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Compositionality, *of*, word-formation

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0 Introduction

One of the criteria generally applied in distinguishing lexical processes from syntactic ones is *compositionality*: the standard assumption is that syntactic processes have transparent (compositional) semantics while word-formation is semantically opaque. In this paper I will argue that this assumption is false: certain processes which are generally held to be syntactic are compositional only to a limited extent, and to the same limited extent most lexical processes are also compositional.

In Section 1. I will develop a formal definition of compositionality which enables us to treat 'noncompositional' phenomena on a par with the strictly compositional cases. Section 2. is a discussion of the semantics of English constructions involving two nouns (or noun-projections) connected by *of*. Such constructions offer a surprisingly wide range of data which is problematic for strictly compositional theories of grammar. In Section 3. I will sketch a solution that violates compositionality minimally.

1 Compositionality

Let me start with an informal statement of compositionality: the meaning of an expression can be derived from the meaning of its constituent parts plus the way these parts are combined. This 'plus' condition is necessary if we want to distinguish between forms MN and NM that have the same constituent parts in a different order, or between forms like 'black bird' and 'blackbird' which have the same constituents in the same order but are subsumed under different contours. In all likeness, Frege has introduced the plus condition with these or similar considerations in mind.

The blackbird example shows that compositionality has two, fundamentally related but technically distinct meanings: I will call these compositionality$_2$ and compositionality$_3$, and reserve the term 'compositionality' for the general principle that subsumes both. Under compositionality$_3$, both 'blackbird' and 'black bird' are treated as composed of 3 elements (hence the name), namely 'black', 'bird', and the suprasegmental contour to which they conform. Under compositionality$_2$, both complex forms are composed of only 2 elements (hence the name), and it is the manner of composition that distinguishes one from the other.

Now we are in a position to give a formal definition of compositionality. Given some unit X of linguistic description, the phonological representation associated with X will be denoted by p(X), and the semantic representation associated with X will be denoted by s(X). The exact nature of these phonological and semantic representations is irrelevant: all that matters is that well-formed linguistic units are equipped with both a phonological and a semantic representation. In other words, the functions p and s are well-defined for any unit of linguistic description.[1] The minimal units for which both p and

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[1] The cases when some element is ambiguous will be treated by assigning them a *set* of semantic representations: with this techical device we can maintain that s is a *function*, rather than a *relation*.

s are defined are standardly called morphemes – for these, the values of p and s are simply listed in the lexicon. The question is how can we compute p and s for higher level units such as words, phrases, sentences or paragraphs.

Compositionality means that we can compute p and s in a bottom up fashion, and the term *non-compositional* is reserved for those units where this bottom up procedure fails. First let us suppose that we have only two constituent parts, N and M, and these together form a larger unit X. The phonological form p(X) of X is given by P(p(N),p(M)), where P is some phonological operation such as concatenation. It might be the case that P is much more complex than concatenation (for instance it can involve a whole series of sandhi rules), the only requirement is that it should be well-defined for all pairs of phonological representations that can serve as input to it.

The 'interpretation function' s should meet exactly the same condition, namely that the semantic representation s(X) of X is given by Q(s(N),s(M)), where Q is some semantic operation such as function application. It might be the case that Q is much more complex (for instance it can involve a complex unification algorithm) – the only requirement is that it should be well-defined for all pairs of semantic representations that can serve as input to it. Now, compositionality$_2$ means that there exists some P$\rightarrow$Q *function*, call it r. The existence of such an r means that we adhere to the Rule to Rule hypothesis: each rule P of combining phonological forms is paired with a rule Q that tells us how to combine the semantic interpretations.

Within the domain of word-formation, inflectional morphology provides a good example of compositional$_2$ processes. Compounding, however, can not be subsumed under compositionality$_2$ – this will be shown on the case of English noun-noun compounding. On the phonological side we clearly deal with a unified process of concatenation, sandhi, and compound stress assignment. This process is the same irrespective of the nouns we take as input for compounding – it will be denoted by P_c.

On the semantic side, however, the process is extremely varied. Compositionality$_2$ would mean that we have to derive the meaning s(NM) of the compound as some function $r(P_c) = Q_c$ of the meanings s(M) and s(N) of the compounded nouns. Under the analysis proposed by Kiparsky (1982), the compund NM means 'an M that is V-ed by N', where V is an appropriate verb. Thus, *ropeladder* = 'ladder *made of* rope'; *manslaughter* = 'slaughter *undergone by* man'; *testtube* = 'tube *used for* test', etc. Notice, that the verb used in the paraphrase is unpredictable, which makes Q_c a function of three independent variables s(N), s(M), and s(V). Compositionality$_2$ can not hold precisely because we can not eliminate the third variable.

In general, compositionality$_3$ will be defined as involving a third, hidden element that plays a role in the process whereby we compute the meaning of the complex expression XY: formally, it is given by s(XY) = Q(s(X),s(Y),s(Z)). In case Z is constant, we can think of its contribution as being part of the 'constructional meaning', and we can maintain full compositionality. But if Z can not be predicted from P, X, and Y, we have a much weaker notion of compositionality. In fact, compositionality$_3$, as defined here, does not qualify as 'compositional' under the usual strict interpretation of this term. However, we will see that it is a useful concept, not only for the description of the semantics of compounding, but also in the description of processes which are generally held to be more 'syntactic'.

2 *of*

In this section I will investigate a wide range of constructions of the form N^i *of* N^j, where N^i and N^j are nominal projections ranging from bare nouns to full NPs. The treatment is intended to be exhaustive in the sense that every 'N of M' construction in English should fit into one or more of the categories developed below. The emphasis will be on the semantics, rather than on the syntax of the constructions involving *of*, and this makes it necessary to choose some particular mode of semantic description.

Rather than using some strictly formal semantic representation such as Montague Grammar, I will use natural language paraphrases as my semantics. This mode of semantic representation has been eloquently defended in Wierzbicka (1980), and there is little I could add to her discussion. Suffice to say that the constructions I treat here are all distinct in the sense that every one means something different than the others. Although these differences in meaning are not defined formally, they are obvious to every speaker of English, and any reasonable formal theory of semantics will capture them.

2.1 NP_1 of NP_2 = NP_1 which belongs to NP_2

the children of a family
the capital of Spain
the color of the dress
the 27th of February
William of Normandy

These examples show what I believe to be the primary meaning of *of* – the meaning 'possessed by', 'being owned by', 'belonging to', etc. It would be extremely hard to single out any one of the possible paraphrases as the true one, and will not attempt to do so. However, the existence of such paraphrases is sufficient to explain the semantic oddity of forms like *??John's necktie of father* as opposed to the perfectly well-formed *the necktie of John's father*.

2.2 N_1 of N_2 = a N_1 having N_2 as its primary characteristic

a dress of silk/a coat of many colors
an area of hills/a story of adventure
a house of six rooms/a look of pity
a family of eight/a child of ten
a woman of ability/a man of action
a matter of (no) consequence/an author of note

Again, the paraphrase 'primary characteristics' is fairly weak. However, it is clear that a *dress of silk* is not a 'dress possessed by silk', 'owned by silk', etc. Conversely, it is obvious that *the children* do not have *a family* as their primary characteristic, most salient feature, etc.

2.3 N_1 of N_2 = N_2 having the amount N_1

a pot of gold/a blade of grass/a bar of soap
two pounds of sugar/five miles of bad road
no more of that/too much of a gentleman

Again, it is clear that the *gold* does not own the *pot*, or that *five miles* do not have *bad road* as their primary characteristic. Moreover, English speakers have clear intuitions that *a pot of gold* is ambiguous between 'a pot containing gold' and 'a pot made of gold'. This kind of ambiguity is captured here by assigning the expression to both the present and the previous construction – the categorization provided here is adequate to the extent that ambiguities of this sort can be captured by it.

2.4 N_1 of N_1-s = the best/most important N_1

remedy of remedies
holy of holies
song of songs

This construction requires the stem preceding *of* to be identical with the stem following *of* – forms like *??torment of pains* simply do not work this way. But this requirement does not mean that forms that fit the pattern are necessarily interpreted with this kind of superlative semantics. A *servant of servants* can simply be a person who serves some people who happen to be servants themselves (this gives us the primary pattern), and a *box of boxes* can simply be a boxful of boxes (this gives us the 'amount' pattern). *Function of functions* has the 'primary characteristic' reading, but even if it did not, the present pattern must be distinct from the 'primary characteristic' pattern, because the meaning 'a remedy that has remedies as its primary characteristic' is not the same as 'the best/most important remedy'.

2.5 the N_1 of N_2 = the N_1 that is/was N_2

the art of painting/the vice of drunkenness
the name of Jones/the city of Boston

Again, the semantic component of the grammar has to account for the fact that *art* does not belong to *painting*, *art* does not have *painting* as its primary characteristic, and *art* is not the amount of *painting* in the above construction. Moreover, *the art of arts* has a reading parallel to the one exemplifed here, and the existence of this reading shows that we have to keep this construction separate from the previuos one.

This construction, in which *of* links a following modifier to the head noun, appears to be the best place for those nouns that govern *of*. Examples like *fear of, case of, sort of, opposite of, image of, sake of*, etc seem to have very little in common. However, they all fit the basic pattern in which the second noun modifies the head noun. Thus, *the fear of flying* is a kind of *fear*, *the image of John* is a kind of *image*, etc.

2.6 a N_1 of a N_2 = an N_2 that is (like) an N_1

a brute of a man/a palace of a house

Here the semantics is reversed: the construction is right-headed. Again, it is is clear that *a brute of a man* is not like *a donkey of a farmer*, that *brute* does not tell about the amount that *man* has, etc. With the 'primary characteristic' reading it is harder to find examples, since the present pattern requires *a/an* before the second noun while that one generally forbids it. However, examples like *a smoker of an unmentionable substance* clearly do not fit into the present pattern, which therefore must be kept distinct.

There is a closely related pattern which appears in examples like *to sacrifice the lamb of cataphor on the altar of c-command*[2] I will assume that this is an instance of the same semantic pattern, in which 'cataphor, which is (like) a lamb' gets sacrificed on the 'altar that belongs to c-command'. If this is true, the indefinite article is not an essential part of this construction.[3]

2.7 Pro_x of all X-s = surprisingly, Pro_x

he of all men
here of all places
this of all times/things
John of all people

This pattern, much like the previous ones, gives us a meaning that can not be attributed to any of the constituent parts. The element that distinguishes this construction from the others is *all*. Under ordinary circumstances, *all* means something like 'every' – the element of 'surprise' is clearly not part of this meaning.

[2]This usage of *of* has been pointed out to me by Charles Fillmore.
[3]Unfortunately, a more detailed investigation of the role of determiners in such constructions is beyond the scope of this paper.

Here again, there seems to be now way to reduce this pattern to any of the previous ones: *John of all people* does not mean 'John, who belongs to all peple', 'John who has all people as his primary characteristic', etc.

2.8 N_1 of NP = among

one of the team
a mind of the finest
the older of the two

This pattern again can not be reduced to any of the others – the examples clearly do not mean 'the older belonging to the two', 'the older having the two as its primaray characteristic', 'the two having the amount older', etc.

2.9 N_V of N

the cancellation of the committee
the shooting of the hunters
the love of God
eaters of pork
the smelling of fish

With deverbal nouns, the power of paraphrase fails – I could not find any simple formula describing the common meaning of the examples listed above. I suggest that they should be treated as containing a completely grammaticalized *of*, one that contributes nothing to the semantics of the construction. Thus, the *of* in these constructions is much like an idiosyncratic case marker – the question is why do we find it with nouns that are derived from verbal stems that do not govern *of*. I suggest that *of* is introduced by the nominalizing suffixes *-ing, -er, -ation*, and *0*, and will mark either the subject or the object of the original verb. If this is true, the lack of uniform paraphrase is not really surprising, since neither subjects nor objects stand in a uniform semantic relation with the verb.

3 Word-formation

In the previous section I have grouped English N^i *of* N^j constructions into nine semantically distinct categories. A more detailed investigation would probably reveal that the rough categories established there can be subdivided into finer subcategories that show more uniform syntactic and/or semantic behavior within a subcategory – the work is by no means finished. However, nine categories are more than enough to establish the point that the meaning of productive syntactic constructions can not be predicted from the meaning of their constituent parts alone.

Nevertheless, speakers of English are obviously able to generate and interpret an infinite variety of constructions in any all the categories discussed above, and we can not reasonably attribute this ability to any kind of lexical or encyclopedic knowledge that lies outside the domain of grammar. Thus the grammarian is faced with the task of devising a rule system that models this kind of knowledge about 'special constructions' in some finitistic manner. What I would like to show in this concluding section is that any rule system capable of modelling the productivity of special constructions will of necessity involve compositionality$_3$ in an essential way.

I will attempt to develop a compositional$_2$ analysis of the 'surprisingly' construction: by using the full power of the 'plus' condition discussed in the first section, it will be possible to reduce the non-compositional aspect of the rule system to a single case of compositionality$_3$. I will suggest that a similar analysis can be developed for the other cases as well, and thus we can have a finite list of patterns involving 'hidden' elements in the semantics.

The first thing to be noticed about the 'surprisingly' construction is that we do not have ordinary NPs in the positions preceding and following the *of*. The second NP must be quantified by *all*, and the first has to be a pronoun or a proper noun.[4] This suggests that the 'surprisingly' construction involves extraordinary constituent structure: in particular, *of* and *all* always appear together in it.

Thus, the initial bracketing is taken to be (Pro) (of all) (N[PL]). Once we have taken this step, the rest of the bracketing is immaterial: the 'surprisinly' element of meaning can be attributed to *of all*. Since this element has has nothing to do with the meaning of *of* or *all*, as they appear in any other construction, this is a clear case of compositionality$_3$: we must say that the meaning 'surprisingly' is derived from the fact that *of* and *all* are put together in this particular manner, i.e. in a constituent that appears only in this special construction.

The NPs in other *of* constructions are also restricted in various ways: this suggests that the constituent structure in these cases involves much more than (NP) (of NP).[5] Whether we attribute a flat, pattern-like structure to these constructions or whether we build them up in a more hierarchical fashion is immaterial – a 'hidden' element of meaning must appear at one of the nodes of the constituent tree. The node where we introduce the unpredictable element will be called the critical node – in every special construction there must be at least one such node.

In the example chosen, the critical node dominates only lexical entries, and if this is always the case, than compositionality$_3$ is a strictly lexical phenomenon. However, it might turn out that one or more of the nodes dominated by the critical node is capable of containing a variety of elements (e.g. any measure phrase, as in the 'amount' construction) – this would mean that we need full templates, containing more or less restricted 'slots' in the lexicon.

However, until the additional power of storing templates in the lexicon is shown to be necessary, I would like to maintain the more restrictive position that compositionality$_3$ involves only lexical entries, especially because in the lexicon compositionality$_3$ is independently motivated by compunding and other processes of word-formation.

To sum up, the meaning representation of morphemes like *of* contains not only overt elements, but also covert ones. These units of meaning are 'hidden' because they can be recovered only if we have an additional pointer to them: this second pointer will be provided by the other element dominated by the critical node.[6]

4 References

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[4] The feature that pronouns and proper nouns share is *+unique referent*. Whenever we can construe the first NP as having a unique referent the construction will be acceptable. Bare nouns will never work: **book of all ...*, but nouns with a determiner can, as long as they are used as generics: *the whale, of all species ...*

[5] The exception is the unmarked 'belongs to' pattern: the standard constituent structure is based on that.

[6] The idea of having elements that can be accessed only if we have two pointers for them receives a natural interpretation in 'spreading activation' models like Quillian (1968) or Kálmán – Kornai (1985).