The career of verb metaphor: Language evolution parallels online processing differences between nouns and verbs

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This paper explores the relationship between online sentence processing and meaning change over time. Specifically, we test the hypothesis, first proposed in Bowdle & Gentner's (2005) *Career of Metaphor*, that novel metaphoric extensions may become new conventionalized word senses over time, driving polysemy. Here we examine whether identified differences between nouns and verbs in online sentence processing—the verb mutability effect—are paralleled by differences in the lexicon, as would be expected if online processing drives lexical changes over time. In Experiment 1, we found that verbs are more polysemous than nouns overall. In Experiment 2, we found that verb senses are rated as being significantly more metaphoric than noun senses, controlling for frequency band; in Experiment 3, we found that historically newer word senses are generally perceived as being more metaphoric than older word senses. Implications for language evolution are discussed.

1. Introduction

Metaphor is widely regarded as an important driver of language change over time (Heine, 1997; Hopper & Traugott, 2003; Xu et al., 2017*).* One proposal for how this might occur is Bowdle and Gentner's *Career of Metaphor* (CoM) account: that with repeated parallel usage, new figurative uses of words become conventionalized and enter the lexicon as new word senses (Bowdle & Gentner, 2005; Gentner & Bowdle, 2001).[1] Thus, the CoM posits that online novel figurative extensions lead to lexical change over time. This is not a new idea, but empirical evidence linking synchronic and diachronic change is hard to find. Here, we investigate this hypothesis through a novel route. We explore differences between patterns of meaning extension for verbs vs. nouns and trace their consequences for language evolution.

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[1] Bowdle and Gentner provided evidence for a further assumption of the CoM theory, namely, *grammatical concordance:* that for noun-noun metaphors, there is a shift in preference from the simile form to the metaphor form with conventionalization.

1.2 Differing patterns of online adjustment between nouns and verbs.

When faced with sentences that show *semantic strain* (e.g., *The lizard worshipped* or *The violin pranced*), people may adjust the standard meaning of one or more word. There is substantial evidence that verbs are more likely to undergo such adjustment than are nouns (Gentner & France, 1988, King & Gentner, 2022; King, 2023). For example, King and Gentner (2022) asked people to paraphrase simple intransitive sentences that varied in degree of semantic strain (e.g., *The husband complained* (low strain) vs. *The motor complained* (higher strain)). Using word2vec (Mikolov et al., 2013), they demonstrated that verbs changed their meanings more under semantic strain than did nouns; and, further, that the *degree* of meaning change increased for verbs (but not nouns) as strain increased. In a further study (Expt. 3), King and Gentner asked raters to judge the type of semantic change that had occurred for the initial noun and verb in each paraphrase. The results showed that verb paraphrases were highly likely to be judged as metaphorically/analogically related to the initial verb. In contrast, noun paraphrases were rarely judged as metaphorically related; rather, they were mostly judged as either taxonomically or metonymically related.[2]

   Thus, there are two attested differences—one quantitative and one qualitative—between nouns and verbs in their patterns of online meaning adjustment. First, verbs are more prone to change meaning under semantic strain than are nouns[3] (*verb mutability*; Gentner & France, 1988; King & Gentner, 2022). Second, online verb meaning extensions are more likely to be metaphoric than noun meaning extensions (King & Gentner 2022). If synchronic processes drive diachronic change, these findings predict different patterns of polysemy in the lexicon between nouns and verbs. Here we test three main predictions:
Prediction 1: Verbs should be more polysemous than nouns overall.
Prediction 2: Verb senses in the dictionary should be more metaphoric than noun senses in the dictionary.
Prediction 3: Newer word senses should be more metaphorical, on average, than older word senses. This follows from the CoM prediction that novel metaphoric extensions can become conventionalized over time and enter the lexicon as word senses; with continued usage, these senses will come to be seen as literal.

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[2] Here, 'metaphoric' was described as "A term involving an analogy or abstract commonality with the original word"; "Metonymic" was described as 'A term that is associated, rather than similar or taxonomically related (e.g., part-whole) and does not share an abstract commonality"; 'Taxonomic' was described as "superordinate or subordinate."

2. Experiment 1

This study tested the key prediction that verbs will be more polysemous than nouns. A secondary prediction was that high-frequency words will be more polysemous than low-frequency words. Third, we predicted that the effect of frequency on polysemy would be stronger for verbs than for nouns. To do this we obtained polysemy counts for 25,688 nouns and 5,698 verbs.[4]

2.1 Results
To test these predictions, polysemy was modeled as a function of word class (noun vs. verb), word frequency, and the interaction between the two. Thus the design was Frequency X Class. We used an iterative model-comparison approach to select the best-fitting model. A log-transformed second-order exponential model resulted in the best fit: $\log Polysemy \sim (\log Frequency)^2 * Class$. The fitted model was then entered into a Type I ANOVA test of fixed effects. The results bore out all three predictions (Figure 1).

First, as predicted, there was a main effect of Class: verbs had more senses overall (M = 3.25, SD = 3.36) than nouns (M = 2.21, SD = 2.21), $F_{1, 31380}$ = 425.14, $p < .0001$. Second, there was a main effect of word frequency $F_{2, 31380}$ = 8377.95, $p < .0001$. Polysemy increased with frequency for both verbs and nouns, and there was a <u>s</u>ignificant positive exponential relationship between Log(Polysemy) and Log(Frequency). Finally, there was a significant Frequency * Class interaction, $F_{2, 31380}$ = 11.672, $p < .0001$: as predicted, the effect of frequency on polysemy was stronger for verbs than for nouns.
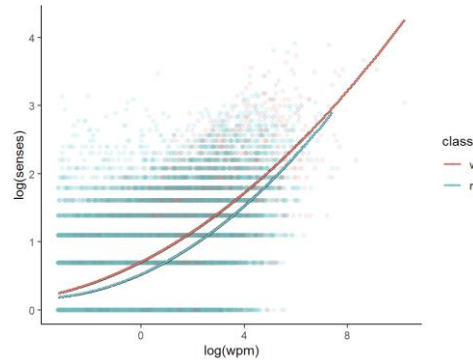

Figure 1. Fitted model results from Experiment 1.

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[4] We selected all verbs and nouns from COCA's top 60,000 most frequent English words (lemmatized) Davies, 2008). Polysemy counts for each lemma were obtained by retrieving all senses for every word using the Oxford Dictionary Online API, resulting in 26,888 nouns and 5,750 verbs (32,638 total). Polysemy counts were unavailable for 3,632 lemmas (3,498 nouns and 134 verbs; 11% of the total number), resulting in a net of 31,386 words in the analysis (25,688 nouns and 5,698 verbs).

3. Experiment 2

Experiment 2 tested Prediction 2-–that verb senses in the dictionary will be more metaphoric than noun senses.

3.1 Method

We selected the top 40 most frequent verbs and nouns (lemmatized) from three different frequency bands, determined using Davies (2008): 100 wpm, 10 wpm, and 1 wpm. As in Experiment 1, all senses for each word were obtained using the Oxford Dictionary Online API (1015 senses total).[5] 116 students at a private university in the Midwest served as raters.[6] Participants provided metaphoricity ratings for every sense of each of the 237 lemmas (a total of 1016 senses) using the following procedure.

Each sense was presented to the raters via an example sentence provided by the Oxford Dictionary, with the corresponding lemma bolded: e.g., *The evening had just **flown** by.* Participants rated the metaphoricity of the bolded word on a 1 to 6 scale. *Metaphoricity* was defined as a word "not being used with its normal literal meaning, but rather with a different meaning that still shares a connection with the normal meaning of the noun."[7] Participants indicated their confidence in each rating on a 1-5 scale and were also able to mark whenever the meaning of the bolded word was unclear in the provided context. Each participant rated only verb senses or only noun senses. This resulted in five ratings per word sense.

The first prediction is that verb senses will be more metaphoric than noun senses overall. Second, we predicted a negative relation between frequency and metaphoricity for both verbs and nouns. This follows from the usage-based conventionalization process proposed in the CoM: the more often a given word sense is used, the more it will be perceived as conventional rather than metaphoric. A final prediction is that high-polysemous words will be rated as more metaphoric than less-polysemous words. On average, if metaphor is a major driver of new sense acquisition, then the more senses a word has, the more metaphoric it should be.

Results

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[5] Senses could not be found for three of the selected nouns, leaving a net of 120 verbs and 117 nouns included in the analysis.

[6] All participants answered "yes" to a question asking them if they were native speakers of English.

[7] This definition of 'metaphoricity' is more general that used by King and Gentner (2022), which emphasized analogical relations (see above). In the present case, we wanted to capture any figurative extension, whether analogical or metonymic.

The 116 participants provided a total of 4138 high-confidence ratings.[8] A linear mixed effect model was fit, with metaphoricity rating as the dependent measure, word frequency, word class, their interaction, and word polysemy entered as fixed effects, and subjects and lemma entered as random effects. The fitted model was entered into a Type III ANOVA test of fixed effects using Satterthwaite's method for determining degrees of freedom.

The results supported our two chief hypotheses. First, word senses of verbs were rated as significantly more metaphoric than those of nouns, $F = 4.76$, $p = .03$. Second, for both verbs and nouns, metaphoricity was negatively correlated with word frequency, $F = 9.42$, $p < .0001$. Finally, polysemy was positively related to metaphoricity, $F = 22.16$, $p < .0001$. However, we did not find a significant Frequency * Class interaction. Despite the pattern suggested in Figure 2), the decline in metaphoricity with word frequency was not significantly steeper for verbs than for nouns.
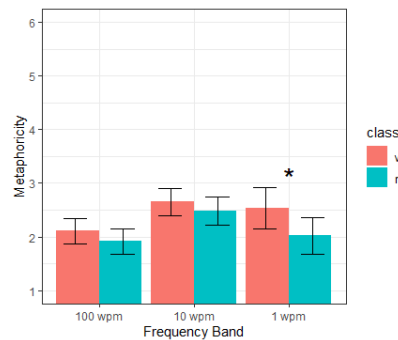

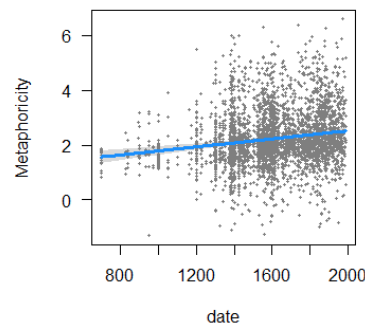Figure 2. Model results for Experiment 2.

Figure 3. Fitted model results from Experiment 3.

4. Experiment 3
Experiment 3 tested Prediction 3 – that newer senses in the dictionary will be more likely to be labeled as metaphoric than older senses, which have evolved to be seen as literal.

4.1 Method

The 1016 senses for which metaphoricity ratings were obtained in Experiment 2 were used in this experiment. The Oxford Dictionary (OD) API used in that study did not provide the age of the senses queried, so we used the Oxford English Dictionary (OED) online to obtain dates. To match the senses provided

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[8] There were 5885 ratings in total. We included only high-confidence ratings (4 or 5) and excluded ratings where the participant indicated that the meaning of the word was unclear to them in the context of the sentence, for a net of 4138 ratings included in the analysis.

by the API to those present in the OED, two trained judges, blind to the study's hypotheses, independently identified the closest possible match.[9] For 68 out of the 1016 senses, no date could be obtained; thus, a net of 948 unique senses were included in the analysis.

4.2 Results

A linear mixed effect model was fit, with metaphoricity rating (obtained in Experiment 2) as the dependent measure, sense age as the fixed effect, and subjects (who provided the metaphoricity ratings from Experiment 2) and lemma entered as random effects. As predicted, the effect of sense age was significant, $\beta = 0.1$, $SE = 0.03$, $t = 3.64$, $p < .001$; as the age of the sense decreased, perceived metaphoricity increased (see Figure 3).

5. General Discussion

This research provides novel evidence for the idea that online metaphoric extensions give rise to new word senses, by tracing processing differences between verbs and nouns. There are four main findings. First, verbs are more polysemous than nouns, reflecting the pattern that verbs are more mutable in online sentence understanding. Second, verb senses are more metaphoric than noun senses, reflecting that verbs are more likely to extend metaphorically in online processing than are nouns. Third, word senses for more frequent words are rated as being less metaphorical than those for less frequent words.

Finally, the final experiment directly examined the evolution of word meaning by examining the age of each sense. We found the age of a word's sense predicted the metaphoricity ratings from Experiment 2, such that older senses were rated as more literal than newer senses. This is consistent with the predictions of the Career of Metaphor. Early in its career, a metaphoric sense will be labeled in a dictionary as *figurative*. With continued usage, alignment across uses strengthens the common meaning so that it comes to be seen as *literal* (Bowdle & Gentner, 2005; Gentner & Asmuth, 2019). Further, King and Gentner (2023) found evidence that verb-noun metaphors are processed via a process of structural alignment akin to that used for noun-noun metaphors. Thus it appears that the Career of Metaphor—from novel to conventional meaning— applies to verb metaphors as well as to noun-noun metaphors. Further research may reveal whether this transition occurs more rapidly for verbs than for nouns.

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[9] Their judgements were based both on the definitions and the example sentences. Agreement was 70%. In cases where they disagreed, one of the authors made the final decision. When both choices were acceptable, the choice with the earlier date was chosen (57/301 disagreements = 19%).

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