Chapter 13
The Ecology of English Noun-Noun Compounds[*]

13.1 Compounds: On the cusp between grammar and lexicon

Compounding forms a subsystem of grammar somewhat distinct from ordinary syntax and morphology. The present chapter explores the properties of this subsystem and its place in linguistic theory. On grounds of manageability I have confined the analysis to English noun-noun compounds, which appear to be representative of compounding more generally in English and other languages.[1]

The surface pattern of English noun-noun compounds (*teabag, oil drum, sunflower, bedframe, copy machine, engagement ring*) is easy to characterize: two concatenated nouns, henceforth N_1 and N_2, that together form a noun.

(1) $[_N\ N_1\ N_2]$

Typically the stress falls on N_1, as in the examples above. However, there are classical well-known exceptions such as *apple píe,* forming a minimal pair with *ápple cake* (another such pair is *álto horn* vs. *alto recórder*). I will not be too concerned with the reasons for the occasional shift of stress, though there are cases such as *aluminum fóil,* contrasting with *tínfoil,* where it turns out to make some difference (see note 21).

Compounding is recursive, often productively. The list in (2) includes some conventionalized combinations, but also several that are no doubt novel to many speakers, yet

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[*] This chapter is an expanded and revised version of Jackendoff 2009, incorporating material from a much longer manuscript of 1998 whose completion was interrupted by the more pressing need to write *Foundations of Language*. The study is based on examination of a corpus of approximately 2500 compounds. About half of these were collected by students in my Semantics course at Brandeis University in spring 1997. I thank Erica Goldman, Joy Budewig, and Kristen Lauer for their help in organizing this material. The corpus also includes many examples from the linguistics literature, in particular all of Lees's (1960) examples, as well as about 400 examples from random issues of the Boston Globe and The Nation. I am grateful to James Pustejovsky for much useful discussion; to him and Joan Maling, Federica Busa, Hildy Dvorak, and Dan Dvorak for further examples; and to Nigel Love, Herbert Brekle, Christian Bassac, Geert Booij, Peter Culicover, Susan Olsen, Biljana Mišić Ilić, Andrew Carstairs-McCarthy, and Shelly Lieber for comments on earlier versions of the chapter.

[1] The corpus happens to include a number of compounds that quite possibly are V-N compounds rather than N-N, for example *watchdog*, *flashlight*, and *repairman*. In most cases the first word is both a noun and a verb form, so it is difficult to judge. In any event, there seemed no interesting reason to omit them from the corpus once they were there.

perfectly interpretable.

(2) [ice cream] cone
[line item] veto
[accident prevention] program
neighborhood [liquor store]
[campaign finance] indictment
[screen door] [key hole]
[winter weather] [skin troubles]
[[[health management] cost] containment] services
(or is it [[health management] cost][containment services]?)
[[[diesel electric] engine] [dump truck]]
[[[Volume Feeding] Management] [Success Formula]] Award [from Gleitman and Gleitman 1970]

As pointed out by Levi 1978 and ten Hacken 1994, the nouns can also be elaborated in quasi-syntactic fashion:

(3) a. *Conjunction:*
[health and welfare] fund
[primary and caucus] states
[cock and bull] story
baseball [gloves and helmets]
[media, retail, and property] empire
[relaxation and [focus concentration]] techniques
[[stress relief] and [aroma therapy]] product
[Fresh Pond Parkway] [sewer separation and surface enhancement] project

b. *Adjective-Noun*
[foreign exchange] flow
[sexual harassment] laws
[First Amendment] values
[smoked [pork shoulder]][boiled dinner]

c. *Paired arguments*
[love-hate] relationship
[Port-cornstarch] mixture
[town-gown] tensions

d. *Numeral-Noun*
[two-car] garage
[2300-word] corpus]
[five-inch] hole
[three-part] harmony
(note **car garage*, **inch hole*, **part harmony*)
[two-axle] [[[diesel electric] engine] [dump truck]]

The frequency of novelty demonstrates that the compounds of English cannot just be listed; rather compounding must include a productive rule system.

Even with the quasi-syntactic complications of (3), the morphosyntax of noun-noun compounds is rather simple. My interest here lies in a different question: how the meaning of a compound is built from that of N_1 and N_2. It is well known (e.g. Selkirk 1982) that N_2 usually is the semantic "head" of the compound, in the sense that the compound usually denotes a particular subtype of the type denoted by N_2, as in the partial paraphrases in (4). For now, let us call this the Head Principle; it will be stated more formally in section 13.5.

(4) a. sunflower = 'a kind of flower'
b. engagement ring = 'a kind of ring'
c. health and welfare fund = 'a kind of fund'

Despite the semantic asymmetry, there is no syntactic reason to elaborate the morphosyntactic structure (1) into an asymmetric structure in which N_2 is somehow syntactically distinguished as the head. In particular, since N_2 is at the end, the plural ending will go on it with nothing further said.

Two sorts of exceptions to the Head Principle are well known. One sort are *exocentric* compounds (called *bahuvrihi* by Panini, as conveyed into modern tradition through Whitney to Bloomfield). These have a tacit semantic head (5), and sometimes use N_2 metaphorically, as it were (6). The other sort (called by Panini *dvandva*) equates the two components (7).[2]

(5) a. blockhead = 'someone with a head like a block' ≠ 'a head like a block'
b. duck call = 'something that makes a noise like the call of a duck'
≠ 'the call of a duck'

(6) a. seahorse ≠ 'a kind of horse'
= 'something that resembles a horse that lives in the sea'

b. pigtail ≠ 'a kind of tail'
= 'a (human) hair arrangement that resembles the tail of a pig'

(7) a. tractor-trailer = 'something that consists of both a tractor and a trailer'
b. fisherman = 'someone who is both a fisher and a man'
c. pantyhose = 'something that is both a panty and hose'

Many writers on compounds explicitly exclude these three types from their analysis. Sections 13.5.3 and 13.7 will show how they fall under a suitably generalized form of the Head Principle.

[2] There are also some families of left-headed compounds in English, such as *attorney general*, *mother-in-law*, *blowup*, and *pickpocket*. But they are not noun-noun compounds.

Even disregarding these cases, the Head Principle is far from sufficient to determine the meaning of a compound. Consider the variety of meaning relations between N_1 and N_2 in (8)-(9).

(8) a. chocolate cake = 'a cake made with chocolate in it'
b. birthday cake = 'a cake to be eaten as part of celebrating a birthday'
c. coffee cake = 'a cake to be eaten along with coffee and the like'
d. marble cake = 'a cake that resembles marble'
e. layer cake = 'a cake formed in multiple layers'
f. cupcake = 'a little cake made in a cup'
g. urinal cake = 'a (nonedible) cake to be placed in a urinal'

(9) a. railroad car = 'a car that runs on a railroad'
b. cattle car = 'a (railroad) car to carry cattle'
c. dome car = 'a (railroad) car that has a dome'
d. refrigerator car = 'a (railroad) car that serves as a refrigerator'
e. dining car = 'a (railroad) car in which one dines'
f. observation car = 'a (railroad) car from which one observes'
g. handcar = 'a (railroad) car powered by hand'
h. police car = ‘a car (automobile) used by the police’
i. grease car = ‘a car (automobile) equipped to be fueled by grease’

This range of semantic relations is not confined to conventionalized compounds: Wisniewski and Gentner 1991 show that a similar wide range is found in people’s judgments of novel compounds.

Moreover (as observed in chapter 5), the compound construction overlaps considerably with *N of NP*. Each pair in (10) shows a paraphrase between a compound and an *N of NP*, but with a different meaning relation between the two nouns in each pair.

(10) a. ant heap = heap of ants
b. heart beat = beat of the heart
c. donut hole = hole of a donut
d. power supply = supply of power
e. shoemaker = maker of shoes
f. love song = song of love

It therefore seems more reasonable to say that the meaning of a noun-noun compound is (for a first approximation) compatible with *any* relation between N_1 and N_2, provided it conforms to the Head Principle. Sections 13.6-7 will in fact show that the class of possible meaning relations between the two nouns is the product of a generative system, so it is impossible to enumerate them.

This conclusion, if correct, decisively refutes the assumption that the meaning of a phrase can be constructed solely from the meaning of its constituents plus the way they are syntactically

combined ("Fregean composition"). Thus no theory that derives meaning just from words plus syntactic structure – be it early transformationalist approaches such as Lees 1960 and Levi 1978, the Minimalist Program, or standard formal semantics – can adequately account for the semantics of compounds.

This conclusion also requires us to abandon the strong version of Construction Grammar (Langacker 1987, Goldberg 1995), in which each piece of syntactic structure can be assigned a constructional meaning, and the meaning of a phrase is constructed from the meanings of its constituents plus the meaning of the construction. In some cases such as the resultative (chapter 9) and the NPN construction (chapter 12), the possible meanings can be enumerated, and one can justifiably say the syntactic structure is ambiguous. But in the case of compounds, where the possible meanings cannot be listed, this move cannot be sustained.

One possible way out is to claim that compounds, like idioms, are stored units. This is certainly true for *some* compounds: speakers store thousands of lexicalized compounds with semi-idiosyncratic meanings. One knows not just that *peanut butter* is a buttery substance made from peanuts, but exactly what peanut butter *is* and what it tastes like.[3] But compounds can't *all* be stored in the lexicon: as we have already observed (and as Levi 1978 points out in response to the strictly lexical account of Jackendoff 1975 (=chapter 2)), new compounds can be built on the fly. For instance, among the several hundred compounds from the Boston Globe in my corpus, at least several dozen were novel to me, including *cotinin* [sic] *level*, *politician tycoon*, *aid inflow*, *locality pay*, and *spring seepage*. Downing 1977 stresses the frequent coining of compounds in particular discourse situations, citing for instance *bike girl* being used for a girl who left her bike in the vestibule, and *apple juice seat* for a seat at which apple juice was set on the table. Some years ago, my daughter left something for our cats, accompanied by the note "Maggie and Peanut's *heat wave present*." Gleitman and Gleitman 1970, Brekle 1986, and Sadock 1998 make similar observations. There is also evidence from acquisition: Clark, Gelman, and Lane 1985 observe that children begin understanding novel compounds and coining their own between about 2½ and 3½ (see Berman 2009 for crosslinguistic documentation). In short, compounding falls under the classical arguments that the grammar cannot just be a list but rather must include a productive rule system.

On the other hand, the difficulty with a productive rule system is that (at least as we have traditionally understood productive syntactic and phonological rules) it suggests relatively exceptionless regularity. How is it possible to reconcile the productivity of compounds with their rampant idiosyncrasy? Levi suggests isolating the lexically listed compounds from the productively generated compounds. But this raises the question: Why should the listed compounds look at all like the productive ones? For instance, if listed compounds are exceptional, then why aren't some of them left-headed?

Looking more closely, we can see that one cannot draw a principled line between listed and generated compounds. For example, *soccer ball*, like *peanut butter*, is listed in my lexicon: I can connect it to particular physical objects. On the other hand, although I may not have ever heard *bocce ball* before, I can guess on the fly that it is a ball for playing bocce. But it certainly is

listed in the lexicons of bocce players, so speakers may differ in whether they list or "generate" particular compounds.

In short, in a theory with a strict division between lexicon and grammar, compounds are problematic.[3]

Some perspective comes from considering VPs. VPs are certainly generated by a productive rule system. At the same time there are hundreds of idioms consisting of whole or partial VPs, and these too must be stored in the lexicon. And the same problems of redundancy arise here: how can the lexicon specify the idiom *give NP the once-over* without somehow mentioning that it contains the good old irregular verb *give*?[4] Of course, the syntactic variety of VPs, especially freely generated ones, is far greater than that of compounds. But the problem of reconciling productivity with lexical listing is qualitatively exactly the same. So compounds do not present a unique problem in this respect.

The Parallel Architecture's treatment of the lexicon, illustrated for VPs in chapters 7-9 and for the NPN construction in chapter 12, generalizes nicely to compounding: it requires no principled line between freely generated compounds and morphosyntactically complex listed items with the same structure. In this approach (shared by HPSG and some versions of Construction Grammar), lexical items and rules of grammatical combination are couched in identical formalisms, so that there is an easy formal transition between one and the other. Moreover, this approach takes for granted the redundancy between general principles (e.g. the free composition of VPs and compounds) and their more specialized elaborations (e.g. VP idioms and conventionalized compounds), and their relationships are stated in terms of inheritance hierarchies. Thus lexically listed complex items that conform to more general structural principles (e.g. *kick the bucket* and *snow man*) can be treated simply as specialized instances of general schemas.[5]

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[3] Ten Hacken 1994 takes his task to be to define a sharp line separating compounding from both lexicon *and* syntax. Such an approach, whatever its a priori appeal, is demanding joints in nature where there aren't any.

[4] Note that it also contains the totally exceptional *once-over*, which looks suspiciously like a compound noun.

[5] Ryder 1994, working within a Cognitive Grammar framework, recognizes the existence of patterns in compounding ranging from the very general to the very particular, which govern both the listed compounds and the production and comprehension of novel compounds. However, she seems to think that the regularities of compounds essentially result from the pull of statistical patterns in what people hear. I acknowledge such influences, particularly at very specialized levels (e.g. if Ryder is correct about the data, why should there be so many compounds beginning with *sea* and so few with *ocean*?). But this chapter shows that there is more going on in compounds than statistical patterns.

As in the approach of chapter 2, a conventionalized compound is fully listed. Its "cost" is measured in terms of its own information content, minus the degree of its redundancy with more general principles, plus the cost of referring to these more general principles. In the case of compounds, the cost of referring to general principles includes the information that one possible relation rather than another is the right one. For example, the 'eaten with' relation in *coffee cake* is predictable by general rule (see sections 13.6-7), but there should still be a cost to the choice between 'cake eaten with coffee' and the equally plausible 'cake made with coffee', parallel to *chocolate cake*, both of which are products of general rules. Of course, the lexicon being what it is, we also expect some proportion of lexicalized compounds to exhibit inexplicable irregularity due to historical drift and capricious coinages. These will be less closely related to general schemas, and will therefore "cost" more to list.

The task for the language learner, then, is to learn the lexicalized compounds and to acquire the rules for interpreting novel compounds. These two processes are obviously interdependent. At the outset, *all* compounds are novel, and children somehow list some of them in their lexicon. The child's evidence for the general principles, insofar as they are not innate, must come from generalizing over the learned compounds (see Jackendoff 2002, section 6.9 for more on this view of acquisition).

One still might wonder whether speakers *really* have general principles for compounding. Gleitman and Gleitman 1970 and Ryder 1994 asked subjects to give putative definitions of constructed novel compounds. In both experiments, subjects were far from reliable in giving answers that conformed to linguists' intuitions, for example giving definitions like (11).

(11) a. Ryder (137)
willow forest: 'a willow that grows in the forest'
giraffe land: 'a giraffe on land'
bottle flower: 'a bottle in which one puts a flower'

b. Gleitman and Gleitman (156-157, 167)
bird-house glass: 'a birdhouse made of glass'
house-bird wash: 'a bird that washed the house'
house-bird boot: 'the boot, the shoe, the house-boot of the bird'

These definitions are reminiscent of the performance of agrammatic aphasics on reversible passives and object relatives: the subjects seem to be driven by a need to create maximal semantic plausibility, grammatical principles be damned. Such results lead us to ask whether there is any grammatical competence at all involved in interpreting novel compounds.

I believe there is, but it is not of the sort we are led to expect from standard syntax. Standard syntax pretty well determines the meaning of a novel phrase from the meanings of the words and the principles – including constructional meanings – for mapping syntactic structure into combinatorial relations among constituent meanings. In the case of a novel compound,

though, the general principles yield only a range of possible meanings. The language user must home in on the intended meaning of a novel compound by making use of (a) the semantic details of the constituent words and (b) the discourse and extralinguistic context. In the experimental situations presented by the Gleitmans and Ryder, the compounds are presented in isolation with no contextual support. And the semantic details of the constituent words press for a meaning relation at odds with that demanded by the grammar, in particular right-headedness. Evidently the grammatical principles are sufficiently unstable (for some speakers) that they can be overwhelmed by semantic plausibility in such situations.

My conclusion is that, although compounding is indeed productive, the productivity is rather fragile by the usual standards of productive grammar. When I teach compounding in Introductory Linguistics, students enjoy building up a compound like (12a) piece by piece, in such a way that everyone understands it at the end. But if I were to present it as a whole to a naive class, few would get it. By contrast, the syntactic paraphrase (12b), while unwieldy, is nevertheless easier to comprehend.

(12) a. an inflectional morphology instruction manual software programming course
b. a course in programming the software that accompanies manuals that teach inflectional morphology

Similarly, example (13a), from the New York Times (3 June 2007), is initially hard to understand, because one's tendency is to parse it pairwise, like (13b). There is no grammatical support for the proper parsing (13c).

(13) a. child camel jockey slavery
b. [[child camel] [jockey slavery]]
c. [[child [camel jockey]] slavery],
i.e. 'slavery of [children serving as camel jockeys]'

The upshot is that the fragility of productive compounding also has to be part of the account.

13.2 Compounds as an evolutionary throwback

Bickerton 1990 and Givón 1979 propose that the language capacity evolved in two stages, "protolanguage" and modern language; they conceive of the former as having had a vocabulary and pragmatics, but no syntax or morphology as such. This stage for them is not just hypothetical: in the standard manner of evolution, it was not thrown away when modern language evolved. Rather, modern language was built on top of it, as a refinement. Moreover, in situations where the complexity of modern language is disrupted or impaired, elements of protolanguage still emerge.

The sorts of situations Bickerton and Givón have in mind include pidgin languages, the two-word stage of language learning, agrammatic aphasia, the language acquired by late first

language learners such as Genie (Curtiss 1977), and what apes instructed in sign language can learn. In each of these cases, vocabulary is acquired and words are concatenated into larger utterances. However, inflectional morphology is at best highly defective, functional categories are rarely used, and syntax does not go much beyond simple basic clauses. Subordination is largely absent, replaced by parataxis (jamming two independent clauses together); and many of the connections between words and between clauses are left up to the hearer's understanding of context.

These situations of course differ from each other in many respects, due to their different genesis (in particular, the apes appear to string words together rather randomly, if we are to believe Terrace 1979). What is interesting is that when less than full language is in evidence, the parts that appear (or remain) are remarkably similar. Bickerton and Givón argue that these are all instances of the resurfacing of protolanguage, which is in some sense more resilient in the brain than the refinements of modern language.

Three further cases can be added to this collection. One is the degree of language competence achieved by the right hemisphere (Baynes and Gazzaniga 2005). Another is the "home sign" created by deaf children of non-signing parents (Goldin-Meadow 2003). The third comes from a massive longitudinal study of immigrant second language learners by Klein and Perdue (1997). All of them turn out to pass through a stage of second-language competence that Klein and Perdue call The Basic Variety (BV) – and some fail to progress beyond this point despite years of exposure.

Klein and Perdue say (333) that although "the BV is a highly efficient system of communication, ... it lacks some of the structural characteristics which we typically find in fully fledged languages." Speakers of BV acquire vocabulary, but there is hardly any morphology or closed-class vocabulary, and no syntactic subordination – only parataxis. Word order in BV is determined in terms of rudimentary functional principles, primarily Agent First and Focus Last[6] – principles that also apply broadly in pidgins and function as strong defaults in modern language as well. These principles do not make use of the syntactic categories and fully articulated phrase structure of standard syntax: they can be regarded as mappings directly between semantic roles and linear order of words in phonology. In short, BV too has the telltale symptoms of protolanguage.

Jackendoff 2002 (chapter 8) suggests that protolanguage is a cognitive "scaffolding" on which modern language is built, both in evolution and in development. Under this view, various "modern" aspects of language can be added or lost piecemeal in different situations, revealing

[6] As pointed out by some of the commentators on Klein and Perdue's paper in the same issue of *Second Language Research*, some of the word order effects may be artifacts of the range of target languages studied by Klein and Perdue. I leave this question open, as it is not too important to the point at hand.

different amounts or aspects of the "scaffolding." The surprise is how robust this protolinguistic scaffolding is, emerging over and over again under different conditions.

In terms of the Parallel Architecture, protolanguage is a subsystem of modern language: it consists of just phonological and semantic components, plus a direct interface between phonology and semantics. By contrast, mainstream generative grammar has to consider protolanguage a completely unrelated system, since it claims that phonological and semantic combinatoriality – and a correspondence between them – cannot exist without the generative capacity of syntax.

This view of modern language as "laid over" a protolinguistic substrate leads to the intriguing possibility that the coverage is incomplete: that relics of earlier stages of the language capacity remain as pockets within modern language. These relics would have more rudimentary grammatical structure, and such grammatical structure as there is would not do much to shape semantic interpretation. Rather, we would expect semantic interpretation to be highly dependent on the pragmatics of the words being combined and on the contextual specifics of use.

Fanselow 1985 and Jackendoff 2002 (chapter 8) suggest that compounding is a strong candidate for such a relic of the simpler system. Fanselow draws parallels between compounding, the two-word stage of language acquisition, Broca's aphasia, deep dyslexia, right-hemisphere competence, the competence of language-trained apes, and the grammatical properties of newspaper headlines,[7] seeing in this ensemble of phenomena manifestations of a "rudimentary language capacity." In confirmation, Klein and Perdue observe that although BV lacks inflectional and derivational morphology, one kind of morphology does appear (in the target languages that permit it): compounding. The point is solidified by the early appearance of creative compounding in child language, well before other morphology.

This view of compounding explains the properties that make it not look like the rest of morphology (differences stressed by Sadock 1998): compounding is actually not a *grammatical* phenomenon, but a *proto*grammatical one. Even the right-headedness of (English) compounds, their most grammatical feature, really relies only on a language-specific correlation of linear order with semantic headedness, not on X-bar head-argument structure. In this respect it resembles the Agent-First and Focus-Last principles of BV.[8]

Pushing this point further, the syntax of English compounding is to some extent even blind to syntactic category. Nominal compounds need not be constructed from two nouns (*doghouse*): there are also compounds like (14), all of which have characteristic lefthand stress of

[7] The relation of newspaper headlines to child language is also explored by De Lange, Vasic, and Avrutin 2008.

[8] Notice, by the way, that the standard Head Parameter in syntax is also a correlation of linear order with headedness. So perhaps it is no surprise that compounds often generalize with X-bar structures in their headedness, as Lieber 1992 suggests.

compounds.[9]

(14) a. $[\text{long}_A\ \text{bow}_N]_N$, $[\text{watch}_V\ \text{dog}_N]_N$

b. $[\text{under}_P\text{current}_N]_N$, $[\text{over}_P\text{coat}_N]_N$, $[\text{under}_P\text{pants}_N]_N$, $[\text{under}_P\text{class}_N]$, $[\text{in}_P\text{flux}_N]_N$, $[\text{in}_P\text{seam}_N]_N$, $[\text{down}_P\text{side}_N]_N$, $[\text{out}_P\text{house}_N]_N$, $[\text{in}_P\text{-joke}_N]_N$

c. $[\text{blow}_V\text{up}_P]_N$, $[\text{cast}_V\text{off}_N]$, $[\text{turn}_V\text{over}_P]_N$ (two senses), $[\text{pop}_V\text{over}_P]_N$, $[\text{pull}_V\text{over}_P]_N$, $[\text{push}_V\text{over}_P]_N$, $[\text{drive}_V\text{in}_P]_N$

d. $[\text{over}_P\text{kill}_V]_N$, $[\text{in}_P\text{flow}_V]_N$, $[\text{out}_P\text{look}_V]_N$

e. $[\text{speak}_V\text{easy}_A]_N$

f. $[\text{hear}_V\text{say}_V]_N$, $[\text{look}_V\text{see}_V]_N$

g. $[\text{once}_?\text{over}_P]_N$

h. $[\text{skin}_N\text{deep}_A]_A$, $[\text{worm}_N\text{eaten}_V]_A$

Moreover, there are pairs of semantically indistinguishable N-N and A/P-N compounds, such as *atom bomb* vs. *atomic bomb*, *sea life* vs. *marine life*, and *topcoat* vs. *overcoat*, suggesting that syntactic category hardly makes a difference. And for some compounds such as *guard dog*, there is no fact of the matter as to whether they are V-N ('a dog that guards') or N-N ('a dog that serves as a guard'). In short, compounding is only barely syntactic. It has right-headedness and the recursive properties illustrated in (2)-(3), but that's about all.

Under this hypothesis, compounding takes on an unexpected status in grammatical theory. It is not some odd peripheral aspect of morphology; it is a system that reveals some of the evolutionary roots of modern language, as it were a coelacanth of grammar. Such a conclusion should not be taken as too radical. After all, the semantic relations that link discourse together are not marked syntactically either. Rather, hearers use the meanings of the sentences plus understanding of the context – including social context – to create the semantic linkages from sentence to sentence, whether spoken by the same or different speakers. Compounding is just the same sort of phenomenon writ small. We return to this point in section 13.8. (Jackendoff 2002 suggests some other possible phenomena in the corners of modern grammar where earlier evolutionary stages might be showing through.)

[9] Lieber 2004 argues that V-P compounds such as *blowup* are simple zero-nominalizations of verb-particle combinations. I find this plausible for many cases, but not for exocentric V-P compounds such as *pullover* (a sweater), *pushover* (a person), and *turnover* (a pastry). Lieber also suggests that P-V compounds such as *overkill* are actually prefixed nominalizations. Here I am less convinced, as there are many semantically idiosyncratic examples, such as *undertow*, *outlook*, *downdrift*, *outcast*. (See also Huddleston and Pullum 2002, 1654-1655.) In any event, the main point about categorial unselectivity stands, even if less robustly.

I am grateful to Lisa Pierce (p.c.) for bringing $[\text{V-V}]_N$ compounds to my attention. Some instances, such as *make-believe* and *stirfry*, are indeed zero nominalizations of compound verbs, but those listed in (14) are not.

13.3 Preliminaries to semantic analysis of English N-N compounds

The framework of Conceptual Semantics is deeply concerned with details of word meaning and how these interact with composition of phrase meanings. At the same time, it incorporates a great deal of what is usually called pragmatics: aspects of meaning that are not encoded in word meanings or in relations conveyed directly by syntactic structure. This outlook impacts on the approach to compounding: the goal is an account of compound meaning that is as rich as the account of word meaning.

The basic intuition, as in other approaches, is that the meaning of a compound is a function of the meanings of its constituents. Thus the problem is: given two nouns N_1 and N_2 meaning X_1 and Y_2 respectively, what is the function $F(X_1, Y_2)$ that yields the meaning of the compound $[N_1\ N_2]$? .

Of course, it is important to recognize the limits of compositionality in compounds. For novel compounds (such as *backgammon ball*), compositionality should be all that is available. But lexicalized compounds usually also incorporate idiosyncratic information. For instance, nothing principled predicts the difference in shape between stereotypical *soup bowls* and *fish bowls*, or that a *boxcar* is a kind of railroad car but a *kiddy car* is a kind of toy. And general principles cannot account for cranberry morphemes (underlined parts of (15a) or what I like to call "strawberry" morphemes (real words within compounds that play no role in the compound's meaning, e.g. underlined parts of (15b)).

(15) a. cranberry, basset horn, bogeyman, pratfall, fascia board, ferris wheel, linchpin, iceberg, fig newton, nightmare

b. strawberry, cottage cheese, polka dot, bobby pin, dogwood, horseradish, monkey wrench, gangway, Charley horse, tea cozy, hillbilly, sheepfold, sidekick, cotton gin, airplane, water moccasin, lawsuit

So sometimes lexicalized meaning has to ignore the semantics of one noun or the other, just as it ignores *bucket* in *kick the bucket*. Still, on the whole there is significant compositionality.[10]

There are also morphemes that (in modern English) appear only as bound morphemes in compounds, but, unlike cranberry morphemes, appear in several compounds each, so we can see what they mean.

[10] If the measure of lexical "cost" is as proposed in chapter 2, the fact that the strawberry morphemes are phonologically independent words ought to count as a redundancy, and subtract from the cost of these compounds in the lexicon, even though their meanings play no role. This might account for the common misspelling of *linchpin* as *lynchpin*, where the cranberry morpheme has been converted into a strawberry morpheme.

(16) a. cookware, dinnerware, stoneware, warehouse (also A-N compounds *hardware, software, wetware*)
b. alleyway, doorway, pathway, raceway, breezeway, gangway (also A-N compound *highway* and V-N compounds *driveway* and *runway*; related to but not identical to free morpheme *way* as in *which way did they go*)
c. playwright, millwright
d. swingset, tv set (bound *–set* = 'apparatus', not 'set')
e. housekeeper, beekeeper, bookkeeper, doorkeeper, gatekeeper, shopkeeper, zookeeper (*keep house/bees/the books* but not **keep a zoo/a door/a gate*

These families of compounds parallel the rootless pairs and triples of chapter 2 such as *retribution/retributive* and *aggression/aggressor/aggressive*: the cost in the lexicon should reflect the common parts. Unlike cranberry morphemes, they lend themselves to creativity, as in the relatively recent coinages *software, wetware*, and *malware.*[11]

A common technique for analyzing compounds has been to establish a phrasal paraphrase and to assign the meaning of the paraphrase to the compound. However, it has often been noticed that it is sometimes impossible to establish a single best paraphrase for a compound. Lees 1960 (123), for instance, discusses the example *pontoon bridge*:

> ... it is not even obvious which interpretation *is* the most commonly used, but the following might occur to us:
>
> [17] bridge supported by pontoons (like *steamboat*)
> bridge floating on pontoons (like *seaplane*)
> bridge made of pontoons (like *blockhouse*)
> pontoons in the form of a bridge (like *cell block*)

Gleitman and Gleitman (1970, 95) make similar remarks: "We suspect that the person who says *lion-house* would consider it rather odd if someone asked him: 'Did you mean *a house for a lion*, *a house suitable for lions*, or *a house lions can live in*?' Obviously the speaker meant any of these indifferently." Levi 1978 also discusses this issue at length.

This problem presents three different cases. First, the paraphrases may be pure semantic

[11] Another minor peculiarity is compounds in which a word has evidently been truncated. The clearest example comes from the names of sports equipment that incorporate the name of the game, e.g. *soccer ball, lacrosse ball, pingpong ball, baseball bat, football helmet, pinochle deck*. By analogy, the ball used in baseball ought to be a **baseball ball*, not a *baseball*, and similarly for *football, volleyball*, and *racquetball*. A random collection of less systematic cases, with the possible truncated part in brackets: *roller[skate] blades, jailbreak[out], cocktail [party] dress, string/woodwind [instrument] ensemble/quartet/ player, bank[note] roll, tap/toe [dance] shoe, folk [song/music] singer*. Jespersen 1942 suggests also *news[paper]boy* and *waste[paper]basket*.

variants, as in Gleitman and Gleitman's 'house for a lion' and 'house suitable for a lion', or *felafel ball* = 'ball made of/created from felafel.' Here, a proper semantic analysis should abstract $F(X_1, Y_2)$ away from the particular way it happens to be expressed in the paraphrase.

Slightly more complex multiple paraphrases arise in cases like (18).

(18) ticket window = 'a window at which tickets are bought/at which tickets are sold'
toll booth = 'a booth at which tolls are paid/at which tolls are collected'
movie theater = 'a theater where movies are seen/at which movies are shown'
grammar school = 'a school where grammar is taught/at which grammar is learned or studied'

Here the multiplicity arises from different ways of orienting the same connection between N_1 and N_2. Following ideas of Langacker 1987 and Fillmore and Atkins 1992, the two paraphrases really express the same conceptualized "event schema", changing only the perspective. *Buy* places the initiative with the recipient of goods, *sell* with the original owner; in a real transaction of course both must play an active role. Similarly with the payment and collection of tolls, the seeing and showing of movies, and the teaching and the learning of grammar. The solution, then, is that $F(X_1, Y_2)$ likely consists of the simple event schema, bereft of perspective or focus. The paraphrases, however, create alternative perspectives, because the overt use of a verb forces us to choose a particular frame of thematic roles.

The following examples, like *pontoon bridge*, present a third situation.

(19) box car = 'car that carries boxes/that resembles a box/that serves as a box'
refrigerator car = 'car that has a refrigerator as significant part/that serves as a refrigerator'
elevator shaft = 'shaft that an elevator travels in/that is part of an elevator'
file folder = 'folder in which one places a file/that forms part of a file'

Unlike (18), these cases are not lexical or perspectival variants of the same relation. *Resembling* a box and *serving as* a box are quite distinct relations.[12]

Lees, Levi, and the Gleitmans suggest that there is no fact of the matter about which paraphrase is correct. Someone learning these words is typically given no evidence (e.g. "This is called a box car because it looks like a box"): the relation is normally taken to be self-evident and

[12] Some of these examples play on an ambiguity in one of the constituent nouns. In *elevator shaft*, is the elevator the box that one rides in, or is it the whole piece of machinery including motor, cables, pulleys, controls, *and* the shaft? *File folder* plays on an ambiguity in *file*: in the first reading, the file is an individual piece in a collection of information; in the second, the file is the physical instantiation of the entire collection. Another possible example is *lipstick*: is it something shaped like a stick that one puts on one's lips, or is it something that one sticks to one's lips? Here the relevant readings of *stick* are totally unrelated.

without need of explanation ("That one is called a boxcar"). *Boxcar* is not ambiguous: it picks out the same objects no matter which reading is assigned to it. It is not like *football* the *game* vs. *football* the *ball*. Nor is *boxcar* vague: it does not leave open a continuous range of possibilities on a scale, the way, say, *cold* does. This being the case, what can the learner do?

I propose that there is another way that *boxcar* can have multiple meanings besides being ambiguous or vague: it can have all the meanings in (19) simultaneously, in cooperation rather than competition. We might call such a word *promiscuous* (by contrast with *ambiguous*). If such a solution seems like giving up, one must remember that a word meaning is an entity in a brain, not in a logical system. It is altogether in the style of the brain to arrive at multiple solutions to the same result, and for a result so obtained to be more stable in perception and memory. A standard example of this is the system for depth perception, which relies on partially redundant evidence from sensory cues (e.g. lens accommodation), perceptual cues – both monocular (e.g. occlusion) and binocular (e.g. stereopsis) – and cognitive cues (e.g. knowing what size familiar objects should be). These all converge on a single perceptual feature: the absolute and relative distances of objects in the visual field.

The claim, then, is that *pontoon bridge* and *boxcar* are promiscuous rather than ambiguous. A learner attempts all possible strategies for combining N_1 and N_2 (presumably in parallel), and since there are multiple satisfactory strategies that do not conflict, *all* such semantic combinations are stored in memory as part of the meaning of the compound. (Of course, if asked to define the compound, speakers will likely give only one of the combinations and be satisfied with that.)

A linguist seeking to analyze these compounds faces the same problem as the learner. The insistence on a single best solution is only a prejudice, which, I admit, is well grounded in scientific and commonsense practice. But in dealing with brain processes it is, I believe, sometimes counterproductive and should be judiciously abandoned when inappropriate.

13.4 Aspects of compound meaning that come from semantics of nominals

The semantics of compounding involves a number of distinct components. This section sketches three components implicated in the combinatorial semantics of nouns in general; the next two sections add components that are specifically involved in compounding.

13.4.1. Profiling

The first general component might be called *profiling* (roughly following the usage of Langacker 1987; Brekle 1975 calls it *topicalization*): picking out a character in an event and designating this character as the one being referred to. For instance, the action of *driving* involves an agent directing the motion of a vehicle; the nominal *driver* picks out the agent. A standard way to notate this is through lambda-abstraction, which binds an argument within an expression to a variable outside (20b). For my purposes a slightly different notation for profiling proves useful. In (20c), the head of the expression is *PERSON* and the expression after the semicolon is

a modifier. What makes the expression a well-formed modifier is that it contains a variable α which is bound by the superscript on *PERSON*. Profiling an argument of a function, then, consists in binding it to something outside the function; this is the semantic counterpart of a relative clause in syntax.

(20) a. DRIVE (A, B) = 'A drives B'
b. λx[DRIVE (x, INDEF)] = 'individual who drives something'
c. [PERSON$^{\alpha}$; [DRIVE (α, INDEF)]] = 'a person α such that α drives something'

Any argument can be profiled; for instance the distinction between *employer* and *employee* is shown in (21a,b). The nominal *orientation* profiles the Path argument of the function ORIENT, yielding the direction in which the theme is oriented (21c).

(21) a. employer: [PERSON$^{\alpha}$; [EMPLOY (α, INDEF)]]
b. employee: [PERSON$^{\alpha}$; [EMPLOY (INDEF,α)]]
c. orientation: [PATH$^{\alpha}$; [ORIENT (X, α)]]

More generally, the distinction between "process" and "result" nominals is that the latter has profiled the theme argument, as in (22).

(22) a. the composition of the song (process nominal):
[$_{\text{Event}}$ COMPOSE (X, SONG)]
b. John's new composition (result nominal):
[MUSIC$^{\alpha}$; NEW; COMPOSE (JOHN, α)]

As noted in previous chapters, the Parallel Architecture notates the relation between syntactic and semantic constituency in terms of coindexing. Thus (20a) and (20c) can be notated more precisely as (23a) and (23b) respectively, and the productive use of the *-er* suffix can be encoded as the schemas (23c,d), where *F* is a variable function of some unspecified number of variables.[13] "=" now stands for the interface relation between syntax and semantics.

(23) a. A_1 drives$_2$ B_3 = [DRIVE$_2$ (A_1, B_3)]
b. drive$_1$-er$_2$ = [PERSON$_2^{\alpha}$; [DRIVE$_1$ (α, INDEF)]]
c. V_1-er$_2$ = [PERSON$_2^{\alpha}$; [F_1 (α, ...)]] (agentive *-er*)
d. V_1-er$_2$ = [OBJECT$_2^{\alpha}$; [F_1 (INDEF, ...); WITH α)]] (instrumental *-er*)

The semantic structure of (23b) also appears in morphologically different nominals such as (24a), as well as in compounds such as (24b). The differences among them show up in the coindexation

[13] This formalization is not too different from many others in the literature, for example Rappaport Hovav and Levin 1992, Lieber 2004, and Booij 2007. I omit the details for specifying that X is an agent; see Jackendoff 1990. I have oversimplified the rest of the semantics of *-er* and *-ee* nominals, as not especially relevant to the present discussion.

between the morphosyntax and the semantic structure.

(24) a. $\text{violin}_1\text{-ist}_2 = [\text{PERSON}_2^{\alpha}; [\text{PLAY}\ (\alpha, \text{VIOLIN}_1)]]$
b. $\text{violin}_1\ \text{play}_2\text{-er}_3 = [\text{PERSON}_3^{\alpha}; [\text{PLAY}_2\ (\alpha, \text{VIOLIN}_1)]]$

13.4.2. Action modality

Busa 1997 develops an analysis of *agentive nominals* – nouns that denote characters individuated by their actions. She points out, for example, that although *violinist* denotes someone who plays the violin, it is actually ambiguous between an occupation (25a), a habitual activity (25b), or an ability (25c). It can even be used in a case where playing the violin is a specific activity on a specific occasion (i.e. a stage-level predicate). For instance, (25d) might be used if all the players in the orchestra are rank beginners, or if the players have switched instruments as a joke (a situation I actually experienced once). All this is unchanged, of course, if we substitute the compound *violin player*.

(25) a. She's a violinist in the Pittsburgh Symphony but hasn't played since they went on strike.
b. She's an occasional violinist.
c. She's a good violinist, but hasn't played since she sold her violin ten years ago.
d. None of the violinists can play the violin!

I'll call these variant interpretations the *action modalities* under which a nominal can be understood.

(25) might suggest that the choice of action modality is just a matter of pragmatics. But there are action nominals whose action modality is an essential part of the lexical meaning (and this is Busa's main concern). For instance, *pedestrian* is a stage-level predicate: someone on foot on a particular occasion. I don't remain a pedestrian when I'm driving my car. Similarly, *passengers* are individuated by their trips: when one counts *passengers* carried by American Airlines, I count as a different passenger on each trip. By contrast, someone who only happens to discuss economics on a particular occasion is unlikely to be called an *economist* (except perhaps sarcastically); being an economist is an occupation. A *customer* may be either current (stage-level) or habitual; for the occupation, the term is *buyer*. A *convict* is someone who has been convicted of a crime – once. And the difference between a *whore* and a *slut* is whether the action in question is an occupation or a habit.

Among compounds, some (e.g. *milkman*, *garbage man*, *mailman*) lexically denote occupations; others (*fisherman*, *bartender*, *violin player*) are more open in their action modality. Novel coinages in particular may often be understood as stage-level, with specific function and specific action. For instance, Downing's (1977) *bike girl*, 'girl who left her bike in the hallway on this particular occasion', is of this sort, parallel to *pedestrian*. In the context of a recipe, *starch bowl*, 'bowl currently containing starch', has this same action modality, which I'll call "current."

An important action modality is Ruth Millikan's (1984) notion of *proper function*.[14] Roughly, "[h]aving a proper function is a matter of having been 'designed to' or of being 'supposed to' (impersonal) perform a certain function" (Millikan 1984, 17). Crucially, an object need not *actually* ever perform its proper function. Millikan's striking example is a sperm: only one of millions ever performs its proper function of fertilizing an egg.

Three major classes of things can have proper functions. The first class is *artifacts*: concrete objects constructed by people[15] who have some function in mind for them, or who benefit from their functioning. The second class is *parts*. For parts of artifacts, such as the back of a chair, the proper function is clear: the part serves part of the proper function of the artifact. But parts of organisms also have proper functions: the heart is to pump blood, the leaves of a plant are to perform photosynthesis, and so on. A third class of objects with proper functions is objects that are "destined" to become something: the proper function of a seed is to become a plant, of an egg to become an animal, and of a fiancée to become a wife – whether or not these situations actually come to pass.

Action modality will be formalized as an operator on a profiled action. So, for instance, the occupation reading of *violinist* can be notated as (26a), and the "current" reading of *starch bowl* as (26b). For a noun that denotes an artifact such as *book*, the proper function is part of its lexical entry, as in (26c).

(26) a. $\text{violin}_1\text{ist}_2 = [\text{PERSON}_2{}^{\alpha}; [\text{OCC}\ (\text{PLAY}\ (\alpha, \text{VIOLIN}_1))]]$
b. $\text{starch}_1\ \text{bowl}_2 = [\text{BOWL}_2{}^{\alpha}; [\text{CURRENT}\ (\text{CONTAIN}\ (\alpha, \text{STARCH}_1))]]$
c. $\text{book}_1 = [\text{BOOK}^{\alpha}; [\text{PF}\ (\text{READ}\ (\text{PERSON}, \alpha))]]_1$

It is an interesting empirical question what the full range of action modalities is.[16]

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[14] Millikan develops the notion of proper function in the context of a theory of language that I find difficult to endorse in general. Nevertheless this notion, extracted from her overall approach, is of great utility in a mentalistic analysis of concepts.

[15] Or other intention-having beings, since it makes sense to include beaver dams among artifacts.

[16] It is important to distinguish proper function from what might be called generic or habitual function. In order to do so, we have to distinguish two senses of "generic." Because compounds, like all common nouns, denote a type, any characteristic action ascribed to them will necessarily be generic over the members of the type. But this does not mean that the action ascribed to a single individual is itself generic. For instance, sperms in general have a certain proper function; but an individual sperm fulfills its proper function at most once. By contrast, an individual *table* may fulfill its proper function many times. Thus a sperm's proper function is a token action, but a table's is a generic action.

Nor should proper function be conflated with habitual action or characteristic activity. Building dams is a characteristic activity of beavers, but it is not the proper function of beavers. It is, however, a generic activity: a beaver keeps doing it over and over again. But another

13.4.3. Cocomposition

An important way in which natural language semantic composition goes beyond simple Fregean compositionality is *cocomposition*, first explored extensively by Pustejovsky 1995. The best-known example involves the complement of verbs such as *enjoy*, which semantically must be an activity. *We enjoyed singing* and *We enjoyed the work* undergo ordinary composition, as their complements are activities. However, the complements in *we enjoyed the book* and *we enjoyed the beer* do not denote activities. Nevertheless, their interpretations *do* incorporate an activity, most probably 'reading the book' and 'drinking the beer' (other possibilities depend on context). Crucially, the default activity is dependent on the choice of noun. Where does this extra piece of meaning come from? The obvious source is the internal structure of the noun's meaning, in particular from the noun's proper function.

Let me formalize just enough of this to make it useful in the analysis of compounds. (27a) is what would result from composing *enjoy* and *book* in simple Fregean fashion; it is illformed because a book is not a kind of activity. (27b) is a slightly more complex but wellformed expression; the unspecified function *F* serves as a sort of "adapter plug" "coerced" into the interpretation, so that all selectional restrictions can be met (Jackendoff 1997, chapter 3). The first argument of *F*, the actor, is bound to *BILL* by the ∀s; this is the semantic expression of control (Culicover and Jackendoff 2005, chapter 12), so that it is Bill who is performing the action *F*.

(27) a. Bill_1 enjoyed$_2$ the book$_3$ = *[ENJOY_2 (BILL_1, [$_{\text{Activity}}$ BOOK_3])]

b. Bill_1 enjoyed$_2$ the book$_3$ = [ENJOY_2 ($\text{BILL}_1{}^{\alpha}$, [$_{\text{Activity}}$ F (α, BOOK_3)])]
'Bill enjoyed doing something (F-ing) with the book'

The content of the coerced function *F* is filled out by incorporating material from the proper function of *book*. (28a) makes this proper function explicit, following the analysis of *book* in (26c). It is now possible to fill out *F* by unifying into it a copy of the function from *book*'s proper function. This will be notated as in (28b): the copy is in italics, and the co-superscripts γ show what it is a copy of.

(28) a. [ENJOY_2 ($\text{BILL}_1{}^{\alpha}$, [$_{\text{Activity}}$ F (α, [BOOK^{β}; PF (READ (PERSON, β))]$_3$)])]

b. [ENJOY_2 ($\text{BILL}_1{}^{\alpha}$, [$_{\text{Activity}}$ *READ*$^{\gamma}$ (α, [BOOK^{β}; PF (READ^{γ} (PERSON, β))]$_3$)])]

One can imagine other formal ways of working this out; Pustejovsky's own formalization

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characteristic activity of beavers, also not its proper function, is dying, and a beaver only does this once.

These examples suggest that action modality may be further differentiated into features, such that the distinction of proper function vs. characteristic action crosscuts the distinction of generic vs. one-time action.

is quite different. But the general idea is clear. First, when pieces of meaning that are expressed cannot link up semantically, it is sometimes possible to add unspoken functions in order to create well-formed semantic connections (coercion). Second, it is possible to fill out these functions by copying them from inside the meanings of nouns (cocomposition). [17]

13.5 Semantic structure of (relatively) simple compounds

13.5.1. The compounding schemata

We now return to compounds proper. Determining the conceptual structure of a compound N_1N_2 involves two factors: establishing the semantic relation between N_1 and N_2, and designating a head – in English, N_2. There are two routes for connecting N_1 to N_2. First, N_1 can be an argument of N_2, as in *violin player*. These are so-called synthetic compounds; the general schema appears in (29a), where *X* and *Y* are the meanings of N_1 and N_2 respectively. Second, N_1 and N_2 can both be arguments of another function *F*, as in (29b).

(29) a. $[Y_2 (..., X_1, ...)]$
b. $[F (\ldots, X_1, \ldots, Y_2, \ldots)]$

The fact that N_2 must be head of a compound can be formalized as (30). Note that this assigns no role to N_1.

(30) *Head Principle*
$[N_1\ N_2] = [Y_2 (\ldots); (\ldots)]$

There are now two ways that the meaning of N_1 can be combined with N_2. First, if N_1 is an argument of N_2, (29a) can be unified directly with (30) to yield (31a). Alternatively, if N_1 and N_2 are arguments of a function *F*, then Y_2 has to be profiled in (29b), so that it can serve as head of the compound. In this case *F* and its arguments and modifiers serve as a modifier of *Y*. This yields (31b) as the general schema for this type of compound.

(31) *N-N compound schemata* (or *constructions*)
a. *Argument schema*: $[N_1\ N_2] = [Y_2 (..., X_1, ...)]$ 'a N_2 by/of/... N_1'

[17] Lascarides and Copestake 1998 work out a version of this type of cocomposition within a somewhat more standard HPSG/formal semantics treatment. In particular, they propose general principles for filling out control relations like that in (27)-(28) and the many more complex cases below.

A fine point on the binding of *READ* in (28): This differs from the usual binding relation, such as the αs and βs in (28a,b). The latter indicate identity of *reference*: the same person is both enjoying and reading. In the notation, the binding variable is superscripted to the referential constituent, and the individual being bound is simply indicated by a bound variable. The binding of *READ*, however, is identity of *sense* (parallel to *ones*-anaphora with NPs): the act of Bill's reading this book cannot the same token action as the generic act of reading a book to fulfill its proper function, and it is subject to different semantic constraints.. This is notated with co-superscripts on the function itself.

b. *Modifier schema*: $[N_1\ N_2] = [Y_2^{\alpha}; [F\ (..., X_1, ..., \alpha, ...)]]$
'an N_2 such that F is true of N_1 and N_2'

What is the range of possibilities for *F*? Many accounts in the literature, for instance Downing 1977, Selkirk 1982, Ryder 1994, and Lieber 2004, have despaired at finding a systematic account of the possibilities. Jespersen (1942, 137-138) says: "Compounds ... say nothing of the way in which the relation is to be understood. That must be inferred from the context or otherwise.... The analysis of the possible sense-relations can never be exhaustive." Other accounts such as Lees 1960 and Levi 1978, noting that *F* is not entirely arbitrary, have attempted to enumerate a set of functions that accounts for all compounds, either in semantic or syntactic terms (e.g. for Lees, in terms of a set of deletable verbs in the underlying forms of compounds).

In the present account there is a generative system that creates an unlimited set of possibilities for *F*. This generative system includes:

- A family of basic functions or relations, many of which can be profiled on either variable
- The set of action modalities, which are applied to the function *F* to provide further possibilities
- Cocomposition of aspects of noun meaning with the function *F*
- A set of structural principles that can be combined to build structurally more complex realizations of *F*

Section 13.4.2 dealt with action modalities. This section deals with the basic functions; section 13.6 with cocomposition; section 13.7 with the structural principles.

13.5.2. Reversibility of basic functions

First I must discuss the reversibility of the basic functions, which has not to my knowledge received much notice in the literature, but which proves very important in appreciating the protogrammatical character of compounding. Consider the pair *beef stew* and *stew beef*. In semantic structure, they both must encode that the stew is made of beef, that is, the same semantic relation obtains between the nouns in both compounds. The difference lies in profiling and action modality: *beef stew* is telling us the makeup of this kind of stew, and *stew beef* is telling us the proper function of this kind of beef. Another example is *lunch bag*, 'bag meant to carry a lunch in', and *bag lunch*, 'lunch meant to be carried in a bag.' (32) illustrates. Both meanings are instances of the Modifier schema (31b), and both have the same modifier, just profiled differently.

(32) a. $beef_1\ stew_2 = [STEW_2^{\alpha}; [MADE\text{-}FROM\ (\alpha, BEEF_1))]]$
b. $stew_1\ beef_2 = [BEEF_2^{\alpha}; [PF\ (MADE\text{-}FROM\ (STEW_1, \alpha))]]$

A slightly more complicated case is the pair *helicopter attack* and *attack helicopter*. In semantic structure, they both must encode that the helicopter is attacking. In the former case, *attack* takes an argument. Hence the meaning of the compound, (33a), is an instance of the

Argument schema (31a).

However, consider what happens in *attack helicopter*, where *helicopter* serves as N_2. Like *beef*, *helicopter* does not take an argument, so the Argument schema cannot be invoked. Rather, *attack* must be part of a modifier. Within the Modifier schema (31b), *ATTACK* does not fit in as an argument of *F*. Rather, it is cocomposed with *F*, and then *HELICOPTER* can be bound to its argument, resulting in (33b). ((33b) also says the modifier is a proper function.)

(33) a. $\text{helicopter}_1\ \text{attack}_2 = [\text{ATTACK}_2\ (\text{HELICOPTER}_1, \text{INDEF}))]$
'an attack on something by helicopter(s)'
b. $\text{attack}_1\ \text{helicopter}_2 = [\text{HELICOPTER}_2{}^{\alpha}; [\text{PF}\ (\text{ATTACK}_1\ (\alpha, \text{INDEF}))]]$
'a helicopter whose proper function is to attack things'

13.5.3. Fourteen basic functions

Here is a list of the (most prominent) basic functions that can fill out *F* in English noun-noun compounds. Please bear with me through this possibly tedious enumeration.

First, in the loosest possible relation, CLASSIFY (X, Y), the meaning of N_1 plays only a classificatory role.

(34) $[Y_2{}^{\alpha}; [\text{CLASSIFY}\ (X_1, (\alpha))]]$, '$N_1$ classifies N_2':
beta cell, X-ray, Leyden jar, Molotov cocktail

The second case is the argument schema Y(X) (35).

(35) $[Y_2(X_1)]$, 'N_2 of/by N_1':
wardrobe color, food surplus, sea level, union member, wavelength, hairstyle, helicopter attack, tooth decay, wavelength, speed limit, birth order, birth rate, collar size, particle shape, crystal structure, bandwidth, used-car prices, onion smell, attention span, German grammar, ship model

Notice that the noun expressing a function (N_2 in (35)) has an inherent semantic argument. Because the other noun satisfies this argument position, the argument is no longer available for phrasal expression, e.g.**the wardrobe color of her clothes, *the food surplus of potatoes*. On the other hand, if the *argument* noun (N_1) itself takes an argument, the compound can inherit *this* argument, as illustrated in (36).[18]

[18] In interpreting a novel compound, say *John's elbow strength*, one must therefore compute a composite argument structure of the type in (36) online. For this to be possible, the grammar must provide more than one system for checking and satisfying theta-roles (or saturating arguments). One is the usual system for composing phrasal meanings, and one is the system of composing compound meanings – *which is partly pragmatic*.

(36) a. the wavelength of the light = the length of [a wave of the light]
b. Bill's hairstyle = the style of [Bill's hair]

Within the class with this relation we also find the vast subclass in which N_2 is morphologically composed of *V+er*, for instance *bus driver* and *screwdriver*, or is a zero derivative of a verb, like *supply*. As seen above, the semantics of *V+er* nominals (and some zero nominals) is precisely 'someone/something that V's'; that is, the noun is essentially nothing but a profiled agent or instrumental argument of the verb. The exact morphology is irrelevant: for instance, *screwdriver* and *paperclip* are parallel in all relevant respects.

(37) a. $[N_1\ [_N\ V_3\text{-er}]_2] = [Z_2^{\alpha}; [Y_3\ (\alpha, X_1)]]$, 'someone who V_3's N_1':
woodcarver, junk dealer, hairdresser, dogcatcher, gravedigger, bus driver, cheerleader, store manager, gym teacher, bartender, bookseller
b. $[N_1\ [_N\ V_3]_2 = [Z_2^{\alpha}; [Y_3\ (\alpha, X_1)]]$, 'someone who V_3's N_1':
life guard, cowherd, fighter pilot, talk-show host
c. $[N_1\ [_N\ V_3\text{-er}]_2] = [Z_2^{\alpha}; [Y_3\ (\text{INDEF}, X_1, \text{WITH}\ \alpha)]]$, 'something that someone V_3's N_1 with':
hairdryer, windbreaker, aircraft carrier, snowblower, flycatcher, carpet cleaner, hedge clipper, metal detector, screwdriver, fire extinguisher, bird feeder, coffee grinder
d. $[N_1\ [_N\ V_3]_2] = [Z_2^{\alpha}; [Y_3\ (\text{INDEF}, X_1, \text{WITH}\ \alpha)]]$, 'something that someone V_3's N_1 with':
power supply, doorstop, wine press, hair dye, noise filter, bookmark, stomach pump, wing support, mouth/eyewash, nail/tooth brush, paperclip, bear/booby/fly/ion/mouse trap, nail/shoe polish, neck brace, ear plug, chicken feed, nail file, toothpick, dog whistle, hearing aid

The argument relation is sometimes reversible (X(Y)), with the extra structure shown in (38a,b). Usually N_1 is a zero- or *–ing* derivative of a verb, so considerations parallel to those in (37) apply.

(38) a. $[[_N\ V_3]_1$ (-ing) $N_2] = [Y_2^{\alpha}; [X_3\ (\alpha, \ldots)]]$, '$N_2$ that V_3's (things)'
attack helicopter, curling iron, guard dog
b. $[[_N\ V_3]_1$ (-ing) $N_2] = [Y_2^{\alpha}; [X_3\ (\text{INDEF}, \alpha)]]$, '$N_2$ that people V_3'
chewing gum, drinking water, cooking apple

The third basic relation is BE (Y, X), 'Y is (also) an X', which yields *dvandva* compounds (39a). As pointed out by Olsen 2001, there are a couple of variants of this function. One denotes objects that are some sort of mixture, lying on the boundary between the two categories (39b); another variant denotes an object composed of both N_1 and N_2 (39c).

(39) a. $[Y_2^{\alpha}; [\text{BE}\ (\alpha, X_1)]]$, '$N_2$ that is an N_1':

boy king, politician-tycoon, maiden aunt, woman doctor, child prodigy, poet-painter, junk mail, waste paper, compound noun, torah scroll, boy toy, washerwoman, fisherman, driver ant, killer shark/bee

b. witch doctor, pantyhose, prose poem, sweater vest, apeman, man-god

c. tractor-trailer, Alsace-Lorraine

The fourth basic function is SIMILAR (X, Y).

(40) [Y_2^{α}; [SAME/SIMILAR (α, X_1)]], 'an N_2 similar to N_1':
piggy bank, string bean, sunflower, kidney bean, I beam, hairpin bend, marble cake, rock candy, pie chart, fiddler crab, animal cracker, tree diagram, bulldog, baby doll, kettledrum, catfish, starfish, zebrafish, sunflower, dragonfly, star fruit, elbow macaroni, Batman, tissue paper, t-shirt, garter snake, hairspring, sandstone, angleworm, ringworm, tapeworm

This function is not reversible, because it is symmetric. Similarity can only be rendered asymmetric due to profiling, most commonly by making one argument subject (Gleitman, Gleitman, Miller, and Ostrin 1996). For instance, *Chicago and Akron are similar* is symmetric, but *Chicago is similar to Akron* and *Akron is similar to Chicago* are not entirely synonymous due to the profiling. It is thus impossible to construct a compound *fish zebra*, 'fish such that a zebra is similar to it.' Such a compound would have conflicted profiling: *zebra* is profiled because it is subject, but *fish* is profiled because it is relativized.

The fifth basic function involves a relation among kinds, KIND (X,Y). It is reversible.

(41) a. [Y_2^{α}; [KIND (X_1, α)]], 'an N_2 of kind N_1':
puppy dog, ferryboat, limestone, pine tree, gemstone, limestone, girl child, alleyway, pathway

b. [Y_2^{α}; [KIND (α, X_1)]], 'an N_2 that is a kind of N_1':
seal pup, bear cub (there are other possible analyses as well, perhaps promiscuously)

The sixth function involves location, BE (X, AT/IN/ON Y). It is reversible (42a,b). A special case is temporal location, 'while' or 'during' (42c).

(42) a. [Y_2^{α}; [BE (α, AT/IN/ON X_1)]], 'N_2 that is located at/in/on N_1':
sunspot, window seat, lake dwelling, tree house, background music, nose hair, donut hole, basement apartment, tree house, background music, focal-plane shutter, blood sugar, groundwater, earwax, brain tumor, back/ear/head/neck/toothache, leg cramp

b. [Y_2^{α}; [BE (X_1, AT/IN/ON α)]], 'N_2 with N_1 at/in/on it':
raincloud, garlic bread, inkpad, stairwell, icewater, water bed, beanbag, sandbag, teabag, sandbox, garlic bread, wax paper, bubble bath, raincloud, ice pack,

icewater,theater district, sandpaper[19]

c. [Y_2^{α}; [BE_{temp} (α, AT X_1)]], 'N_2 that takes place at time N_1':
spring rain, morning swim, 3 a.m. blues

This class of compounds also includes many where location is involved in the proper function of the object –

(43) a. [Y_2^{α}; PF ([BE (α, AT/IN/ON X_1)])], 'N_2 whose proper function is to be at/in/on N_1':
door mat, gravestone, street light, kitchen sink, hair ribbon, bathroom scale, urinal cake, shoelace, pocket knife, bag lunch, pocket watch, desk calendar, lawn chair, tablecloth, farmhouse, wallpaper, ceiling fan, coffee-table book, seat cushion

b. [Y_2^{α}; PF ([BE (X_1, AT/IN/ON α)])], 'N_2 whose proper function is to have N_1 at/in/on it':
steam room, boiler room, oyster/snail/tortoise shell, hot-air balloon, lamp post, doghouse, birdcage, henhouse, beehive, insane asylum, cow shed, pigpen

some where the location is characteristic rather than a proper function –

(44) a. [Y_2^{α}; CHAR ([BE (α, AT/IN/ON X_1)])], 'N_2 characteristically at/in/on N_1':
seashell, house plant, housefly, seabird, water buffalo, bedbug, caveman, fieldmouse, earthworm, fruitfly, farm boy

b. [Y_2^{α}; CHAR ([BE (X_1, AT/IN/ON α)])], 'N_2 with N_1 characteristically at/in/on it':
bear country, duck pond, Indian territory

and some where the thing being located is information.

(45) [Y_2^{α}; PF ([BE (X_1, AT/IN/ON α)])], 'N_2 whose proper function is to have N_1 in/on it':
address book, notebook, notepad, graph paper, order blank, index card

Several further elaborations of this case will appear in section 13.6.

The seventh function is COMP (X,Y), 'X is composed of Y'. This is one of the basic "parts and boundaries" functions discussed in chapter 5. It is reversible.[20]

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[19] These cases verge closely on 'X with Y as a part', below. It is not clear to me whether they are distinct.

[20] The compounds in (46a) have characteristic compound stress on N_1. Another class with the same meaning relation has stress on N_2.

(i) N_2 composed of N_1, N_2 stressed
cardboard box, tin can, fur coat, liquid detergent, aluminum foil, leather jacket, glass jar, ceramic mug, wool sweater, oak table, paper towel, brick wall

(46) a. [Y_2^{α}; [COMP (α, X_1)]], 'N_2 composed of N_1':
felafel ball, rubber band, rag doll, tinfoil, brass instrument, jellybean, inkblot, corkboard, card catalog, wood chip, crop circle, cloud cover, sugar cube, rag doll, steel drum, tinfoil, dungheap, bearskin rug, ice sculpture, soap scum, bloodstain, case tier, scar tissue

b. [Y_2^{α}; [COMP (X_1, α)]], 'N_2 that N_1 is composed of':
wallboard, bathwater, brick cheese, sheet metal, book matches, plate glass, pack ice, sheet ice, head lettuce, loaf sugar, lump sugar, brick tea, leaf tobacco, foam rubber

The eighth function is 'X is made out of Y', MADE (X, FROM Y). This differs from COMP (X, Y) in that in this case the object or substance Y is no longer in evidence. For instance, one can still find the onions in an onion roll (COMP), but one can no longer find the olives in olive oil (MADE FROM). The distinction is however slippery. This function too is reversible.

(47) a. [Y_2^{α}; [MADE (α, FROM X_1)]], 'N_2 made from N_1':
apple juice, olive oil, grain alcohol, cane sugar, cornstarch, tomato paste, bean curd, goose grease, petroleum jelly, coal-tar product, maple syrup, elderberry wine

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As observed by Jespersen 1942, these have a bit more syntactic freedom than standard compounds:

(ii) a. The box is cardboard. It's a cardboard box.
?The ball is snow. It's a snowball.
b. a part/mostly cardboard box
*a part/mostly snowball
c. a wood(en) and cardboard box
*an ice and snowball
d. a cardboard box and a wood(en) one
*a snowball and an ice one

These differences suggest that the examples in (i) are not compound nouns but rather nouns preceded by a syntactic modifier. This is a bit curious, in that *tin cán* and *aluminum fóil* fall under the "false compounds" in (i), the "false compounds", but *tínfoil* falls under the "true compounds" in (46a). That's just how the lexicon is, I guess.

In any event, just because a "false compound" is phrasal, this does not mean it has to be constructed online. It is as easy to store in the lexicon as a "true compound." After all, we do store lots of phrasal collocations in memory, all the way from *salt and pepper* to *When in the course of human events,...*. So the type in (i), although it may be structurally different from compounds, need not necessarily be radically different in its status in the lexicon.

b. [Y_2^{α}; [MAKE (X_1, FROM α)]], 'N_2 that N_1 is made from':
sugar beet, rubber tree

Another of the functions of chapter 5 is PART (X,Y), 'X is a part of Y.' Again it is reversible, with two variant paraphrases (48b,c), depending on whether the part is count or mass.[21]

(48) a. [Y_2^{α}; [PART (α, X_1)]], 'N_2 that is part of N_1':
backbone, whalebone, cigarette butt, suit coat, oar handle, apple core, doorknob, fingertip, computer screen, bicycle seat, pigskin, bedspring, ticket stub, tree trunk, bra strap, razor blade, shoelace, stovetop, mold cavity, stew beef, cake flour, lunch meat

b. [Y_2^{α}; [PART (X_1, α)]], 'N_2 that has N_1 (count) as a part':
snare drum, lungfish, string instrument, wheelchair, rattlesnake, fur seal

c. [Y_2^{α}; [PART (X_1, α)]], 'N_2 that is composed in part of N_1':
gingerbread, cinnamon bun, cheesecake, noodle soup, dill pickle, jelly roll

The tenth function is (CAUSE X,Y), 'X causes Y.'

(49) [Y_2^{α}; [CAUSE (X_1, α)]], N_2 that is caused by N_1':
sunburn, diaper rash, knife wound, surface drag

A closely related function is MAKE (X,Y), 'X makes Y.' It is reversible.

(50) a. [Y_2^{α}; [MAKE (X_1, α)]], 'N_2 made by N_1':
moonbeam, anthill, foot/fingerprint, horse shit, anthill, gopher hole, snake poison, suntan, bullet hole, knife wound, beeswax

b. [Y_2^{α}; [MAKE (α, X_1)]], 'N_2 that makes N_1':
honeybee, lightbulb, musk deer, textile mill, lighthouse, silkworm, songbird, candy factory, sweat gland, polio virus

It is sometimes hard to distinguish MAKE from CAUSE. Perhaps MAKE (X,Y) decomposes as CAUSE (X, (COME INTO EXISTENCE (Y)).

[21] The difference between COMP and PART can be illustrated by the ambiguity of *clarinet quartet*. On the COMP reading it means 'quartet of four clarinets'; on the PART reading it means 'quartet of which a clarinet is a distinctive member', e.g. a clarinet and three strings.

I note that PART is formalized here differently than in chapter 5. In particular, the inverse cases in (48b,c) would be formalized in chapter 5 using CONT ('containing'), the inverse function of PART. Further work is needed to reconcile the two treatments.

The twelfth function might be paraphrased as 'X serves as Y.' This can be reduced to a more basic analysis: 'function of X is as a Y' or even 'function of X is to do what Y does.'

(51) [Y_2^{α}; [BE (PF (α), PF(X_1))]], 'Y whose (proper) function is to function as an X':
handlebar, feature film, extension cord, farmland, retainer fee, buffer state, guard dog, guidebook, fighter plane, ferryboat, retainer ring, booster shot, retainer fee, i.d. card, endpoint

The thirteenth function is HAVE (X,Y), 'X has Y', in many senses of 'have'. It too is reversible.

(52) a. [Y_2^{α}; [HAVE (α, X_1)]], 'Y that has (an) X'
AIDS baby, career, glamour girl
b. [Y_2^{α}; [HAVE (X_1, α)]], 'Y that X has':
writer's cramp, shepherd's dog, gangster money

The fourteenth basic function is the only that does not seem especially "basic": PROTECT (X, Y, FROM Z), 'X protects Y from Z.' It creates two families of compounds, depending which two of its three arguments are realized in the compound.

(53) a. [Y_2^{α}; [PROTECT (α, X_1, FROM Z)]], 'N_2 protects N_1 from something':
chastity belt, lifeboat, safety pin, safety lock
b. [Y_2^{α}; [PROTECT (α, Z, FROM X_1)]], 'N_2 protects something from N_1':
mothball, flea collar, cough drop, mosquito net, sun hat, speed bump, mud flap, gas mask, lightning rod, snow shed, bug spray, rain boots, dust jacket, firescreen, headache pill, windshield, surge protector, bird sanctuary, game preserve

This list of functions is not far off others that have been proposed in the literature. With the exception of PROTECT, they seem rather plausible as functions that are readily available pragmatically, i.e. to a protogrammatical capacity for building meanings. An important question is how many of these functions are available for compounding crosslinguistically, and what other functions might appear in other languages' compounds (this question is addressed explicitly and implicitly in many of the articles in Lieber and Štekauer 2009).

13.6 Using material from the meanings of N_1 and N_2

If this were all there were to filling out the interpretation of compounds, the number of possible relations in compounds would be 14, or allowing for all the variants and reversibility, somewhere in the 20s or 30s – clearly not enough. To create a larger range of relations, two other devices come into play: material from the internal semantic structure of the two nouns, and coercion of more structure to create more distant relations between N_1 and N_2. We take these up in turn.

Consider the range of locative relations illustrated in (43)-(45). The basic relation appears

to invoke only locations paraphrasable by *at*, *in*, or *on* – perhaps the least marked spatial relations. However, other spatial relations do in fact occur within the meanings of compounds. In most of these cases, we discover that the spatial relation in question is involved in the proper function of one or the other of the nouns, usually N_2. For instance, a *water fountain* is a fountain that water flows out of; but the proper function of a fountain is for liquid to flow out of it. Now notice: since the proper function of N_2 is a modifier, it can be used to fill out the content of *F* in the modifier schema (31b). (54a) shows the internal structure of *fountain*. Its proper function, 'liquid flows out of', cocomposes with *F* to produce the semantic structure (54b) for *water fountain*.[22]

(54) a. $\text{fountain}_1 = [\text{FOUNTAIN}_1{}^{\alpha}; [\text{PF (FLOW (LIQUID, OUT-OF } \alpha))]]$
b. $\text{water}_1\ \text{fountain}_2 = [\text{FOUNTAIN}_2{}^{\alpha}; [\text{PF (FLOW (WATER}_1\text{, OUT-OF } \alpha))]]$

Similar cases are *coal mine* ('dug out of'), *gas pipe* ('flows through'), *Charles River bridge* ('crosses over'), and Downing's (1977) *toe-web* ('extends between'). In all these cases, N_2 has a proper function, and N_1 is an argument of the proper function.

This approach accounts for large families of compounds such as those in (55). (55a-d) are further sources of locative relations; (55e) involves a different sort of proper function.

(55) a. N_2 is a container:
$\text{coffee}_1\ \text{cup}_2 = [\text{CUP}_2{}^{\alpha}; [\text{PF (HOLD (COFFEE}_1\text{, IN } \alpha))]]$
also photo album, carbarn, soapdish, fishtank
b. N_2 is a vehicle:
$\text{cattle}_1\ \text{car}_2 = [\text{CAR}_2{}^{\alpha}; [\text{PF (CARRY (CATTLE}_1\text{, IN } \alpha))]]$
also baby carriage, garbage/icecream/oil truck
c. N_2 is an article of clothing:
$\text{pinky}_1\ \text{ring}_2 = [\text{RING}_2{}^{\alpha}; [\text{PF (WEAR (INDEF}^{\beta}\text{, } \alpha\text{, ON [PINKY}(\beta)]_1))]]$
also face mask, necktie, ankle bracelet, skullcap, earring, backpack, fanny pack, wristwatch
d. N_2 is itself a location:
$\text{liquor}_1\ \text{store}_2 = [\text{STORE}_2{}^{\alpha}; [\text{PF (BUY/SELL (INDEF, LIQUOR}_1\text{; IN } \alpha))]]$
also fruit market, movie theater (SHOW/SEE), law school (LEARN/TEACH)
e. N_2 is an incipient stage of something else:
$\text{rose}_1\text{bud}_2 = [\text{BUD}_2{}^{\alpha}; [\text{PF (BECOME } (\alpha, \text{ ROSE}_1))]]$
also chick embryo, grass seed, dinosaur egg

This structure also accounts for cases in which N_2 is agent or instrument of an action but is

[22] Brekle 1986 calls this kind of cocomposition a *stereotype compound*. Bassac 2006 analyzes this process – correctly, in my opinion – in terms of Pustejovsky's (1995) *qualia structure* internal to noun meanings, most prominently the telic quale, which specifies proper function of an object.

not derived from a verb. (The agentive and instrumental cases in (37) thus also fall redundantly under this schema.)

(56) a. N_2 is an agent or causer:
$silk_1\ merchant_2$ = [$MERCHANT_2^{\alpha}$; [OCC (SELL (α, $SILK_1$))]]
also eye doctor, pork butcher, sanitation engineer, locksmith, brick mason, car thief, Beatles fan, computer virus, rocket fuel

b. N_2 is an artifact:
$glue_1\ gun_2$ = [Y_3^{α}; [PF (SHOOT (INDEF, $GLUE_2$, FROM α))]
also fishnet, ant bait, bread/butter/steak knife, peppermill, handsoap, snow shovel, grapefruit spoon

Another such case arises when N_2 denotes an information-bearing item such as a song, in which case N_1 can describe the topic of the information (what the information is *about*).

(57) $love_1\ song_2$ = [$SONG_2^{\alpha}$; [BE (INFORMATION (α), ABOUT $LOVE_1$)]]
also Passion play, research paper, success story, fairy tale, horror film, newsletter, lexicalization problem, grammar lesson, cookie recipe

In all the cases so far, *F* has been filled out from material in the lexical entry of N_2. It is also possible to use material from N_1. Consider *cannonball*, 'ball whose proper function is to be shot from a cannon.' The notion of shooting comes not from the meaning of *ball* but from the proper function of *cannon*. This time, since *SHOOT* is in a modifier of N_1, it is not automatically in a position where it can satisfy *F*, as seen in (58).

(58) $cannon_1ball_2$ =
[$BALL_2^{\alpha}$; PF (*F* (α, [$CANNON_1^{\beta}$; PF (SHOOT (INDEF, BALL, FROM β))]))]

However, we can fill out *F* by means of co-composition, which copies material from the proper function of a complement into an unspecified function, just as in *enjoy the book* (28). This yields (59).[23]

(59) $cannon_1ball_2$ =
[$BALL_2^{\alpha}$; PF (*SHOOT*$^{\eta}$ (*INDEF*, α, *FROM*
[$CANNON_1^{\beta}$; PF (SHOOT (INDEF, BALL, FROM β))]))]
'a ball whose proper function is for people to shoot it from a cannon (whose proper function is for people to shoot balls from it)'

Further cases of cocomposition from N_1 will appear in the next section.

[23] Exactly how all the material *SHOOT (INDEF, ..., FROM (...))* is copied over is an important formal detail that must await further investigation.

13.7. Generative schemata for *F*

So far we have seen cases in which either N_1 is an argument of N_2 (*helicopter attack, hair dryer*, etc.) or vice versa (*attack helicopter*), cases in which N_1 and N_2 are co-arguments of a basic function (*limestone, sunspot*, etc.), cases in which N_1 is an argument of a modifier within the lexical meaning of N_2 (*coffee cup, silk merchant*, etc.), and cases in which the proper function of N_1 serves as a modifier of N_2 (*cannonball*). Suppose none of these possible relations makes sense. Then further options have to come into play, in which the relation is more complex.

A first case involves combining two of the basic functions. A *swordfish* is a fish with a part that is like a sword, so it involves both PART and the SIMILAR functions.

(60) $sword_1fish_2 = [FISH_2^{\alpha}; [PART ([Z^{\beta}; SIMILAR (\beta, SWORD_1)], \alpha)]]$
also alphabet soup

A second case involves the locative relation again. A *street singer* is not someone who sings streets (like a *ballad singer*), but someone who sings *in* the street. Here the basic locative relation is involved, but it is not composed with *F* itself, as in *street sign*. Rather, it is added as a modifier to *F*, which in this case is the occupation or characteristic activity of singing:

(61) $street_1\ sing_3\text{-}er_2 =$
$[PERSON_2^{\alpha}; [OCC/CHAR ([SING_3^{\beta}(\alpha); [BE (\beta, IN\ STREET_1)]])]]$
also skywriter, water skier (ON instead of IN), grasshopper (INSECT instead of PERSON)

(61) falls under schema (62), which is a specialized version of the modifier schema. This has a second function *G* to be filled out, which is a modifier of the modifier *F*. In the case of (61), *F* is filled out from the meaning of N_2 and *G* is filled out by the basic locative function.[24]

(62) $N_1\ N_2 = [Y_2^{\alpha}; [F^{\beta} (\ldots\alpha\ \ldots); [G (\ldots X_1, \ldots\ \beta, \ldots)]]]$

But the locative function is not the only basic function that can appear as *G* in (62). Another basic function is found in (63), *steamboat*. Here *F* is filled in from the lexical semantics of *boat*, 'something whose proper function is to move in water', and *G* is the basic function *CAUSE*, encoding the means by which the boat moves.

(63) $steam_1boat_2 = [BOAT_2^{\alpha}; [PF(MOVE^{\beta} (\alpha)); [CAUSE (STEAM_1, \beta)]]]$
'a boat that moves by steam causing it to do so'

Next consider *barbershop*. Like *store* and *market* in (55d), a *shop* is a place whose proper function for goods and services to be bought and sold in it. However, a barber shop does not sell

[24] In (61), the binding of β is to the event of singing, not to the singer. Similarly in (62), β is bound to the event *F*.

barbers (like a *cheese shop*), it sells what barbers do, namely cutting hair. In other words, the thing being sold is found in the proper function of N_1. Hence it is necessary again to invoke cocomposition, and the resultant function linking N_1 and N_2 uses material from the meanings of *both* nouns.

The general schema under which *barbershop* falls is (64). This time the second function, *G*, is an *argument* of the modifying function *F*, and instead of being filled in by a basic function, it is filled in by cocomposition from the meaning of N_1.

(64) $[N_1\ N_2] = [Y_2{}^{\alpha}; [F\ (\ldots, G(\ldots X_1 \ldots), \ldots, \alpha, \ldots)]]$

The meaning of *barbershop* then comes out as (65). *F* is realized as *BUY*, from the proper function of *shop*; *G* is realized as *OCC(CUT (…HAIR))*, from the action modality of *barber*. The fact that *G* arises by cocomposition is notated in italics.

(65) $barber_1 shop_2$ =
$[SHOP_2{}^{\alpha}; [PF\ (BUY\ (INDEF^{\delta},$
$[\mathit{CUT}^{\gamma}\ ([BARBER^{\beta}; OCC\ (CUT^{\gamma}\ (\beta, HAIR(INDEF)))]_1, \mathit{HAIR}(\delta)); IN\ \alpha))]]$
'a shop in which someone buys the action of a barber cutting his hair (which is what barbers do for a living)'
also toll booth, 'a booth at which one pays tolls (which is what one does with tolls).'

For a still more complex case, consider *piano bench*, 'bench on which one sits while playing the piano'. Sitting comes from the proper function of *bench*, and playing comes from the proper function of *piano*. These two functions are connected by the basic function of temporal location, 'while'. Thus there are three independent components involved in linking N_1 and N_2, two of which come from what might be called "encyclopedic knowledge" of pianos and benches. The general schema is (66), in which *F* is the part contributed by N_2, *G* is the part contributed by cocomposition from N_1, and *H* is a basic function that connects them. The structure of *piano bench* is shown in (67), where *F* is *PF (SIT)*, *G* is *PF (PLAY)*, and *H* is $\mathit{BE}_{\mathit{Temp}}$ *(…AT)*.

(66) $[N_1\ N_2] = [Y_2{}^{\alpha}; [F^{\beta}\ (\ldots, \alpha, \ldots); [H\ (\beta, [G(\ldots X_1 \ldots)])]]]$

(67) $piano_1\ bench_2$ =
$[BENCH_2{}^{\alpha}; [PF\ (SIT^{\beta}\ (PERSON^{\gamma}, ON\ \alpha);$
$[BE_{temp}{}^{\delta}\ (\beta, AT\ [\mathit{PLAY}^{\varepsilon}\ (\gamma, [PIANO^{\zeta}; [PF\ (PLAY^{\varepsilon}\ (PERSON, \zeta)]]_1))]]]$
'a bench on which one sits, such sitting being while one plays a piano (which is what one does with a piano)'
also bass stool, bike helmet, lobster bib, dessert wine, coffee cake

A final case is exocentric compounds such as *blockhead*, which violate the Head Principle. These result from combining the modifier schema for compounds with a general coercion schema

for metaphor: (68) says that one can refer to an object by using the name of something that resembles it.

(68) *Metaphor coercion*
$N_1 = [Z^{\alpha}$; SIMILAR $(\alpha, X_1)]$, 'something that is similar to X'

Notice first that this schema is invoked in *swordfish* (60) to characterize the part of the fish that is like a sword. But now consider what happens if this schema is the outermost material in linking X and Y together. In this case, the semantic head of the compound corresponds to Z, i.e. it is unexpressed, in violation of the Head Principle. However, N_2 is still "headish" in that it is the thing that Z is being compared to. Aside from that, the meanings of N_1 and N_2 are incorporated in the same way as in ordinary compounds, interweaving basic functions and cocomposition. Here are five cases, each slightly different in how the constituent nouns are incorporated. Since these are exocentric compounds, the head has to be lexically stipulated.

(69) a. $pig_1tail_2 = [HAIR^{\alpha}$; [SIMILAR $(\alpha, [TAIL_2^{\beta}$; PART $(\beta, PIG_1)])]]$
'hair that is similar to the tail of a pig'
b. $canvas_1back_2 = [DUCK^{\alpha}$; [SIMILAR $([BACK_2 (\alpha)], CANVAS_1)]]$
'duck whose back resembles canvas'
c. $bird_1brain_2 = [PERSON^{\alpha}$; [SIMILAR $([BRAIN_2^{\beta} (\alpha)], [\textit{BRAIN}^{\beta} (BIRD_1)])]]$
'person whose brain is similar to that of a bird'
d. $sea_1\ horse_2 = [ANIMATE^{\alpha}$; [SIMILAR $(\alpha, HORSE_2)]$;
[CHAR (BE $(\alpha$, IN $SEA_1))]]$
'animate entity similar to a horse that is characteristically in the sea'
e. $coat_1tail_2 = [Z^{\alpha}$; [SIMILAR $(\alpha, TAIL_2)]$; [PART $(\alpha, COAT_1)]]$
'something that is similar to a tail and that is part of a coat'

13.8. Closing remarks

By the time we get to the semantic structures in (59)-(69), a large proportion of the meaning is connective tissue: unexpressed basic functions, bound variables, and cocomposed functions. Nevertheless, the overall result should be clear. The semantic relation between N_1 and N_2 arises by coercing extra functions into the structure, either in argument or in modifier positions, and by filling these functions out either with basic functions or with internal semantic structure from N_1 and N_2. The generative system for compound meanings can be summed up as follows:

(30) *Head Principle*
$[N_1\ N_2]\ =\ [Y_2 (\ldots); (\ldots)]$

(31) *N-N compound schemata* (or *constructions*)
a. *Argument schema*: $[N_1\ N_2] = [Y_2 (..., X_1, ...)]$ 'a N_2 by/of/... N_1'
b. *Modifier schema*: $[N_1\ N_2] = [Y_2^{\alpha}$; [F $(..., X_1, ..., \alpha, ...)]]$
'an N_2 such that F is true of N_1 and N_2'

(68) *Metaphor coercion*
$N_1 = [Z^{\alpha}; \text{SIMILAR } (\alpha, X_1)]$, 'something that is similar to X'

(70) *Auxiliary principles*
a. Cocomposition of F in (31b) with
i. a basic function
ii. a modifier of Y_2 (e.g. Y_2's proper function)
iii. X_1 (if X_1 takes arguments, as in *attack helicoper*)
iv. a profiled modifier of X_1 (e.g. X_1's proper function)
b. Expansion of an argument or modifier of F as G(…)
i. Cocomposition of G with a basic function
ii. Cocomposition of G with a profiled modifier of X_1
c. Recursion on step b: Expansion of an argument or modifier of G

This is fairly straightforward when there is only one coercing function *F*, as seen in sections 13.5-6, but complexity increases quickly with multiple coercions, as in section 13.7. The resulting number of options for the semantic relation between N_1 and N_2 also increases quickly, which seems consistent with the literature's limited success at enumerating them. In the present approach, the repertoire of possible relations is created by a generative system which, aside from the rudimentary linking of N_1 and N_2 into the structure, is entirely within the semantics. So in a sense Jespersen is correct in saying "The analysis of the possible sense-relations can never be exhaustive" – and yet it is systematic.

One might object that *piano bench* does not *feel* as complex as (67). I offer three replies to such an objection. First, for decades we have been accustomed to vaunting the covert complexity of language beneath its intuitive transparency. The covert complexity for Conceptual Semantics should not be any less than for other formal theories of syntax and semantics, particularly given its aspiration to semantic explicitness. In fact, by virtue of the Parallel Architecture, it has been possible to keep *all* complexity out of the syntactic component – it is only the *meaning* that is complex. Second, for those who find *any* sort of formalism objectionable, the challenge is to find a notation that (a) is more perspicuous, (b) still retains all the necessary semantic distinctions, and (c) does so with a constrained set of basic relations and schemata.

A third, more substantive reply is that another important system in language has properties similar to compounding: discourse. The semantic connections among sentences in discourse are by definition not expressed in syntax, which is confined to the structure of individual sentences. As is well known, the semantic connections among sentences are highly dependent on world knowledge:

(71) a. Max fell. Bill pushed him. (S_2 causes/explains S_1)
b. Max fell. Bill helped him up. (S_2 follows S_1)

(72) a. The car collided with the building. The headlights broke. (S_2 is result of S_1)
b. The car collided with the building. The clutch broke. (S_2 causes/explains S_1)

Asher and Lascarides 2003 (from which (72) is taken) work out a formal logic of discourse connection that depends on about ten basic relations, which can link up sentences or groups of sentences in the discourse – and not always sequentially, but rather in a plethora of possible ways. (See also Clark 1996 for the hierarchical complexity of connections among sentences in conversation.) Some of the relations posited by Asher and Lascarides parallel basic relations in compounding. For instance, cause/result appears in both systems, and their Elaboration function, where S_2 specifies details of S_1, can be construed as parallel to PART in the compound system: the event denoted by S_2 is a part of the event denoted by S_1. Asher and Lascarides call their system of rules a "glue logic": it fills in plausible pieces of meaning left inexplicit by lexical and syntactic content, thereby gluing the sentences' meaning together. The system proposed here for compounding has parallel properties, but it glues together nouns inside a compound instead of sentences.

A serious consideration of discourse, then, makes it clear that only part of language understanding can be controlled by the orderly composition of lexical meanings, guided by syntactic structure. Discourse requires much wilder "seat-of-the-pants" composition, guided only by semantics and pragmatics. The relevance for the present enterprise, of course, is that it provides a point of comparison for analyses like those in section 13.7, where a great deal of unexpressed "glue" is necessary to connect the nouns in a compound. It also further justifies the view of compounding as protolinguistic, that is, as a subsystem that is less grammatically structured than the standard phenomena investigated by syntactic theory.

The questions raised by this account are the same ones that have persisted in the literature, but they can perhaps now be couched more precisely. Here are five; other researchers will surely have more.

- What is the full set of basic functions, and how uniform are they crosslinguistically?
- To what extent are these functions generally available for pragmatics (including discourse) and nonlinguistic conceptualization?
- To what extent are these functions special to language – or to English?
- How extensive can coerced and cocomposed functions be in compounds, and to what extent does the answer differ between lexicalized and novel compounds?
- What other basic morphosyntactic patterns must be added to the simple N_1N_2 structure in (30)-(31) in order to account for the quasi-syntactic elaborations in (3) (e.g. *health and welfare fund*), and what is their status vis-a-vis morphology, syntax, and protolanguage?

The first and third of these questions may be answered in part by the typological descriptions in Lieber and Štekauer 2009; the fifth may be addressable in the framework of Construction Morphology laid out in Booij 2009. Other traditional questions have been answered by the present account, for example why the possible relations between N_1 and N_2 are so varied yet not altogether wild, precisely how the meanings of the two nouns contribute to the meaning of the compound, and how a balance can be struck between regularity and idiosyncrasy in the evaluation of the "cost" of compounds. Above all, because the Parallel Architecture liberates the generative capacity of semantics from that of syntax, it has been possible to give a semantically-based

account of compounds that is sufficiently formal to see what is going on, while keeping the syntax as absolutely simple as it looks.

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