Supporting information: Comparing subjectivity with alternative accounts of adjective order

1 The predictive power of inherentness

Whorf (1945): "English adjectives form two main cryptotypes with sub-classes. A group referring to 'inherent' qualities-including color, material, physical state (solid, liquid, porous, hard, etc.), provenience, breed, nationality, function, use-has the reactance of being placed nearer the noun than the other group, which we may call one of non-inherent qualities, though it is rather the residuum outside the first group-including adjectives of size, shape, position, evaluation (ethical, esthetic, or economic). These come before the inherent group, e.g. *large red house* (not *red large house*), *steep rocky hill*, *nice smooth floor*."

Martin (1969): "The purpose of this experiment is to investigate judgments of essentiality and nonessentiality. You will be asked to decide which of two adjectives you feel is more essential to the meaning of nouns which it modifies, that is, which adjective seems to be more substantive or inherent in its meaning. Choose whichever of the two adjectives seems more substantive to you when modifying the noun *object*."

Kemmerer (2000): "Analysis of these preferences has shown that they are due primarily to rather abstract semantic features, such as whether an adjective. . . encodes a property that is inherent to the kind of object specified by the noun."

2 Subjectivity vs. subsectivity

Indeed, subjectivity and subsectivity are related. Here are the reasons why we dont think this is a competitor. Two measures with ordinary people that can get at subjectivity. Subsectivity is a theoretical construct, not a behavioral measure. Also, it is binary and we have systematic graded behavior in the orders. Whether subjectivity predicts ordering within the class of adjectives, and indeed it does.

3 In search of noun effects

Compositional accounts of ordering preferences hold that the fundamental factor in predicting adjective ordering is whether or not an adjective is used to form a complex concept/subkind description: first you form the concept, then you modify it with additional

adjectives (McNally and Boleda, 2004; Svenonius, 2008).[1] This would imply that an interaction between the noun and a modifying adjective—whether they combine to form a complex concept—should have a large influence on adjective ordering. Indeed, a more general hypothesis is that *some* interaction between a noun and adjective will influence how closely the adjective is placed to that noun. This interaction could be caused by concept-formation, differential subjectivity, or other factors. We tested for such an interaction in Expt. 1 and found that noun-specific naturalness did not explain any variance in ordering preference above and beyond adjective-level naturalness. Looking in more detail, there were two adjective-noun pairs in our data with trends in the predicted direction: the naturalness ratings for *hard* and *soft* suggested a preference to occur closer to the noun *cheese*. (Plausibly because hard and soft cheeses are natural kinds.) While these adjective-noun interactions do not survive correction for multiple comparisons in our statistical analysis, they do indicate that a different set of materials might reveal by-noun effects on ordering preference. Here we follow up on this result with a new set of materials that were chosen to maximize the probability of noun effects.

3.1 Ordering preferences

This experiment was a direct replication of *Expt. 1.1 Ordering preferences*, using a different set of nouns. We aimed to choose nouns that formed idiomatic, complex concepts with our previous set of adjectives. Complex concepts tend to be described using the two-word name, yielding more occurrences of this bigram than would be expected from the unigram frequencies of the noun and adjective. This provided a way to extract candidate complex concepts from corpora.

Participants. We recruited 50 participants through Amazon.com's Mechanical Turk crowdsourcing service. Participants were compensated for their participation.

Design and methods. The design was identical to our original naturalness ratings experiment: participants were asked to indicate which of two object descriptions sounded more natural, using a sliding scale. Each description featured a noun modified by two adjectives; description pairs contained the same words with the relative adjective order reversed (e.g., "the big blue thing" vs. "the blue big thing"). Adjectives were chosen at random from the original set of 26. The nouns were a smaller set of five (compared to the original ten). Nouns were chosen to maximize the probability of detecting noun-specific effects on adjective ordering preferences. In particular, we expected that nouns that are likely to form complex concepts should be highly collocational with that adjective. We thus searched for nouns that occur in particular adjective-noun phrases more frequently than predicted by the individual noun and adjective probabilities; in other words, nouns whose adjective-noun combinations were under-predicted by their individual word probabilities.

To find these nouns, we estimated the probability $p(A)$ of each adjective from our set of 26 by computing its relative frequency in an adjective-noun sequence in the BNC. We

[1] Bouchard (2005) makes a similar claim, namely that the formation of complex concepts can override adjective ordering preferences.

Noun	# of adjectives	range of ratios	minimum ratio	maximum ratio
thing	23	10.4	0.1	10.5
eyes	18	120.6	0.12	120.7
hair	15	82.9	0.03	83.0
cheese	13	114.0	0.4	114.4
apple	11	674.0	1.1	675.1

Table S.1: For each chosen noun, the number of adjectives (out of 26) that it occurs with; and for each adjective A that the noun occurs with, the range of ratios $p(A, N)/\hat{p}(A, N)$ (empirical to predicted probability of occurrence); the minimum ratio; and the maximum ratio.

then computed the relative frequency of each noun $p(N)$ occurring in an adjective-noun sequence. Finally, we estimated the predicted joint probability of each adjective-noun combination by taking the product of each individual probability estimate: $\hat{p}(A, N) = p(A) \cdot p(N)$. Comparing $\hat{p}(A, N)$ to the empirically estimated $p(A, N)$ establishes which adjective-noun combinations are under-predicted—more collocational—and thus likely to name complex concepts. We then restricted nouns to those 50 that maximize the observed range of under-predictedness while simultaneously requiring that each noun be attested to occur with at least 11 of the 26 adjectives; from these 50 nouns, we selected the following four: *apple, cheese, eyes, hair*.[2] (Recall that *cheese* occurred in our original materials, where it suggested possible by-noun effects with the adjectives *hard* and *soft*.) To these four nouns we added a fifth: *thing*. While *thing* did not occur in the top 50, it did occur naturalistically with the most adjectives (23) out of the set of 26, thus allowing it to serve as a filler for the various object descriptions. The selected nouns, together with the number of adjectives they occur with, their range of ratios of empirical to predicted joint probabilities, and their minimum / maximum ratios, are shown in Table S.1.

Results. To evaluate the role of specific noun information in determining ordering preferences, we performed the same nested linear model comparison from our original naturalness ratings experiment. The models we compared predicted naturalness ratings either by ADJECTIVE (i.e., the adjective farthest from the noun) only, or by ADJECTIVE together with its interaction with NOUN (i.e., the modified noun). The model comparison revealed that noun-specific ratings did not explain any additional variance in ordering preference beyond adjective-level ratings ($F(1, 104) = 1.10, p < 0.30$). Thus, we again fail to find evidence of noun-specific effects on ordering preferences in our new materials.

Given the lack of noun effects on ordering preferences, we should continue to find that adjective subjectivity predicts ordering preferences. Indeed, it does: adjective subjectivity scores (obtained in *Expt 1.2 Subjectivity*) account for 85% of the variance in the new naturalness ratings (r^2=0.85, 95% CI [0.64, 0.93]; Fig. S.1). As with our original materials, more subjective adjectives are preferred farther from the noun.

[2]We restricted to a small subset of the 50 target nouns in order to maximize statistical power to identify noun effects on ordering.

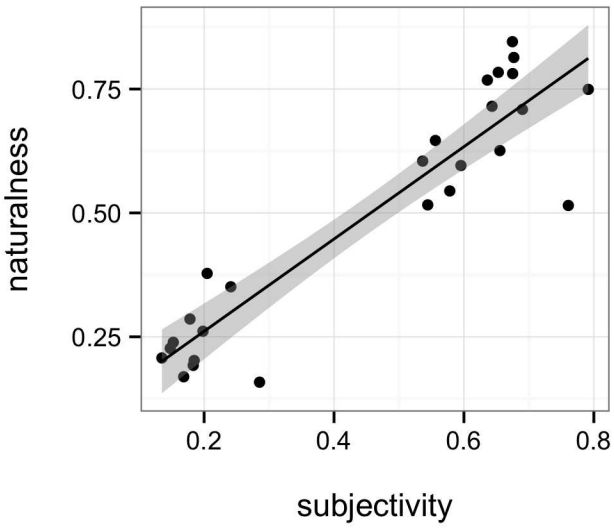

Figure S.1: Mean naturalness ratings plotted against mean subjectivity scores for each of the 26 adjectives tested in Expt. 2.

3.2 Discussion

We failed to find evidence in support of compositional accounts of ordering preferences, which hold that the most important factor in determining order is whether or not an adjective forms a complex concept with the noun it modifies. Using nouns chosen to maximize the probability of complex concepts formed with our 26 adjectives, we failed to find evidence that adjective ordering preferences depend on the modified noun. We do continue to find that subjectivity predicts ordering preferences. It is quite possible that noun-effects (and hence effects of concept composition) would be found with a different set of adjectives. However, this already suggests that the effect of modified nouns explains only a small part of the overall story of adjective order; subjectivity seems to do better.

References

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