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# Ontology of Olfactory Entities

Analytic papers concerning the content of olfactory experiences commonly start with a statement that olfaction has gained significantly less philosophical attention than vision. While it is certainly true, in the last years philosophers formulated a significant number of alternative accounts of olfactory content. These positions 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 present the environment as being in a certain way. Second, olfactory experiences present odours, like coffee odour or vanilla odour (Batty 2010b; Cavendon-Taylor 2014). Despite these two common assumptions, authors disagree how to properly characterize olfactory content. For example, it is claimed that olfaction presents odours instantiated by surrounding space (Batty 2010d), or instantiated by entities that are sources of odours (Mizrahi 2014), for instance an onion odour instantiated by an onion. On the other hand, it is postulated that odours are presented 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 seem to be an ontological controversy between two views: one according to which odours presented by olfaction should be characterized as features and second in which they are interpreted as objects.

The above 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, competitive notions of what does it mean to be an object or a feature. In this paper, I aim to systematically address the "feature or object" status of odours presented by human olfaction by starting from considerations regarding the visual content. We have got a

strong intuition that vision presents objects, like red square, which possess properties, like redness and squareness. What is more, a great deal of our intuitions regarding what does it mean to be an object or a feature is grounded in a way in which entities are visually presented. Because of that objects and features presented by vision may be considered as paradigmatic examples of perceptually presented objects and features. Starting from this point one may analyze what characteristics differentiate objects and features presented by vision. On this basis it may be then investigated whether the entities presented by olfaction possess characteristics that justify including them in the same ontological category as visually presented objects or features. This procedure also allows to reveal that olfactorily presented odours are *sui generis* entities that do significantly differ in their characteristics from visually presented ones.

Such investigations constitute a first step in establishing whether different human modalities are ontologically unified by organizing the environment according to the same categories. For example, it may be the case that all of them present entities which, in virtue of sharing ontological characteristics, should be named 'objects'. On the other hand, it is possible that human perceptual modalities are disunified as they present entities possessing significantly different characteristics.

The paper starts by explicating the notion of "perceptually presented entities" and specifying the type of perceptual experiences I am interested in (section 1). Later (section 2), I present three major types of ontological characteristics that will be used in investigating the ontology of entities presented by vision and olfaction. Subsequently, by using the distinguished types of characteristics, I compare visually and olfactorily presented objects by (I) investigating whether these entities are subjects or properties (section 3), (II) analyzing their mereological structure (section 4), and (III) formulating their identity conditions (section 5). Relying on the obtained results (section 6), I argue that olfactorily presented odours

constitute a *sui generi* ontological category different from the categories of visually presented object and features. However, odours and visually presented objects share important characteristics: they are both *primary subjects* having *unitary synchronic individuator*.

## 1. Entities and Experiences

Before starting to analyze the ontological characteristics of olfactorily and visually presented entities, it is important to clarify two methodological points. First, what are the entities I want to analyze. Second, which perceptual experiences are relevant for my investigations.

In case of the first question, perceptually presented entities should be distinguished from the entities that causally influence the perceptual system (see Young 2016 for a similar distinction). When I have got a typical olfactory experience, it may be presented to me that there is a vanilla odour in the surrounding. It probably happens because there is a complex chemical mixture that influences olfactory receptors. One can also experience and olfactory hallucination when she is presented with a vanilla odour without corresponding chemical mixture (see Mole 2010). In these examples the vanilla odour is a presented entity, while the chemical mixture is the causally influencing entity. What is the most important in the following investigations, is that these entities may have different characteristics. For instance, the chemical mixture has a complex mereological structure as being composed of various molecules but presented vanilla odour is rather uniform.

In this paper, I am interested in ontological characteristics of perceptually presented entities and not external entities that causally influence perceptual mechanism. In other words, I investigate what is the proper ontological description of the environment as it is presented through senses. Because of that I understand representational content in a rather narrow way

as composed of that what is perceptually presented. This category contains entities (1) such that the phenomenal character of perceptual experiences alone provides a justification for a belief that they are present in the environment and (2) such that perceptual experiences dispose us to actions as if these entities were present (which may happen without relying on phenomenology like in cases of blind-sight). Using our vanilla odour example, the phenomenal character of experience justifies a belief that there is a vanilla odour in the surrounding and this experience dispose us to actions consisting, *inter alia*, in searching for a place with higher or lower odour intensity. On the other hand, such experience does not justify, at least without some additional knowledge, a belief that there is a mixture composed of many different chemical molecules.

The second methodological question concerns the perceptual experiences whose content I plan to investigate. The olfactory and visual experiences may be understand in two broad ways as (1) multimodal perceptual experiences or as (2) experiences combined with amodal beliefs only partially formed on the basis of perceptual experiences. For example, if I see a milk bottle, grab it and sniff to check if milk is not spoiled, I have got a multimodal experience having visual, tactile, and olfactory aspects. When I feel smoke I can form a belief, relying on a perceptual experience together with some additional knowledge, that my neighbour is making a barbecue; this would be an unimodal experience associated with a belief only partially formed on the basis of perceptual experiences.

In this paper I do not consider content of such broad experiences. The following investigations are restricted to unimodal olfactory and visual experiences with intuitive examples like “feeling a vanilla odour which is sweet and very intense” or “seeing a red square in the centre of visual field”. In case of visual perception, I concern relatively low-level features, like colours and shapes, as there is no agreement within the philosophy of perception whether human vision presents kinds or causal relations (e.g., Bayne 2009).

## 2. Ontological Characteristics

Authors working in the field of analytic metaphysics distinguish various ontological categories of entities, like objects, properties (interested as universals or tropes), kinds, events, processes, and relations to name the most common ones. A criterion for enlisting an entity as an element of one of the ontological categories if whether this entity satisfy characteristics that are possessed by each member of this category. Within ontological discussions three types of such characteristics seems to be the most relevant.

*(1) Relations to other entities*

Entities belonging to different ontological categories have different abilities for standing in relations to other entities. Probably the best known philosophical distinction of this kind is that between subjects and properties. It is often claimed that there is an asymmetry of instantiation between the entities characterized as subjects and entities characterized as properties: subjects instantiate properties but not *vice versa* (...). Using the classical example it seems that Socrates is a subject instantiating a property of "being wise" but "being wise" does not instantiate Socrates. As will be shown later, this distinction will be of high relevance in discussion regarding olfactorily presented entities.

*(2) Internal structure*

Another type of characteristics that may differentiate entities from different categories concern their structure. Such characteristics may describe mereological structure where the fundamental distinction divides atomic entities (i.e. which do not have any parts) from complex one, or topological structure which may differentiate between entities that may exist while being spatially dispersed and those which has to be topologically connected (...). Another important distinction concerning internal structure is that between entities that are

composed of temporal parts existing at different moments and those which lack such parts; in ontological investigations it is often used to discern between processes and objects (...).

*(3) Identity conditions*

The third type of characteristics describe identity conditions both in their synchronic and diachronic aspect. The synchronic identity conditions determine what is necessary and sufficient for and entity $x$ existing at $t_1$ and entity $y$ also existing at $t_1$ to be identical. Analogously, diachronic identity conditions characterize such rules for objects existing at different moments. An important contemporary example of using identity conditions to differentiate between ontological categories comes from debates about universal or particular status of properties: strict similarity is sufficient for synchronic identity of universals but is not sufficient in case of tropes (i.e. particular properties, (...)).

In the subsequent sections, I show that by using the above three types of characteristics visually presented objects and visually presented features should be interpreted as belonging to different ontological categories. Relying on this result I concern whether olfactorily presented odours belong to the same category as visually presented objects or as visually presented features.

In the further examples a red square will serve as a paradigmatic object presented by vision, while a shade of red and squareness will be treated as paradigmatic visually presented features. I do not assume that vision presents only objects and features (and not, for instance, events). In addition, I accept that there may be visually presented entities that are commonly named ‘objects’ but in fact differ in ontological characteristics from paradigmatic objects like red squares so strongly that they should be interpreted as members of a different category.

## 3. Relations to Other Entities: Subjects and Properties in Vision and Olfaction

There is a strong intuition that a subject/property distinction differentiates between visually presented objects and visually presented features. It is a red square that posses a shade of red and squareness and not the other way round. However, it is less obvious what is the source of this intuitive asymmetry. For instance, it is not an asymmetry of existential dependence: features presented by vision are always instantiated by something (object, or sometimes a place (...)), but also objects are not visually presented as featureless. In addition, it is not an asymmetry of uniqueness: a feature may be visually presented as instantiated by many objects, for example we may perceive several objects of the same shade of red, but also a single object is usually presented as having many features.

I propose that the intuitive subject/property asymmetry in vision should be explicated by referring to the unificatory role of visually presented objects. It is widely accepted that human vision is able to resolved the so-called Many Properties Problem, i.e. it can distinguish between situations of perceiving different arrangements of the same elements (...). 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 presented elements are the same: two objects, redness, greenenness, triangularity, and squareness, but they are combined differently. Because of that many authors postulate that visual content cannot be characterize as a list of element, as in both of the above situations such a list would be the same. On the contrary, content should be described in terms of objects connected with features by an instantiation-like relation (...).

While the Many Properties Problem is solved by combining objects with features, these two types of elements do not play the same role. In particular, there is an asymmetry of unification: a single objects unifies many features into a perceptual unit, but a single feature does not unifies many objects into such unit. If redness and squareness are combined with the same object, then a red square is presented. It is a perceptual unit which is crucial for

perceptual organization of visual scene and on which further visual processes operates. For instance, a red square: (1) can be attentively selected (...), (2) can be tracked through movement (...), (3) is perceived as a figure differentiated against background (...), and (4) may be combined with other units and become a part of a larger whole (...).

However, a feature does not usually create a perceptual unit from several objects. For example, if there is a red square presented on the left side of the visual field and a green square on the right side, these two figures do not compose a single perpetual unit despite being both combined with squareness. It is difficult to simultaneously focus attention on both of them and they seem to be two separate figures rather than a single whole composed of two parts (...). What is more, one of these figures may become a part of a larger whole without changing the status of the other figure (...). For example, a red square by spatially connecting it to a larger object *O* will be perceived as a part of this larger object, but the green square will still be perceived as separate from *O*. In addition, it is much more difficult to track and re-identify several objects having the same features than to track and register changes in several features of a single figure (...).

Because of the above difference, the intuitive subject/property asymmetry between visually presented objects and visually presented features is grounded in the unificatory role of objects in creating perceptual units. However, this postulate needs a further specification. First, it seems that visually presented features can also play an 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 as several nearby objects may be perceived as a single perceptual group if they share features like 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 (...).

Nevertheless, these observations do not undermine the special unificatory role of objects presented by vision. First, while some features may unify other features into some type of perceptual units they themselves, in order to solve the Many Properties Problem, has to be unified into a perceptual units by objects. It is not the case with objects that unify features without a need to be themselves unified into another perceptual unit. Similarly in the case of the second point, while a feature like colour may unify objects into a perceptual group, such grouping process operates on already 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 visually presented subjects. It is possible that there are also other entities, for instance places, with the characteristic of subjects.

We may express the crucial difference by stating that presented 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 characterized, when they constitute a perceptual unit together with objects, as *properties* of objects and, due to their limited unificatory abilities, as at most *secondary subjects*.

The above considerations show that visually presented objects have different ontological characteristics, concerning relations to other entities, than visually presented features. Now, we can ask whether odours presented by olfaction are, like visually presented objects, the *primary subjects*.

The first question that should be asked is whether olfaction, like vision, is able to solve the Many Properties Problem. Indeed, some authors claim that human olfaction has no ability to solve it, mainly due to rudimentary spatial aspect of olfactory experiences. Probably the

best-known argument against the ability for olfactory solution to the Many Properties Problem is the air fresher example provided by Clare Batty (...). Let's imagine that one tries to cover a cigarette odour with an air freshener odour and as a result is presented with two odours. In case of vision, I can perceive two objects in many ways, for example the first object on the left of the second one the right, or *vice versa*, or one partially overlapping another. However, there seem to be no such variation in olfactory experiences; when we perceive cigarette and air fresher odours we do not discern between a situation in which a cigarettes odour is on the right or on the left from an air fresher odour.

While the above description may be accurate, it focuses too strongly on the contingent way in which the Many Properties Problem is solved in vision. The core ability for solving the Many Properties problems lays in discriminating  situation in which different arrangements of the same elements are present. Vision due to its rich abilities for spatial discrimination may discern between cases where the same objects are differently positioned and it may be the case that olfaction, due to its limitations in presenting space, cannot make analogous discriminations in case of odours. However, from this it does not follow that there are no other cases of the Many Properties Problem in which olfaction can succeed (...).

For instance, olfaction does not only present odours but also their various features like higher or lower intensities, hedonic properties, trigeminal properties such as irritating or cooling (...). Let's consider a rather unfortunate case in which one is presented with high-intensity cigarette odour and low-intensity onion odour both quite irritating. It is plausible that this situation can be olfactorily distinguished from another one in which the same elements are presented but intensities are reversed: low-intensity cigarette odour and high-intensity onion odour both quite irritating. If such situations can be olfactorily distinguished then, as in standard descriptions of the Many Properties Problem, the olfactory content cannot be describes as a list of elements: cigarette odour, onion odour, low-intensity, high-intensity, and

irritating, as such list is the same in both situation. The content should be rather described in terms of odours-intensities-trigeminal features combinations. The intensity-features seems to be particularly well suited for constructing olfactory examples of the Many Properties Problem. It is so because there exist cases of ansomia where people are able to merely perceive intensities of odours without being presented with their qualitative character (...). It suggests that intensity-features and qualitative-features of odours are represented separately and the task of the perceptual system is to unify them within a more complex representation.

What is more, the above example of solving the Many Properties Problem in olfaction reveals an analogous asymmetry of unification between odours and other elements of olfactory content. A combination of an odour with other properties 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 other to cigarette odour with its features. However, the reverse does not hold: from the fact that both onion and cigarette odours are irritating it does not follow that there is a single perceptual unit formed by this two odours and unified by trigeminal property. Analogously for other olfactory properties, two presented odours having a common features of “being sweet” or “being unpleasant” do not seem to form a single perceptual unit.

Apart from the introspective plausibleness, the above conviction is also supported by the presence of figure/ground discrimination in olfaction. It is often claimed that situation of being presented with two odours are situations in which one odour in discriminated on the background constituted by another odour (...). However, figure/ground discrimination phenomena occure not within one, but between two competing perceptual units. It suggests that when two odours are presented, then each of them, together with its features, constitute a separate perceptual units.

Relying on the above observations, odours can be characterized as subject of olfactorily presented features analogously as visually presented objects are subjects of visually presented features. However, one may doubt whether odours satisfy conditions for being *primary subjects*. Such status of odours may be more controversial as there are positions according to which olfaction presents odours as instantiated by space around us or by entities that are sources of odours (...). According to these propositions while odours bind features into perceptual units they themselves are constituents of units unified by something else.

I believe that this propositions are unjustified mainly because space around us does not unify olfactorily presented entities and odours-sources are not presented in unimodal olfactory experiences. As was already stated, human olfaction has limited abilities to make spatial discriminations. Olfactory experiences dispose us to actions, like sniffing to feel an odour more strongly or waving our hands in front of face to reduce an unpleasant odour, which suggest that odours are presented us having a spatial characteristic of being around us (...). However, unlike in case of visual objects, odours are not presented as having unique spatial localization or spatial boundaries. Because of that odours presented simultaneously seems to have the same spatial characteristics and in fact according to positions where odours are characterized as instantiated by place, they are assumed to be instantiated by a single place "somewhere around" (...). However, if such place is interpreted as subject of odours, then it follows that in every olfactory experience we have got a single perceptual unit composed of all olfactorily presented elements unified by a single place. It is implausible as such unit will have mutually exclusive characterising as being, for instance, both highly and lowly-intense, both pleasant or unpleasant, or both of cigarette odour and air fresher odour. What is more, according to such proposal both presented odours would constitute a single perceptual unit unified by a single place-subject (...). This result is inconsistent with the presence of

figure/ground discrimination phenomena in olfaction suggesting the odours are treated as separate perceptual units.

Accoring to the second idea, the olfactory *primary subjects* are not odours but their sources. There is no consensus whether olfaction presents sources and philosophers have offered several arguments that unimodal olfactory experiences do not present odours' sources. Most notably, it is commonly the case that odour is present long after its source is gone. Because perceptual content is commonly understood as determining accuracy conditions of experiences (...), a perceptual experience presenting a source of an odour would be inaccurate if the source is no longer present. However, it is implausible to interpret such cases as some sort of olfactory illusions. As an illustration, let's imagine a World War I soldier who starts to feel a chlorine odour and so retreats. While the source of the gas, a gas shell, no longer exists, his olfactory system properly fulfils its representational function as it recognizes an odour and disposes a soldier to an evolutionary beneficial action.

I believe that even if arguments such as the one above are unsuccessful, and olfaction indeed presents the odours' sources, there is still no need to interpret them as subjects of odours. If odours' sources are subjects they should be able to unify two or more odours into a perceptual unit. In this case, two following olfactory experiences should be possible: (1) odour A having a source X and odour B having a source Y and (A) odour A and odour B both having the same source X. In the second case two odours should be unified into a perceptual unit. However, it unlikely that human olfaction alone, without information from other senses, can distinguish whether two presented odours have the same or different sources; especially given its lack of abilities to make spatial discriminations. What is more, as it was already noticed, it is implausible that two simultaneously presented odours can form a single perceptual unit as such cases has a form of one odour being discriminated on a background of the second one.

The above considerations show that olfatorily presented odours are *primary subjects* just us objects presented by vision. This support a thesis that odours should be interpreted as belonging to the same category as visually presented objects and not as visually presented features. In the next sections, I judge whether this verdict is also supported by considerations regarding internal structure and identity conditions of odours.

## 4. Internal Structure: Mereology of Vision and Olfaction

In the previous section, I have expressed an intuition that visually presented objects seem to be subjects of features presented by vision. The second, equally strong intuition is that visually presented objects not only possess features but also have parts.

First, even within the simplest visually presented objects, like a red square, one can distinguish components that have different properties than the whole object. For instance, a red square is composed of four edges and the interior between them. While each of the edges has a property determining its size, it is a different size than that of the whole square. It seems that when human vision resolves the Many Properties problem by forming perceptual units unified by objects, these units have a rudimentary mereological structure.

Second, simpler objects may become parts of a more complex one, in particular, when they are spatially connected (...). For example, it is likely that while being visually presented by two squares, one red and one green, which are connected by sides, then we are also presented with a more complex, rectangular figure composed of these two squares. Again, components of that figure has different properties than the whole: they are of different shape, different size, and different colours as they are wholly green or wholly red which is not the

case about the complex figure. What is more, 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 of each of the two squares or track changes in their features independently from one another. The human vision not only has binding mechanism responsible for solving the visual Many Properties Problem, but also further processes of perceptual organization that combine simpler objects into more complex ones (...).

Relying on the above observations we may ask whether the visually presented features also have parts in a way analogous to that in which parts are possessed by objects presented by vision. Namely, we may ask (1) whether even simplest visually presented features have parts with different properties than the whole feature and (2) if visually presented features cam be combined into more complex features while maintaining their status of being two different entities with properties distinct from those of a whole they compose.

If we choose a shade of red as an example of a visually presented feature, then it seems that neither (1) nor (2) are satisfied. Within a shade of red we are unable to distinguish components that have different properties, like hue, brightness, or saturation, than the considered colour. What is more, there is no visual process which combines two colours into another, more complex colour in which the initial, simpler colours can still be distinguished as separate elements maintaining their features from before the combining. For example, combining a shade of red with a shade of yellow will produce a shade of orange which has properties that makes it similar both to redness and yellowness, but these colours are not perceived as two separate parts of orange.

On the other hand, the verdict will be probably different if one takes a squareness as an example of a visually presented features. The feature of squareness seems to be composed of several other features, for instance describing orientation of edges or angle at which edges meet. One of these orientation-features may be “verticality” or “horizontality” but the

squarness itself is not horizontal of vertical in a way in which shade of red is dark or bright. In addition, shape-features may be visually combined into more complex shapes while still maintaining their status of separate entities. For instance, by combining squarness with triangulrity a house-like shape can be obtained. In such a shape its square-component and triangular-component can still be easily distinguish and still have different features than the house-like whole (like “having four edges” and “having three edges” in contrast to “having six edges” possessed by the whole shape).

Because of that the category of visually presented features is not uniform in respect of internal structure. There are features that, similarly like visually presented objects, have parts and can be combined into whole while remaining its status of separate entities. However, there are also features that lack parts and cannot be combined into part-having wholes. Relying on these observations we may ask whether odours are merologically more like objects or features presented by vision.

It is commonly claimed that olfactory perception is more ‘synthetic’ rather than ‘analytic’ (...). What it means is that olfactory experiences do not reflect the complexity of chemical mixtures influencing the olfactory receptors but present homogenous odours. An example from psychological literature is the lemon odour which does not seem to have any internal structure. However, there are also odours, like the one arising from being presented with pyridine and lavender mixture (...), which seem to be composed of two elements with different properties (e.g., one component may be more sweet or pleasant than the whole). Because of that one may suppose that odours are mereologically more like visually presented features than visually presented objects. In respect of their internal structure the category of odours in not uniform as we are presented both with partless odours and with odours that seem to have a part-whole structure. We may also suppose that some combinations of odours result in presenting a new uniform odour (like in case of visual mixture of yellow and red) and

other combinations result in being presented with complex odour having the initial odours as parts (analogously to combining squareness and triangularity into a house-like shape).

However, the mereology of odours has some peculiar features which may suggest that the their internal structure is significantly different both from the structures of objects and features presented by vision. The empirical investigations show that while people are able to perceive some odours as having components with features different than a whole odour, this s ability is limited in number of such odour-parts that can be distinguished (...). For instance (...), when a complex odour composed of eight simpler ones (like strawberry, lavender, honey etc.) is presented, 90% of participants are able to distinguish no more than four components. These components have different features than the whole complex odour in an analogues way in which red and green squares has different features than a rectangle they compose. For instance, a red square is wholly red what is not true about rectangle. Similarity, a honey component of a complex odour is wholly honey-like what is not true about the complex odour. What is particularly interesting, is that such odour-parts do not seem to exhaust the qualitative character of the complex odour. Referring to our previous example, the phenomenal character of an eight-component odour seems to be something more than the combination of its three or four components a person is able to distinguish. This has an important consequences for the olfactory mereology.

Classical mereological conceptions characterize parthood-relation as reflexive, antisymmetric, and transitive. What is more, they accept two intuitive rules knows as *weak supplementation principle* and *strong supplementation principle* (...). In intuitive terms, *weak supplementation principle* states than an entity cannot have only one proper part, i.e. a part that is not identical with the whole object[1]. According to *strong supplementation principle*, if

[1] More precisely: if *x* is a proper part of *y*, then there is *z* such that *z* is a part of *y* and *z* does not have any common part with *x*.

an entity *x* is not a part of entity *y*, then *y* has not exactly the same parts *x*[2]. These supplementation principles seems to be satisfied by visually presented objects and those visually presented features that can be plausibly described as having parts. In fact, it feels even senseless to speak about figures presented by vision that have only one proper part, like a red square whose only proper part would be its bottom edge, or complex features like house-like shape whose only part would be triangularity. Similarly, if one visually presented object or shape-feature is not a part of another object or feature, then the part-structure of these objects or features has to be distinct. For instance, it seems impossible to be visually presented with a spatially separated red square and a green square having exactly the same edges.

On the other hand, it is likely that mereology of odours is non-classical as it does not satisfy any of the supplementation principles. It is possible to be presented with an odour in which we can distinguish only one component (...). It falsifies *weak supplementation principle* as such component is a proper part of odour without presence of any other proper parts. What is more, because distinguished components do not exhaust the qualitative character of an odour, it seem possible that there exist two odours, neither of which is a part of another, having exactly the same parts. This possibility is inconsistent with the *strong supplementation principle*.

The above observation suggest that internal structure of odours presented by human olfaction is significantly different from that of visually presented objects and features. While objects and features presented by vision differ in their mereological characteristics, for example there are partless features but not partless objects, entities belonging to these categories satisfy the basic principles of classical mereology. It is not the case with odours whose mereology is not a classical one as it does not satisfy the supplementation principles.

[2] More precisely: if *y* is not a part of *x*, then there is *z* such that *z* is a part of *y* and *z* does not have any common part with *x*.

## 5. Identity Conditions: Essential Properties and Continuity

The investigations concerning the identity conditions have two aspects. First, is the question of the synchronic identity condition which is answered by providing an identity criterion for entities that exist at the same moment. Second, is the question of the diachronic identity conditions which, by analogy, can be answered by specifying an identity criterion for entities existing at different moments. Below, I start from discussing synchronic, and then diachronic identity conditions for visually presented objects and features as well as for olfactrily presented odours.

### *5.1 Synchronic identity*

Human vision is able to present several objects sharing their features. For instance, one may simultaneously perceive two red squares of the same size. Because of that synchronic identity criterion for visually presented objects cannot be formulated in terms of such features as having the same colour, size, shape etc. is not sufficient for the identity. However, it seems that to be simultaneously presented with two red squares these figures cannot have exactly the same localization as a presentation of such perfect overlap would be not visually different from a presentation of a single square.

Nevertheless, some authors doubt whether we cannot be visually presented with two objects located at the same place. The provided examples include semi-transparent, overlapping gabor-patches (...), colourful mists that mix with each other (...), or moving objects whose trajectories intersect and for the moment are at exactly the same place (like in well-known ambiguous streaming/bouncing stimuli, ...). On the other hand, there are reasons

to believe that such examples do not constitute genuine examples of being presented with two objects at exactly same location (...), as they may be described in terms of objects whose locations partially overlap or which are positioned in the same direction but at different distance from the observer.

However, if there indeed are cases in which one can be visually presented with two objects at the same place, then a different characterization of objects' synchronic identity conditions has to be adopted. In this case it is possible to be visually presented with two objects sharing both features describing location and those describing usual visual qualities like colour or shape. Because of that, in order to properly formulate synchronic identity criterion for visually presented objects, one has to postulate, as in philosophical theories of "thisness", special identifying properties which only function is to individuate objects (...). According to such view, vision does not present objects as having locations, colour, shapes, etc., but also as having a property similar to "being the object A" or "being the object B" (numerically different from A). In fact, some psychological theories postulate mechanisms, like visual indices or object-files (...), whose function is to individuate object without representing their qualitative features.

I do not attempt to resolve the above controversy. What is more important in the context of this paper, is that both above positions share an important property. According to the first position, having the same location is the necessary and sufficient identity condition for the objects presented by vision. The proponents of the second position believe that sharing location is not sufficient for identity, but visually presented object are identical if and only if they have the same identifying property.

Because of that we may state that according to both of the above theories visually presented objects are synchronically individuated by a *unitary individuator*. It is so because there is a single property whose sameness constitutes the synchronic identity criterion. I

believe that no property have such distinguished individuatory role in case of visually presented features.

A visually presented feature like a shade of red has properties describing its hue, brightness, and saturation. Sharing some of these features is not enough for visually presented properties to be identical, as some of them may be shared by different shades of red or even by shade of red and a shade of green with the same brightness. However, sharing all of these properties seem to constitute a necessary and sufficient condition for synchronic identity. If we are comparing a colour-feature F and a colour-feature G, then F and G would be in fact the same feature if hue, lightness, and saturation of F are the same as hue, lightness, and saturation of G. The same is true about shape-features like squareness. Sharing a single property characterizing shapes, like those describing number of edges or connections between them, does not guarantee that one shape is the same as another, but sharing all those features seems to entail the synchronic identity.

In addition, having the same localization is not sufficient for the synchronic identity of visually presented features as one can be presented with two features at the same place, for example a colour and a texture. Minimally, to formulate a proper synchronic identity criterion two properties has to be taken into account: localization and a property specifying the feature-type. For instance, vision does not present two colour-type features, like a shade of green and a shade of red, at exactly the same place.

It seems that there are two approaches to characterizing synchronic identity conditions for visually presented features. First relies on the identity of all qualitative properties and second is based on the identity of location and a property describing the feature-type. However, none of these approaches characterize visually presented features as having *unitary individuator* as there is no single property whose solely constitutes the synchronic identity criterion of features.

Below, I argue that synchronic identity conditions of odours presented by human olfaction has the same general characteristic as synchronic identity conditions of visually presented object, i.e. also odours have *unitary individuator*.

Psychologists often claim that olfaction is able to recognize common patterns in highly variable chemical stimuli and recognize them as exemplars of one of the previously learned categories (...). This categorization process is what allows us to recognize that we are presented with a coffee odour as well as with a distinct vanilla odour, and not to merge them into a single entity. Similarly, olfactory categorization makes it possible to be presented with coffee odour even in situations which does not involve the exactly same chemical mixture in the environment.

In the previous sections, I pointed out that olfaction presents different types of properties, like intensity-properties, trigeminal-properties, hedonic-properties, or qualitative properties of odours like sweetness. The categorization-properties such as "being coffee odour" or "being vanilla odour" constitute another type of olfactorily presented properties which is of special relevance in the context of synchronic individuation. It seems that one can be presented with two odours sharing various properties like being sweet or equally pleasant. On the other hand, we are never presented with more than one odour sharing a categorization-property. There are no olfactory experience in which one simultaneously experiences two or more coffee odours differing only in, for instance, their intensity. This intuition is confirmed by the fact being simultaneously presented with two odours has a form of distinguishing one odour on the background of another one (...). It would be difficult to make a figure/ground discrimination in case of odours sharing categorization-property, as it involves, for instance, distinguishing coffee odour on the background of coffee odour.

Because of that the categorization-properties in olfaction are analogous to location-properties or identifying-properties in theories of synchronic identity of visually presented

objects. Categorization-properties of odours are *unitary individuators* as odour $O_1$ and odour $O_2$ are synchronically identical if and only if the categorization-property of $O_1$ is the same as the categorization property of $O_2$.

The lack of developed spatial aspect of human olfaction, which plays an important role in visual individuation, together with well developed mechanisms of olfactory categorization, led some authors to believe that the human olfaction achieves "categorization without individuation" (...). However, it seems that the more appropriate description is that olfaction "individuates by categorization". Odours are synchronically individuated in the same general way as visually presented objects in virtue of an *unitary individuator*, but while in olfaction the categorization-properties serve as an individuators, this role is played by location-properties or identifying-properties in vision.

*5.2 Diachronic identity*

The topic of how human vision presents diachronic identity between objects is well investigated within the cognitive psychology. The main research paradigms are (1) Multiple Object Tracking in which participants track and re-identify several moving target-objects among distractors (...) and (2) Object-Specific Preview Benefit where the task is to recognize whether one of the objects presented later has the same feature as an object presented earlier (...). The theoretical assumption behind these paradigms is that factors which makes re-identification of objects harder or makes a time needed for finding the common feature of objects longer are likely to break the presented diachronic identity. Measuring rates of errors and reaction times, rather than participants verbal reports about perceived identities, allow to investigate how sameness is established by low-level, perceptual mechanism without the changes introduced by higher-level reasonings and beliefs.

The psychological investigations resulted in widely held consensus that vision presents objects as being diachronically the same as long as they move in spatiotemporally continuous fashion and maintain spatial coherence (...). It means that diachronic identity stops to be visually presented when objects, *inter alia*, do not move continuously but "jump" between places or disappear for a longer period of time[3]. Similarly, diachronic identity breaks when objects undergo topological changes like dividing into fragments or even if a hole is added to an object as such changes disrupts the spatial cohesion (...). Changes of other features, like colour or topology-preserving shape changes are claimed to preserve the diachronic sameness (...).

The scientific results suggest that diachronic identity criterion for visually presented objects should be formulated both in terms of some of the objects properties and a relation of spatiotemporal continuity. There are properties, mainly topology-related, whose change causes that object after the change is not recognized as the same as the object before the change, but there are also changes of properties which do not break identity. Using the classical metaphysical terminology, we can name them essential and contingent properties, 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. Because of that we may state that an object *x* is diachronically identical to the object *y* if and only if *x* has the same essential properties as *y* and *x* is continuous with *y*.

The division between essential and contingent properties seems to be also applicable to visually presented features. For instance, colours presented in subsequent moments are not recognized as being the same if they differ in hue. However, a feature is recognized as the same even if it changes its localization through time. What differentiates visually presented

[3] The only exception are cases of brief occlusion where contours of an object are gradually deleted and then gradually reappear. Such deviations from spatiotemporal continuity does not break the sameness of objects (...).

objects and visually presented features in regard of diachronic identity is the role of continuity relations.

The disturbances of continuity are likely to break the diachronic identity between objects but it is not the case for visually presented features. Let's consider a situation in which we are presented with a square object at place $P_1$ which then is suddenly replaced by a triangular object at place $P_2$, and next is again replaced by a square object at place $P_3$. I believe that there is a strong intuition that the shape of the earliest object would be recognized as the same as the shape of the last object. It is so despite the lack temporal continuity as there is a gap between a presentations of the first and the second square object, lack of spatial continuity as objects appear in disjoint places, and lack of 'qualitative continuity' as shapes of objects do not change gradually. Because of that diachronic identity criterion for visually presented features may be formulated solely in terms of essential features, without a reference to continuity relations.

While synchronic identity conditions of odours are similar to those of visually presented objects, the situation seems to be different in case of diachronic identity conditions. Within properties possessed by odours presented by human olfaction we can draw a distinction between essential and contingent ones. For instance, we can track an odour and recognize it as being the same despite changes in its intensity. However, categorization-properties of odours are essential. If at one time we are presented with an odour categorized as coffee odour and at subsequent moment with odour categorized as vanilla odour, then these odours will not be recognized as diachronically identical.

The presence of the essential/contingent properties distinction is a common characteristic of odours and visually presented objects and features. Nevertheless, it seems that the continuity relations are far less important for formulating diachronic identity criterion for odours than it is the case when objects presented by vision are concerned. Similarity as in

case of visually presented features one can easily imagine a situation of first being presented with an coffee odour which then suddenly disappears and after an odourless period of time again a coffee odour is presented. As in the case of visually presented features, such situation is likely to be recognized as two presentations of the same odour despite lack temporal and qualitative continuity.

In fact, the difference between the importance of continuity in vision and olfaction is well justified by difference in the properties of entities that cause visual and olfactory experiences. The human vision is suited for tracking solid objects with quite well-defined boundaries which move along continuous trajectories. On the other hand, olfaction reacts to chemical combinations which boundaries are vague, can easily mix with other combinations, and may change their condensation in rather unpredictable way due to various environmental factors. In such circumstances, in particular given the very limited abilities of human olfaction to represent space, it is more reliable to re-identify odours relying on their qualities than on continuity relations to odours perceived earlier.

## 6. Objects, features, and odours

The above investigations clearly show that visually presented objects and visually presented features differ significantly in their ontological characteristics and can be plausibly treated as belonging to different categories of entities. Objects presented by human vision (1) are *primary subjects*, (2) have parts and may be become parts of more complex objects, (3) have *unitary synchronic individuators*, and (4) not only essential properties but also continuity relations are crucial for their diachronic identity. On the other hand, visually presented features (1) are at most *secondary subjects*, (2) there exist partless features, (3) they are synchronically individuated by combinations of properties, and (4) diachronic identity

condition of features can be formulated solely in terms of essential properties without invoking the notion of continuity.

It is also not difficult to notice that olfactorily presented odours cannot be easily interpreted as belonging to the same category as visually presented objects or visually presented features. Odours are (1) *primary subjects* just as visually presented objects, (2) they posses non-classical mereological structure what significantly differs them from both visually presented objects and features, (3) have, again just as visually presented objects, *unique synchronic individuators*, but (4) as in case of visually presented features their diachronic identity criterion can be formulated by referring only to essential properties and without ascribing a significant role to continuity relations.

Through the paper I was assuming that one can be presented simultaneously with two odours in a form of a figure/ground discrimination. However, there are authors who doubt whether human olfaction has such ability and propose to interpret figure/ground phenomena as switching between experiences of two single odours (...). Nevertheless, choosing this option preserves the main ontological characteristics of odours described above. First, it is not relevant for a description of odours mereological structure and diachronic identity conditions. Second, the claim that odours have *unitary synchronic individuator* is also true, and in fact trivially true, if only one odour can be presented at a given time. In this case the property of "being an odour" serves as an *unitary individuator*. Third, even if there are no situations of being presented with two odours, the unificatory role of odours may be demonstrated by concerning subsequent olfactory experiences. For instance, coffee odour with low-intensity at $T_1$ and coffee odour with high-intensity at $T_2$ constitute a single perpetual unit in which different intensity-properties are unified by the same odour. On the other hand, there is no single perceptual unit created by different odours having the same intensity, for example coffee odour with low-intensity at $T_1$ and vanilla odour also with low-intensity at $T_2$.

Given the above results it is not surprising that there is an ongoing controversy whether to interpret olfactorily presented odours as objects or as features. They share some, but not all, characteristics with the paradigmatic perceptually presented entities, i.e. objects and features presented by human vision. Because of that one should postulate that odours presented by human olfaction constitute a third ontological category which is different both from the category of visually presented object and from the category of visually presented features. In this sense human vision and human olfaction are disunified as they present objects with significantly different ontological characteristics.

However, this disunity is not complete. In particular, both modalities, vision and olfaction, presents entities that allow for forming perceptual units by being *primary subjects* and can be efficiently identified and discerned from one another by an *unitary individuator*. It is worth noting that these common ontological characteristics of visually presented objects and olfatoctorily presented odours are achieved despite it is only vision that has extensive ability to represent space. While vision individuates, at least in the majority of situations, its *primary subjects* by an unique spatial localization, the olfaction achieves the same goal by uniquely categorizing presented odours.

The above results pose a question concerning the ontological unity of all human perceptual modalities. Further investigations may reveal that entities presented by other senses, like auditorily presented sounds, gustatorily presented flavours, or tactilely presented objects, should also be characterized as *primary subjects* having an *unitary individuator*. However, it may also be the case that this significant similarity occurs only between vision and olfaction. What is more, it one can also investigate whether and to what extent vision or olfaction are ontologically unique in relation to other human perceptual modalities. For instance one may ask if the classical mereology of vision is a standard among senses or

maybe an exception as mereology of entities presented by other modalities is more like the mereology of odours.

## 6. Conclusions

The analysis of ontological characteristics possessed by olfactorily presented odours show that that they constitute a different category of entities than objects and properties presented by vision. This suggest that in the controversy between interpreting odours as objects and interpreting odours as features both alternatives are false as odours significantly differ from paradigmatic, visually presented features and objects. However, the ontologies of human vision and human olfaction are not completely different as both these modalities present entities that are *primary subjects* having an *unitary individuator*. The question for further investigations is whether this common aspect is what ontologically unifies all human senses.

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