# Metaphor, emotion, and the evolved sensory interface

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Languages use figurative meanings derived from sensory experience. Sensory experience itself is an evolved interface rather than a true reporting of objective reality, and it contains a shared source of categories (e.g., warm, bitter, dark) upon which to ground language learning. Most sensory categories are additionally used to describe aspects of our social experience with usages that are similar across languages. Here we consider whether the content of these figurative usages is exclusively emotional. We used 99 concepts commonly metaphorized by 54 sensory/spatial adjectives. We measured the emotional content of those concepts using the semantic differential, and then used dual categorization tasks (IATs) to measure human conceptual alignments between concepts (N = 3405). Emotional content strongly predicted alignments, but significant additional alignment was found when two concepts shared a common sensory metaphor. Sensory metaphor conveys conceptual social information that goes well beyond emotional content.

## 1. Introduction

The human language faculty is a complex biological adaptation that evolved by natural selection (Pinker, 2003; Bloom & Pinker, 1990). There are large families of metaphorized lexical items in many languages that have both sensory meanings and social meanings. The use of sensory metaphor to describe persons is highly conserved across diverse languages (Asch, 1955, 1958). There has been a great deal of speculation concerning the foundational role of metaphor (and abstraction) in the evolution of human language (e.g., Cusky & Sommer, forthcoming; Ellison & Reinöhl, 2022; Smith & Höfler, 2014). Recent work on sensory metaphor has emphasized its use for conveying emotion (e.g., Citron & Goldberg, 2014), but emotional expression through non-verbal information is also highly conserved across many classes of terrestrial vertebrates (e.g., Congdon et al., 2019; Filippi et al., 2017; Lingle & Riede, 2014). The present study tested whether sensory metaphors leverage additional proto-conceptual information in the evolved sensory interface of humans (Hoffman, 2018; see also Zhu et al., forthcoming).

Here we show that concepts metaphorized by the same sensory metaphors show alignment strength that suggest unique conceptual contributions from shared evolved subjective categories, in addition to emotional content.

### *1.1. The Sensory Interface*

Categories of subjective experience, including those for taste, smell, touch, sight and hearing, generally represent a shared source of mutual sensory understanding despite being inherently subjective. Even children can come to realize that there is no obvious way of knowing whether the appearance of "red" is the same from person to person, yet simply assuming a shared experience seems to work for language learning. For humans with the most common form of anomalous trichromatic color vision, for example, the consistency of difference in where color boundaries labels fall (e.g., green traffic lights appear pale green to those with deuteranomaly) provides additional confirmation that color experiences normally reflect an evolved 3-dimensional interface representing the ratios of activity across three cone types in consistent categories. Based on models of evolutionary processes, Hoffman (2018) has proposed that all perceptual categories are best construed as a kind of interface that summarily captures aspects of the world's structure sufficient for survival and reproduction in ways that provide fitness without needing to be true, complete, or accurate.

### *1.2. Metaphorizing the Sensory Interface*

The social psychologist, Solomon Asch, famously showed that certain kinds of personality descriptors colored other descriptors (1946). In particular, the words *cold* or *warm*, quite strongly changed the interpretation of the word *intelligent*. Less well known, Asch asked whether personality descriptors like warm and cold, which are sensory metaphors, vary from language to language (1955, 1958). He employed the aid of 6 experts in 6 languages from diverse language groups to collect evidence of the use of sensory metaphor in those languages in the descriptions of persons. Although usages varied in their details from language to language (e.g., a sour person might be one who had suffered a personal loss), Asch concluded that the similarities of use across languages were too prevalent to be accidental. Thus, Asch argued that seemingly unrelated languages chose similar sensory metaphors for recognizable social experiences.

A reductive interpretation of Asch's finding might be that the emotional properties of sensory experiences were the only information that was being conveyed. For example, the basic tastes (salt, sweet, bitter, sour, savory) could be construed as varying in valence, arousal and dominance, and it might be these emotional properties that are primarily communicated by their use. Metaphors appear to convey emotion more strongly than literal counterparts (Citron & Goldberg, 2014). How might one differentiate sense-specific meaning from emotional communication?

### *1.3. Research Strategy*

Here we report the result of an investigation in which we used psychological tools well-designed to implicitly measure conceptual alignment (the implicit association test or IAT, Greenwald et al., 1998), in combination with psychological tools designed to implicitly measure affective content (the Semantic Differential or *SemD*; Osgood et al., 1957). Although we expected that emotional content would explain a great deal of the variance when testing for alignment among concepts using the IAT (Xiong et al., 2006), we expected to find more specific effects of metaphoric alignment as well. That is, we expected that concepts that were commonly metaphorized by the same word (e.g., “smart” and “hurtful” can both be described as “sharp”) might show conceptual alignments on the IAT above and beyond their measured emotional similarity.

A pre-registered pilot study using 7 sensory metaphors (each with 2 distinct meanings) measured conceptual alignments of 21 different concept pairs using IATs. Seven IATs paired concept pairs from same-metaphor sources and 14 used random pairings across metaphors. SemD ratings of the concepts were used to establish a 3-dimensional SemD score of emotional alignment. This pilot established that IAT scores could be predicted based on the correlation between the 3-dimensional SemD difference scores for each pair of words, and estimated that the small (non-significant) effect size of shared metaphoricity would require a much larger sample of items to reliably detect.

## 2. Methods

The present study was conducted online during the summer of 2022. Although not pre-registered, the analysis plan was developed as a replication of the pilot study which had pre-registered the exclusion criteria. Moreover, only a single planned (maximal) analysis was conducted. A total of 2783 (121*23) participants completed IATs while 522 (18*29) participants provided SemD ratings. About 18% of IAT participants were excluded for inattention (based on pre-registered criteria) and about 5% of ratings participants were excluded for poor attention, based on very low correlations between their ratings and the mean ratings for other participants.

### *2.1. Stimuli*

A total of 99 concepts were selected based on distinct metaphoric senses of sensory or spatial adjectives. Different senses were operationalized as having a separate tab on thesaurus.com for that meaning and the meaning being figurative. For example, BRIGHT had tabs indicating figurative senses of *intelligent*, *promising*, and *cheerful*, among others. Thirty-three of the concepts were the sole metaphoric use listed for a sensory category, the other 66 concepts were groups of 2-6 figurative meanings from 21 sensory/spatial categories.

For each concept, an antonym appropriate for that metaphoric meaning was chosen by the authors from those provided by thesaurus.com in consultation with each other (e.g., *unintelligent*, *unpromising*, and *doleful*). Lists of synonyms (four for the target concept, and four for the antonym) were selected for each of the target pairs for use in IATs where the target concepts would be the category labels. The complete stimuli are available in supplemental online materials.

### *2.2. IATs*

Concepts (and their antonyms) were paired as category labels either with concepts metaphorized by a *shared metaphoric source* (55 unique pairings were tested) or by a *different metaphoric source* (66 randomly-selected pairings). The latter pairings included 33 pairings among the concepts derived from sensory words that had at least two figurative meaning (*baseline*), and 33 pairings that crossed these with concepts from the list of sensory words with only a single figurative meaning (*control*). Thus, 121 unique IATs were created. Each consisted of the standard 7 blocks of trials, with 16 trials of practice at the two concepts separately, then 16 and 24 trials with the two mixed together, then 24 practice trials to reverse the labels on one of the categories, and then 16 and 24 trials with the two mixed together with the opposite alignment. The side of response, the order of alignment, and the dimension that switched were all randomized. On average, 19 participants were successfully tested with each of the 121 IATs. A D-score (difference in mean RTs divided by the pooled standard deviation) was computed for each participant. The experiment was run on PsyToolkit (Stoet, 2010, 2017); data were collected on Mechanical Turk via Cloud Research – i.e., TurkPrime (Litman et al., 2017).

### *2.3. Semantic Differential Data*

Semantic differential ratings across 12 scales were collected for each target concept and its antonym. The concepts were divided across 18 different surveys to divide the labor. Participants had to complete a brief attention test prior to doing the ratings to ensure they were attentive. Ratings were averaged by concept and subjected to PCA (Dunteman, 1989) with normalized variables (scaled, centered) and orthogonal rotation. The first 3 components were consistent with *Evaluative*, *Potency*, and *Activity* dimensions normally identified by SemD procedures (corresponding to emotional valence, dominance, and arousal). Each concept/antonym pair was then assigned a 3D vector representing the difference between the two words along those three dimensions. The correlation between the vectors for concepts paired in our IATs was used as the *emotional alignment* predictor of IAT-assessed alignment (D-scores).

## 3. Results

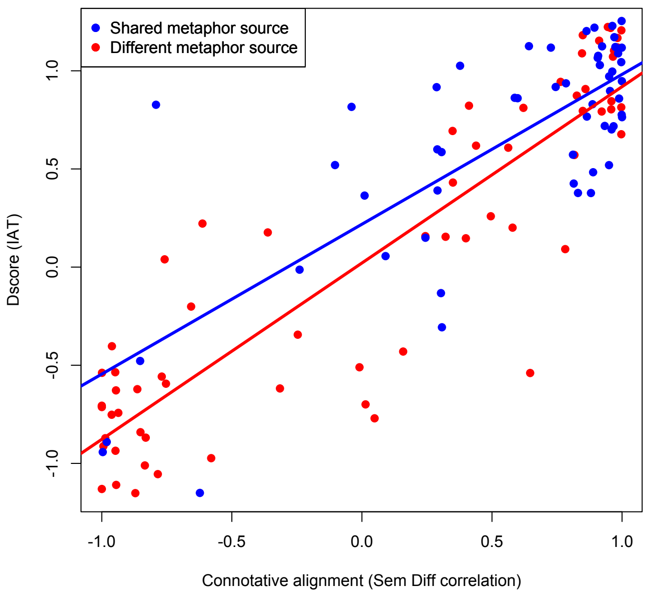


Figure 1. Mean IAT score (conceptual alignment) is plotted as a function of measured emotional alignment of concepts. Even with emotion taken into account, IAT scores are higher for concept pairs that are metaphorized with the same sensory word. Best fitting regression lines are shown.

Linear mixed effect regression (LMER) was used to analyze the D-scores for the IATs (computed using the advanced method Greenwald et al., 2003) with a maximal model, including both the *emotional alignment* predictor, and a three-level metaphor-source predictor representing the type of concept combination used (*baseline* random pairings vs. *shared metaphoric source* vs. *control* pairings). As expected, *emotional alignment* strongly predicted IAT scores, $\beta$ = 0.79, $t(114.9) = 10.5$, $p < .0001$. However, there was also a significant effect of *shared metaphor source*, $\beta$ = 0.22, $t(114.9) = 2.21$, $p = .029$. The results are shown by item in Figure 1, collapsing *control* and *baseline* pairings (which did not differ from each other) into a single category of *different metaphor source*.

## 4. Discussion

Abstraction, analogy, and the creation of figurative meaning are among the powerful drivers that have allowed human cognition to create categories that expand the classes of entities that words can refer to. The present results suggest that when people use sensory metaphor to convey more abstract meanings, they are tapping into information in our evolved perceptual interface that might be hard to otherwise articulate. The IAT appears to be particularly sensitive to emotional conceptual alignments among words, but also to more fine-grained meanings: Concepts metaphorized by the same sensory/spatial sources are, on average, more positively aligned than would be predicted based on their emotional content alone.

Recent criticisms of the IAT chiefly concern its use as a measure of individual differences (Schimmack, 2021). As a measure of cognitive patterns in populations, such as those shown here, it is like other group measures. When two categories are easily combined (align), switching the category alignment has a bigger cost, and this is what the IAT measures. Thus, in our data a high positive correlation in emotional content leads to a strongly positive IAT score, but a high negative correlation in emotional content leads to a strongly negative IAT score. Across all of this emotion content, however, there remains a strong positive shift in IAT measured alignment that suggests that sharing a metaphorized sensory meaning provides another form of category alignment. While it is possible that the semantic differential is simply inefficient at detecting emotional content, this seems unlikely to explain the current results.

The evolved sensory interface (Hoffman, 2018) that we experience as the directly-perceived world is a shared interface that provides a common sensory ground necessary for language learning. We can access abstract information in that shared sensory interface when we communicate about our social experiences using sensory words.

## 5. Supplementary Materials

Supplementary materials including all verbal stimuli used, and the full data set used for analysis, as well as the primary analysis code in R, are available online at https://osf.io/n47fk/?view_only=b00befa5bc074a5a8f0e09bc8a17b784.

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