

Individuating the Senses of ‘Smell’:

Orthonasal vs. Retronasal Olfaction

Keith A. Wilson, University of Oslo

1. Introduction

The question of how we should divide up, or individuate, sensory modalities has a long history, with little consensus as how it should be resolved.¹ While it is often claimed that humans have just five senses—a view that dates back to Aristotle (350 BC)—this conventional view has come under increasing pressure from recent scientific advances which identify a host of additional internal and external ‘senses’. These include, but are not limited to

- (i) *thermoreception* (temperature)
- (ii) *haptic touch* (as distinct from tactual touch)
- (iii) *texture* (as distinct from tactual pressure)
- (iv) *proprioception* (bodily position)
- (v) *kinaesthesia* (bodily movement)
- (vi) *equilibrioception* (balance and acceleration)
- (vii) *agency* (self-generated action)
- (viii) *trigeminal* sensations (‘hot’ and ‘cool’ flavours)
- (ix) *nociception* (as distinct from the sensation of pain)

¹ For an overview, see Matthen (2015).

not to mention a host of possible and actual non-human senses.² Moreover, a burgeoning scientific and philosophical literature on multisensory perception and cross-modal effects presupposes the existence of a distinction between *unimodal sensory modalities* — visual, auditory, gustatory, olfactory, and so on. — and *multisensory experience*; e.g. flavour perception (Smith 2016). The precise grounds for this distinction, however, are rarely spelled out, and attempts to elucidate it often end up sidestepping the question (Fulkerson 2014a) or in a form of proof by exhaustion (Macpherson 2011, 2015), neither of which is entirely satisfying.³

The individuation problem is significant for both the conceptual and metaphysical basis of perception, since we perceive the world in multiple ways—e.g. through vision and touch—each with a distinctive mode of presentation or phenomenal character. Yet the world does not appear to us to be divided between the senses, but as a complex and integrated whole. The 'chemical senses' of taste, smell and trigeminal sensation present a particularly interesting test case for theories of sensory individuation due to the inherently multisensory nature of flavour perception (Auvray and Spence 2008). Indeed, some theorists (Rozin 1982; Smith 2015) have claimed that humans have not one, but *two* olfactory senses: (1) *orthonasal olfaction*, in which odorants are inhaled via the nose in what English speakers generally refer to as 'smell'; and (2) *retronasal olfaction*, in which odorants are exhaled from the back of the throat, typically when chewing or swallowing food and drink. This enables different theories of sensory individuation to be evaluated against a realistic test case — namely, olfaction — along with olfaction's relation to other senses.

In this paper, I aim to do two things. First, I evaluate how traditional philosophical criteria for individuating sensory modalities (§2) fare with respect to olfaction. I argue that these are at best inconclusive, since they cannot settle the question without further

² See Wilson and Macpherson (2018) for a representative summary.

³ I discuss these views further in §4.3.

potentially question-begging assumptions, and at worst contradictory, and so should be rejected (§3). I use this to motivate an alternative broadly Gibsonian account of sensory individuation that highlights the ambiguity between two distinct notions of a sense-modality: a *physiological sensory channel* and an *experiential modality* (§4). I argue that the resulting 'dual-concept' framework facilitates a more useful and accurate characterisation of human sensory architecture than competing accounts. This in turn enables us to diagnose much of the philosophical disagreement in this area as the result of a failure to recognise that there are two distinct and mutually complementary concepts of a sense-modality at play here, rather than, as has traditionally been assumed, only one. The resulting framework supports the conclusion that while humans have two physiological pathways for olfaction, we only have one sense of smell, along with a multimodal flavour sense that we call 'taste' (§5).

2. The Individuation Problem

The question of how to individuate the senses may itself be subdivided into the following questions:⁴

Type-individuation question (TYPE): Upon what grounds should we consider two occurrences of a sense-modality to be of different modality types (visual, auditory, tactual, etc.)?

Token-individuation question (TOKEN): Upon what grounds should we consider putative occurrences of a sense-modality to be numerically distinct?⁵

While TYPE has received considerably more attention in the philosophical literature than TOKEN, the two questions are necessary interrelated since without knowing how

⁴ Cf. Macpherson (2011, p. 14), who divides the problem slightly differently.

⁵ Alternatively, one can formulate these questions in terms of token experiences falling under sensory types. For an account along these lines, see O'Callaghan (2015).

to identify candidate 'token' senses, we cannot ask whether they are of different types, and two such putative 'tokens' can only be identical if they are of the same type.⁶ TYPE and TOKEN are thus mutually dependent, though it is not obvious which, if either, has explanatory priority.

According to the traditional Aristotelian view of the senses, smell, or olfaction,⁷ is one of five external or *exteroceptive* senses, consisting of a single type and token modality. We can summarise this view as follows:

(A) Humans have a single token olfactory modality

In an influential paper, however, the psychologist Paul Rozin observes that "olfaction is a *dual sense*: it functions both for sensing objects in the outside world and for objects in the mouth" (1982, p. 397; my emphasis). Indeed, Rozin goes so far as to claim that "[t]he olfactory system is the only major sense modality that is frequently confused with another sense modality (taste)" (*ibid.*)—a claim echoed by Spence, Auvray and Smith (2014), and Smith (2015, p. 323).

While it is unclear precisely how to interpret Rozin's claim, some psychologists and philosophers who are aware of the distinction have taken this to mean that humans have not one, but *two* senses of smell, these corresponding to the operation of the orthonasal and retronasal olfactory pathways. As stated, however, Rozin's claim is ambiguous between (at least) three different interpretations:

⁶ For consistency with the literature, I follow Macpherson's (2011) terminology, though Macpherson's use of the term 'token' is somewhat misleading since it refers not to particular spatiotemporally located instances of a given modality type, but to what are properly called its *occurrences* in a given kind of organism (cf. §§2.1–2.2). For present purposes, 'token' and 'instance' should be taken to refer to occurrences, though nothing in my argument turns upon this point. I thank an anonymous reviewer for pressing this point.

⁷ To avoid begging the question, I will use the term 'olfaction' and 'olfactory' in preference to 'smell', where the former are taken to be neutral as to whether we have one or two olfactory senses (see §4.1).

- R_{type}** Humans have two token olfactory modalities of different modality types
- R_{token}** Humans have two token olfactory modalities of the same modality type
- R_{role}** Humans have a single token olfactory modality that performs two different functional roles

In order to differentiate Rozin's claim from (A), we must establish which, if any, of the above interpretations is correct.

First, however, it will be helpful to set out some criteria that have been offered in response to the type- and token-individuation questions, along with some of the difficulties that accompany them (§§2.1–2.2). I then apply these criteria to the case of olfaction (§3) before presenting an alternative account (§4).

2.1. Type-Individuation

Following Grice (1962), Macpherson (2011) identifies four main criteria that have traditionally been used, either individually or in combination, to individuate sense-modality types. These are:

- (I) *Proximal stimulus*: the kinds of physical objects and/or properties that are directly detectable by each sense; e.g. light (or colour) in the case of vision, sound (or timbre) in audition, the various chemical properties associated with odours and tastes, and so on.
- (II) *Sense-organ*: the physical organ or sensory system used to detect sensory stimuli; e.g. the eyes (or visual system) for vision, the ears (or auditory system) for audition, the nose (or olfactory system) for olfaction, and so on.

- (III) *Phenomenal character*: the subjective quality⁸ that is characteristic of perceptual experiences in the relevant modality.
- (IV) *Representational content*: the objects and/or properties that experiences in the relevant modality represent.

Note that the above criteria are neither wholly independent nor exhaustive.⁹ The sense-organ criterion, for example, presupposes an individuation of sensory organs that might be thought dependent upon the proximal stimuli that are detected by those organs, i.e. (I). Similarly, according to *intentionalist* views of perception, e.g. Byrne (2001), an experience's phenomenal character supervenes upon or is identical to its representational content, in which case (III) and (IV) will covary. Moreover, an experience's representational content might be thought to depend upon the kinds of proximal or distal stimuli that are detected, as per (I) and (II). Finally, advocates of *Naïve Realism* and *relationalism* typically deny that perceptual experiences have representational contents (e.g. Campbell 2002; Martin 2002; Brewer 2006, 2011), in which case (IV) may be rejected in favour of phenomenal character being partly constituted by external particulars, and so dependent upon the proximal and/or distal objects of perception. Even so, such theories must explain why the phenomenal character of, for example, an object's shape differs according to whether it is experienced via vision or touch.

In order to provide a comprehensive theory of sensory individuation, one must specify a criterion, or set of criteria, for individuating the senses, including the various 'hidden' senses mentioned above, rather than separate criteria for each. This creates a

⁸ I will use 'phenomenal character' in preference to 'qualia' throughout since the latter is ambiguous between the qualitative character of experience — "what it's like" (Nagel 1974) — and a non-representational mental object, i.e. a *sense-datum* (cf. Block 1996), or quality thereof.

⁹ Other possible criteria include the spatiotemporal characteristics of the relevant modality, and how information is processed and/or integrated (see §4.1).

potential difficulty for single-criterion accounts since each of the Aristotelian external senses is capable of detecting a diverse range of objects and properties. Touch, for example, may be further divided into sub-modalities for pressure, texture, shape, temperature, and pain, each of which has dedicated receptors in the skin (Fulkerson 2014b). However, a comparable subdivision of vision into sub-modalities for colour, shape, texture, and depth seems intuitively incorrect. Multi-criteria approaches, on the other hand, face the problem of precisely which combination of criteria to adopt, and how to resolve conflicts between them. Yet further views appeal to conventional usage (Nudds 2011; Richardson 2013), pragmatic or contextual considerations (Fulkerson 2014a), or statistical analysis (Macpherson 2015) to try and resolve these issues.¹⁰ Since space considerations preclude an exhaustive evaluation of each of these positions, I will confine myself to a couple of illustrative examples.

Grice (1962) imagines a hypothetical "Martian" who possesses two pairs of visual organs which, despite being physiologically identical, generate experiences with quite different phenomenal characters.¹¹ Were we to take the Martian's phenomenological reports at face value, we might say that they have not one, but two distinct visual senses, where this can be construed as either (1) two different modality types, or (2) two occurrences, or 'tokens', of a single type. These options are analogous to the corresponding interpretations of Rozin's claim, R_{type} and R_{token} , respectively. Which, if either, is correct, and how such cases can in principle be decided will depend upon the type- and token-individuation criteria that one adopts. Either way, Grice argues that such examples show that the sense-organ criteria alone is insufficient to individuate modality types, since one must also take phenomenal character into account.

¹⁰ See §4.3 for discussion.

¹¹ Whether such a scenario is genuinely conceivable may depend upon one's view of the mind-body problem (cf. Chalmers 1996).

Lest this problem be thought to be confined to the realms of science-fiction, *dolichopteryx longipes*, the brownsnout spookfish, has eyes that are divided into distinct upper and lower parts. The upper eye-pair contains lenses that focus light onto the creature's retinas in the standard way. The lower eye-pair, however, contain mirrored surfaces that reflect light onto a separate pair of retinas, thus maximising the light collected from the darker waters below (Wagner, Douglas, Frank, Roberts and Partridge 2009). As in Grice's hypothetical example, whether this counts as one or two type or token visual senses will depend, among other things, upon: (a) whether the spookfish's visual organs are regarded as a single 'pair' of dual-function eyes, or separate upper and lower eye-pairs; (b) whether the representational content and/or phenomenal character of the resulting experiences differ markedly (§3.1.3); and (c) whether the relevant sensory systems are spatially and phenomenally continuous with one another (§3.2.1–2). While we have no way of assessing the visual experiences of brownsnout spookfish, assuming they have any, a careful consideration of human olfaction shows that we ourselves might be somewhat analogous with respect to the sense of smell (§3).

2.2. *Token-Individuation*

In relation to the individuation of token sense-modalities, there is less of an established literature to go on. Indeed, Martians and spookfish notwithstanding, many find the idea of a creature that has multiple instances or occurrences of the same modality-type difficult to grasp, or somewhat uncanny.¹² In addition to the type-individuation criteria listed above, however, plausible token-individuation criteria include:

- (i) *Spatial contiguity*: whether experiences present a single spatially unified field, as per human vision and arguably audition (see Wilson ms), or distinct spatial regions.

¹² I suggest a possible reason for this in §4.2.

- (ii) *Phenomenal continuity*: whether there is a smooth continuum of potential percepts, suggesting a single token modality, or an abrupt change in phenomenal character, as with Grice's Martian, suggesting independent tokens.
- (iii) *Counterfactual dependency*: whether the loss or impairment of one putative token modality would, were this physiologically possible, qualitatively affect the phenomenal character of the other putative token modality.
- (iv) *Intersubstitutability*: whether loss or impairment of one putative token modality would affect the kinds of discriminations, judgements or tasks that the organism is capable of carrying out.

Again, the above criteria are neither uncontroversial nor exhaustive. They do, however, receive support from a consideration of cases. *Photopic* (i.e. normal light) and *scotopic* (i.e. low-light) vision in humans are generally considered to constitute a single token-modality largely due to their spatial and phenomenal continuity, i.e. (i) and (ii) above. Indeed, were one unaware that these forms of vision employed distinct receptors on the retina, one might consider the difference between them merely a matter of degree, e.g. in brightness and colour saturation, rather than a difference in kind. Similarly, binocular vision is a result of both eyes working together to form a single contiguous field of view rather than independent left and right hemi-fields, as is conceivably the case in creatures whose eyes are capable of viewing independent regions of objective space. Furthermore, the loss or impairment of one eye results in a reduction in depth information that affects the phenomenal character of the resulting visual experience, suggesting a unified token modality, as per (iii). In such cases, however, the *kinds* of visual discriminations and tasks that the organism is able to make or perform remain largely unchanged, as per (iv), despite the decrease in spatial accuracy due to the reduction in depth information. This contrasts with the case of the

spookfish described above, whose upper and lower eye-pairs appear to have evolved distinctive functions such that the loss of the upper or lower eye-pair would presumably disrupt its behaviour more profoundly than the loss of one eye does in humans. The above considerations suggest that for us, at least, both eyes form part of a single token visual sense, rather than two distinct tokens.

3. Orthonasal and Retronasal Olfaction

Having set out some standard criteria for sensory individuation, I now examine how these fare in the case of olfaction. As noted above, orthonasal olfaction occurs when air containing one or more *odorants*,¹³ i.e. chemical substances to which we have olfactory sensitivity, are taken in through the nose, typically by breathing or sniffing. These are propelled upwards into the nasal cavity where they pass over the *olfactory epithelium*, a network of receptors that is capable of detecting upwards of 400 distinct chemical signatures (Olender et al. 2012). The nerves extending from these receptors connect via the olfactory bulb to the piriform cortex, which in turn projects into the amygdala, hippocampus, thalamus, entorhinal cortex,¹⁴ orbitofrontal cortex (OFC), and other brain areas. Orthonasally-sensed odorants (or the resulting sensations) are typically experienced as being located in or around the nose, though may also be 'referred' to an external location — a nearby odour source, for example — on the basis of vision or touch.¹⁵

Retronasal olfaction — a term that did not enter into scientific usage until 1984 (Bartoshuk, Sims, Colquhoun and Snyder 2019) — occurs when pulses of odorant are

¹³ As the terms 'odour' and 'smell' are ambiguous between the objective stimuli for olfaction and the phenomenal character of the resulting experiences, I will use the term 'odorant' to refer to olfactory stimuli, reserving 'smell' for the experiential modality (§4).

¹⁴ Along with other elements of the limbic system, the entorhinal cortex also receives direct projections from the olfactory bulb, thus explaining olfaction's unique influence upon emotion, memory and behaviour (Jacob 2002, p. 304).

¹⁵ For discussion of olfaction as a form of exteroception, see Richardson (2011).

propelled upwards via the throat from the back of the nasal cavity (hence: 'retro'), typically as a result of chewing or swallowing. Odorants then pass over the olfactory epithelium before being exhaled via the nose. In contrast to orthonasal olfaction, retronasally-sensed odorants (or the resulting sensations) are typically experienced as located in the mouth or back of the throat due to what is known as *oral referral* (Spence, Auvray and Smith 2014). The perceived location of the odour, or odour source, thus differs from the location of the olfactory detectors in a way that is consistent with retronasal olfaction's distinctive role in flavour perception.

While the existence of two distinct olfactory pathways might be considered *prima facie* evidence for R_{type} , this does not yet establish the importance of this distinction for the individuation of olfactory modalities. To do that we must apply the type- and token-individuation criteria set out in §2, as discussed below.

3.1. Type-Individuation Criteria

3.1.1. Proximal Stimulus

The proximal stimuli for olfaction are the chemical compounds and/or their properties that are detectable via the olfactory epithelium. While philosophical accounts of olfaction differ on precisely *what* we perceive via olfaction,¹⁶ there is no evidence that we can detect different kinds of odorants via the orthonasal and retronasal pathways. Indeed, while odorants can undergo physical changes in the nose and throat due to moisture, heat and other physical effects, it would be surprising if the two pathways were sensitive to different proximal stimuli given that both share the same olfactory receptors (though this does not rule out differences in the typical distal objects of olfaction). Rather, what differs between the two is the route by which odorants reach the olfactory epithelium, i.e. through the nose or via the back of the throat. The

¹⁶ Recent accounts of odours include object-based views (cf. Batty 2014), property-based views (Lycan 2014), stuffs (Mizrahi 2013), and olfactibilia (Richardson 2018).

proximal stimulus criterion alone, then, would suggest that there is only one olfactory modality type.

3.1.2. Sense-Organ

The second type-individuation criterion is less straightforward to evaluate. Each of the traditional five senses has a dedicated organ—or pair of organs in the case of hearing and sight—with the nose being the obvious locus of olfaction. It is less clear, however, whether the sense-organ for retronasal olfaction should be extended to include the mouth and/or those parts of the brain and nervous system that transmit and process olfactory stimuli.

Here, different precisifications of the sense-organ criterion deliver different results. On a coarse-grained version of the criterion, the entire olfactory system including nose, mouth and the relevant brain regions might be considered to constitute a single 'sense-organ'. This would render orthonasal and retronasal olfaction sub-modalities of a single modality-type in much the same way as texture, pressure and temperature might be considered sub-modalities of touch (§2). Similarly, a view that individuated sense-organs in terms of sensory receptors alone would classify orthonasal and retronasal olfaction as a single modality on the basis that both employ the same receptors in the olfactory epithelium.¹⁷ On a fine-grained version of the sense-organ criterion, however, only the retronasal pathway would extend to the mouth and throat, with the orthonasal pathway limited to the nose and nasal cavity. This would suggest the existence of two distinct olfactory senses with overlapping mechanisms. While this kind of sharing of sensory mechanisms might seem unusual, there seems to be no reason to rule it out in principle. After all, human sensory organs might have evolved to employ multiple combining or overlapping parts rather than dedicated external

¹⁷ Alternatively, we could abandon the traditional labels and classify the chemical senses as a single integrated modality, as per the dominant view of touch (cf. Fulkerson 2014b).

and/or internal organs, without this requiring that the resulting 'senses' formed a single modality-type.

The picture becomes increasingly complex when we consider olfactory neural architecture. Perhaps unsurprisingly given that we can detect the difference between them, orthonasal and retronasal olfaction activate many, but not all, of the same brain regions. Retronasal olfaction differentially activates brain areas that are more typically associated with gustation rather than smell, though there is also a large degree of overlap (Small, Voss, Mak, Simmons, Parrish and Gitelman 2004; Small, Gerber, Mak and Hummel 2005). If the sense-organ criterion extends to include those elements of the nervous system and brain that are dedicated to sensory processing, then the evidence for this kind of differentiation at a relatively early stage of sensory processing might support a distinction in modality-type. Indeed, psychologists have posited the existence of a dedicated "flavour network" in the brain, lending weight to the idea that flavour, rather than retronasal olfaction, should be considered a first-class sense-modality (Small, Voss, Mak, Simmons, Parrish and Gitelman 2004, p. 1896). However, given the degree of overlap between orthonasal and retronasal olfaction, this would potentially lead to both being considered sub-modalities of flavour rather than olfaction. While this might make sense for retronasal olfaction given its close connection with gustation, classing orthonasal olfaction as a form of flavour experience seems bizarre, not to mention the difficulty of explaining similar interactions with touch, audition and vision (cf. Smith 2015, p. 340).

Without further precisification or additional criteria, then, the sense-organ criterion alone cannot decide between (A), R_{type} , and R_{token} . At this point, one might be tempted to choose whichever version of the criterion best accords with our pre-theoretical intuitions about taste, smell and flavour (whatever those might be). However, we should be wary of this approach. Part of the reason for adopting individuation criteria is to help adjudicate difficult cases, such as olfaction. Adjusting the criteria to fit our

preconceptions would therefore undermine the reason for adopting them in the first place. Alternatively, we might appeal to some principled, non-arbitrary way of determining how to individuate sense-organs; e.g. in biology and the natural sciences. However, the question of whether to adopt a coarse- or fine-grained individuation account of sense-organs cannot be settled by appealing to scientific evidence alone since the same question will arise in relation to the interpretation of that evidence, and so the problem recurs. This presents us with an apparent dilemma: do we (1) accept the verdict of the sciences in individuating sense-organs, ignoring any potentially conflicting phenomenological evidence, or (2) adopt some further, or different, criteria? Given the existence of other difficult cases, such as those described in §2.1, we might well agree with Grice that the sense-organ criterion alone is insufficient for the individuation of modality-types. An appeal to further criteria, such as phenomenal character, therefore seems warranted.

3.1.3. Phenomenal Character

Olfactory quality space is, by most accounts, orders of magnitude larger than, for example, colour space, which is typically characterised as having just three dimensions.¹⁸ Moreover, the distinction between simple (i.e. mono-molecular) and complex (i.e. compound) odours is notoriously hard to discern introspectively, with exposure to even a single substance yielding stimulation of dozens, or even hundreds, of receptor types—coffee being a case in point (Smith 2015, p. 343). Given our ability to differentiate between orthonasal and retronasal olfactory experiences, however, it is clear that there must be some difference in their respective phenomenal character. Indeed, one might intuitively expect there to be a substantive difference due to the latter's role in flavour perception. Rozin, for example, claims that "the same olfactory

¹⁸ For discussion of how quality space theory relates to olfaction, see Young, Keller and Rosenthal (2014). For colour space, see Hardin (1988).

stimulus seems qualitatively different when referred to the mouth or the outside world" (Rozin 1982, p. 397) and that "[i]t seems very likely that the olfactory component of flavor differs markedly from the olfactory consequences of the same substance in the external world" (*ibid.*, p. 400). Smith concurs, stating that "[t]he cases ... involving cheese, coffee, and chocolate show how orthonasally and retronasally presented odour stimuli lead to different experiential effects" (2015, p. 328). What evidence is there for these claims, and are the resulting differences in phenomenal character sufficient to warrant a distinction in modality-type?

In addressing these questions, anecdotal examples include, once again, coffee, which smells rich and delicious, but can taste somewhat watery or disappointing by comparison, and cheeses that have an off-putting smell, but taste delicious in the mouth (Rozin 1982, p. 397; Auvray and Spence 2008, p. 1023; Smith 2015, p. 327). The existence of such cases would seem to support the kind of marked phenomenal difference that Rozin predicts. However, despite their intuitive appeal, such cases do not settle the matter since they involve comparing an orthonasal *olfactory* experience, e.g. the smell of coffee or strong cheese, with a multisensory *flavour* experience of the same object. This shows that, in combination with gustatory and/or somatosensory stimulation, retronasal olfaction can yield an experience whose phenomenal character and/or hedonic value can be quite different to an orthonasal olfactory experience of the same odour source. But this falls short of what needs to be demonstrated, since the olfactory component of flavour experiences is not readily dissociable from gustatory and other sensory components via introspection, meaning that any difference may be entirely due to the contribution of gustation and/or other modalities. Hence these examples fail to compare like with like.

To convincingly demonstrate a difference between the phenomenal character (or content) of orthonasal and retronasal olfactory experiences of the same substance one would need to hold the non-olfactory components of the experience constant,

preferably by eliminating them altogether. Only then would any resulting difference in phenomenal character be attributable to the variation in olfactory pathway alone. When such experiments are conducted under controlled circumstances (Heilmann and Hummel 2004; Small, Gerber, Mak and Hummel 2005), the only differences that have yet been found concern the odour's perceived intensity and location. Moreover, these effects vary between odourants and "may be dependent upon whether an odor has been previously experienced retronasally (i.e., whether it is a food odor)" (*ibid.*, p. 599), as is consistent with retronasal olfaction's role in flavour perception. Notably, the only food odour tested in this study was chocolate, which showed no difference in phenomenal character apart from perceived location due to oral referral, with non-food odorants exhibiting differences in both intensity and location.¹⁹ Though any difference in phenomenal character is sufficient to demonstrate a degree of differentiation, this falls short of the kind of marked difference in character that Rozin et al. predict, and that is suggested by the anecdotal examples of cheese or coffee.

Even if more dramatic differences were found, however, one would need to rule out two possible confounds. First, as previously noted, odorants can undergo physical changes in the mouth or throat prior to detection at the olfactory epithelium. Some of these may affect the phenomenal character of the resulting experience. This possibility thus needs to be eliminated or controlled for, as in the above studies, in order to attribute the resulting difference to the olfactory pathway, as opposed to physical differences in proximal stimuli at the point of detection. Second, different concentrations of the same odorant can seem qualitatively distinct in a way that goes beyond apparent differences in intensity (Moskowitz, Dravnieks and Klarman 1976). If the resulting variation in phenomenal character is found at different intensity levels in both olfactory pathways, this would seem insufficient to warrant a distinction in

¹⁹ See §§3.2.1–2 for discussion.

modality-type since the difference is potentially attributable to variation in intensity alone.²⁰ In the absence of more dramatic cases, then, it remains at best unclear whether we can individuate orthonasal and retronasal olfaction by means of phenomenal character, except perhaps for differences in perceived location and/or intensity (see §3.2).

3.1.4. Representational Content

As noted above, the content of olfactory experience may depend upon the metaphysics of perception (representationalism, relationalism, etc.), its phenomenal character (according to intentionalism), and/or the proximal or distal objects of olfaction. Since each of these issues is contentious in its own right, I bracket discussion of this criterion other than to note that, as a consequence of these dependencies, the criterion is susceptible to the same problems and ambiguities that I discuss above.

3.2. Token-Individuation Criteria

I turn now to evaluating the token-individuation criteria set out in §2.2 with respect to olfaction, starting with the question of whether the phenomenal character of orthonasal and retronasal olfactory experiences can be considered continuous with, or distinct from, one another.

3.2.1. Spatial Continuity

As noted above, odorants — or olfactory sensations, depending upon how one characterises olfactory experience — are perceived as located in or around the nose, mouth or throat, depending on the presence or absence of oral referral (§3). However, there remain significant unknowns concerning the precise physiological mechanisms that govern this. Many of the possibilities, including the presence of tactile sensations

²⁰ Small, Gerber, Mak and Hummel (2005, p. 599) also highlight perceived intensity as confound in relation to brain imaging studies.

in the mouth or throat, detection of airflow in the nasal cavity, and trigeminal cueing have been ruled out experimentally (Small, Gerber, Mak and Hummel 2005, p. 594). Instead, this appears to depend upon a variety of factors that jointly determine the type and/or degree of oral referral experienced. These include:

- (a) the presence or absence of gustatory stimulation
- (b) whether gustatory and olfactory stimuli are congruent or incongruent with one another
- (c) whether or not the stimulus is a foodstuff
- (d) the relative timing of gustatory and olfactory stimuli
- (e) whether olfactory and gustatory stimulation are attributed to the same source object, and
- (f) the precise pattern of stimulation of the olfactory epithelium (cf. Heilmann and Hummel 2004, p. 417).

If these cues are disrupted, for example by presenting a incongruent gustatory stimulus, or one that occurs significantly before or after the corresponding olfactory stimulus, the odorant will typically be perceived as located in the nose or back of the throat even when presented retronasally (Lim and Johnson 2012).

Of particular significance for the evaluation of spatial continuity, odorants may be experienced as located at different points in the mouth or throat (Lim and Johnson 2011). This suggests that oral referral may not be an all-or-nothing affair, but rather a matter of degree. Thus, either the range of experienced locations (i) is divisible into discrete orthonasal and retronasal regions with a distinct boundary, or step-change, between the two, or (ii) forms a smooth continuum. According to the spatial continuity criterion, the first scenario would favour R_{token} (or possibly R_{type} , depending upon other variations in phenomenal character discussed below), while the second favours a

single-token view. Current experimental data is inconclusive as to which of these possibilities is correct, but the question is, at least in principle, answerable through further empirical research.

3.2.2. Phenomenal Continuity

A further difference between the phenomenal character of orthonasal and retronasal olfactory experience concerns its perceived intensity. Specifically, orthonasal detection of an odorant typically results in a higher intensity olfactory experience than retronasal detection of the same odorant, particularly for food odours. This is true even when the concentration of the odour source is held constant (Diaz 2004). One might hypothesise that this is due to differing quantities of the odorant reaching the olfactory epithelium because of absorption and transmission effects within the orthonasal and retronasal pathways. In an ingenious experiment, however, Heilmann and Hummel (2004) controlled for this possibility by sampling the concentration of odorant within the nasal cavity itself, using the resulting measurement to adjust the amount of odorant delivered. Surprisingly, they found that orthonasal delivery results in a more intense olfactory experience than retronasal delivery even when the same concentration of odorant is present in the nasal cavity.²¹

Combined with the phenomenon of oral referral, Heilmann and Hummel's findings might be taken to show that orthonasal and retronasal olfaction are phenomenally distinct after all. Variations in perceived location and intensity are, however, consistent with the kind of changes in phenomenal character and/or representational content found in other sense-modalities, such as vision and hearing. Indeed, this might be taken to constitute a form of distance constancy effect.²² Retronasal odorants, being located within the body, typically result in a larger quantity

²¹ Though not for all odorants. Cf. Small, Gerber, Mak and Hummel (2005, p. 597, 600).

²² A possibility suggested to me by Charles Spence.

of odorant reaching the olfactory epithelium during eating or drinking than would be the case for the same concentration of odorant delivered orthonasally. The olfactory system then compensates for this by adjusting the perceived intensity of retronasal and orthonasal olfactory experience to better approximate the distal, rather than proximal, concentration. The existence of such a constancy effect would, according to Burge (2010), render olfaction a fully-fledged perceptual modality rather than, as Burge himself claims, a mere stimulus–response mechanism (cf. §4.1). In any case, while such variations give grounds for thinking there is some difference in phenomenal character between olfactory pathways, it is not of the dramatic kind that Rozin et al. suggest. Rather, such differences may, by comparison with other sense-modalities, arguably be accommodated within a single type or token modality.

Notwithstanding the anecdotal cases discussed in §3.1.3, which compare unimodal olfactory and multimodal flavour experiences, orthonasal and retronasal olfaction might also intuitively be thought to share the same quality space (cf. Young, Keller and Rosenthal 2014). Moreover, retronasal quality space is also potentially continuous with, or a subset of, flavour quality space. This might be taken to support the idea that the chemical senses form a single unified token-modality as opposed to being divided into distinct taste, smell, trigeminal, and/or flavour modalities. To establish this conclusively, however, would require a substantive body of psychophysical evidence. If, on the other hand, orthonasal olfaction and flavour count as distinct modality-types on the basis of some other criterion, such as proximal stimuli, this might motivate treating retronasal olfaction as a component of flavour perception as opposed to being purely olfactory (cf §3.1.2).

The phenomenal and spatial continuity criteria raise the question of precisely how much variation in phenomenal character is required to constitute a distinct type or token modality. The spatial continuity criterion suggests one possible answer: token modalities are distinct when there is a spatial discontinuity between them — a matter

which is, in principle at least, empirically verifiable. The phenomenal continuity criterion suggests another: token modalities reflect discontinuities in quality space. While these two criteria are not exhaustive and may be combined in various ways, without some principled reason to prefer one over the other, the problem of how best to apply them remains. Indeed, this is just the phenomenological analogue of the problem that dogged the sense-organ criterion concerning how to choose an appropriate precisification without making question-begging or *ad hoc* assumptions about the 'correct' modality types. Without further precisification, however, the present criteria are not decisive in the case of olfaction, at least with our current level of empirical knowledge.

3.2.3. Counterfactual Dependency

The counterfactual dependency and intersubstitutability criteria concern what happens to one putative token modality (e.g. orthonasal olfaction) in the event of the loss or impairment of another (e.g. retronasal olfaction). Smith (2015, pp. 329–30) cites three kinds of dissociation that can occur between orthonasal and retronasal olfaction in pathological cases. The most obvious involves the disruption or blockage of the airways; e.g. due to nasal polyps (Landis, Hummel, Hugentobler, Giger and Lacroix 2003). This is analogous to blocking light from entering one eye, or sound from entering one ear, which would not normally be taken to show that we have two token senses of vision or hearing. By parity of reasoning, we should not rest too much weight upon such cases in olfaction since they concern the purely mechanical aspects of odorant transmission, rather than the functioning of the sensory organ *per se* (depending upon how such organs are individuated; cf. §3.1.2). Smith's third example, however, suggests that damage to one olfactory pathway can cause a sensory deficit that does not affect the other pathway. Unlike damage to one eye, which affects the phenomenal character of the resulting visual experiences due to the loss of depth

information, this suggests that the functioning of one olfactory pathway can be impaired without affecting the phenomenal character arising from the other. According to the counterfactual dependency criterion, this favours R_{token} over (A).

3.2.4. Intersubstitutability

On first approximation, it does not appear to be possible to substitute orthonasal for retronasal olfaction due to the obvious physiological difficulties involved. Indeed, the two pathways seem to have quite different functions: one samples odours in the surrounding environment, the other works in conjunction with gustation to create flavour perception. The core contribution of olfaction, however—namely, identifying a *kind of stuff* (cf. Mizrahi 2013)—remains common to both, despite a difference in target objects. Moreover, since the exact mechanism for disambiguating the two pathways is not fully understood, it remains an open question whether one could with suitable 're-plumbing', e.g. via a prosthetic device, induce orthonasal olfaction while eating or drinking, and retronasal olfaction when sampling the external environment. If it were possible to retrain the use of one's olfactory pathways in this way, then there would be no principled reason why orthonasal or retronasal olfaction could not compensate for the loss or impairment of the other, despite the considerable practical barriers to doing so, thus favouring (A) over R_{token} .

3.3. Summary

The type-individuation criteria for proximal stimulus (I) and potentially phenomenal character (III) would seem to favour the traditional view of olfaction as a single type-modality, i.e. (A). Crucially, however, it is unclear whether differences in the perceived location and intensity of orthonasal and retronasal olfactory stimuli are sufficient to ground a difference in modality type and/or token. The Aristotelian view receives further support from the consideration of spatial and phenomenal continuity, as per token-individuation criteria (i) and (ii), though the details are controversial and in need

of further empirical support. The sense-organ (II) and representational content (IV) criteria, however, fail to deliver any clear verdict, at least without further precisification. Counterfactual dependency (i) and possibly intersubstitutability (ii), on the other hand, seem to speak in favour of R_{token} on the basis that orthonasal and retronasal olfaction are at least somewhat independent, though again the details are debatable and require additional empirical support.

What conclusion we take from these conflicting results depends upon which criteria, and crucially which precisifications of the criteria, we take to be important for type- and/or token-individuation of sense-modalities. One way of answering the individuation questions for olfaction would therefore be to pick a criterion, or set of criteria, and stick with it. This approach, however, requires a degree of selectivity about the evidence, along with a certain arbitrariness about what counts as a sufficient difference in, for example, phenomenal character in order to constitute a separate type or token modality — issues that are not settled by the choice of criteria alone. Alternatively, one could select whichever precisifications of the relevant criteria deliver a clear verdict in the case of olfaction. However, as previously noted, to avoid the charge that such a method is question-begging or *ad hoc*, the selection and precisification of criteria must be done in a principled manner that is both independently justifiable and successfully generalises to other sense-modalities. Given the difficulty of these tasks, this scarcely leaves us any further forward. To the contrary, the standard type-individuation and proposed token-individuation criteria either fail to offer a definitive result in the case of olfaction, or else deliver conflicting results with no obvious way of resolving the conflict. If so, then so much the worse for these criteria.

The original puzzle thus remains. Do orthonasal and retronasal olfaction constitute one sense or two, and how exactly are we to decide this? In the following section, I sketch an alternative approach which suggests that the answer lies in an ambiguity in

the question concerning the meaning of the term 'sense'. By identifying two distinct, but complementary, notions of a sense-modality, the resulting 'dual-concept' framework provides an alternative to both traditional and contemporary approaches, thereby helping to articulate and clarify the relationships between the senses.

4. The Dual-Concept Framework

The alleged duality of olfaction illustrates a tension between (a) providing a purely physiological account of sensory systems; e.g. olfaction, gustation, trigeminal, and (b) classifying the resulting forms of perceptual experience; e.g. 'taste' (aka flavour) and smell. Indeed, the traditional type-individuation criteria may themselves be divided into distinct groupings along physiological and experiential lines. Instead of shoe-horning all these and other criteria into a single one-size-fits-all model, or adopting a purely pragmatic or contextualist approach, we can instead choose to recognise this distinction in the way that the notion of a sense-modality is employed. Though it has received relatively little attention in the philosophical literature,²³ such a response to the problem of sensory individuation can be found in the work of J. J. Gibson (1966, 1979).²⁴

In this section, I present and evaluate a version of what I will call the *dual-concept framework* for sensory individuation (§4.1), with particular reference to the case of olfaction (§4.2). I conclude by defending the view against objections, including comparisons with contemporary pluralistic accounts (§4.3).

²³ Matthen (2015) being a notable exception.

²⁴ I do not claim here to present a faithful or comprehensive account of Gibson's view. Rather, the proposed framework employs some of Gibson's key insights into the nature of sensory systems while remaining neutral on other aspects of his ecological theory of perception; e.g. affordance perception.

4.1. *Sensory Channels vs. Experiential Modalities*

Gibson makes two distinctive claims about sensory individuation. The first is that there is not only one, but two distinct conceptions of a sense-modality as follows:

- (1) *A sensory channel*, or physiological mechanism for detecting and extracting certain types of information from environmental stimuli: light, sound, chemical properties, etc.
- (2) *An experiential modality*, which relates to a distinctive form of experience that enables an organism to make certain kinds of perceptual discriminations and perform related tasks.²⁵

The second, and perhaps more surprising, claim is that these two conceptions are not competing notions of what constitutes a sense-modality, but rather mutually complementary components of an overarching account of human sensory architecture. Thus, according to Gibson, it is not a question of which of (1) and (2) is the correct or predominant use of the term 'sense' or 'sense-modality'. Rather, both conceptions have equal prominence, and indeed are closely interrelated.

This duality of concepts is less obvious in the case of vision, hearing and touch, where the two notions appear to be closely aligned (though not precisely if one takes the role of bodily orientation into account). In the case of taste, smell and various forms of bodily awareness, however, the appearance of a one-to-one correspondence breaks down and we instead require a many-to-many mapping between sensory channels—olfaction, gustation, trigeminal, somatosensation, and so on—on the one hand, and experiential modalities: taste, smell, touch, etc., on the other. Rather than attempting to combine both conceptions into a single unitary calculus, as on traditional philosophical

²⁵ Gibson (1966) calls these "sensory" and "perceptual" systems, respectively. However, this terminology is potentially confusing given the wide and varied use of these terms in philosophy, and so I adopt the more neutral terms above.

approaches, the dual-concept framework emphasizes their distinctness. To the extent that our everyday concept of a 'sense' tracks either of these notions, it is ambiguous between a sensory channel and an experiential modality. This in turn renders the question of whether we have one or two 'senses' of smell ambiguous between:

Physiological question (CHANNEL): Do humans have one or two distinct olfactory sensory channels?

Experiential question (EXPERIENCE): Do humans have one or two distinct forms of olfactory experience?

CHANNEL relates primarily to physiological and mechanistic considerations, encompassing (though not limited to) the traditional proximal stimulus and sense-organ criteria. EXPERIENCE, on the other hand, relates primarily to the psychology and phenomenology of perception, encompassing (though not limited to) the traditional phenomenal character and representational content criteria.²⁶ Token-individuation criteria (i) and (ii), which concern aspects of phenomenal character, are subsumed under the latter, whereas (iii) and (iv) relate to functional considerations that cross-cut the physiological/experiential distinction.

Central to the Gibsonian picture is the idea that sense-modalities of each kind can be mapped onto one another to explain how the relevant sensory channels contribute to the formation of experience. In some cases, this may be a straightforward one-to-one mapping. The prevalence of cross-modal effects, however, raises doubts as to whether even supposedly paradigm cases of 'unimodal' perception, such as seeing, are limited to a single sensory channel, i.e. vision, or whether other channels such as

²⁶ Here I depart somewhat from Gibson, who regarded "modes of activity", and in particular attention, to be central to the individuation of experiential modalities (1966, p. 49). However, one need not subscribe to this aspect of Gibson's view in order to endorse the dual-concept framework.

equilibrioception and proprioception also play a role (cf. Briscoe 2019, p. 18). In the case of olfaction, however, the relevant sensory channel (or channels) may contribute to, and indeed transform, perceptual experience in more than one modality; e.g. smell and 'taste' as standardly understood, i.e. *flavour perception*. The distinction between *unimodal* and *multimodal* experience can thus be drawn in terms of whether a given experiential modality, e.g. touch or smell, constitutively depends upon the activity of one or more sensory channels; e.g. temperature, pressure, olfaction. Thus, considered as an experiential modality, flavour perception is inherently multimodal since it involves the activity of multiple sensory channels.

Furthermore, the framework enables a clear distinction to be drawn between *unisensory* (e.g. auditory) and *multisensory* (e.g. audiovisual) experiences that result from the activity of two or more experiential modalities. The McGurk effect (McGurk and MacDonald 1977), for example, involves a multisensory experience of auditory and visual stimuli, though subjects can be mistaken about which aspects of the resulting phenomenology are due to which sensory channel due to the presence of cross-modal interactions. It is to the dual-concept framework's credit that it enables these kinds of theoretical distinctions to be drawn in a relatively natural and straightforward way. The same cannot be said for the rival pluralistic approaches discussed below, where the application of one or more of individuation criteria results in a logically coherent, but otherwise unwieldy profusion of classifications that are not necessarily helpful in explicating the nature of perceptual processing or experience (§4.3).

Returning to the case of olfaction, then, odorants proceed through the orthonasal or retronasal pathway — a physiological distinction — to the olfactory epithelium, where information is extracted concerning the presence or absence of various physical properties. This sensory channel (or channels) can give rise to two different forms of perceptual experience: (i) a *smell experience*, typically as a result of activity in the

orthonasal pathway, possibly in conjunction with the trigeminal channel; or (ii) a *flavour experience*, typically corresponding to activity in the retronasal pathway alongside gustatory, somatosensory, trigeminal, and other channels (Spence, Auvray and Smith 2014). Thus, as noted by Smith (2015, p. 330), both smell and flavour experiences are, strictly speaking, multimodal since each may include a trigeminal component — and much more besides in the case of flavour experience, which is multisensory in the sense defined above.

Philosophical debate over whether flavour is a first-class sense-modality or a combination of unisensory experiences can now be seen to rest upon the ambiguity between the sensory channel of *gustation*, i.e. 'taste' in the strict scientific sense, and the experiential modality of *flavour*, i.e. 'taste' in the everyday sense. Thus, contrary to Rozin (1982) and Spence, Auvray and Smith (2014), we need not attribute any mistake to the folk in using 'taste' to include both gustation and retronasal olfaction, since by this they do not mean the sensory channel of gustation, but the experiential modality to which both the gustatory and olfactory channels contribute. Similarly, 'smell' need not be taken to be exhaustive of the contribution of olfaction to experience, some of which is more readily attributable to 'taste', aka flavour perception. Our ordinary language concerning smell, taste and/or flavour perception thus remains in good order.

To avoid such terminological disputes, philosophers would do well to adopt the scientific terms — olfaction, gustation, vision, audition, somatosensation, proprioception, equilibrioception, etc. — to refer to sensory channels, whilst reserving the more familiar everyday terms — taste, smell, sight, hearing, touch, etc. — for experiential modalities.²⁷ In conjunction with the dual-concept framework, this enables questions concerning inter-modal binding and cross-modal effects to be formulated more precisely while highlighting that our understanding of both domains is capable

²⁷ I do not mean to suggest that common usage of these terms is exclusively employed in these ways; manifestly, it is not.

of revision in light of the empirical evidence (§4.3). Indeed, much of the confusion and disagreement within the philosophical literature on these issues can be diagnosed as being due to the conflation of these two distinct, but complementary, conceptions of a sense-modality, and the—in Gibson's view, misguided—attempt to combine them into a single unitary concept.

4.2. Olfactory Types and Occurrences

In order to make progress with the physiological and experiential questions, we need to answer these in a way that allows not only type-, but token-individuation of sensory channels and experiential modalities. As we have seen, the individuation of olfactory sensory channels depends upon physiological facts about sense-organs and the proximal stimuli for olfaction. For an organism to have multiple such channels of the same type would therefore require the existence of multiple physiological mechanisms for detecting olfactory proximal stimuli that employ the same method of information uptake. As with the individuation of sense-organs, this is an empirical question that is best answered by biological and evolutionary science. I will therefore refrain from taking a firm stance on this here other than to note that the orthonasal and retronasal pathways seem at least plausible candidates for sensory channels, albeit ones whose physical realisations substantially overlap. Thus a version of R_{token} remains a viable view of olfactory sensory channels.

The individuation of experiential modalities, on the other hand, belongs primarily to the domain of philosophy and psychology. According to the dual-concept framework, the types of olfactory experience that occur in humans is determined by the phenomenology and psychophysics of olfaction. Here it is more difficult to understand what could constitute multiple occurrences of the same experiential modality type, since if the phenomenal characters of two experiences were wholly indistinguishable, we might naturally conclude that they are necessarily experiences of

the same type. This, along with the alleged ambiguity of our everyday use of the word 'sense', perhaps explains the seeming uncanniness of the token-individuation question in relation to experiential modalities noted in §2.2. However, multiple tokens of experiential modalities are nevertheless possible where these differ along one or more dimensions, or are capable of occurring simultaneously. Two token visual senses differentiated only by their spatial content, but which are otherwise phenomenologically indistinguishable, would constitute such a case. Other criteria, such as those listed in §2, then come into play in determining whether such an arrangement constitutes multiple occurrences of a single (e.g. visual) type, or multiple types, as seems more plausible in the case of the spookfish and Grice's Martian.

If we restrict ourselves to purely olfactory experience, however, there appears to be relatively little difference in the phenomenology of orthonasal and retronasal olfaction. As noted above (3.1.3, 3.2.1–2), those differences in perceived location and intensity that do exist can readily be accommodated within a single experiential modality, as is uncontroversially the case for vision, audition, and touch. Moreover, as both Rozin and Smith point out, despite—or perhaps because of—retronasal olfaction's role in flavour perception, it often goes unnoticed as a distinctive form of olfactory experience. This suggests that the relevant experiential distinction is not between orthonasal and retronasal olfaction *per se*, but between orthonasal 'smell' and multimodal flavour experience, i.e. 'taste'. While the latter includes a substantial contribution from retronasal olfaction, it is not one that can be readily isolated via introspection. This does, however, help to explain the felt similarity between certain odours and flavours, since both share a common olfactory component and overlapping quality space (cf. Smith 2015, p. 339). A version of R_{type} therefore seems the correct view of olfactory experience, which includes flavour, independently of the individuation of olfactory sensory channels.

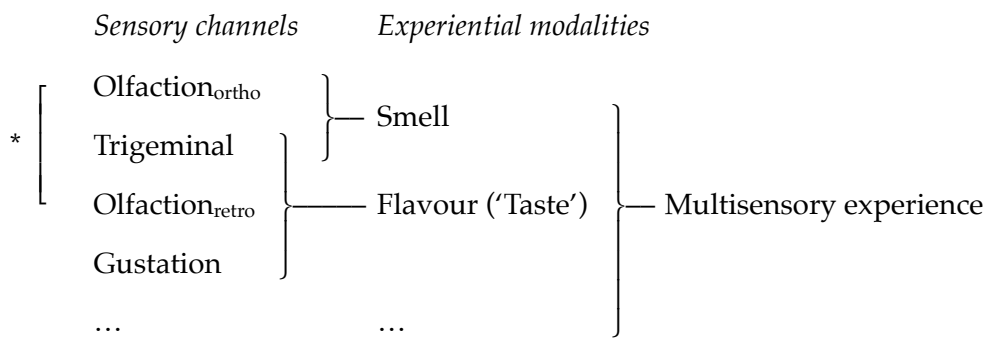


Figure. 1

Depending on the empirical evidence, then, there are either one or two olfactory sensory channels which, along with trigeminal and other sensory channels, give rise to both smell and flavour experiences. This yields the partial taxonomy of the chemical senses illustrated diagrammatically in *Figure 1*, which shows the mapping between the two kinds of 'senses' posited by the dual-concept framework. (The asterisk indicates that the relevant token modalities may or may not be identical, with ellipses indicating other sense-modalities.) Furthermore, both smell and flavour, aka 'taste', form part of more complex multisensory experiences involving visual, auditory, tactual, and/or other experiential components. Indeed, it remains an open question whether there are any truly unisensory experiences, or whether all perceptual experiences are effectively multisensory. Both possibilities, however, can readily be accommodated within the Gibsonian framework.

4.3. *Objections*

In this section I consider three objections to the dual-concept view of sensory individuation set out above, and compare it to contemporary pluralist and fine-grained approaches.

The first objection is that dual-concept framework simply leaves the problem of how to individuate olfactory and other modalities untouched. Indeed, it replaces it with two such problems concerning the individuation of sensory channels and

experiential modalities, respectively. Since each of these ultimately requires the use of individuation criteria such those listed in §2, it suffers from the same difficulties in selecting and precisifying those criteria as more traditional views, and so the problem remains.

In response to this worry I would point out three things. First, by subdividing the problem of how to individuate sensory modalities into what are arguably two more manageable issues, the dual-concept framework makes a significant contribution towards articulating a comprehensive and scientifically accurate account of human sensory systems. While this does not resolve all the issues surrounding sensory individuation, including the precisification of various criteria, it offers a simple and effective conceptual framework within which questions about multisensory processing and experience can more accurately be formulated and addressed, and so represents genuine progress on these issues. Second, by providing a principled reason to divide the available criteria along physiological and experiential lines, the dual-concept framework answers the question of what happens when these criteria pull in different directions, as in the case of olfaction. This in turn clarifies both which criteria and what kinds of evidence are relevant to each form of sense-modality, thus resolving a potential source of problems for multi-criteria approaches. Third, the dual-concept framework diagnoses the historical disagreement between and among philosophers and scientists on this issue as being due to a failure to recognise two distinct, but mutually complementary, notions of a sense-modality in favour of pursuing a unitary single-concept account. As such, it offers a novel, but powerful, response to the individuation problem, albeit one whose details require further explication.

The second objection concerns the alleged ambiguity of our everyday concept of a sense. Why should we think that there are two, and only two, such notions? Though the merits of the dual-concept framework are largely independent of claims about ordinary language usage, it is not unusual for folk-psychological concepts to be

ambiguous. Indeed, some relevance theorists argue that *all* substantive linguistic terms are polysemous, and so have multiple meanings (Carston 2012). It should therefore not be surprising that our everyday concept of a 'sense' fails to precisely track the philosophical distinction between sense-modalities, or either of the conceptions that Gibson identifies. Nevertheless, disagreement in the philosophical and scientific literature attests to the controversial nature of this concept, as well as to a certain duality in its application. It is natural, for example, to move from talking of experiential to physiological 'senses' when it is pointed out that much of the flavour of food comes from 'smell' (i.e. the retronasal olfactory channel) and not 'taste' (i.e. the gustatory channel). Yet we also say that we savour food by *tasting* it (in the experiential sense), since English has no equivalent verb for flavour. Precedent can therefore be found for both of the Gibsonian conceptions in ordinary usage.

It is important, however, to differentiate the dual-concept framework from the idea that there are rival folk-psychological and scientific concepts of a sense. Call this the *folk/expert view*. Rather, what is novel about Gibson's view is that neither of the two conceptions he posits has explanatory priority. In contrast to the folk/expert view, along with various forms of non-naturalism according to which the referents of the senses depend, if they refer at all, upon our linguistic conventions (Nudds 2011; Richardson 2013) or pragmatic considerations (see below), the dual-concept framework emphasises that both conceptions are required in order to give a full account of human sensory systems. Consequently, *pace* Richardson (*op. cit.*), both folk and scientific usage can be wrong about, for example, the individuation of taste or smell, and so liable to revision in light of empirical evidence.

The final objection concerns whether the proposed view is genuinely distinct from pluralist accounts according to which there is no single privileged way of individuating the senses, but rather a multitude of possible ways. Fulkerson (2014a), for example, advocates a form of pragmatism in which sense-modalities are relativised

to some explanatory project or theoretical goal, and so not mind-independent natural kinds. Psychologists and biologists, for example, typically employ different individuation criteria to the layperson and each other, according to their explanatory and communicative interests. As such, philosophers who agree upon all the physical and experiential facts, but disagree about whether there are, for example, one or two olfactory senses, are simply talking past each other. Fulkerson's view thus amounts to a form of *contextualism* about the concept of a sense-modality according to which there is, strictly speaking, no fact of the matter about which notion of a sense is the correct one. Instead, theorists simply appeal to whichever notion is most the useful or relevant for their specific purpose.

A different form of pluralism is advocated by Macpherson (2011, 2015), who argues that instead of choosing some specific criterion or set of criteria, we should combine all the available criteria to construct a complex multidimensional space of possible modality-types. This abstract space is then reduced to the minimum number of dimensions required to capture the relevant distinctions using principal component analysis — a statistical technique that eliminates redundant information. Each possible and actual sense-modality type is then identified with the corresponding subregion of the resulting multidimensional space, with coarse- and fine-grained modality types occupying overlapping regions. While it is unclear whether Macpherson thinks we have multiple *concepts* of a sense, as per Fulkerson, or a single highly flexible concept,²⁸ in contrast to the dual-concept framework, her approach aims to incorporate a plurality of individuation criteria within a unitary account of modality types.

While a dual-concept approach can to some extent be accommodated by each of these forms of perceptual pluralism (to use Fulkerson's term), there remain several important distinctions. While pluralism doesn't preclude certain methods of

²⁸ Some of Macpherson's remarks, e.g. Macpherson (2011, p. 22), seem to suggest the latter.

individuation being more useful or important than others — in scientific explanation, for example — it does not accord any special status to the Gibsonian conceptions of a sensory channel or experiential modality. Similarly, on Macpherson's account, this distinction cross-cuts the space of possible modality types, since each relates to a subset of the traditional individuation criteria. Nor does pluralism help to explain why both of these conceptions are essential components of a comprehensive theory of human sensory systems. Indeed, by combining the Gibsonian notions into a single calculus, pluralism arguably only serves to obscure this crucial distinction, which does not emerge naturally from either account, even if it can be retrofitted in an *ad hoc* or contrived manner.

Finally, both forms of pluralism focus only upon type-individuation and are silent on token-individuation. Though Macpherson is undoubtedly sensitive to both, her view does not readily apply to the latter, and so fails to explain the essential interdependence of these two questions. In contrast, by dividing the available criteria into distinct physiological and experiential domains, the dual-concept framework makes it intelligible both (a) how each domain can admit of multiple 'tokens', or occurrences, and (b) how the relevant type- and token-individuation criteria are connected. While one can always devise finer-grained taxonomies that may have a certain theoretical interest, all other things being equal we should aim for the simplest explanation any given phenomenon. By highlighting the distinction and relationship between two very different conceptions of a sense-modality, the dual-concept approach manages to combine a low degree of complexity with a high degree of explanatory power. As such, it represents an advance upon both pluralism and the traditional kinds of responses to the individuation problem that have dominated philosophical thinking on this topic since antiquity.

5. Conclusion

I have argued that the question of whether orthonasal and retronasal olfaction constitute one or two distinct 'senses' is ambiguous between the existence of distinct *sensory channels* — an issue that turns upon empirical evidence concerning the physiological and neurological mechanisms employed during orthonasal and retronasal olfaction—and distinct *experiential modalities*, an issue that depends upon the phenomenal character and/or representational content of olfactory experience. While current empirical evidence is inconclusive on the former, reflection upon the phenomenology of olfaction suggests that humans have one experiential modality dedicated to *smell*, this consisting of orthonasal olfaction plus the trigeminal sensory channel, in addition to a multimodal *flavour* modality, commonly known as 'taste', to which retronasal olfaction makes a significant contribution.

If this view of sensory individuation is correct, then the duality of olfaction is not between distinct olfactory *senses*, but two different conceptions of a sense-modality. As Gibson recognised, the resulting conceptions should not be understood as offering competing views of sensory individuation, but as mutually complementary elements of an overarching account of human sensory architecture — a comprehensive explanation of which requires both. This requires splitting our naïve and somewhat confused pre-theoretical conception of a 'sense' into two distinct concepts corresponding to the Gibsonian notions of a sensory channel and experiential modality, respectively. The resulting 'dual-concept' framework thus offers a novel and powerful response to the problem of individuating the senses that helps to clarify both the nature of olfaction and articulate the relation between the physiology and phenomenology of sensory experience more generally.

Acknowledgements

Thanks to Barry Smith, Charles Spence, Fiona Macpherson, Ophelia Deroy, Solveig Aasen, audiences at the Universities of Edinburgh, York, Warwick, Sussex, Oslo, the European Society of Philosophy and Psychology, and an anonymous reviewer for *Synthese* for helpful comments and feedback. This work was supported by grants from the Arts and Humanities Research Council (grant number AH/L007053/1) and Norwegian Research Council (grant number 275465).

References

- Aristotle (350 BC). *On the Soul*. In *The Complete Works of Aristotle: The Revised Oxford Translation*, Book 2, chs. 6–12 & Book 3, chs. 1–2, ed. Jonathan Barnes, Princeton, NJ: Princeton University Press, 1984.
- Auvray, Malika, and Spence, Charles (2008). The Multisensory Perception of Flavour. *Consciousness and Cognition*, 17: 1016–31.
- Bartoshuk, Linda M., Sims, Charles A., Colquhoun, Thomas A., & Snyder, Derek J. (2019). What Aristotle Didn't Know About Flavor. *American Psychologist*, 74(9), 1003–11.
- Batty, Clare (2014). Olfactory Objects. In D. Stokes, M. Matthen & S. Biggs (Eds.), *Perception and Its Modalities* (pp. 222–45). New York: Oxford University Press.
- Block, Ned (1996). Mental Paint and Mental Latex. *Philosophical Issues*, 7, 19–49.
- Brewer, Bill (2006). Perception and Content. *European Journal of Philosophy*, 14(2), 165–81.
- (2011). *Perception and Its Objects*. Oxford: Oxford University Press.
- Briscoe, Robert E. (2019). Bodily Awareness and Novel Multisensory Features. *Synthese*, 20(1), 1–29.
- Burge, Tyler (2010). *Origins of Objectivity*. New York: Oxford University Press.
- Byrne, Alex (2001). Intentionalism Defended. *The Philosophical Review*, 110(2), 199–240.
- Campbell, John (2002). *Reference and Consciousness*. Oxford: Oxford University Press.
- Carston, Robyn (2012). Word Meaning and Concept Expressed. *The Linguistic Review*, 29(4), 607–23.
- Chalmers, David (1996). *The Conscious Mind*. Oxford: Oxford University Press.
- Diaz, M. E. (2004). Comparison Between Orthonasal and Retronasal Flavour Perception at Different Concentrations. *Flavour and Fragrance Journal*, 19, 499–504.
- Fulkerson, Matthew (2014a). Rethinking the Senses and their Interactions: The Case for Sensory Pluralism. *Frontiers in Psychology*, 5, 1–14.
- (2014b). *The First Sense: A Philosophical Study of Human Touch*. Cambridge, MA: MIT Press.
- Gibson, James J. (1966). *The Senses Considered as Perceptual Systems*. Boston: Houghton Mifflin.
- (1979). *The Ecological Approach to Visual Perception*. Boston: Houghton Mifflin.
- Grice, H. P. (1962). Some Remarks About the Senses. In R. J. Butler (Ed.), *Analytical Philosophy*, First Series. Oxford: Basil Blackwell.
- Hardin, C. L. (1988). *Color for Philosophers: Unweaving the Rainbow*. Indianapolis: Hackett.

- Heilmann, Stephan, & Hummel, Thomas (2004). A New Method for Comparing Orthonasal and Retronasal Olfaction. *Behavioral Neuroscience*, 118(2), 412–19.
- Jacob, Tim (2002). The Olfactory Sensory System. In D. Roberts (Ed.), *Signals and Perception: The Fundamentals of Human Sensation* (pp. 297–308). Houndmills: Palgrave Macmillan.
- Landis, B. N., Hummel, T., Hugentobler, M., Giger, R., & Lacroix, J. S. (2003). Ratings of Overall Olfactory Function. *Chemical Senses*, 28, 691–94.
- Lim, Juyun, & Johnson, Maxwell B. (2011). Potential Mechanisms of Retronasal Odor Referral to the Mouth. *Chemical Senses*, 36, 283–89.
- (2012). The Role of Congruency in Retronasal Odor Referral to the Mouth. *Chemical Senses*, 37, 515–21.
- Lycan, William (2014). The Intentionality of Smell. *Frontiers in Psychology*, 5(436), 1–8.
- Macpherson, Fiona (2011). Introduction: Individuating the Senses. In F. Macpherson (Ed.), *The Senses: Classical and Contemporary Readings* (pp. 3–43). New York: Oxford University Press.
- (2015). The Space of Sensory Modalities. In D. Stokes, M. Matthen & S. Biggs (Eds.), *Perception and Its Modalities* (pp. 432–61). Oxford: Oxford University Press.
- Martin, M. G. F. (2002). The Transparency of Experience. *Mind and Language*, 17, 376–425.
- Matthen, Mohan (2015). The Individuation of the Senses. In M. Matthen (Ed.), *The Oxford Handbook of Philosophy of Perception* (pp. 567–86). Oxford: Oxford University Press.
- McGurk, H., & MacDonald, J. (1976). Hearing Lips and Seeing Voices. *Nature*, 264, 746–48.
- Mizrahi, Vivian (2013). Sniff, Smell, and Stuff. *Philosophical Studies*, 171(2), 233–50
- Moskowitz, H. R., Dravnieks, A. & Klarman, L. A. (1976). Odor Intensity and Pleasantness for a Diverse Set of Odorants. *Perception & Psychophysics*, 19(2), 122–28.
- Nagel, Thomas (1974). What Is It Like to Be a Bat? *The Philosophical Review*, 83(4), 434–50.
- Nudds, Matthew (2011). The Senses as Psychological Kinds. In F. Macpherson (Ed.), *The Senses: Classic and Contemporary Philosophical Perspectives* (311–40). New York: Oxford University Press.
- O'Callaghan, Casey (2015). The Multisensory Character of Perception. *The Journal of Philosophy*, 112(10), 551–69.
- Olender, T., Waszak, S. M., Viavant, M., Khen, M., Ben-Asher, E., Reyes, A., Nativ, N., Wysocki, C. J., Ge, D., Lancet, D. (2012). Personal Receptor Repertoires: Olfaction as a Model. *BMC Genomics*, <https://doi.org/10.1186/1471-2164-13-414>
- Richardson, Louise (2011). Sniffing and Smelling. *Philosophical Studies*, 162(2), 401–19.
- (2013). Flavour, Taste and Smell. *Mind and Language*, 28(3), 322–41.

- (2018). Odours as Olfactibilia. In T. Crowther & C. Mac Cumhaill (Eds.), *Perceptual Ephemera* (pp. 93–114). Oxford: Oxford University Press.
- Rozin, Paul (1982). 'Taste–Smell Confusions' and the Duality of the Olfactory Sense. *Perception & Psychophysics*, 31(4), 397–401.
- Small, D. M., Voss, J., Mak, Y. E., Simmons, K. B., Parrish, T., & Gitelman, D. (2004). Experience-Dependent Neural Integration of Taste and Smell in the Human Brain. *Journal of Neurophysiology*, 92(3), 1892–903.
- Small, D. M., Gerber, J. C., Mak, Y. E., & Hummel, T. (2005). Differential Neural Responses Evoked by Orthonasal versus Retronasal Odorant Perception in Humans. *Neuron*, 47, 593–605.
- Smith, Barry C. (2015). The Chemical Senses. In M. Matthen (Ed.), *The Oxford Handbook of Philosophy of Perception* (pp. 314–52). Oxford: Oxford University Press.
- (2016). The Nature of Sensory Experience: The Case of Taste and Tasting. *Phenomenology and Mind*, 4, 212–27.
- Spence, Charles, Auvray, Malika, & Smith, Barry (2014). Confusing Tastes and Flavours. In D. Stokes, M. Matthen, and S. Briggs (Eds.), *Perception and Its Modalities* (pp. 274–74). Oxford: Oxford University Press.
- Wagner, H. J., Douglas, R. H., Frank, T. M., Roberts, N. W., Partridge, J. C. (2009). A Novel Vertebrate Eye Using Both Refractive and Reflective Optics. *Current Biology*, 19(2), 108–14.
- Wilson, Keith A., & Macpherson, Fiona (2018). 'The Senses'. In D. Prichard (ed.), *Oxford Bibliographies in Philosophy*. New York: Oxford University Press. <https://doi.org/10.1093/obo/9780195396577-0368>
- Wilson, Keith A. (ms). 'The Auditory Field: The Spatial Structure of Auditory Experience'. Manuscript submitted for publication.
- Young, Benjamin D., Keller, Andreas, & Rosenthal, David (2014). Quality-Space Theory in Olfaction. *Frontiers in Psychology* 5.