and they are distinguished in virtue of having different properties to other components, or to the whole complex odour itself.

The above considerations show that odours are not only represented as subjects of olfactory features. They can be also represented as having a mereological structure composed of non-spatial, qualitative parts.

4 Persistence through Time and Change

The last characteristic related to perceptual objecthood is the ability to persist through time and change. According to this characteristic, entities represented as objects are represented as diachronically identical despite significant changes concerning their properties, unless those changes break some relations of spatiotemporal or qualitative continuity. The topic of how human vision represents the diachronic identity of objects has been well investigated within cognitive psychology. The main research paradigms are (1) Multiple Object Tracking, in which participants track and re-identify several moving target-objects among distractors (see Pylyshyn 2007), and (2) Object-Specific Preview Benefit, where the task is to recognise whether an object presented later has the same feature as an object presented earlier (see Kahneman et al. 1992). The theoretical assumption behind these paradigms is that factors that make the re-identification of objects harder or that make the time needed to find the common feature of objects longer are likely to break the represented diachronic identity. Measuring rates of errors and reaction times, rather than participants' verbal reports about perceived identities, allows for the investigation of how sameness is established by a low-level, perceptual mechanism without the changes introduced by higher-level beliefs.

These psychological investigations have resulted in a widely held consensus that vision represents objects as being diachronically the same as long as they move in a spatiotemporally continuous fashion and maintain spatial coherence (Scholl 2007). This means that diachronic identity stops being visually represented when objects, inter alia, do not move continuously but "jump" between places, or disappear for a long period of time.[7] Similarly, diachronic identity breaks when objects undergo topological changes like dividing into fragments or having a hole added, as such changes disrupt spatial cohesion (van Marle and Scholl 2003; Zhou et al. 2010). Changes, for example changes in colour or topology-preserving shape changes, are claimed to be contingent for diachronic sameness (Pylyshyn 2007: 37).

The scientific results suggest that the diachronic identity criterion for visually represented objects should be formulated in terms of both some of the object's properties and a relation of spatiotemporal continuity. There are topology-related properties, whose change leads to the object after the change not being represented as the same as the object before the change, but there are also changes in properties that do not break identity. Using classical metaphysical terminology, we can name these properties essential and contingent, respectively. However, sharing essential properties is not sufficient for objects to be diachronically identical, as they also have to stand in a spatiotemporal continuity relation. So we can state that an object x is diachronically identical to an object y if and only if x has the same essential features as y and x is continuous with y.

The significance of continuity relations is what differentiates the diachronic identity conditions of visually represented objects from those of visually represented features. It seems that features can also be visually represented as persisting through certain changes, and the division between essential and contingent properties is also applicable in their case. For instance, colours represented in subsequent moments are not recognised as being the same if they differ in hue. However, a feature is recognised as the same, even if it changes its localisation through time. Further, as demonstrated by the occurrence of perceptual constancies in the case of visual feature perception, features may be represented as being the same, despite some changes concerning their qualitative character (e.g., Almäng 2016, Kraft and Brainard, 1999). For instance, a colour property may be re-identified while being presented in various lighting conditions.

On the other hand, while disturbances of continuity are likely to break the diachronic identity between objects, this is not the case for visually represented features. Let's consider a situation in which one perceives a square object at place P_1 that is then suddenly replaced by a triangular object at place P_2, which in turn is replaced by a square object at place P_3. I believe that there is a strong intuition that the shape of the earliest object will be recognised as the same as the shape of the last object. This is the case despite the lack of temporal continuity, as there is a gap between the presentation of the first and the second square object; a lack of spatial continuity, since objects appear in disjointed places; and a lack of 'qualitative continuity', as the shapes of objects do not change gradually. Therefore, a diachronic identity criterion for visually represented features may be formulated solely in terms of essential features, without reference to continuity relations.

The diachronic identity conditions of olfactorily represented odours seem to be more like those of visually represented features than visually represented objects. Within

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[7] The only exceptions are cases of brief occlusion where the contours of an object are gradually deleted and then gradually reappear. Such deviations from spatiotemporal continuity do not break the sameness of objects (Scholl 2007).

features possessed by the odours represented by human olfaction, we can also draw a distinction between the essential and the contingent. For instance, we can track an odour and recognise it as being the same despite changes in its intensity (see Young 2017; for considerations how actions like sniffing help in obtaining intensity constancy). However, categorisation-features of odours are essential. If, at one time, an odour categorised as coffee is represented, and at a subsequent moment an odour categorised as vanilla is represented, then these odours will not be recognised as diachronically identical. Furthermore, as recently argued by Millar (2017), there is also evidence for the presence of perceptual constancies in case of odour perception. For instance, one can have an olfactory experience of a persisting coffee odour even if, at subsequent moments, there are phenomenal changes caused by variations in the chemical components influencing the olfactory mechanisms (see also Young 2016).

Millar believes that the presence of olfactory perceptual constancies provides an important argument for a thesis that odours are represented as objects because it shows that odours are represented as persisting entities. However, the type of persistence provided by perceptual constancies is common for both objects and features, so arguments referring to constancies are insufficient in showing that odours are represented as persisting in a manner specific for objects. As stated earlier, the crucial role of continuity relations is characteristic in the persistence of objects. Nevertheless, it seems that continuity relations are far less important for formulating a diachronic identity criterion for represented odours than they are for visually represented objects. Similarly, as in case of visually represented features, one can easily imagine a situation of first being presented with a coffee odour, which then suddenly disappears and after an odourless period a coffee odour with the same features is presented again. Similarly as with visually represented features, such a situation is likely to be recognised as two occurrences of the same odour, despite a lack of temporal and qualitative continuity.

The above observations suggest that the diachronic identity perception of odours is determined mainly not by continuity, but by similarity relations, where higher similarity is correlated with a higher number of shared features. In fact, while the number of odours that human olfaction can distinguish is a matter of debate, it is established that there is a correlation between the overlap of compounds in chemical mixtures and likelihood that odours are recognized as being the same (Gerkin and Castro, 2015; Bushdid et al. 2014).[8] It suggests that the identity conditions of olfactorily represented odours are connected with the similarity of their features because similarity in chemical-mixture composition is likely to be correlated with the ability to cause the perception of similar olfactory features. In this case, an odour O_1 is represented as diachronically identical to an odour O_2 if and only if O_1 is represented as sharing a sufficient number of features with O_2, where what is 'sufficient' (and which features are the most important) is a matter of detailed empirical investigation.[9]

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[8] However, it should be noted that it is only a correlation, and there are cases in which dissimilar chemical mixtures are represented as having indistinguishable olfactory qualities (see Weiss et al. 2012).

[9] This approach does not assume that experiencing odours as being the same requires perfect indistinguishability, and so does not entail an implausible conclusion that virtually no objects are experienced as smelling the same way (see Young 2016).

In fact, the difference between the importance of continuity in vision and olfaction is well justified by differences in the properties of entities that cause visual and olfactory experiences. Human vision is suited to tracking solid objects with quite well-defined boundaries that move along continuous trajectories. Conversely, olfaction reacts to chemical mixtures whose boundaries are vague, can easily overlap with other mixtures, and may change their density in rather unpredictable ways due to various environmental factors. In such circumstances, particularly given that olfactory abilities to represent space are less developed than the visual ones, it is more reliable to re-identify odours referring to the similarity of their features than to patterns of continuity relations.

5 Objects and Odours

According to the above investigations, objects are represented by human vision (1) as *primary subjects*, (2) as entities with mereological structure, and (3) as persisting through time not only in virtue of having essential characteristics but also in virtue of standing in continuity relations. Given this, such visually represented objects posses all the characteristics relevant for perceptual objecthood. This issue is less clear in case of olfactorily represented odours. Odours are represented by human olfaction (1) as *primary subjects*, (2) as having non-spatial mereological structure, but (3) are not represented as persisting through time in virtue of standing in continuity relations. To sum up, while olfactorily represented odours are subjects of properties and are mereologically complex entities, they persist in a way that is more characteristic of features than of objects.

Given the above results it is not surprising that there is ongoing controversy about interpreting odours represented as objects or as features. They posses some, but not all the characteristics that are crucial for perceptual objecthood. In consequence, one may propose that because odours are not represented as paradigmatic objects, but are also not represented as paradigmatic features, they are represented as members of a *sui-generis* ontological category. In this sense, human vision and human olfaction are dis-unified as they represent entities as having different ontological characteristics. However, this disunity is not complete. In particular, both vision and olfaction represent entities that allow for forming perceptual units by being *primary subjects*. It is worth noting that these common ontological characteristics are represented despite the fact that only vision has the extensive ability to represent space.

Compliance with Ethical Standards   I comply with the Ethical Standards of "Philosophia".

Conflict of Interest   The author declares that he has no conflict of interest.

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