Compounds and the limits of compositionality

Chris Potts, Ling 130a/230a: Introduction to semantics and pragmatics, Winter 2024

Jan 23

1 Goals

- Take lexical meaning more seriously.
- The dark side of compositionality? (Move to a more flexible notion of compositionality?)
- Levin et al. 2019 as an outstanding example of
  - Complementary empirical methods in linguistics (intuitions, corpora, experiments)
  - Semprag interacting with general cognition
  - Open science: `https://osf.io/6rgse/`

2 The basics of English compounds

(1) Stress pattern: on the head in modifier constructions (general for English) but generally on the modifier for compounds.

Modifier-head	Compound
toy STORE	TOY store
brick FACTORY	BRICK factory
white HOUSE	WHITE house
black BIRD	BLACK bird
black BOARD	BLACK board

(2) Adverbial modifiers block compound readings:

a. really white house

b. light blue bird

(3) Contrastive readings with compounds will tend to sound like language games:

a. BLACK birds are rarer than BLUE ones.

b. *BLACKbirds are more common than GREEN ones.

c. [Inspecting photos of famous houses]
#The president lives in the WHITE house and Mark Twain lived in the BROWN one.

(4) Entailment:

a. That blackbird is green!

b. #That black bird is completely orange!

3 Partee (1995) on compounds and compositionality

(5) **Compositionality**: The meaning of a whole is a function of the meanings of the parts and of the way they are syntactically combined.

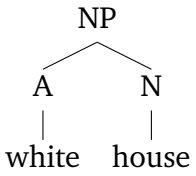
(6) Partee (1995:341): "In compounds, on the other hand, there is no general rule for predicting the interpretation of the combination [...]. A TOY store (in typical contexts) is a store that sells toys, a TOY box is a box that holds toys, and so on. Semanticists in general do not expect a semantic theory to provide a compositional semantics for compounds but do expect a compositional semantics for modifier–head construction. The reasoning is that a native speaker cannot generally interpret a novel compound on first hearing on the basis of knowledge of the language alone, but can do so for a novel modifier–noun construction."

We might question how predictable regular modification actually is (Partee 1984:161):

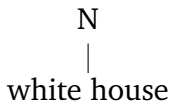
(7) a. flat surface
b. flat tire
c. flat note
d. flat beer
e. flat file

Our focus, though, is on the degree to which compound meanings are predictable, and on what the answer means for the status of the compositionality principle.

(8) a. Adjectival modification (some kind of subsective modification):



b. Compound (no parts, hence no compositional analysis):



If syntacticians say that compounds have syntactic structure, then this poses a dilemma for us, as compositionality would compel us to give meanings to the sub-parts and predictably derive the meaning for the whole, but Partee said that that can't be done – see (6).

4 Levin et al. (2019)

> "In this paper, we propose that the head–modifier relation found in a given compound is strongly influenced by the nature of its referent: in particular, whether the referent is construed as an artifact, an entity made by humans for a purpose, or as a natural kind, an entity that exists independently of humans." (Levin et al. 2019)

4.1 Theoretical background

(9) Discussion limited to endocentric compounds – those that entail the property named by the head noun:

a. *birthday cake* entails *cake*

b. *pinto bean* entails *bean*

(10) Exocentric compounds are different:

a. *ladyfinger* does not entail *finger* (or *lady*)

b. *paperback* does not entail *back* (*paper*?)

(11) Natural kinds vs. artifacts:

a. Natural kind are generally not made by people, and they are defined by their essential physical attributes – animals, minerals, molecules, planets, etc.

b. Artifacts are generally created with specific purposes in mind – tools, foods, art, etc.

c. Vagueness alert! The line between natural kinds and artifacts can be hard to draw. Levin et al. (2019:438) consider the challenges posed by living things that are bio-engineered to have specific properties.

4.2 Central hypotheses

(12) **Events vs. essences hypothesis** (p. 438): Compound names for artifacts will tend to differ from compound names for natural kinds. In compound names for artifacts, the modifier will tend to make reference to an event associated with the artifact, whereas in compound names for natural kinds, the modifier will tend to make reference to properties reflective of the essence of the natural kind.

By (9), reference will be determined by the head noun.

(13) **Event-related modifier hypothesis** (p. 439): A compound name for an artifact will tend to have one of two types of modifiers:

a. a modifier that denotes a participant in an associated event, whether of creation or use;

b. a modifier that otherwise makes reference to an associated event, e.g., specifies its time or occasion of use or its mode of creation.

(14) **Essence-related modifier hypothesis** (p. 440): A compound name for a natural kind will tend to use one of three types of modifiers:

a. **Perceptual**: a modifier that refers to the kind's perceptual properties, especially appearance;

b. **Environmental**: a modifier that refers to the kind's habitat, including geographic location of origin;

c. **Borrowed**: a modifier that is a word borrowed from another language.

4.3 Corpus study

Example sources Online databases from the domains of food/cooking (utensils, cakes, cookies, greens, and legumes) and jewelry/precious minerals (bracelets, necklaces, rings, earrings, gemstones, pearls, corals, and ebonies).

In-class mini-study We'll do a poll in which we use Table 2 (p. 445) to classify the following compounds according to their head–modifier relation:

(15) a. kidney bean
b. pinto bean
c. bundt cake
d. depression cake
e. charm bracelet
f. bubble necklace

Coding Done by three linguistics graduate students uninformed about the goals of the study (p. 447).

Hypotheses Table 3 collapses Table 2 into the categories used for analyses:

(16) a. Artifact referent: Event (by (13))
b. Natural kind referent: Perceptual, Environmental, Borrowed (by (14))

Results (simplified from Table 4):

	Natural kinds		Artifacts	
Perceptual/Environmental/Borrowed	548	(84.2%)	369	(36.9%)
Event	36	(5.5%)	574	(57.4%)
Other	67	(10.3%)	57	(5.67%)
Total	651		1000	

Statistical analysis Levin et al. (2019:448) further support these results with chi-squared tests, which in essence test whether the numbers in their Table 4 (or as above) are different from what we would expect if the modifier types and referents were independent of each other, taking into account the different rates at which these are observed (row and column totals).

4.4 Production experiment

Hypotheses

(17) a. Artifact referent: Use (by (13a))

b. Natural kind referent: Appearance or place of origin (by (14a, b))

Example item

(18) i. You subscribe to a service that sends you new food items every month. This month, you receive a new type of chickpea.

a. It comes from Istanbul.

b. It is green in color.

c. You use it to make hummus.

ii. What two-word name would you give to this new food?

iii. How much do you think this chickpea would cost? (distractor)

iv. Where would you store this chickpea in your home? (distractor)

(19) Potential responses:

a. Istanbul pea (place of origin)

b. green chickpea (appearance)

c. hummus chickpea (use)

Participants 50 crowdworkers on Amazon Mechanical Turk (p. 455).

Coding Done by the authors, I believe (p. 455).

Results (simplified from Table 6):

	Referent	
Modifier	Artifact	Natural Kind
Place/Appearance	83 (48.8%)	151 (95.6%)
Use	87 (51.2%)	7 (4.4%)
Total	170	158

Statistical analysis Levin et al. (2019:448) present a regression model in which the nature of the object (artifact or natural kind) is used to predict the modifier type (place/appearance or use), together with predictors meant to capture the unanalyzed sources of variation coming from different participants and different experimental items. The analysis further supports the above picture.

4.5 Free-response comprehension experiment

Norming study Designed to find a set of novel compounds that sounded reasonably natural to people. The full set is in Appendix B.

Example items Participants gave free-text responses to prompts. Here are two actual items with 4 randomly sampled responses for each.

(20) Imagine that you encounter the compound *stew skillet*. What would you think this refers to?

a. a skillet used specifically for cooking stew
b. skillet to use for making stew
c. A skillet specially made to cook stew in.
d. A skillet that is used to make stew.

(21) Imagine that you encounter the compound *swamp squash*. What would you think this refers to?

a. squash grown in swamp
b. A squash grown in swamps.
c. A type of squash that grows best in swampy conditions.
d. squash that grows in the swamp

Design Crossed design (p. 459) with randomized order and 20 distractors referring to abstract objects (e.g., *ghost notion*). The crossed-design ensures that, for example, if you saw *bean towel* you did not also see *beer towel*, and that everyone saw a balanced combination of modifier/head combinations. We'll elaborate on this when reviewing our own study.

Coding Done by the authors using the same protocols as used in the corpus study (p. 459).

Results (simplified from Table 8):

Modifier	Head	Example	Event	Perceptual/Environmental
Artifact	Artifact	stew skillet	93%	7%
Natural kind	Artifact	stream wheel	88%	12%
Artifact	Natural kind	stew chickpea	66%	34%
Natural kind	Natural kind	stream vegetable	15%	85%

Statistical analysis Levin et al. (2019:448) again use a regression model that tries to control for unanalyzed sources of variation coming from the participants and the items. The model uses the modifier type (artifact or natural kind) and the head type (artifact or natural kind) to predict the overall interpretation (event or perceptual/environmental). It supports the above picture, and they also find evidence of an *interaction* between modifier and head type that you can see in the above table: the modifier matters more when the head is a natural kind than when it is an artifact.

5 Our forced-choice comprehension experiment

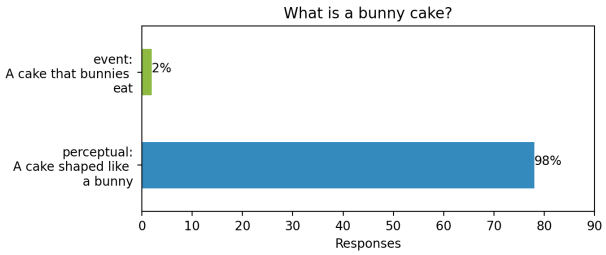
5.1 Design

	Mod/Head	Question	Perceptual	Event
0	nk/art	What is a bunny cake?	A cake shaped like a bunny	A cake that bunnies eat
1a	art/art	What is a stew skillet?	A skillet with a color and texture resembling stew	A skillet used in the creation of stew
1b	art/nk	What is a stew chickpea?	A chickpea that tastes like stew	A chickpea used as an ingredient in stew
2a	art/art	What are spaghetti scissors?	Scissors shaped like spaghetti	Scissors used in the creation of spaghetti
2b	art/nk	What is spaghetti lettuce?	Lettuce shaped like spaghetti	Lettuce made of spaghetti
3a	nk/art	What is a swamp thermometer?	A thermometer that has a swamp-green colored liquid	A thermometer used to study swamps
3b	nk/nk	What is a swamp squash?	A squash that smells like a swamp	A squash used to encourage swamp growth
4a	nk/art	What is a stick whisk?	*Free-form responses requested;*	
4b	nk/nk	What is stick broccoli?	*Chris annotated using the paper's Appendix A.*	

Survey A	Survey B
0	0
1a (art/art)	1b (art/nk)
2b (art/nk)	2a (art/art)
3a (nk/art)	3b (nk/nk)
4b (nk/nk)	4a (nk/art)

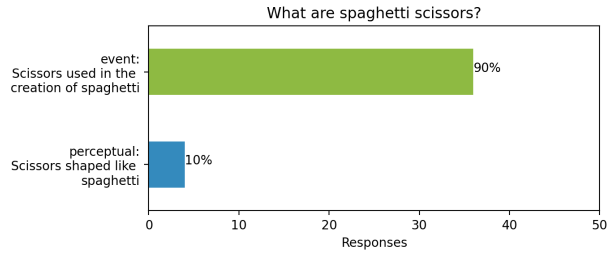
Participant count $N = 80$

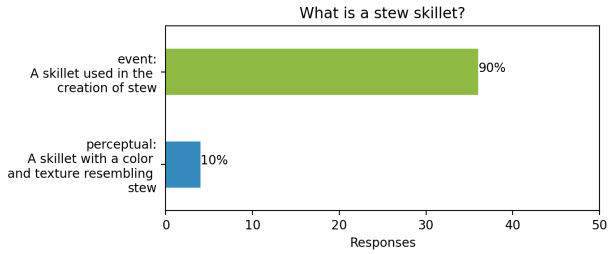
5.2 Warm-up item



5.3 Artifact modifier, artifact head

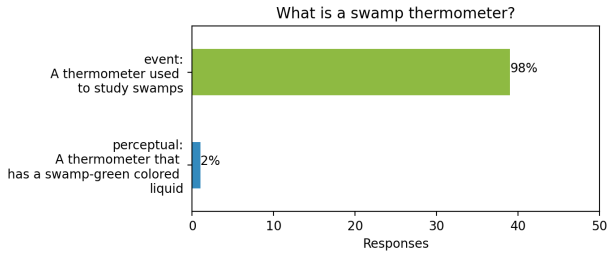
Both examples are consistent with (13a) and (13b), respectively, and aligned with Table 8, row 1:

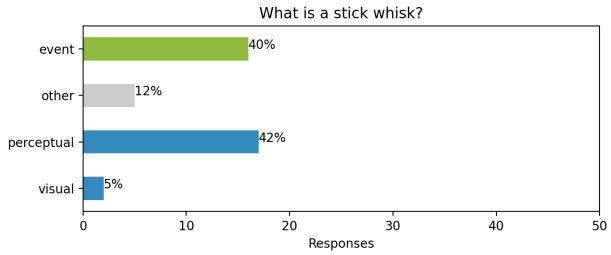




5.4 Natural kind modifier, artifact head

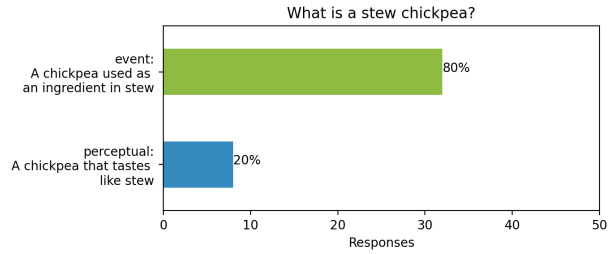
The left example is consistent with (13a) and aligned with Table 8, row 2, but the right example is less aligned with it.

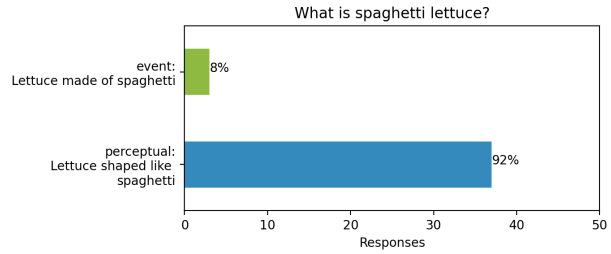




5.5 Artifact modifier, natural kind head

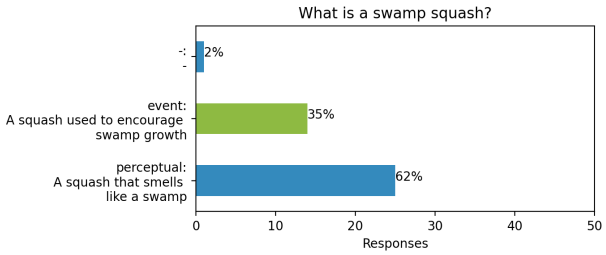
These examples seem to reflect the overall uncertain for this category relative to the others. The left pattern is unexpected given (13) and (14) but consistent with Table 8, row 3. Levin et al.'s data for these examples show the same pattern.

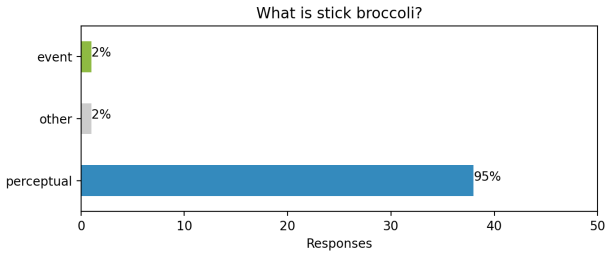




5.6 Natural kind modifier, natural kind head

The left example is slightly different from what we might expect given (14) and Table 8, row 4, whereas the right example is completely aligned with that hypothesis and those results.





6 Conclusion

From the paper's conclusion (p. 464):

> More broadly, we hope that this study exemplifies that the challenges posed by semantic context-dependence can and should be tackled. Dowty (1979) and Partee (1995) suggest that a fully compositional account of compound interpretation is not possible, as it requires context to precisely identify the relationship between a compound's head and the modifier. Here we have developed an account of this form of context-dependence by showing that the relationship posited between a compound's head and modifier depends largely on whether the compound's referent is an artifact or a natural kind, and specifically on the features salient to human interaction with that particular type of referent. More generally, we suggest that any time a semantic analysis depends heavily on context, it should be taken as a challenge to explain how. This paper has tried to respond to one such challenge.

References

Levin, Beth, Lelia Glass & Dan Jurafsky. 2019. Systematicity in the semantics of noun compounds: The role of artifacts vs. natural kinds. *Linguistics* 57(3). 429–471. doi:10.1515/ling-2019-0013.

Partee, Barbara H. 1984. Compositionality. In Fred Landman & Frank Veltman (eds.), *Varieties of formal semantics*, 281–311. Dordrecht: Foris. Reprinted in Barbara H. Partee (2004) *Compositionality in formal semantics*, Oxford: Blackwell 153–181. Page references to the reprinting.

Partee, Barbara H. 1995. Lexical semantics and compositionality. In Lila R. Gleitman & Mark Liberman (eds.), *Invitation to cognitive science*, vol. 1, 311–360. Cambridge, MA: MIT Press.