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Beyond smell: rethinking the figurative force of olfactory language

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Abstract: This study examines the usage, semantics, and affective valence of olfactory metaphors in English, addressing a gap in sensory language and metaphor research. We analyze eight basic smell lexemes (*smell*, *aroma*, *scent*, *odor*, *stench*, *stink*, *reek*, *fragrance*) in the iWeb corpus, tracing their abstract noun collocates through frequency counts, WordNet hypernym paths, intersection analysis, and affective valence ratings. Our results reveal that English olfactory metaphors are highly productive, mapping smell perception onto a broad array of abstract experiences, especially socioemotional and moral domains. The eight patterns exhibit pronounced affective polarization: while some (e.g., *fragrance*, *aroma*) skew positive, most (e.g., *stink*, *stench*, *reek, odor*) skew negative, reflecting both olfactory hedonics and a cognitive negativity bias. These findings deepen our understanding of how sensory language structures abstract thought and affirm the rich figurative potential of smell in English, with implications for theories of sensory language, conceptual metaphor, and embodied cognition.

Keywords: smell; olfactory metaphor; sensory language; emotion; morality

1 Introduction

Smell has long been regarded as the least cognitively significant of the senses in metaphorical language, especially in English, where it has been assumed to play only a marginal role in structuring abstract thought. This study challenges that assumption. Through a large-scale corpus analysis, we show that olfactory metaphors in

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English are not only productive, but deeply embedded in the conceptualization of emotion, social perception, and moral judgment. By systematically analyzing metaphorical patterns formed with smell-related lexemes, this research reveals the central role of olfaction in abstract cognition and offers new insights into how embodied sensory experience underlies the language of complex human experience.

Previous research on sensory perception in metaphorical cognition has often suggested that smell plays a minor role compared to other senses, especially vision (e.g., Caplan 1973; Sweetser 1990). Sweetser (1990: 43) argued that smell has "fewer and less deep metaphorical connections with the mental domain than the other senses," and therefore excluded smell from her proposed structure of perceptual metaphors. In an early study of English perceptual verbs, Caplan (1973) briefly addressed the metaphorical use of smell with the example *John smelled danger in the air*. He characterized this usage as having an "almost abstract meaning" but quickly dismissed it as being of little conceptual significance, highlighting what he saw as the general inability of taste and smell verbs to convey abstract meanings (Caplan 1973: 275). Caplan concluded that, unlike verbs related to vision, touch, and hearing, verbs of smell and taste lack semiotic complexity.

More recent research suggests that smell can serve as a conceptual source for certain social, epistemological, and emotional experiences. Cognitive linguistic studies across several European languages have shown that smell is often mapped onto target domains related to intuitive mental processes, such as guessing and suspecting (Ibarretxe-Antuñano 1999, 2019; Jarque and Pascual 2015; Kövecses 2019; LeFevre 2011). Kövecses (2019) further found that smell is associated with target domains of badness and undesirable atmospheres in English, carrying a negative evaluative meaning. Storch (2013) reported that Luwo, a Nilotic language of Sudan, conceptualizes knowledge in terms of odor. O'Meara and Majid (2020) showed that smell plays a role in both metaphorical and metonymic extensions in Seri, a language of northwestern Mexico. Notably, Seri conceptualizes negative emotions, such as anger, as a bad smell, a mapping previously unrecognized in the metaphorical conceptualization of emotions. While these studies point to cross-linguistic variability in olfactorily motivated metaphorical conceptualization, they have not challenged the assumption that smell is conceptually and figuratively insignificant.

In a recent cross-linguistic study focused on the grammatical coding of smell in Cha'palaa, a language of Ecuador, Floyd et al. (2017:188) noted that "it is striking how often English smell terms are used with a metaphorical meaning rather than a literal olfaction meaning." This observation, though made in passing and not based on systematic usage data, suggests that smell may have greater figurative potential in English than previously recognized (Majid 2021). This empirical possibility is especially worth pursuing in light of the extensive research on the biochemistry and neurobiology of olfaction, which highlights the high capability of human olfaction

and its essential adaptive functions (e.g., Bushdid et al. 2014; Hasin-Brumshtein et al. 2009; Haviland-Jones and Wilson 2008; Laska 2017; Lundström et al. 2017; McGann 2017; Sarafoleanu et al. 2009; Yeshurun and Sobel 2010).

While prior research has mapped smell onto certain social, epistemological, and emotional target domains, it has lacked the usage-based empirical analysis needed to fully understand the true figurative potential of olfactory language. O'Meara and Majid (2020: 386) emphasized the untapped potential of smell as a sensory source for abstract cognition and conceptualization and called for further research to "uncover patterns that may otherwise remain overlooked." They noted that the figurative potential of smell, "even in major languages," is still not fully understood.

To advance this understanding, systematic analysis based on extensive usage data is needed, particularly in English, where previous research has not thoroughly explored the usage patterns, productivity, and target domain semantics of olfactory metaphors. A glimpse into natural language usage, such as that found in the iWeb Corpus, reveals the pervasiveness of smell-based conceptualization of abstract experiences. Consider in (1)–(7) as examples:

(1) *Investors will smell inadequacy from a mile away if a team shows even the slightest pinch of poor partnership.*

(2) *I think there are too many websites out there that are very obnoxious and reek of desperation.*

(3) *You invest a lot of time and effort in coaching your players, and you can't wait for the sweet smell of success.*

(4) *The stench of corruption and collusion is palpable.*

(5) *When I leave a room do I leave an aroma of goodness and mercy behind me?*

(6) *With her disastrous romantic track record, the scent of failure tainted the relationship from the beginning.*

(7) *Apparently there is a smell of treason in the air. And the smell does not come from Russia.*

All of these examples involve a lexical item that denotes olfactory perception – *smell*, *reek*, *stench*, *aroma*, *odor*, or *scent*. For the purposes of this study, we refer to such smell-related lexemes collectively as "smellex," a term that encompasses both nouns and verbs associated with olfaction. As these examples illustrate, smellex terms serve as metaphorical source concepts that map sensory experience onto abstract domains, enabling non-chemical perception to be understood as smell. These abstract concepts can be negative, such as *inadequacy, desperation, corruption*, *collusion, failure*, and *treason*. They can also be positive, such as *success, goodness,*

and *mercy*. These examples suggest that English olfactory metaphors are surprisingly rich, as noted by Floyd et al. (2018).

This observation raises several key questions: How productive are olfactory metaphors in English? Are there systematic patterns in how smell maps onto its target domains? Do related but distinct smellex terms correspond to similar or different target domains? Are certain target domains more productive than others in terms of the variety of collocating concepts within the target category? The goal of this study is to answer these questions through a corpus-driven analysis.

2 Data and methods

2.1 Corpus data

The data used for this study was sourced from the iWeb Corpus, part of the BYU corpora (https://corpus.byu.edu/). This corpus comprises 14 billion words, 22 million web pages, and 95,000 websites. Its selection as the data source for this study was based on its immensity, high speed or near instantaneousness, informativeness for contemporary English usage, and advanced architecture that supports a wide range of queries.[1]

Linguistic research of metaphorical expressions indicates that metaphors often transcend individual lexemes and emerge in patterns of structural dependency as sites of figurative interpretation (Croft 2003). Many metaphors are formed within a limited number of basic grammatical structures that systematically align form with meaning, reflecting metaphorical mappings as source-target dependencies (Lederer 2019; Sullivan 2016). Olfactory metaphors draw on the sense of smell as source domain to conceptualize abstract non-chemical precepts as target domains. Therefore, identifying structures of source-target dependency involving smellex terms as the source concepts is a necessary first step toward understanding the conceptual range of the target domains in olfactory metaphors.

This study focuses on eight commonly used smellex terms that denote olfactory perception. These items were identified under {olfactory perception} or {smell} in the WordNet (Princeton University 2010). To examine target concepts associated with the smellex terms as source concepts, we analyzed nouns referring to abstract entities in the noun slot of the structural pattern [SMELLEX_*of*_N] where N (noun) and

1 For details on the corpus, see the overview https://corpus.byu.edu/iweb/help/iweb_overview.pdf.

SMELLEX are linked by the preposition *of*.[2] The specific source-target dependency patterns investigated were as follows:

(8) Smellex patterns
  (a) [*smell of* N]
  (b) [*aroma of* N]
  (c) [*scent of* N]
  (d) [*odor of* N]
  (e) [*stink of* N]
  (f) [*reek of* N]
  (g) [*stench of N*]
  (h) [*fragrance* of N]

Noun retrieval for these patterns was conducted using the List function in the iWeb search interface. The eight patterns were individually queried, and the results were sorted by token frequency of the lemmas in the N slot. This process yielded 8601 distinct nouns, which formed the raw dataset for metaphor identification. Metaphors were identified using the MIP/MIPVU principle, which detects metaphors based on the conceptual misalignment between the referent of a noun (target concept) and the literal meaning of the source concept within a structural dependency relationship (Pragglejaz Group 2007; Steen et al. 2010). For olfactory metaphors, abstract nouns referring to non-chemical entities were considered, as these nouns misalign with the literal olfactory meanings of smellex terms. As such the abstract nouns cannot be "interpreted in a single domain" together with the smellex term without invoking cross-domain metaphorical mapping, to use the words of Croft (2003: 162).

To identify abstract nouns within the retrieved dataset, we examined the hypernym paths of each noun in WordNet and selected those classified as {abstraction}, a second-level category beneath the root node {entity}. A hypernym path is a hierarchical sequence of increasingly general concepts (hypernyms) that links a specific word or a set of cognitive synonyms (synsets) to the most abstract root category in WordNet, typically {entity}. A Python program was used to extract the hypernym paths for the 8601 nouns. Out of these, 5084 were classified as {physical entity}, 2516 as {abstraction}, and 1001 were untraceable due to morphological idiosyncrasies (e.g., *showbiz*, *self-effort),* acronyms (e.g., *bbq*), low frequency of use (e.g., *misandry*, *attractant*), proper nouns including brand

2 The query of each pattern only focused on nouns that immediately follow the preposition *of*. This approach may miss tokens that appear further away from the preposition. Therefore, the retrieval of collocates should not be considered exhaustive.

names (e.g., *cheetos, pine-sol*), foreign loanwords (e.g., *soba*), or misspellings/false compounds (*impatiens*, *bubblegum*).

After excluding the untraceable nouns, we manually reviewed the accuracy of the WordNet classifications of the remaining nouns. Abstract nouns were defined as those referring to things that cannot be perceived by the senses. Based on this definition, a significant number of items (n = 1832) classified by WordNet as {abstraction} was excluded. These included nouns referring to physical entities or substances (e.g., *forest*, *perfume*, *blood*) and those associated with physical entities or substances by metonymy (e.g., *springtime*, *Christmas*, *death*).[3] Conversely, 38 abstract nouns (e.g., *risk*, *innovation*) incorrectly classified by WordNet as {physical entity} were reinstated. Following this manual annotation, 632 distinct abstract nouns, many collocating with more than one smellex term, were retained and included in the corpus analysis of olfactory metaphors.

2.2 Methods

The corpus analysis focused on four aspects: (1) the distributions, productivity, and communicative efficiency of the eight smellex patterns representing olfactory metaphors, (2) the semantic coverage of the target domain concepts, defined as the range of semantic meanings, (3) the intersection of target domains among the eight smellex patterns, and (4) the affective valence of the target concepts.

2.2.1 Analysis of productivity and communicative efficiency

For the first objective, we conducted three frequency counts for the target concepts of each of the eight smellex terms. Type frequency refers to the number of distinct lexical items that can fill a given slot in a construction (Ellis 2002: 166). High type frequency is a strong indicator of productivity, as it facilitates schematic pattern formation and expansion to novel uses (Bybee 2006; Goldberg 1995). However, type frequency alone is insufficient for understanding the generalizability of a pattern. As variability among instances also promotes productivity (Goldberg 2019), the analysis of semantic coverage, described in 2.2.2, will shed further light on the productivity of the smellex patterns.

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3 For a discussion of the metonymic connection of *death* to olfaction, see Jing-Schmidt (2021), which argues that abstract nouns like fear, death, youth, sex, and disease in [SMELLEX of N] operate metonymically, invoking the associated body effluvia (chemical secretions) that our olfactory system can detect, even though they do not denote airborne odorants themselves.

Token frequency measures the number of occurrences of a given type in a corpus. A high correlation between type and token frequencies suggests communicative efficiency (Winter 2016). Hapax legomena, items that occur only once in a corpus, represent novel uses and further highlights productivity (Baayen and Lieber 1991; Baayen and Renouf 1996). We calculated type and hapax frequencies and assessed communicative efficiency by correlating type and token frequencies.

2.2.2 Analysis of semantic coverage

To study semantic coverage, we traced hypernym paths of the 632 nouns in WordNet, categorizing them level by level along hierarchical semantic paths. Each path, or synset, represents a set of cognitive synonyms, showing conceptual and semantic relationships. For example, the hypernym path of *corruption* includes {entity, abstraction, attribute, quality, immorality, unrighteousness, dishonesty, corruptness}. Results are presented as tree diagrams in the Results Section.

2.2.3 Intersection of target domains

To understand the intersection among the eight smellex patterns, we analyzed the semantic intersections of their target concepts using UpSet plots generated in RStudio (Version 1.2.5033) with the UpSetR and grid packages. UpSetR plots effectively visualize overlaps in large datasets (Conway et al. 2017), helping identify shared and unique metaphorical target concepts across the smellex patterns. This approach allowed us to discern both common and unique associations between smellex terms and uncover the complexity and distribution of metaphorical mappings across multiple target domains.

2.2.4 Affective valence analysis

Research shows that smell words often carry affective connotations, reflecting olfactory hedonics (Winter 2016). To investigate whether and to what extent olfactory hedonics is reflected in olfactory metaphors, we annotated the target concepts for affective valence. Warriner et al. (2013) provide a valuable and widely used database of affective valence ratings for 13,915 English lemmas. However, the dataset does not offer sufficient coverage for the full range of abstract target concepts examined in this study. Many nouns in our dataset, particularly low-frequency nouns related to moral, social, and psychological domains, are not included in their database. To ensure consistent annotation across the full set of target concepts, we used LLM-based scoring, calibrated to the same 1–9 valence scale as Warriner et al. (2013).

This allows for interpretive alignment with established norms, while offering the flexibility to rate previously uncovered lexical items critical to our analysis. Importantly, recent work by Brysbaert and colleagues (Brysbaert et al. 2025), as well as Trott (2024) and Martínez (2024), has demonstrated that state-of-the-art LLMs match or outperform human annotators in lexical and sentiment tasks. Notably, the Warriner research group has itself shifted toward LLM-supported scoring, indicating a growing consensus around the validity and scalability of this approach. For this study, we used ChatGPT-4o, which allowed for high-coverage, internally consistent annotation across a semantically diverse dataset. For our study, the annotation process was guided by the prompt:

> Please rate this list of nouns for affective valence on a scale from 1-9 (1 is most negative, 9 is most positive) based on broad cultural understanding or linguistic conventions of English. An example of a word rated as 1 is *racism* and an example of one rated as 9 is *happiness*.

Human evaluators conducted consistency checks to validate the annotations. Because of the size of the data, repeated queries were conducted to obtain complete ratings of all the target nouns. Kruskal–Wallis rank sum test was conducted on the valence scores to explore significant differences among the eight patterns in terms of the affective valence of their target concepts. The valence distributions and concentrations for the eight smellex patterns were visualized in violin plots, supplemented with word clouds for visualization of the lexical specificity of the valenced target concepts, using RStudio packages (wordcloud, ggplot2, dplyr, grid).

3 Results

3.1 Productivity and communicative efficiency

Table 1 summarizes the type, token, and hapax legomena frequencies, for the target concepts of the eight patterns of olfactory metaphor. The percentage of metaphorical types over the total retrieved types of collocates of each pattern is also provided. Token frequencies range from 50 to 1034, while type frequencies span from 42 to 289, reflecting considerable variation in productivity. The pattern with the highest percentage (59 %) of abstract or metaphorical types is [*stink* of N], suggesting that this pattern is used metaphorically more often than it is used in a literal olfactory sense. This is followed by [*reek* of N] with 38 % of all types being abstract nouns, suggesting a considerable potential for metaphoric use. The other six patterns are used less frequently in a metaphorical sense than in a literal olfactory sense.

Table 1: Frequencies of abstract nouns across eight smellex patterns.

Pattern	Type	Percentage of abstract types over all N types	Token	Hapax legomena
[*smell of* **N**]	289	10 %	1034	170
[*stink of* N]	202	59 %	369	149
[*reek of* N]	182	38 %	322	133
[*fragrance* of N]	89	15 %	375	51
[*aroma of* N]	73	6.5 %	99	54
[*scent of* N]	60	3 %	81	48
[*odor of* N]	43	6 %	50	39
[*stench of* N]	42	7 %	50	36

A strong correlation between the type and token frequencies, r (6) = *0.90*, p = *0.0019*, indicates high communicative efficiency across the patterns. Hapax legomena frequencies, ranging from 36 to 170, indicate significant novel and rare noun uses, even within the less productive patterns. Judging on overall type, token, and hapax frequencies, [*smell of* N], [*stink of* N] and [*reek of* N] are the most productive patterns when they are used metaphorically.

3.2 Semantic coverage of target domains

In tracing the hypernym paths of the 632 abstract nouns associated with the eight types of smellex terms, we found that 42.4 % (n = 268) share the first three levels of hypernym paths: {entity, abstraction, attribute}, where {attribute} includes two immediate subordinate synsets {state} (e.g. *power*, *corruption*) and {quality} (e.g. *freedom*, *desperation*). Another 37 % (n = 234) share the first three levels of the hypernym path {entity, abstraction, psychological feature}, from which the path further divides into two major synsets {event} (e.g. *success*, *sexism*) and {cognition} (e.g. *truth*, *stupidity*). The remaining 20.6 % (n = 130) belong to less common third-level hypernym synsets, such as {trait}, {communication}, {relation}, {group}, {measure}, {personality}, {motivation}, and {property}, each comprising a relatively small number of nouns.

Figure 1 presents two tree diagrams that illustrate the immediate sub-synsets of the hypernym {attribute}, along with their respective subordinate semantic categories represented by nodes. In these tree diagrams, each branch represents a hypernym path, with color gradients indicating the type frequencies of nouns that appear in the metaphorical patterns under each sub-synset. The color continuum ranges from red to yellow, with redder nodes indicating higher type frequencies. For

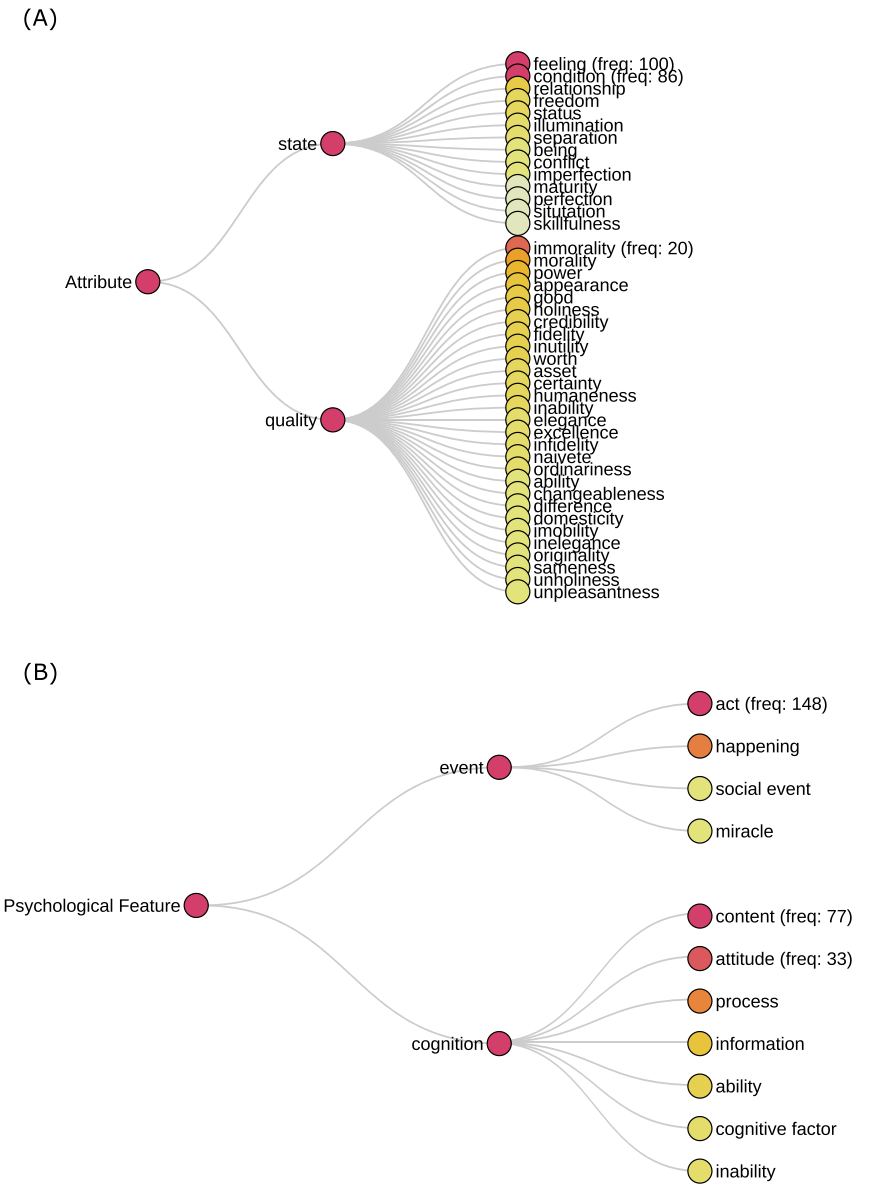

Figure 1: Tree diagrams of semantic hypernym paths of noun slot across eight patterns starting from third-level synsets. (A) Shows hypernym paths of noun types under the third-level synset {attribute} that contain {state} and {quality} as the most productive sub-synsets. (B) Shows hypernym paths of noun types under the third-level synset {psychological feature} with {event} and {cognition} being the most productive sub-synsets.

instance, under the hypernym {state}, the subordinate semantic set {feeling} contains 100 nouns across the eight patterns, while under {quality} the semantic set {immorality} is the most productive, containing 20 nouns.

To further analyze the hypernym paths connected to the third-level source nodes {attribute} and {psychological feature}, as depicted in Figure 1, we created four additional tree diagrams shown in Figure 2. Figure 2(A) and (B) detail the hypernym paths rooted at {state} and {quality}, respectively, while Figure 2(C) and (D) focus on the paths rooted at {event} and {cognition}.

As can be seen from Figure 2, several synsets stand out due to their higher type frequencies, highlighted in red, compared to other synsets at the same path level. These include {emotion}, {psychological state}, {unrighteousness}, {wrongdoing},

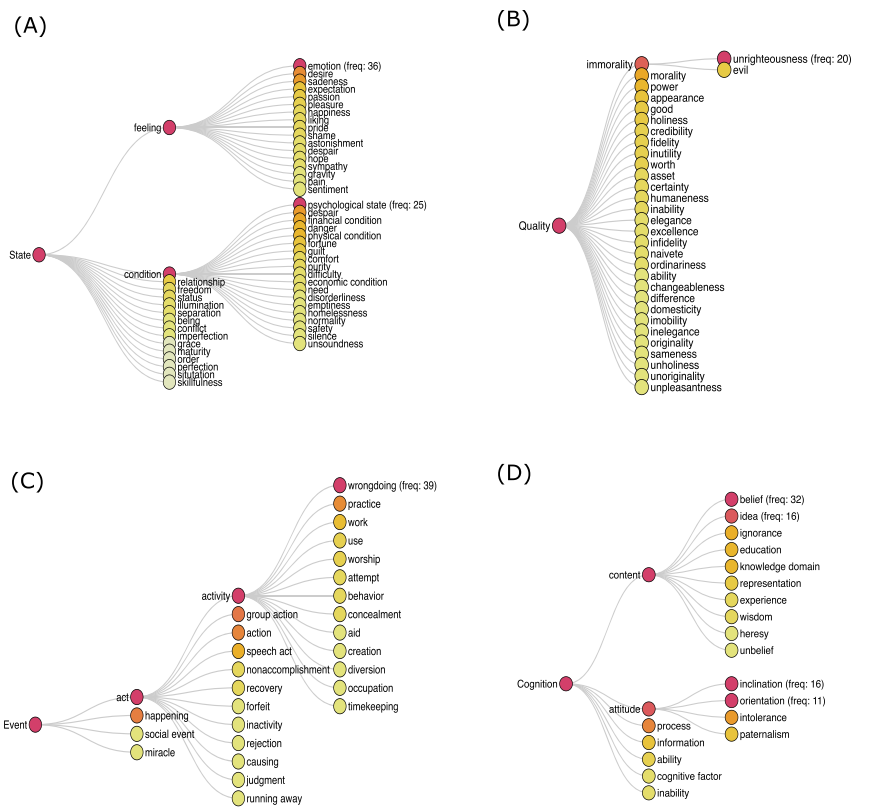

Figure 2: Tree diagrams of semantic hypernym paths of noun slot across eight patterns starting from fourth-level synsets. (A)–(D) Show hypernym paths of noun types under the fourth-level synset {state},{quality}, {event}, and {cognition} respectively.

{belief}, and {inclination}. This suggests that as target domains of olfactory metaphors socioemotional experiences and moral judgments serve as focal points in smell-based metaphorical conceptualization.

3.3 Target domain intersections

The total number of intersections among the eight patterns is 59, ranging between two-way to seven-way intersections. Figure 3, plotted with UpSetR, shows the eight sets of target nouns in a matrix-based layout to visualize all 59 intersections in descending type frequency.

In Figure 3, the rows represent the eight smellex patterns where the horizontal bars on the left show the type frequencies of the target nouns involved in cross-pattern intersections. For example, the bottom row shows that [*smell of* N] has 137 nouns shared with other patterns. The columns represent cross-pattern intersections where the vertical bars on the top represent the total number of target nouns shared across the patterns, shown as black dots connected by vertical lines. For instance, the first column from the left indicates that [*stink* of N] and [*smell* of N], being connected in a two-way intersection, share 23 target nouns. This is followed by the intersections between [*reek* of N] and [*stink* of N], and between [*reek* of N] and

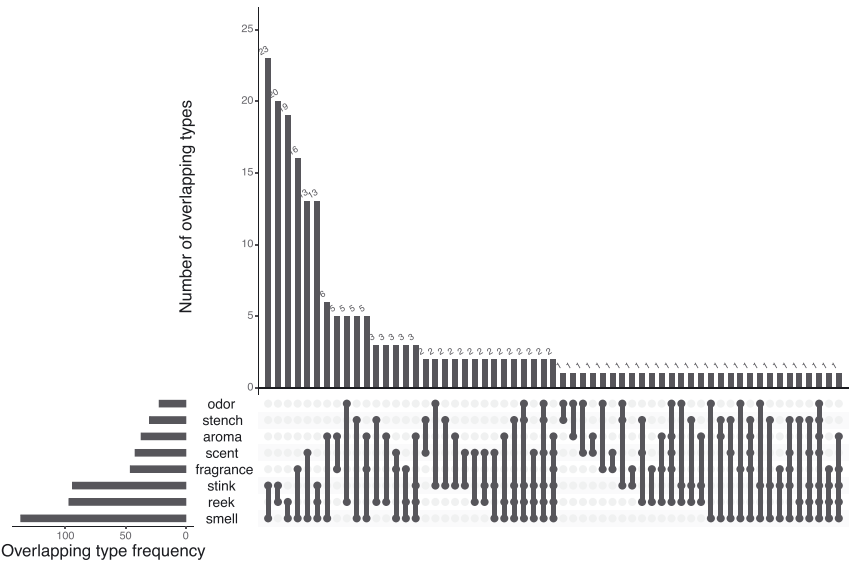

Figure 3: UpSetR plot of the eight patterns and their intersections ordered in type frequency.

[*smell* of N], involving 20 and 19 shared nouns, respectively. As the size of the intersection decreases, the degree of overlap increases, meaning more patterns share fewer target nouns. For example, the third column from the right shows a seven-way intersection with one shared target noun. The 59 intersections shown in Figure 3 account for 202 noun types, representing 32 % of the total target noun types. This substantial degree of overlap suggests that many target concepts are not limited to a single pattern but recur across multiple smellex patterns, forming a network of olfactory metaphors.

To explore the specific target concepts involved in the intersections, Figure 4 plots 33 intersections arranged by degree of intersection in descending order with the shared target nouns placed above the vertical bars. It shows the overlapping types shared among three or more patterns. (One set of target nouns too large to be placed above the vertical bar is asterisked and appears beneath the caption).

As seen in Figure 4, a set of target concepts (*n = 20*) stands out for its prominence in high-degree intersections, appearing in four or more patterns. Among them, *desperation* is unique as the only concept shared across all patterns except [*fragrance of* N]. Closely following are *corruption* and *hypocrisy*, which occur in a six-way intersection that excludes [*aroma of* N] and [*fragrance of* N]. Seven target

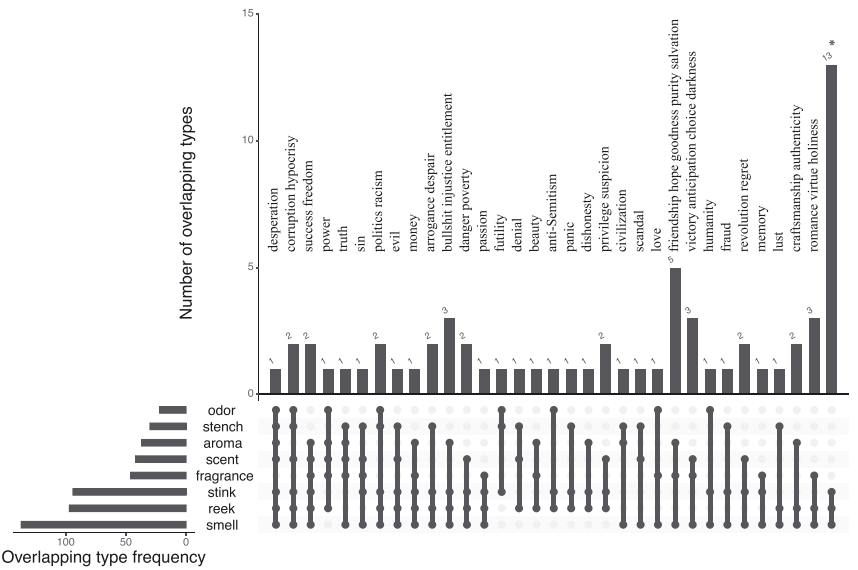

Figure 4: UpSetR plot of the eight patterns and their intersections ordered by degree of intersection * [*smell:reek:stink*] 13 overlapping items: *fascism, nostalgia, cruelty, government, mortality, scam, bias, bigotry, cowardice, favoritism, illiteracy, loneliness, sexism.*

concepts – *power*, *truth*, *sin*, *politics*, *racism*, *evil*, and *money* – appear in six distinct five-way intersections. Additionally, eight concepts – *arrogance*, *despair*, *bullshit*, *injustice*, *entitlement*, *danger*, *poverty*, *passion* – occur in four different four-way intersections. Collectively, these 20 nouns span a core set of socioemotional, moral, and political concepts, ranging from emotional states like *desperation* and *despair*, to moral judgments such as *hypocrisy*, *sin*, and *corruption*, to socially charged themes like *racism*, *politics*, and *poverty*, highlighting the central role of olfactory metaphors in expressing moral and social judgments and evaluating psychological conditions.

3.4 Affective valence

A Kruskal–Wallis rank sum test revealed significant differences in valence scores across the eight smellex patterns ($\chi^2(7) = 517.91$, $p < 0.001$). Post-hoc Dunn's tests with Bonferroni correction identified specific pairwise differences ($\alpha = 0.05$). [*fragrance of* N] and [*aroma of* N], the highest-scoring patterns, differed significantly from the lowest-scoring patterns, including [*stink of* N] ($p < 0.001$ for both), [*stench of* N] ($p < 0.001$), [*odor of* N] ($p < 0.001$), and [*reek of* N] ($p < 0.001$). Mid-range patterns ([*smell of* N], [*scent of* N]) were also distinct from extreme negative patterns (e.g., [*smell of* N] vs. [*stink of* N], $p < 0.001$; [*scent of* N] vs. [*stench of* N], $p < 0.001$), but not from one another ($p > 0.05$). Among the most aversive patterns, [*stink of* N] was rated significantly worse than [*stench of* N] ($p = 0.020$), which in turn differed from [*odor of* N] ($p = 0.002$). These results demonstrate a clear hierarchy in perceived valence, with [*fragrance of* N] and [*aroma of* N] representing the most positive associations, [*smell of* N] and [*scent of* N] occupying an intermediate range, [*stench of* N], [*reek of* N], and [*odor of* N] tilting toward the negative end, and [*stink of* N] reflecting the most negative evaluations.

To understand the distribution and density of valences within the target domains of individual patterns, we use the violin plot that reveals both the overall distribution shape and local concentration of data in one diagram (Hintze and Nelson 1998), to explore how the valence ratings skew within individual smellex patterns.

In Figure 5, each violin represents the full range and density of affective ratings for the target nouns of a given pattern, with an embedded boxplot indicating the median and interquartile range. The violins are color-coded according to each pattern's mean valence, ranging from red (more negative) to green (more positive). The density distributions across the violin plots reveal distinct affective profiles for each smellex pattern, with the width of each shape indicating the relative concentration of valence ratings at different points along the 1–9 scale. The results show clear affective differentiation across the smellex patterns. [*fragrance of* N] and [*aroma of* N] display highly positively skewed distributions, with dense clustering at the positive end of

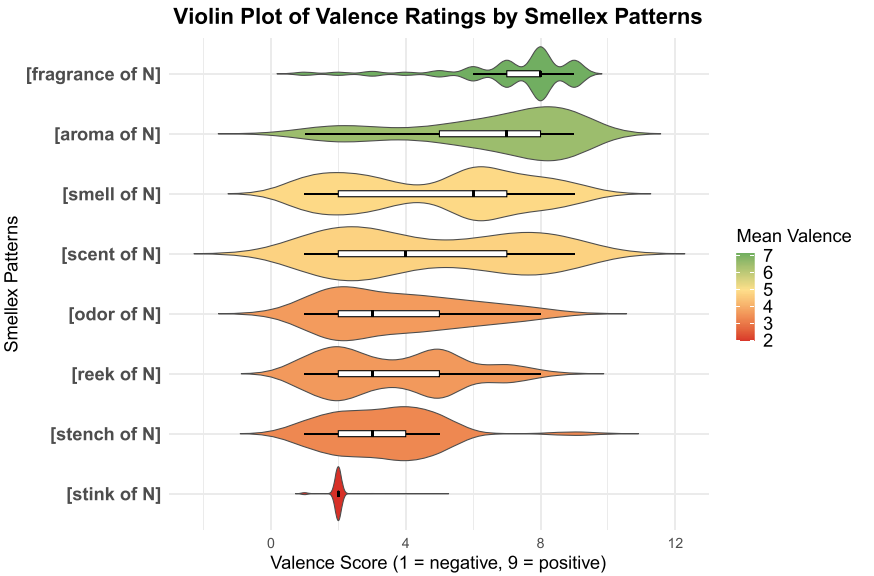

Figure 5: Violin plot of valence ratings by smellex patterns.

the scale (7–9), indicating strong positive connotations. In contrast, [*odor of* N], [*stench of* N], and particularly [*stink of* N], are skewed toward the negative end, with [*stink of* N] showing an almost entirely compressed distribution at the negative extreme, reflecting near-exclusive alignment with negatively valenced concepts. This suggests a narrow and consistently negative evaluative range for this pattern. Mid-spectrum constructions like [*smell of* N] and [*scent of* N] exhibit broader distributions spreading across the full valence scale. It is however noticeable that their violin plots exhibit a pronounced constriction around the midrange valence score of 5, suggesting absence of a clustering around neutrality, but rather a bimodal or polarized distribution. This pattern indicates that these smellex patterns tend to collocate with both positively and negatively valenced concepts, rather than neutral ones. Overall, the violin plot demonstrates that smellex patterns are not neutral grammatical templates, but rather metaphorical frames that carry distinct affective and evaluative profiles.

To get a closer look at the lexical specificity of the target domain, especially the most entrenched collocates of each smellex pattern, Figure 6 shows the word clouds of the target concepts, plotted in the color space between black (extremely negative valence) and bright green (extremely positive valence) with gradations of hue between the two. Visually, the relative sizes of the word clouds mirror the frequency-based productivity of each smellex pattern (Table 1), with larger clouds, such as

[*Smell of*_NOUN] [*Stink of*_NOUN]

[*Reek of*_NOUN] [*Fragrance of*_NOUN]

[*Aroma of*_NOUN] [*Scent of*_NOUN]

[*Odor of*_NOUN] [*Stench of*_NOUN]

Figure 6: Word clouds of target concepts of eight metaphorical smellex patterns.

[*smell of N*], [*stink of N*], and [*reek of N*], indicating higher type frequency, while smaller clouds like [*scent of N*], [*odor of N*], and [*stench of N*] reflect more limited collocational scope. The overall color impression reinforces the valence profile of each smellex pattern in terms of distribution and density patterns (Figure 5). The positive smellex patterns, especially [*fragrance of N*], are dominated by green-colored nouns like success, freedom, *Christ*, *God*, *love*, *hope*, and *relaxation*, reflecting strong associations with culturally prized, spiritual, and uplifting concepts. In contrast, the negative patterns, particularly [*stink of N*] and [*stench of N*], are saturated with black-colored terms like *desperation*, *hypocrisy*, *corruption*, and *fraud*, emphasizing their strongly negative evaluative charge. Patterns like [*smell of N*] and [*scent of N*] show a mix of green and black, indicating their semantic polarization. Overlapping themes can be seen in the recurrence of negative words such as *desperation, corruption, hypocrisy* in multiple clouds. Most noticeable is *desperation,* which stands out in several clouds, mirroring its prominence in the intersection results (Figure 4).

4 Discussion

The usage, productivity, semantic coverage, and affective valence of olfactory metaphors in English have not been systematically studied. By examining olfactory metaphors in a large English corpus, this study filled a critical gap in the literature. The findings demonstrate that English olfactory metaphors are highly productive, spanning a broad range of metaphorical target domains with polarizing affective valences whereby sociomoral and socioemotional domains emerge as the most prominent. Notably, these target concepts display a marked negativity bias, centered on themes such as corruption, injustice, and other moral violations and threats, as well as undesirable emotional states, which reflect the evolutionary role of olfaction as a powerful early warning mechanism against contamination and danger in the environment.

4.1 Olfactory metaphors are productive

The frequency distributions of abstract concepts in the N slot across the eight smellex patterns reveal a level of metaphorical activity previously unexpected and unexplored. Based on frequencies, [*smell of* N] is the most productive and most versatile pattern, followed by [*stink of* N] and [*reek of* N]. In contrast, patterns like [*aroma of* N], [*scent of* N], [*odor of* N], and [*stench of* N] are lower in type, token, and hapax frequencies, suggesting more restricted use. On this continuum of productivity,

[*fragrance of* N] stands out with moderate type frequency, low hapax frequency, but high token frequency, suggesting its tendency to attract certain entrenched prototypes while being relatively limited in generating new metaphors compared to the more productive patterns. In terms of the percentage of metaphorical types among all noun collocates, the preference of [*stink of* N] for metaphorical rather than literal use may be explained by Miller's (1997) observation that the word *stink* has a forcefulness in expressing moral and social disgust.

The fact that most other patterns are still more often used literally than metaphorically does not diminish the significant metaphorical utility and effectiveness of these patterns when employed figuratively. When used metaphorically, these patterns demonstrate creativity and richness in conceptual mapping, showing that olfactory metaphors are significant and powerful in English. The predominance of literal usage over metaphorical usage means simply that there are many more actual substances or odorants that emit smells than there are concepts metaphorically described as smells.

While the strong correlation between type and token frequencies across the eight smellex patterns suggests their collective communicative efficiency, the patterns differ markedly in the diversity of their target concepts – a more revealing indicator of metaphorical productivity (Goldberg 2019). Notably, [*smell of* N] stands out for its broad semantic range and affective variability, encompassing concepts from highly positive (e.g., *success*, *freedom*) to deeply negative (e.g., *corruption*, *sin*). This wide semantic and evaluative span indicates its conceptual reach and makes it one of the most versatile olfactory metaphors in the dataset. In what follows, we discuss more closely how these patterns map onto recurring semantic domains and how they diverge in affective valence, revealing deeper insights into the figurative logic of smell in English.

4.2 Overlapping target domains center on socioemotional and sociomoral concepts

The findings on semantic coverage of the target domains across the eight patterns reveal more metaphorical target domains than previously known in the literature on English smell metaphors. The WordNet hypernym paths indicate the prominence of semantic categories related to psychological features and moral judgments. Specifically, the synsets {emotion}, {psychological state}, {unrighteousness}, {wrongdoing}, {belief}, and {inclination} exhibit higher type frequencies. This suggests that olfactory metaphors are especially effective in expressing complex, abstract concepts related to emotions, moral judgments, and mental states. The strong presence of these semantic categories points to the significant role that smell-related language

plays in the conceptualization and communication of emotion and morality in English.

The UpSetR analysis demonstrates significant overlaps of target domains across the eight patterns, illuminating the way English olfactory metaphors form a conceptual network linked by shared target concepts. Notably, a wide range of negative concepts such as *desperation*, *corruption*, *hypocrisy*, *sin, politics, racism, evil, arrogance, despair, bullshit, injustice, entitlement, danger, poverty* appear in high-degree intersections. A smaller set of positive concepts like *success, freedom*, and *truth* also recur in multiple patterns. This shows how olfactory metaphors are strongly associated with socially and morally charged evaluations as well as culturally salient values.

In the socioemotional domain, the recurrence of *desperation* as a key target concept across all but one pattern is particularly intriguing. What are the conceptual schematic properties shared by an olfactory object or odorant and desperation as a social percept? The neural psychology of olfaction suggests that most odorants are chemically complex and are detected as blends of volatiles without a breakdown of individual features (Stevenson 2012). Similarly, the word *desperation* refers to a complex blend of consuming emotional urgency, uncontrolled social exposure, and compromised dignity. Like olfaction being a sense that is both intense and unavoidable, overpowering other sensations (Miller 1997), desperation is overwhelming and can dominate a person's thoughts and actions. Being desperate suggests to others that one has been reduced to their most basic needs or is acting without dignity and therefore may be perceived as a social failing or defect character. The olfactory conceptualization of desperation reflects a pervasive cultural perception of neediness as a repugnant social stigma, as illustrated by the following examples:

(9) *Your followers can find your tweets to reek of desperation. Be disciplined in your usage of hashtags.*

(10) *Think of your job interview process to be similar to dating. If you stink of desperation, nobody wants you.*

It is clear that rather than treating desperation as a neutral affective state, these metaphors cast it as a social excess, loss of composure, and even moral taint. The metaphorical framing of *desperation* through olfactory terms in the Anglo-American context illustrates how a socially stigmatized gestalt of affective behavior that violates cultural norms around self-control, composure, or independence is rendered perceptible and judgment-laden via culturally conditioned mappings from odors. While this evaluative framing appears culturally specific, further cross-linguistic

research is needed to determine whether similar associations exist in other linguistic and cultural traditions.

Examples (9) and (10) above suggest that desperation is conceptualized as detectable through subtle, involuntary behavioral cues to which the perceiver is attuned. In other words, when desperation "leaks" out of a person the way an odor does, the perceiver can sense the emissions, not through reasoned analysis, but through intuitive detection. Thus, the speaker uses the olfactory metaphor as cautionary evaluation, issuing to their addressee a stern warning about unintentional social leakage and advising them to mask or manage it.

The same conceptual pattern where the target concept is intuited can be seen in positive uses of olfactory metaphors, as in (11) and (12):

(11) *Not having any actual knowledge… Benny's explanation has the smell of truth to it…*

(12) *So after 50 years of struggle, the smell of freedom is in the air. But the pain and suffering are far from over.*

In (11), the context makes it clear that the speaker does not have factual knowledge, but there is something about the explanation that feels right. The *smell of truth* conveys a tentative, surface-level impression, a kind of intuitive plausibility. Similarly, the expression *the smell of freedom is in the air* in (12) evokes the anticipation or nearness of freedom, as if freedom can be sensed before it is fully attained. The intuitive, tentative, and often elusive qualities of the target concepts, positive or negative, schematically align with the properties of airborne chemosensory stimuli, which are inherently volatile, diffuse, and complex, making smell an apt sensory source for metaphorical mappings of socially and emotionally elusive states.

In the domain of moral judgments, the same pattern is evident. Concepts such as *corruption*, *hypocrisy*, *bullshit*, *sin*, and even *politics* center on violations of ethical or social norms, often covert or disguised. Corruption, hypocrisy, sin, and bullshit all involve hidden breaches of integrity, aligning closely with metaphors of smell that suggest detecting what others try to conceal.[4] While invisible or intangible, these concepts are presumed to leave a trace. Just as a foul odor can signal unseen decay, abstract wrongdoings like hypocrisy or corruption are "sniffed out," reinforcing the metaphor of olfaction as a means of intuitive detection. These concepts evoke an emotional response rooted in feelings of impurity or contamination. Their metaphorical pairing with foul smells reflects the deep-seated connection between olfaction and the visceral experience of moral revulsion (Haidt 2003; Hauser 2006).

4 While *sin* originates in religious contexts as a transgression against divine law, it is also used more broadly in secular discourse to denote serious moral failings. In this study, it is considered alongside other norm violations that may be covert or concealed.

Often invoked in contexts of disillusionment, these concepts carry connotations of deception and manipulation. When politics, bullshit, or hypocrisy are said to "stink," it reflects a broader cultural skepticism or cynicism toward institutions and discourses perceived as morally compromised. In general, these concepts share key features that make them especially compatible with olfactory metaphors: they are morally transgressive, socially contaminating, and often hidden yet sensed – eliciting intuitive, affectively charged judgments rooted in suspicion and moral revulsion.

This metaphorical framing of moral wrongs as covert yet detectable lays the groundwork for another striking feature of olfactory metaphor: its amplification through hyperbole. A semi-idiomatic pattern of the form [*smell* N *(from) a mile/miles away/off*] emerged from manual annotation of olfactory metaphors in the iWeb data. We refer to this figurative use of a smell verb with distance expressions as the "remote olfactory metaphor", which combines metaphor and hyperbole to express heightened social or moral intuition, as illustrated in (13)–(15):

(13) *But millennials can smell disingenuousness from a mile away.*

(14) *District Attorney Clarke, however, has a reputation for smelling crime a mile off.*

(15) *Guys can smell desperation from miles away, so stop posting all those half-naked selfies.*

What makes this pattern particularly interesting is the hyperbolic use of the adverbial phrase *(from) a mile/miles away/off*, which exaggerates spatial distance to intensify the perceived offensiveness of the violation and the social acuity of the perceiver. Hyperbole, as a rhetorical device, communicates subjective evaluation by deliberately amplifying experience beyond literal truth, especially in domains lacking objective measures (Quintillian 2001). This aligns with the subjectivity inherent in metaphor, which selectively maps features across conceptual domains (Lakoff and Johnson 1980). By combining metaphor and hyperbole, the pattern dramatizes olfactory sensitivity as a figurative source for exceptional epistemic insight.

Any account of odor-based conceptions of morality would be incomplete without addressing the emotion of disgust and its role in moral reasoning. Cognitive and neural scientists have long recognized *moral disgust* as an extension of core physical disgust – an adaptive system evolved to protect the body from oral incorporation of contaminants (Gert 2015; Kelly 2011; Miller 1997; Rozin et al. 2008). Rozin et al. (2008) identified moral violations as one among nine domains that elicit disgust in North American culture, alongside others such as food, body products, animals, sexual behaviors, and poor hygiene. In earlier cross-linguistic work, Haidt et al. (1997) found that the term *disgust* is widely used to describe unsavory social behavior, leading

Rozin et al. (2008: 763) to conclude that people experience a viscerally felt similarity between "emotional reactions to feces and to sleazy politicians." This conceptual connection between disgust and morality is aptly described as the "moralizing capacity of disgust" by Miller (1997: 179–180) who notes that "we express many of our bread-and-butter moral judgments in the idiom of disgust." Addressing the unique potential of smell to articulate moral sensibility compared to vision and hearing, Miller writes (1997: 77–78), "[I]t is nearly impossible to keep bad smells out of the moral domain. The language of sin and wickedness is the language of olfaction gone bad. Vision and hearing, the higher senses, do not play this role in the articulation of our moral sensibility." Hauser (2006: 199) argues that our moral sense of right and wrong is wired in our brain with disgust playing a powerful role in automatically "driving an evasive response" to physical and moral contaminants.

Neurophysiological research lends support to the link between smell and morality. A recent meta-analysis by Salvo et al. (2025) confirmed a bidirectional relationship between disgust and moral judgment: moral transgressions tend to elicit disgust, and conversely, inducing disgust intensifies moral condemnation. These findings confirm the sensory and physiological grounding of moral evaluation, providing evidence that moral disgust is a genuine form of disgust and help explain why olfactory experience provides such a powerful sensory foundation for metaphorical expressions of moral judgment.

4.3 Olfactory metaphors show polarizing valences and negativity bias

Our analysis of affective valence demonstrates affective polarization with patterns like [*fragrance of* N] and [*aroma of* N] approaching the positive end while [*odor of* N], [*stench of* N], [*reek of* N] approaching the negative end. In particular, [*stink of* N] skews sharply to the negative extreme. Even the midrange patterns like [*smell of* N] and [*scent of* N] are not neutral, tilting to positive and negative valences, respectively. This polarizing trend aligns with psychological and neurobiological insights on hedonic olfaction in that odors invoke either distinctly pleasant or unpleasant emotional responses (Richardson and Zucco 1989; Rouby and Bensafi 2002; Royet et al. 2000; Seubert et al. 2017). As the most salient dimension of olfaction, hedonic perception helps us tell risks from rewards in uncertain physical environments. In a recent EEG study of hedonic olfactory processing, Callara and colleagues (Callara et al. 2021) found that the orbital frontal cortex (OFC) acts as the main node for odor perception and evaluation of pleasant and unpleasant odorants, whereas no specific path was observed for a neutral stimulus. This study provides neurophysiological evidence for the hedonic processing of olfaction.

Behind the pronounced hedonic polarization of affective valence, our analysis also reveals a strong negativity bias across the olfactory metaphors: five of the eight patterns attract more negatively target concepts than positive ones, underscoring their dominant role in expressing socioemotional and sociomoral judgments, particularly moral revulsion. From a functional perspective, this pattern makes perfect sense. As a frontline sensory defense against ingestive harm, olfaction has evolved to be sensitive to potential environmental dangers that are otherwise difficult to detect (Herz et al. 2004; Miller 1997). That is, olfaction is programmed with a bias for negative stimuli. Callara et al. (2021) found that unpleasant stimuli evoked a path from OFC to cingulate gyrus associated with negative emotion. This neurobiological pathway supports the visceral emotional reactions associated with foul smells, particularly disgust. Such evolved connectivity contributes to what cognitive scientists describe as the negativity bias, defined as the tendency to allocate greater attention and emotional weight to negative stimuli over neutral or positive ones (Baumeister et al. 2001). Our finding that negative target concepts are more prevalent and broadly distributed across the majority of smellex patterns reflects this cognitive bias and is consistent with prior research on the asymmetry of affect in emotive language (Foolen 2015; Jing-Schmidt 2007).

Overall, the productivity, semantic coverage, and affective polarization with a negativity bias seen in our results represent a significant departure from previous research on English olfactory metaphors. Our study shows that the figurative reach of olfaction in English is more extensive than previously understood. It goes far beyond merely representing "bad character or dislikable mental characteristics" (Sweetser 1990: 37) or "badness" and "general atmosphere" (Kövecses 2019: 335). It plays a consistent and reliable role in expressing emotions, social perceptions, and moral judgments, and in forming a robust and interconnected conceptual network for metaphorically representing these target domains. The affective polarization of olfactory metaphors, capturing both positive and negative target domains, reflects the intrinsic hedonic nature of the sense of smell. The overwhelming negativity bias of olfactory target concepts reflects the evolved chemosensory acuity of human olfaction as a defensive device. While prior work has highlighted guessing and suspecting as key metaphorical targets, our study goes further by identifying a broader schematic mapping: from the detection of volatile, often hidden chemosensory cues to the metaphorical framing of socioemotional evaluation, moral judgment, and epistemic vigilance.

Our findings confirm earlier anecdotal observations by Floyd et al. (2018) regarding the surprising frequencies with which English smell terms are used with a metaphorical meaning, although we did not find evidence that they are used more often metaphorically than literally apart from [*stink of* N]. These findings expand on earlier studies that noted a general negative trend in olfactory metaphors (Kövecses

2019; O'Meara and Majid 2020). Our study thus challenges a longstanding assumption in sensory metaphor research: that olfaction plays only a marginal role in figurative conceptualization. While it is well established that olfactory qualities are difficult to describe directly in language – a phenomenon known as the ineffability of smell (e.g., Levinson and Majid 2014; Majid and Burenhult 2014; Olofsson and Gottfried 2015; Viberg 1983) – our data shows that English possesses at least eight commonly used smellex terms that support a robust metaphorical space.

More broadly, the underestimated figurative reach of smell in English mirrors a deeper cultural tendency to undervalue the epistemic significance of olfaction. Anthropologists such as Classen (1993, 1997) have characterized smell as a perceptually, culturally, and linguistically inferior sense in Western traditions. Haviland-Jones and Wilson (2008: 235) attribute the overlooked importance of olfaction as a sensory system to the persistent cultural belief that olfaction is a "primitive and vestigial system." As McGann (2017) argues, the myth of the human as a "non-smeller" has obscured the cognitive capacities of olfaction. By challenging this myth, our study invites further cross-linguistic research into the figurative potential of olfactory language.

Our corpus-driven findings complement experimental evidence of embodied linkage between olfactory perception of offensive smells and social suspicion and moral disgust (e.g., Lee and Schwarz 2012; Salvo et al. 2025) by providing linguistic evidence of how smell metaphors reflect and convey social and moral cognition. The association of smell metaphors with concepts like *corruption*, *hypocrisy*, and *bullshit* highlights their visceral and embodied nature, especially in view of the link between moral cognition and disgust, making abstract moral judgments tangible and emotionally resonant. As Miller (1997: 74) puts it, "smell may no longer occupy the glorious role that vision assumed, but when it comes to the power to disgust it is no contemptible weakling." The moral valences of smell and the neurophysiological connection of olfactory metaphor to disgust as part of the mapping of smell to socioemotional and sociomoral experience support broader theories of embodied cognition, which emphasize the role of sensory experience in shaping abstract thought (Barsalou 1999, 2008; Gallese and Lakoff 2005; Gibbs 2005; Johnson 2017; Pecher and Zwaan 2005; Van Dantzig et al. 2008).

While this study offers important insights, there are limitations that need to be addressed. First, it focuses on a specific dependency pattern ([SMELLEX of N]) and does not account for other metaphorical constructions involving smell-related terms, such as [(*to have/with*) *a nose for* N] (*the journalist with a nose for news*) or [*sniff out* N] (*People can sniff out fakes*). Expanding the analysis to include additional patterns would provide a more comprehensive understanding of olfactory metaphors. Second, less frequent smellex terms, such as *whiff*, and *sniff*, were excluded from this study. These terms may reveal additional metaphorical extensions and should be

explored in future research. Finally, our reliance on WordNet to identify abstract concepts revealed limitations not only in its moderate lexical coverage, but also in its dated classifications, which required extensive manual correction. This underscores the need for more comprehensive and consistently updated lexical resources when conducting metaphor analyses. These limitations notwithstanding, our study provides a robust foundation for future research on olfactory metaphors in English and other languages.

5 Conclusions

This study significantly advances our understanding of olfactory metaphors in English by demonstrating their extensive productivity, their rich figurative potential, and their centrality in conceptualizing moral, social, and emotional judgments. By highlighting the diverse and reliable ways in which the basic smellex terms organize abstract thought, this research reveals the epistemic value of olfaction and contributes to the broader field of embodied cognition.

Our study makes both theoretical and methodological contributions to olfactory metaphor research. Theoretically, our findings challenge the previously held view that smell plays a minor role in metaphorical conceptualization, showing how basic olfactory vocabulary in English serves as a potent source for rich olfactory metaphors that significantly and consistently influence the conceptualization of emotion and morality. Smell, through its deep neurophysiological connection to disgust – a primary defensive emotion – serves as a sensitive and reliable sensory foundation for socioemotional and moral judgment. This metaphorical potency of smell is evident in contemporary English usages despite what Miller (1997: 75) calls "the twentieth-century American obsession with not smelling," highlighting the cognitive significance of olfaction in abstract reasoning.

Methodologically, this study demonstrates the value of combining WordNet classifications, corpus-driven analysis, and innovative visualization techniques such as UpSetR and violin plots. These methods generate layered insights into the usage patterns, productivity, semantic coverage, and affective valence of olfactory metaphors. Additionally, our findings also reveal the limitations of existing lexical databases like WordNet, which would benefit from an expansion of coverage and more consistent classifications of the English lexicon, potentially supported by the integration of large language models (LLMs) to enhance coverage and interpretive accuracy.

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