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Olfactory language requires an integrative and interdisciplinary approach

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Olfaction was poignantly dubbed the "mute sense" by Diane Ackerman [1], and it is regularly claimed that modern and ancient languages lack resources to communicate about smells [2]. In a recent article [3], I argued that such conclusions are untenable in the face of emerging cross-cultural evidence: numerous languages around the world have sizeable lexicons for expressing smell qualities, smell can be encoded in grammar, smell talk is more frequent in some cultures, and under experimental conditions naming of odors can be comparable to naming of visual entities. Thus there is converging evidence from lexicon, grammar, discourse, and psycholinguistic experimental studies that together point to the same conclusion—the language faculty is amply equipped to express our experience of smell. It is a matter of speaking the right language.

Olofsson and Pierzchajlo [4] to the contrary conclude that odor naming is "uniquely poor" and to support this conclusion they discuss a study my colleagues and I conducted using a diverse sample of languages [5]. In that study, speakers from 20 languages named visual, auditory, tactile, gustatory, and olfactory stimuli, and we measured (among other things) consistency of naming. Olofsson and Pierzchajlo note that if you collapse over all languages, then naming agreement was lowest for smell and olfactory stimuli predominantly elicited source-based descriptors (e.g., *smells like banana*) which the analyses in our original paper had indeed demonstrated [5]. However, Olofsson and Pierzchajlo do not take into account that our study also provided evidence of an interaction between language and sensory modality. An interaction effect indicates that the relationship between an independent and

dependent variable is affected by a third variable—in this case, the relationship between sensory modality and naming agreement is a function of the specific language a person speaks. To illustrate, while English speakers showed high agreement for naming visual stimuli, they had low agreement for naming olfactory and gustatory stimuli. In contrast, Umpila speakers (Australia) showed highest agreement for naming olfactory stimuli, while Tzeltal speakers (Mexico) showed highest agreement for naming gustatory stimuli. Averaging across English, Umpila, and Tzeltal speakers, therefore, obscures the full picture. The languages show qualitatively distinct patterns. Similarly, the type of descriptor elicited for olfactory stimuli varied across cultures. Lao and Semai speakers were more likely than speakers of other languages to use abstract basic smell words over concrete source-based ones. Independently, other studies show that odor naming is comparable to visual naming for the Jahai [6] and Semaq Beri [7] of the Malay Peninsula—both sensory modalities elicit equally high naming agreement and equivalent rates of basic vocabulary. Taken together, the current data clearly demonstrate differences across cultures in odor naming abilities (see Box 1). An integrative theory of olfactory language has to account of this fact.

Olofsson and Pierzchajlo note that the real world provides multisensory contextual support that scaffolds the odor concept. I agree and have likewise argued so elsewhere [8,9]. I also agree that experimental studies will be crucial to adjudicate between different mechanistic accounts of olfactory language and its relation to other cognitive processes. For example, I argued [3] that the processing of odor valence is earlier than odor identification, whereas Olofsson and Pierzchajlo argue the opposite. The current data cannot adjudicate between these accounts because the previous experimental paradigms differ on too many dimensions. For conceptual clarity it is important to distinguish between affective valence (the direct experience of valence) and semantic valence (semantic categorization of valence) [10]. My claim is that the direct experience of valence always precedes categorization or identification. This seems to be borne out by recent data that demonstrates an initial, fast neural response to odor valence in the olfactory bulb that may itself be projected from olfactory receptor neurons [11]. This gives further credence to the idea that the direct experience of valence precedes odor identification. Careful future experiments will undoubtedly clarify this issue further.

Whatever the specifics in this case, I maintain that laboratory experiments will only be one part of research on olfactory language in the future. A cognitive science of olfaction must

provide a mechanistic account of the representations and processes at play in an individual mind. But it must also provide an account of global cross-cultural variation, historical patterns of language structure and use, and developmental learning trajectories within a person's lifetime. This means going beyond experiments towards a transdisciplinary approach that includes linguistic elicitation, text analysis, conversation analysis, ethnographic observation, case studies, surveys, computational approaches, and beyond. Putting things in context means looking at olfactory language in all its richness—and that means getting out of the lab too!

Box 1: Future directions for odor naming studies

Psychologists typically use pleasant odors in naming studies, in particular food and floral odors. This is due in part to methodological convenience and in part the applied focus of previous research. To definitively characterize odor naming abilities, however, we should not be limited to one corner of the total odor space. Odors should be representatively sampled. This is the logic underlying cross-cultural color naming studies where colors are sampled equally spaced over a non-linguistic color similarity space. Unfortunately, there is no definitive psychophysical odor similarity space making it infeasible to apply this approach to odor naming studies at the moment (although see [12] for exciting developments).

This focus on pleasant odors is likely skewing our understanding of olfactory language. Languages with basic smell terms all make more distinctions between types of unpleasant odors than types of pleasant odors. Unpleasant odors have distinct evolutionary relevance, and the brain rapidly processes warning signals from odors to prepare a behavioral response [11]. It is not surprising, therefore, that unpleasant odors are the most significant for people to communicate about. Whether unpleasant odors are also distinct in odor naming profiles (or discourse frequency) is currently unknown.

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