

Smell identification and the role of labels

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Abstract

There has recently been a re-evaluation of our sense of smell, which is now considered a very sensitive and discriminating sense modality by scientists and philosophers. However, the consensus in the literature is that humans, and certainly Western subjects, are very poor at identifying smells: they produce the ‘veridical label’ for an odour in just 30-50% of cases and there is wide inter-subjective variation in their responses. This suggests that we rarely know what we smell. Is this the right conclusion to draw from the evidence? This paper takes a closer look at the empirical evidence on the smell naming performance of Western subjects and argues that a comparative model of olfactory language and categorisation is more effective at explaining the evidence than a model on which each smell kind is supposed to correspond to one label. One result of applying a comparative model is that we are not quite as poor at naming smells as the commonly cited data would suggest. Another result is a better understanding of the kinds of knowledge we may gain by smelling and how these relate to the linguistic resources, experiences, and practices of different speakers and communities.

Keywords

smell, olfaction, identification, labels, olfactory language

1. Introduction

Historically, our sense of smell has been deemed informationally impoverished, not very discerning, subjective, ineffable, and generally of little value (for an overview, see e.g. Batty, 2019; Barwich, 2020; Majid, 2021). In recent years, we have witnessed a radical revision of this view. Olfactory science has revealed that human olfaction is actually very powerful, with evidence that we are capable of detecting and discriminating a very high number of different molecular compounds, sometimes at very low concentrations (e.g. Laska, 2011; Young et al., 2014).¹ Philosophers now recognise that olfactory experiences, while different from visual ones, are not mere sensations, but exteroceptive perceptions capable of presenting us with aspects of our environment (e.g. Batty, 2010; Barwich & Smith, 2022). Finally, research on non-Western languages has refuted the universality of the claim that smell is incapable of linguistic expression. This claim stems from a focus on Western languages, which lack a dedicated olfactory lexicon. However, Aslian languages such as Jahai and Maniq, spoken by hunter-gatherer communities, have rich olfactory lexica: “abstract” words which designate qualities and apply to diverse objects and substances, are specific to smells, and are used confidently and consistently in everyday contexts (e.g. Wnuk & Majid, 2014; Majid & Burenhult, 2014; Levinson & Majid, 2014).² For instance, Jahai includes one word “for the smell of petrol, smoke, bat droppings and bat caves, some species of millipede, root of wild ginger, leaf of

¹ The estimated magnitude of discriminable odourants is debated, but Young and colleagues note that the majority of the 166 billion molecules with 17 or less atoms that have been studied has a smell that can be distinguished from that of all others; additionally, mixtures of chemicals smell different from the sum of their components (Young et al., 2014).

² Thai speakers also consistently use a range of smell descriptors (Wnuk et al., 2020), though some are generic terms for pleasant and unpleasant smells, similar to the English ‘fragrant’ and ‘stinky’, and some are compounds formed with those generic terms.

gingerwort, wood of wild mango, among other odor sources” (Majid & Burenhult, 2014, p. 267).

In the context of this re-evaluation of our sense of smell, there remains one significant exception. The consensus in the literature is that humans are generally very poor at identifying and naming smells. This claim may resonate with some of us, as the experience of smelling a new shower gel or spice mix and struggling to put the smell into words is common. But according to many experiments, people are really bad even with familiar smells, such as lemon, peanut butter, garlic, or mint. A recent review summarises the results of the vast literature on the topic: “it has repeatedly been shown that correct naming performance for a set of common everyday odors rarely exceeds 50% [...], and this number is considerably lower for more unfamiliar and uncommon odors” (Jönsson & Olsson, 2012, pp. 115-116). Some studies found that on average subjects used the “veridical label” (e.g. ‘lemon’ for lemon odour) in 50% to 60% of trials (e.g. Cain, 1979; De Wijk & Cain, 1994), but much lower rates of successful naming have been reported even for supposedly familiar odours, for instance less than 40% (Cameron et al., 2016), 37% (Distel & Hudson, 2001), or even 26.3% (Huisman & Majid, 2018). Cross-linguistic research indicates that an exception should be made for speakers of those Aslian languages with specialised olfactory lexica, who are by far superior to Western subjects in producing correct and intersubjectively consistent labels (e.g. Majid & Burnehult, 2014).³ When it comes to Western speakers, however, some suggest that we should more aptly speak of an inability, rather than an ability, to name olfactory stimuli (Jönsson & Olsson, 2012, p. 115).

³ This is a guarded exception, with some researchers pointing out that these subjects’ smell naming performance is still significantly inferior to the colour naming performance of Western subjects (Olofsson & Pierzchajlo, 2021).

Most relevant data concerns labelling performance, i.e. performance in producing a label or ‘name’ in response to an olfactory stimulus. But there are some reasons to think that subjects struggle with olfactory identification, not just with retrieving and producing a verbal label. Subjects who cannot name a smell report being familiar with it; sometimes, they also experience a “feeling of knowing” what the smell is and that they will soon retrieve the name — a so-called “tip-of-the-nose” experience (e.g. Lawless & Engen, 1977; Cain et al., 1998; Jönsson et al., 2005). However, unlike in typical tip-of-the-tongue experiences — say, when a face looks familiar but the person’s name just escapes us — subjects do not seem to have any information about the word itself — e.g. first letter, length, synonyms (Lawless & Engen, 1977; Jönsson & Olsson, 2003). Subsequently retrieving the name is less frequent (Jönsson et al., 2005), and when this does not happen subjects report only limited information about the stimulus, such as odour category, what the source could be, if it is edible, or where the odour could be found (Lawless & Engen, 1977; Engen, 1987; Stevenson & Mahmut, 2013; Jönsson & Olsson, 2003).⁴ As Jönsson and Olsson put it, tip-of-the nose experiences arise “when attempting to realise that the present odor comes from, for example, cinnamon, rather than from attempting to recall that this red-brown piece that I already know is called ‘cinnamon’”(2003, p. 657).

If we are so bad at olfactory identification, a natural conclusion is that we rarely know what we are smelling. On the face of it, this would be a serious limitation of the recent claims on the power and significance of our sense of smell. What use is our subtle olfactory detection

⁴ The earlier studies report that information about the odour and its source is available to subjects who cannot name the odour, while the later studies report that this information is very limited. The evidence is difficult to conclusively assess also because responses are not always scored for accuracy (Jönsson & Olsson, 2012, p. 126).

and discrimination, one might think, if we are not even in a position to tell that we are smelling lemons or peanut butter when we do?

In this paper, I take a closer look at the empirical literature on the olfactory naming performance of Western subjects, with the goal of better understanding what kind of identification abilities, and thus potentially what kind of knowledge of what they are smelling, these subjects have. To achieve this goal, I argue, we need to investigate the role of linguistic labels in identification. I propose to adopt a model of olfactory language and categorisation that goes beyond assessing subjects' capacities in terms of their choosing or failing to choose one 'veridical label' for each kind of smell. In Section 2, I discuss what can be learnt from subjects' naming responses that are considered wrong on the 'veridical label' model. I show how the alternative comparative model allows us to better account for some intuitions about the correctness of labels while respecting the inter-subjective variation in label choice. Against this model, there are reasons to partially re-evaluate the smell naming and identification performance of Western subjects. In Section 3, I discuss some lessons and implications for research in olfactory cognition: on how we should assess smell identification abilities, on the kinds of abilities and knowledge manifested in smell naming, and on explanations of Western subjects' comparative difficulties with smell naming.

2. Labels and similarities

2.1 Near and far misses

A key piece of evidence from studies on smell labelling or naming are responses which are classified as 'non-veridical'. While sometimes subjects will simply state that they cannot

name the smell, they often produce labels which do not match the ‘veridical’ one. For illustrative purposes, below are the two examples provided by Engen (1987): all responses for Johnson’s baby powder and for an artificial micro-encapsulated (scratch-and-sniff) lemony stimulus with assigned label ‘lemon’ – including the number of subjects who gave that response, when more than one.

Table 1

Johnson’s baby powder	Lemon (micro-encapsulated)
Correct (21)	Correct (12)
No response (6)	Don’t know (3)
Powder (3)	Air freshener
Soap (3)	Bathroom freshener
Air freshener	Berry, as in magic marker
Baby oil	Candy
Baby wipes	Citron, citrus
Rose	Citrus fruit
Suntan lotion	Hard candy
Tissue	Like pine
Toilet paper	Magic markers, special

Vanilla	Citrus, not a lemon or lime
Wax	Cleaner, Lemon Fresh Pledge
Band-Aid	Orange
Bubble gum	Nothing
Dentist's office	Some kind of fruit
Flower	
Hand lotion	
Man's perfume	

Looking at these two examples, one intuitive thought is that in many cases subjects seem to be 'getting something right'. For instance, while baby powder is not the same as baby wipes, and smells a bit different, it does not smell that different. Researchers have, to an extent, been sensitive to this observation. Following Cain (1979), non-veridical responses are sometimes classified into 'near misses', for instance saying 'grapefruit' for orange odour, 'nutmeg' for clove, 'disinfectant' for bleach, and 'far misses', which include answers that are too generic, such as 'spice' for garlic or for almond extract, or 'air freshener' for tea leaves, and specific but wrong answers, such as 'mustard' for garlic, or 'cheese' for machine oil (examples from Cain, 1979; Cain et al., 1998). But even when this distinction is made, only responses that match the veridical label are counted as successful identification – see e.g. the 26.3% reported by Huisman and Majid (2018).

Now, Johnson’s baby powder and lemon were probably familiar smells among the test subjects; other stimuli may result in many more far than near misses. Cain himself, however, already pointed out that *far* misses deserve our attention too:

Subjects may actually convey considerable semantic information even in far misses. [This term — for which we must take blame (Cain 1979) — has unfortunate consequences for on the surface it may imply just ‘junk’ answers.] (Cain et al., 1998, p. 321).

One sense in which far misses are not junk answers is that analysing them allows us to better understand what kind of linguistic resources subjects use in naming smells. These analyses confirm that speakers of Western languages typically appeal either to hedonic descriptors (e.g. ‘nice’, ‘bad’, ‘disgusting’) or to words for objects and substances that have or give off smells, that their answers, if allowed, will be fairly long, that uncertainty will be expressed, and that there will be very little inter-subjective agreement (e.g. Sulmont-Rossé et al., 2005; Majid & Burenhult, 2014; Huisman & Majid, 2018). Notably, the lack of agreement is not merely the result of using different but synonymous words, such as ‘citrus’, ‘citrusy’, and ‘citrus fruit’; rather, subjects often use words for very different kinds of things, such as pine, magic marker, orange, and Lemon Pledge cleaner.

There is another sense in which far misses may not be junk. Cain and colleagues noted how far misses often convey relevant information about the stimulus. This holds for generic answers, which mention a determinable of the ‘veridical label’: “if subjects give the answer fruit to lemon, they have by our definition made a far miss, though coming this close probably deserves more ‘credit’” (Cain et al., 1998, p. 321). But, they note, it also holds for more determinate labels. For instance, ‘baby wipes’ and ‘baby oil’ in response to Johnson’s baby powder intuitively convey relevant information about the kind of smell or its source. Other

odour naming studies typically report at least one example where researchers found a label other than the ‘veridical’ one to be appropriate. For instance, when French subjects responded to the smell of eugenol either with ‘odour of cloves’ or with ‘odour of dentist’, researchers noted that “those two names are equally valid”: eugenol is present both in cloves and in dental filling material (Sulmont-Rossé et al., 2005). Another example is Huisman and Majid’s (2018) choice of using ‘chlorine’ as the ‘veridical’ label for bleach in their experiment with Dutch subjects because ‘bleach’ was being used only by 3 out of 83 subjects. Sometimes, a label significantly different from the ‘veridical’ one has been classified as a near, rather than far, miss, as it was judged “erroneous yet appropriate” — e.g. ‘fennel’ for anise odour (Huisman & Majid, 2018).

These observations raise two questions which I aim at addressing. How can we explain the intuition that sometimes even far misses are cases where subjects ‘get something right’? This is not straightforward especially given the wide inter-subjective variation among answers classified as non-veridical. Moreover, given cases where we would judge that a label is appropriate even if it is not the ‘veridical’ one, are we in general justified in taking ‘non-veridical’ responses as demonstrating a failure of smell identification?

2.2 A comparative model of smell language and categorisation

There are two widely held claims in the literature on olfactory language and cognition: a) Western languages such as English, Dutch, German, and French lack specialised words for smells; and b) smells are often described using words for sources of smells (e.g. Dubois & Rouby, 2002; Levinson & Majid, 2014; Majid & Burenhult, 2014; Dufour & Barkat-Defra-

das, 2016; Kleiber & Vuillaume, 2016). In English, we use words for kinds of things that have or emanate smells, such as ‘chocolate’ or ‘apple’, for their non-olfactory properties, such as ‘mouldy’, ‘burnt’, or ‘sweet’, and for situations whether those odorous things are found, for instance talking of ‘bakery’, ‘forest’, or ‘Christmas’ smells. This quote from Holley (2002) illustrates the point with reference to perfumery practice:

In some cultural practices, such as those exemplified by perfumery, odors become dissociated from their sources insofar as their qualities rather than their referents are brought into focus. However, the linguistic tools available to a speaker remain those relevant to source naming, and because a vocabulary to describe pure qualities is almost nonexistent (at least in French and English), qualities must therefore be designated by the names of their most representative sources (2002, p. 19)⁵

In fact, this linguistic strategy is very common in everyday life, in contrast with how we talk about colours by means of specialised colour terms such as ‘red’, ‘yellow’, or ‘blue’. This difference was noted by Engen (1987), who observed that olfactory categories cannot be understood on the model of colour, where words correspond to specific qualities. Odour categorisation, Engen suggests, is comparative, making reference to sources and contexts where smells are found:

People do categorise odors, but not with semantically cohesive general nouns. Rather, they do it in terms of the similarity of odors and the similarity of the context or kind of object in which odors may be perceived (1987, p. 500)

⁵ Holley also says that “odor naming turns out to be odor-source naming”. The thesis I defend, following Martina (2022), is instead that we name, and talk about, odours using words for odour sources.

I have recently put forward an account of English smell reports, i.e. reports about the way things smell, which makes it explicit how source-based linguistic resources can be used to characterise olfactory quality. Taking as a starting point explicitly comparative reports such as ‘the perfume smells like lavender’, I argue that many smell reports are implicitly comparative: “they characterise a smell in terms of its similarity to the characteristic smells of sources of smells that are salient within the linguistic community” (Martina, 2022, p. 2). For example, ‘the perfume smells like lavender’ means that the perfume has a smell which is relevantly similar to the smells characteristically had or given off by lavender. In line with the evidence on the lack of a specialised olfactory lexicon in languages like English, ‘lavender’ picks out lavender, the plant. The verb ‘to smell’ tells us that the comparison made by the report is with respect to smell; so the smell of the perfume is compared to the class of the characteristic smells that lavender has or gives off.

I have argued that the account can be applied more widely: to smell reports that are not explicitly comparative, and to reports that specify the comparison class in terms of various properties of sources of smells (e.g. ‘mouldy’, ‘ripe’), the material these are made of (e.g. ‘woody’, ‘metallic’), or their sensible properties perceivable in other senses (e.g. ‘sweet’, ‘warm’) (see Martina 2022, Sec. 2.1). For instance, ‘the peaches smell ripe’ and ‘spoiled milk has a sour smell’ are also comparative in import.

This analysis makes clear what the commitments of a smell report are. Reports such as ‘the perfume smells like lavender’, ‘the perfume smells lavender-y’ and ‘the perfume has a lavender smell’:

may be true of something that is not a lavender plant or flower or indeed does not contain any lavender matter — for instance, the perfume may be a completely artificial one. This

is so because the smell of the perfume can be relevantly similar to the characteristic smell of lavender independently of whether or not its source or bearer (the perfume) is of the F kind (lavender) (Martina, 2022, p. 4)

In other words, even though they feature source-based terms, smell reports are not claims about the nature of the source of a smell: they are descriptions of smells in terms of typical sources or non-olfactory properties of these sources. This is why we can say that a coffee smells like apricot and caramel, or that it has a dark chocolate smell, without saying that it contains these ingredients. We can thus talk about smells in English and similar Western languages in spite of the limitations of our lexicon.

While this is an account of reports, i.e. sentences, the key claims can plausibly be extended to linguistic responses to olfactory stimuli which are not full reports. Verbal responses such as ‘like chocolate’, ‘sweet’, ‘of lavender’, ‘mould’, ‘lemon-like’, or ‘burnt’ can be used to respond to questions like ‘what smell is this?’, ‘what does this smell like?’ and instructions such as ‘name this smell’ or ‘describe this odour’. Given this, I suggest that in the relevant contexts, even simple labels featuring words for odour sources and non-olfactory properties of these sources can be used to characterise smells by implicit comparison.

A comparative account of smell language has an important implication: different smell reports and labels, and in particular reports and labels that appeal to different comparison classes, can be true or correct characterisations of the very same smell. This is because the same smell can be similar to the characteristic smells of different sources, either in the same or in different respects. For instance, the smell of benzaldehyde may be equally well described as ‘almond’, ‘marzipan’, or ‘maraschino cherry’, which all have the distinctive almond-y smell (Lawless, 1991, pp. 53-54). Sometimes, different reports can highlight different notes in a

smell. Milk chocolate can be said to smell both milky and like cocoa, characterising the same smell as similar, in different respects, to creamy, sweet dairy products and to cocoa (Martina, 2022, p. 12).

There are many reasons why subjects may choose different reports or labels. Subjects may choose personal references (e.g. my grandma's house), or their paradigm for an object with a certain kind of smell may differ due to their environment or past experience. For example, speakers from different cultures may associate somewhat different smells with the label 'bakery': some sweet smells, some savoury, some spiced (Martina, 2022, p. 11). Moreover, research on olfactory categorisation shows that, partly because of the qualitative complexity of smells, which and how many categories subjects form depends on which similarity criteria and comparison class they deem salient in the context (e.g. Jraissaty & Deroy, 2021; Kurtz et al., 2000; Wise et al., 2000; Chastrette, 1998). As highlighted in a methodological review by Kaepler and Mueller (2013), factors such as variation in similarity criteria and paradigms, choice of comparison class, potentially subjective selection of labels by the experimenters, and personal associations are all relevant factors in studies on olfactory cognition that rely on linguistic evidence.

Engen's own suggestions about our odour categorisation strategies have similar implications. As Herz (2003) explains, Engen thought that our categorisation and naming of smells was best understood on a 'collocation' model, i.e. with reference to a semantic network "achieved through the association of lexical items that regularly co-occur" (2003, p. 595). For instance, 'onion', qua label for a smell, would not only be in proximity with its determinable 'vegetable' in the network, but also with 'garlic', 'pizza', and 'bad breath'. This has consequences for the correct use of these labels: "an individual may respond to the odor of onion, and may

be correct in each case by naming it onion, garlic, pizza, or bad breadth” (ibid.). This model also predicts that label choice will be sensitive to a subject’s past experience, to where and how they have encountered the smell they are naming.⁶

Assuming that a comparative model is plausible, we can now see how it can be helpfully applied to the results of odour naming experiments.

2.3 Labelling beyond the ‘veridical label’

Data on labelling or naming performance is typically obtained with reference to a ‘veridical label’ for each odorous stimulus. Some researches have criticised this approach on the grounds that the veridical label reflects either the experimenter’s expectations or, for artificial odourants, the choice of the manufacturer (Dubois & Rouby, 2002; Sulmont-Rossé et al., 2005). As a result, the chosen label sometimes finds little approval among experimental participants. For instance, in a cued identification study, where subjects choose from a list of labels, no subject chose the label ‘chocolate’ for the artificial chocolate flavouring presented — ‘caramel’ and ‘vanilla’ were preferred (Sulmont et al., 2002). But the problem is more general: there seems to be little agreement on descriptors for smells even outside of experimental settings, and Western languages lack a dedicated, widely shared smell lexicon. The typical approach of assessing identification against one ‘veridical’ label relies on this presupposition:

⁶ Engen (1987) connects the collocation model to the idea that episodic memory plays a distinctive role in olfactory cognition, claiming that “what is stored about odors is not likely to involve semantic categories... Rather, odor memory involves perceptually unitary episodes” (1987, p. 501). The comparative model proposed here is neutral on this issue: categorisation and label choice are affected by personal past experiences, but this does not per se show that identification is based on episodic memory specifically.

either subjects identify a smell as F, where F corresponds to that label, or they fail to identify the smell.⁷ This presupposition is unjustified. As we have seen in Section 2.1, the presupposition is already questioned in practice: researchers sometimes make an exception so as to be able to count multiple labels as equally appropriate (e.g. ‘clove’ and ‘dentist’ for eugenol smell). On a comparative model of olfactory language, these cases are not exceptions, nor do they have to be treated as incorrect but nonetheless appropriate. We have a systematic explanation of why multiple labels can be correct descriptors for the same smell: the same smell may be similar, in the same or different respect, to the characteristic smells of different kinds of things. A comparative model allows us to follow our intuitive correctness verdicts about specific cases while respecting the fact that there is genuine inter-subjective variation in what subjects identify a smell as.

Sometimes it is obvious that subjects are making reference to different odour sources which have olfactory qualities in common. For instance, the same smell can be similar to citron and Lemon-fresh Pledge cleaner (Table 1) — these are both things with a characteristic lemony smell. This is so even though the class of typical smells of Lemon-fresh Pledge is more restricted than the class of typical smells of lemon.⁸ Similar considerations apply to the autobiographical label ‘my mother's strawberry ice cream’ for strawberry odour (Sulmont-Rossé et al., 2005).

⁷ Dubois and Rouby worry that the ‘veridical label’ approach unjustifiably presupposes that there are names that really refer to odours. I do not think this is quite the problem: as we have seen, the words we do have, even if source-based, can be used to characterise smells, albeit comparatively.

⁸ Besides, given that the stimulus was an artificial odourant, we cannot exclude that the scented cleaner was even a better example than lemon for the kind of smell presented.

In other cases, one would be in a position to judge whether the comparative label is correctly used only if one is familiar with the smells of a variety of sources. For instance, if one is familiar both with the spice clove and with dental fillings, one would be in a position to associate the smell of eugenol with both kinds of source. Similarly, calling olive oil smell ‘seasoning of canned fish like canned sardines’ or flower smells ‘cleaning supply’ or ‘bathroom freshener’ (Sulmont-Rossé et al., 2005) can be understood if one is familiar with the relevant culture-specific references. Sometimes, one may find difficult to recognise the correctness of certain labels unless one has undergone a specific range of experiences, as in perfumery training. For example, a study found that while perfumers associate compounds benzyl acetate, methyl anthranilate and terpenyl acetate with jasmine, orange blossom and lavender, respectively, this is not so for non-experts, who select different labels for those compounds when presented with a list including ‘jasmine’, ‘orange blossom’ and ‘lavender’ (Prost et al., 2001). An interesting issue is that the effects of expertise and past experience do not simply affect the determinacy or specificity of the labels produced or chosen by a subject. Experts in a smell-related domain will be in a position to make more fine-grained distinctions and may use more determinate labels. However, some of the labels used by non-experts are extremely specific, for instance referring to specific brand-name products (e.g. Lemon-fresh Pledge).⁹ Here a comparative model allows us to map the relations of a smell to labels at different levels in a hierarchy of determinacy or abstraction.

⁹ As a reviewer pointed out, research on perceptual categorisation indicates that experts tend to categorise entities in a domain at a different level of abstraction than non-experts (e.g. bird experts would categorise a particular bird as ‘sparrow’, non-experts as ‘bird’, cf. Johnson & Mervis, 1997). This raises interesting questions about potential differences between visual and olfactory categorisation, and about the relation between labels and categories in the two domains.

In some cases, subjects may be focusing on a different respect of similarity than the one relevant to the comparison specified in terms of the ‘veridical label’. Relevant examples may be calling anise smell ‘fennel’, liquorice smell ‘anise’, bleach smell ‘chlorine’, or onion smell ‘garlic’ (Huisman & Majid, 2018; Sulmont-Rossé et al., 2005; Engen, 1987).¹⁰ Other examples may be ‘mustard’ in response to garlic odour, which highlights the pungency common to the typical smells of both kinds of source, and ‘like pine’ for lemon odour, which might focus on the freshness common to the typical smells of both pine and lemon. Sometimes the smell may be inherently multifaceted, thus affording different comparisons depending on what note one focuses on. Cain and colleagues suggest that this may be the case of ketchup smell being described as ‘radish’, ‘chutney’, ‘lemon’, and ‘mustard’ (Cain et al., 1998).

As Prost and colleagues (2001) point out, the reasons for the association need to be established on a case-by-case basis, as it may be grounded in common chemical compounds, qualitatively similar smells, or even conceptual associations. A potential example of the latter is mustard being described as ‘pickles’ and ‘dill’: pickles and dill — and their smells — are frequently present in contexts (e.g. a sandwich or burger) in which mustard is (Cain et al., 1998). Of course, when labels are extremely personal, it may be difficult to establish what the comparison made is, and so whether it is apt. One such example is the description ‘paste that I used in elementary school, when I was 12 years old’ used for bitter almond smell (Sulmont-Rossé et al., 2005).¹¹

¹⁰ Interestingly, in the last study, 84% of subjects who had named liquorice odour as ‘anise’, chose the label ‘anise’ in a subsequent cued identification task even when the label ‘liquorice’ was available.

¹¹ This description is actually not so idiosyncratic: the authors of another study decided to include a French label referring to adhesive paste or glue as a second correct label for bitter almond smell (Sulmont et al., 2002).

The fact that the same smell can be associated with very different kinds of sources is also demonstrated by experiments on the effects of positively vs. negatively connoted linguistic labels. In these experiments, the same olfactory stimulus is presented with positive or negative labels across trials. For instance, violet leaf odour is labelled alternatively ‘fresh cucumber’ and ‘mildew’, and a solution of isovaleric and butyric acid ‘parmesan’ and ‘vomit’. Many subjects respond very differently depending on the label, giving different pleasantness and intensity ratings, associated memories, and descriptors, often without realising that they have been presented with the same stimulus — psycho-physiological responses such as skin conductance and sniff volumes also differ (Herz & von Clef, 2001; Djordjevic et al., 2008; Distel & Hudson 2001).¹² Notably, not all combinations of stimuli and labels elicit such different responses. For instance, responses to menthol, with labels ‘breath mint’ and ‘chest medicine’ was much less susceptible to label influence. The researchers hypothesise that different subjects found the match of menthol with one label significantly more appropriate than with the other — Herz and von Clef suggest that while a German subject reported being unfamiliar with menthol as used in chest medicine, US subjects experience menthol most typically in medicine than in candy (2001, pp. 388-389).

This evidence on ‘ambiguous’ smells shows that very different labels can be accepted as apt characterisations of the same odour, and that some matches are found to be more apt than others. Moreover, there is little reason to think that only one of the two alternative associations is ‘right’. For instance, it would be arbitrary to hold so that only ‘parmesan’ is a veridical label for the smell of isovaleric and butyric acid — in this case, there are even chemical

¹² It is controversial whether these different responses amount to changes in olfactory perception itself (e.g. Martina, 2021); this issue does not affect the current discussion.

grounds: those acids are present in both parmesan and vomit (Barwich, 2020, pp. 265-266). Indeed, the labels chosen in these experiments are often not the name of the actual odorous thing or substance presented, but refer to two kinds of things associated only by olfactory similarity. Consider, for instance, ‘banana bread’ and ‘nail polish remover’ for 2-heptanone, or ‘green mango’ and ‘hospital disinfectant’ for juniper berry — only almond extract was presented with the label ‘almond extract’ as one of the alternatives (Djiordjevic et al., 2008). This did not prevent those associations of labels and smell to be perceived as apt by subjects, which in turn made it possible to obtain effects due to the positive and negative connotation of the labels. The comparative model straightforwardly accounts for this evidence: the same smell can be correctly identified as the smell of different kinds of things, and thus can be correctly identified by using different labels.

3. Some lessons for the study of olfactory cognition

I have presented the comparative model of olfactory language and categorisation as more plausible and explanatorily powerful than a model on which there is a more straightforward correspondence between linguistic labels, categories, and successful identification. In this section, I outline some implications of adopting a comparative account of olfactory language for existing and future research on olfactory cognition.

3.1 Re-assessing our smell identification abilities

When we consider our labelling practice within a comparative model, we have grounds for a partial re-evaluation of the performance of Western subjects. Since matching the ‘veridical

label' is not necessary in order to correctly label a smell, and thus to linguistically express one's identification of the smell, a broader range of answers can be counted as correct. Sulmont-Rossé and colleagues reach a similar conclusion: "an identification index based on the veridical label, which does not take into account personal names, may underestimate the participants' ability to identify odors" (2005, p. 26). This is not to say that anything goes: we may want to discount some answers because they are too generic, for instance, and sometimes the answer may be unacceptable because the smells compared are just not similar enough (e.g. when using 'cheese' for motor oil). However, as the examples above illustrate, correct answers will include some answers usually classified as 'far misses'.

How much of a difference this re-classification of subjects' answers would make to rates of correct identification will likely depend on the stimuli and labels used. For example, Kaeppler (2019) reports that classifying 'near misses' – understood as "names of substances that are perceptually or semantically similar to the true odor source" – as correct changed the overall rate of correct identification in her sample from 37.59% to 58.75%. Given this, it may be that some of the very low rates of successful naming typically reported in the literature would need to be revised given a more inclusive re-classification of subjects' answers.

Whether this revision matters depends on our goals. It probably does not matter when we are comparing olfactory and visual identification – the former is clearly still much harder – or when we want to assess subjects' general olfactory capacities, for instance when the aim is to diagnose a loss of olfactory sensitivity. In fact, in the latter context, a simple cued identification task with four alternative labels is normally used. It may matter, though, when we are interested in estimating smell identification abilities of individuals and groups, including in cross-cultural and cross-linguistic comparisons, and when we want to understand how identi-

fication works and how it relates to perception and to language. With the latter goals in mind, the discussion in Section 2 motivates some recommendations and suggestions.

With respect to the results of existing research based on the ‘veridical label’ approach, a recommendation is that we move the focus away from the average correct identification rates usually reported and which are cited to motivate the claim that we are very poor at naming smells (see Introduction). Rather, we should focus on the more fine-grained and informative data that existing studies provide; these tell us, for instance, which stimuli were easier to identify, what kind of linguistic resources were used, how much inter-subjective variation there was, and to what extent subjects found the designated labels apt.¹³

When it comes to future research, a first suggestion is to assess subjects’ free identification performance against a wider range of labels, all considered ‘correct’, rather than against one label. This would ideally rely on a reference list of multiple labels for each of the odorous stimuli used, developed by investigating what labels a representative sample of subjects within a language and culture most often produces, agrees on, or finds apt for the stimulus. In general, accepting, as a rule, multiple labels for each stimulus as correct would allow researchers to better capture successful identification – as noted earlier, this is sometimes already done on occasion for obviously ‘ambiguous’ stimuli.

At the same time, it may help to incorporate a wider range of approaches beyond free naming tasks. An example methodologically in line with the present suggestions is offered by Sulmont-Rossé and colleagues (2005), who combine a repeated free naming task to assess whether subjects can re-identify a smell – whatever label they use – and a cued identification task

¹³ I discuss some of this evidence further in Section 3.3.

with a large range of labels to choose from (72) (see also Sulmont et al., 2002).¹⁴ The study found that the rate of successful cued identification was similar to the rate of repeated free identification. Given the key role of linguistic labels in smell identification performance, further research is also needed on smell language and its use within specific communities (see e.g. Huisman & Majid, 2018; Iatropoulos et al., 2018).

3.2 Identifying smells and sources

The comparative model allows us to get clearer on the role that source-based linguistic labels play in smell identification. As a result, we can gain insight into the kinds of identification abilities subjects may be exercising in using those labels, and thus into the kinds of knowledge they may manifest. Consider the claim, put forward by Jönsson and Olsson, that inability to name odours is likely “a consequence of not knowing exactly what it is that smells this way, that is, of a failure to identify the odor source” (2012, p. 117). In light of the data on labelling performance, they then conclude that there is, among Western subjects, “a lack of odor source knowledge” (p. 128). Is this the right conclusion to draw?

On one reading, odour source knowledge is knowledge of the actual source of the smell one is perceiving. This would be manifested in identifying the odorous object or substance one is actually presented with, for instance identifying by smelling that the thing under one’s nose is a lemon. If this is the identification ability that we want to assess, then there is only one correct label to be used, for instance ‘lemon’ – or, at most, a few labels with different levels of specificity, say ‘citrus fruit’. It may well be that the smell of this lemon is relevantly similar

¹⁴ Cued identification with very few alternative labels, the authors observe, is not the best way to investigate identification because subjects may proceed by elimination of alternative labels.

to the smell of oranges, a cleaning product, bathroom freshener, and pine, so that – on the comparative model – it can be correctly described with reference to all these sources; but the actual source is just one.

Knowing, by smelling, what one is actually smelling is certainly a useful kind of knowledge in everyday scenarios, and future research across disciplines should further investigate it. However, most experiments in the literature we discussed so far do not test whether subjects possess this kind of knowledge. Sometimes, the aim is explicitly different, as in the cross-linguistic literature where smell naming is typically compared to colour naming (e.g. Majid & Burenhult, 2014; Huisman & Majid, 2018). Here what matters is the ability to characterise the olfactory quality perceived, in response to questions such as ‘what smell is this?’ or ‘how does this smell?’. In many experiments, actual source identification is not what is *in fact* tested. This is because of the variety of odorous stimuli used — ordinary objects, oils and extracts, scented pens, scratch-and-sniff stimuli — and the diverse origin of the labels chosen — label chosen by other subjects in previous work, name given by the manufacturer, name coming from a list of perfumers’ descriptors — often within the same experiment. Here is an illustrative example: “with regard to the chemicals, the veridical labels were the names usually associated with their odor (e.g. mushroom for oct-1-en-3-ol), with regard to the essential oils, the flavors and the fragrances, the veridical labels were the names given by the manufacturer and with regard to the natural products, the veridical labels were the names of the product (bleach, olive oil, etc.)” (Sulmont-Rossé et al., 2005, p. 24). An answer scored as correct because it matched the expected label, then, did not coincide with the name of the actual source.

The comparative model allows us to shed light on what other kinds of knowledge subjects may manifest by using a label. First, subjects may manifest their knowledge of what kind of smell, i.e. what olfactory qualities, they are presented with. For instance, they may correctly identify the perceived smell as ‘rose’, whether it is produced by a rose, rose essence, or an artificial fragrance, or they may use either ‘clove’ or ‘dentist’ to identify the olfactory qualities in common to cloves and dental fillings. This is analogous to visually identifying the colour property common to a diverse range of objects, even though the linguistic resources available in Western languages to express knowledge of smell qualities will as a rule be source-based.

Second, by using the very same labels, subjects may manifest their knowledge of a likely or potential source of the smell they perceive. For instance, they may know that the current smell may be coming from a scented cleaning product as well as from a lemon; from dental filling paste as well as cloves; from parmesan as well as from vomit. This is arguably a kind of odour source knowledge, even if it does not amount to identification of the source or odorous thing that is actually present.¹⁵ Labelling performance may thus demonstrate an ability to identify sources by smelling, where this ability can, in the right context, allow one to identify precisely the actual source of the smell. In everyday contexts, identification by smelling is informed by contextual cues, including linguistic information, information from other sense modalities, and background knowledge. This constrains which odorous thing, among the potential sources that one is capable of associating with certain olfactory qualities, is the one

¹⁵ Sometimes, subjects identify an aspect or note in a qualitatively complex smell, say the apricot note in a coffee; they may convey that the current smell given off by coffee is similar to the smell to the typical smell of apricots just in some respects, without conveying that it is so similar overall that the current smell may be coming from apricots, rather than coffee. For a discussion of multifaceted smells, see Martina (2021).

that is actually present. If we are in a kitchen, for instance, facing a jar of dark brown, nail-shaped small objects, we would easily identify cloves by smelling. But given that many objects and substances we encounter in everyday scenarios do share some olfactory qualities, being in a position to associate that kind of smell to other sources too is very useful.

What the comparative account shows is that the kind of linguistic resources used by a speaker will not, on its own, reveal what kind of identification capacity is being exercised, and so what kind of olfactory-based knowledge may be ascribed to the speaker. Considerations about the context and the speakers' and audience's intentions and expectations will be necessary.¹⁶ This applies across linguistic and sub-linguistic communities. For example, wine and coffee tasters, which may form sub-linguistic communities within their language, may use source-based language primarily to describe the smells and flavours of wines and coffees, respectively: their intention is typically not to identify ingredients in these drinks. Perfumers, on the other hand, may sometimes be interested not only in describing the notes in a fragrance, but also in picking out formula ingredients. Speakers of languages such as Jahai and Maniq may use abstract, non-source-based terms for smells to describe smells — smells themselves are the focus of various cultural practices and beliefs —, but also in contexts where their interest is to identify certain non-olfactory properties of sources — to convey, say, that, based on how things smell, a certain animal should not currently be eaten (Wnuk & Majid, 2014).

Olfactory identification relies on strategies of linguistic expression and categorisation that may differ from those most typical of visual identification. Nonetheless, even the inter-subjectively varied and uncertain labelling performance of Western subjects at least sometimes reveals their knowledge of olfactory qualities and of likely, and actual, sources of smells.

¹⁶ On the different communicative uses of comparative language, see Martina (2022, Sec. 3).

3.3 Learning and linguistic practices

I suggested that the odour naming or labelling performance of Western subjects should be partly re-evaluated. However, this performance remains clearly different both from their visual naming performance — naming of properties like colours, or of visible objects like oranges — and from the odour labelling performance of speakers of languages with specialised olfactory lexica, such as Jahai and Maniq. As we have seen, English, Dutch, and French speakers find it harder to name smells than visible objects and pictures and, unlike the Jahai and Maniq, report uncertainty, use long descriptions, and exhibit significant inter-subjective variation. The third lesson I want to highlight concerns how we should explain Western subjects' relative difficulties with smell naming.

These difficulties been considered a puzzle and has even been described as the “most contentious issue in human olfactory processing” (Herz & Engen, 1996, p. 301). Various potential explanations have been advanced.¹⁷ Researchers have appealed to our neural architecture, hypothesising that olfactory perception and language processing areas of the brain are directly linked but poorly integrated, leading to olfactory information reaching semantic processing when only minimally elaborated (e.g. Olofsson & Gottfried, 2015). In line with explanations in terms of neuro-cognitive limitations, it has been proposed that olfactory perception and the conceptual-linguistic system employ representations with incompatible compositional formats (Young, 2020). Some alternative explanations appeal to limitations of our perceptual capacities. These explanations are controversial, especially in light of the current general re-

¹⁷ For further discussion of these explanations, see e.g. Majid (2021), Olofsson & Gottfried (2015), Jönsson & Olsson (2012).

evaluation of our olfactory perceptual capacities (see Introduction). On one view, the key function of olfactory perception is to determine hedonic valence, i.e. whether stimuli are pleasant or unpleasant; olfactory perception is not directed at discrimination of olfactory quality, and as a result at odour identification (e.g. Yeshurun & Sobel, 2010). Relatedly, discrimination and identification is deemed to be unimportant, with detection being the key function of olfaction (e.g. Köster, 2002). The hypothesis that olfactory discrimination is quite poor after all has also been proposed (Jönsson & Olsson, 2012).

In light of our discussion, the performance of Western subjects does not appear so puzzling. An observation that everyone agrees with is that Western subjects, as a rule, just do not learn how to talk about smells very much and are not often exposed to smell-related words.¹⁸ In contrast, colour words are over-learned from a very young age, and labelling by seeing, whether with real-life objects or pictures, is a huge part of formal and informal education. If we do not have much practice with talking about smells, it is no surprise that we find a lack of agreement with labelling smells, with past experience and cultural differences affecting our choices, and a general difficulty with this task. These variations and difficulties can be expected to be more significant in experimental settings, where we cannot rely on contextual information and other senses to narrow down the pool of potential sources for the smell we perceive. One can grant Jönsson and Olsson that a lack of social consensus around odour labels cannot on its own explain Western subjects' poor naming performance, because there generally is agreement about the names of familiar, everyday odorous objects (2012, p. 118). The issue is that agreement on these names is not enough unless we have practice in using those names to talk about smells.

¹⁸ Majid (2021) provides a summary of relevant studies.

Speakers who are superior at odour labelling and identification seem to have more practice with smell talk. Consider speakers of Aslian languages, for whom smells are much more important at least in part due to their hunter-gatherer mode of subsistence (Majid, 2021). Huisman and Majid raise precisely this hypothesis: “perhaps Jahai speakers talk about odors more frequently than English speakers do” (p. 584). Or consider experts such as wine tasters and Iranian herbalists, who identify smells that are relevant to their domain of expertise with greater precision and accuracy than laypeople, including people who are familiar with those smells because they encounter them often (Sezille et al., 2014; Croijmans et al., 2016; Poupon et al., 2019). Experts have distinctive perceptual skills, for instance they attend to smells more analytically than novices, they have much more conceptual knowledge, and they share standards of assessment, all of which will contribute to agreement in their descriptions (Smith, 2007). But a key feature that makes a difference to their odour naming performance seems to be practice with, and often formal training in, talking about the smells in their domain of expertise (Croijmans et al., 2016, p. 18).

If linguistic practices explain so much of the inter-subjective variation in labelling performance, then we should expect this performance to improve with practice among non-experts. And we have evidence that this is so. Even brief training with associating odours and labels, with feedback, results in improved identification, including improved free identification, i.e. where subjects need to produce the labels without cues (Desor & Beauchamp, 1974; Cain, 1979; Cain et al., 1998; Morquecho-Campos et al., 2019). Notably, mere familiarity with, and exposure to, the odours to be identified does not lead to similar improvements. While the actual smell naming performance of Western subjects is comparatively inferior, this suggests that there is significant potential given the right learning environment.

This idea is consistent with the broader literature on olfactory recognition and identification. First, performance improves dramatically in cued identification, when subjects choose from a list instead of self-generating a label. Reported cued identification performance rates, typically using 4 alternative labels, go from 76% (De Wijk & Cain, 1994), to 79% (Fusari & Ballesteros, 2008) and even to between 85% and 100% with familiar odours (e.g. Cain & Krause, 1979; Engen, 1987; Hummel et al., 2007; Nordin et al., 1998).¹⁹ Providing pictures of the object associated with the odour or coherent colours (e.g. red for cherry odour) also improves identification (e.g. Zellner et al., 1991; Kobayashi et al., 2008). Cued identification data tells us that subjects, in general, have the capacity to associate labels to smells.²⁰

Second, odour recognition memory, i.e. recognition that an odour has been smelled before, has been shown to significantly exceed identification performance (e.g. Lawless & Cain, 1975; Olsson et al., 2009; Frank et al., 2011). When subjects are also asked to name odours, either in cued or un-cued conditions, they almost always recognise across two trials odours that they named correctly twice, as well as odours they named consistently, even if with incorrect labels (Lehrner et al., 1999; Frank et al., 2011). This suggests that there are cognitive capacities in place that can provide scaffolding for odour identification and labelling.

¹⁹ Some of this data comes from research developing effective tests to diagnose impairments and disorders of olfactory sensitivity, such as anosmia and hyposmia, where cued identification is often taken as a proxy for olfactory discrimination capacities.

²⁰ Performance on an even simpler identification task suggests that these associations can be made quickly: when subjects are first presented with a label (e.g. ‘wood’), then with the odour, and only need to press a button to indicate whether the odour corresponds to the label, they can respond within 200 to 5000 milliseconds after stimulus delivery, with close to “ceiling-level” accuracy (Olofsson et al., 2012).

Third, there is dramatic variation in rates of correct free or un-cued labelling performance depending on the stimuli used, even when focusing on smells that are supposedly familiar to the subjects. Consider the following examples involving English speakers. Distel and Hudson (2001) reported that cinnamon and orange were identified by 71% of subjects while honey and rosemary only by 8% and 11% of subjects. Engen (1987) reports percentages of correct identification ranging from 27% for the rose-smelling phenylethyl alcohol to 75% for the branded Bazooka bubble gum, and from 0% for musk and 83% liquorice with scratch-and-sniff stimuli. The data by Cameron and colleagues (2016) also fits this pattern, going from peppermint with 90% accurate naming to shoe polish, which was ‘virtually impossible to name’ (see also Kaeppler, 2019). One might wonder whether ‘natural’ odorous objects and substances, such as actual honey, coffee, or roses, would make identification easier because their smells are richer and thus convey more information or simply because they are the kinds of sources we actually encounter in everyday life — as opposed to solutions in a jar, scented pens, or scratch-and-sniff cards. However, artificial everyday items produced by famous brands, such as Vick’s Vapo-Rub or Johnson’s baby powder are often much more consistently identified than natural objects (see e.g. Cain & Krause, 1979; Engen, 1987; Sulmont-Rossé et al., 2005; Huisman & Majid, 2018). One thought is that smells that are most often correctly identified are those for which subjects have more opportunities to form stable connections between the source, the smell, and a label – as may be with a common branded product with an exceptionally stable and distinctive smell.

Overall, the importance of linguistic practices suggests that there may be significant untapped potential, as opposed to a constitutive inability to come to know what we are smelling. Thus, while there may well be some neuro-cognitive limitations to the human ability to label

smells, we do not need to appeal to more committal explanations that question the powers of our olfactory quality discrimination in order to account for the evidence on labelling.

4. Conclusion

In this paper, I looked at our olfactory identification abilities through the lens of language. I argued that a comparative model of olfactory language and categorisation is more effective in explaining the empirical evidence than a model on which each smell kind is supposed to correspond to one label. A comparative model allows us to acknowledge cases where very different labels be correct, and may thus all manifest successful identification of a smell. One result is that the labelling and identification performance of Western subjects should be partly re-evaluated: we are not, after all, quite as poor as the data typically cited would suggest. Another result is a better understanding of the kinds of knowledge we may gain by smelling, and how they relate to the linguistic resources available to different speakers. Finally, we can account for a lot of the inter-subjective variation in naming ability as well as in label choice by appealing to factors such as training with naming smells, and past experience and familiarity with certain associations of smells, kinds of sources, and labels, without questioning the powers of olfactory perception itself.

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