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Coordination of parts of words

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Abstract

Coordination of parts of words, as in *ortho and periodontists*, has to be interpreted at the level of the word parts because the above NP can felicitously describe a pair of one orthodontist and one periodontist. This paper develops a theory of denotations for arbitrary word parts, in which the coordinate word parts denote their own sound, and the rest of the word is a function from sounds to word meanings. This yields the correct interpretation for number in coordinate constructions. The paper also explores phonological constraints on coordinate structures, and shows how certain ungrammatical structures that can be interpreted by the semantics are ruled out on phonological grounds.

Keywords: coordination, semantics, prosody

1. Introduction

In this paper I argue that the correct interpretation of coordination of parts of words, as in (1) below, requires a semantics that interprets coordination at the level of the visible string, thus assigning separate meanings to the word parts *ortho*, *perio*, and *dontists* (an orthodontist is a specialist in straightening teeth; a periodontist specializes in gums and supporting structures).

(1) ortho and periodontists

The paper develops such a semantics, which is based on the principle of phonological decomposition (to be defined shortly); it also explores the phonological constraints on coordinate structures below the word level.

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The evidence that interpretation has to be at surface level comes from plural morphology. Specifically, the NP *ortho and periodontists* is not synonymous with *orthodontists and periodontists*. Suppose that Bill is an orthodontist and Martha is a periodontist; then sentence (2a) below has a reading on which it is true, whereas sentence (2b) does not have a true reading.

(2) a. Bill and Martha are ortho and periodontists. (true)
b. Bill and Martha are orthodontists and periodontists. (false)

The contrast is similar to the ones below: if Mike is married to Mary and Jim is married to Jill, then (3a) is true and (3b) is false. Also, sentence (4a) can be true, while (4b) is incoherent.

(3) a. Mike and Jim are husbands of Mary and Jill. (true)
b. Mike and Jim are husbands of Mary and husbands of Jill. (false)

(4) a. Konishki and Takanohana are heavy and light sumo wrestlers.
b.#Konishki and Takanohana are heavy sumo wrestlers and light sumo wrestlers.

The explanation of the last two contrasts is straightforward: sentence (3a) can be true in a monogamous situation because the noun *husbands* allows a cumulative relation between its two plural arguments (Scha, 1981), while in (3b) each predicate conjunct is plural, so each must apply to a plural argument. In sentence (4a) the coordinate adjective *heavy and light* modifies the head noun *sumo wrestlers*; the entire NP is plural, but it can felicitously apply to a pair of one heavy sumo wrestler and one light one. The predicate in sentence (4b) is formed by coordinating two plural NPs; it thus implies that each of the sumo wrestlers is both heavy and light.

Both of these contrasts are the consequence of coordination at different syntactic levels—sentences (3a) and (4a) have coordination below the level of the predicate, while in (3b) and (4b) coordination is between predicates. Drawing on this parallel, we conclude that in (1) the conjunction *and* operates on the word parts *ortho* and *perio*. The structure relevant to interpretation must therefore be (5) below, with coordination at the surface level.

(5) [ortho and perio]dontists

The challenge, then, is to provide a semantics for word parts that will allow us to interpret structures like (5) with the correct truth conditions; this would require assigning separate meanings to the word parts *ortho*, *perio*, and *dontists*. We do want to preserve the meaning of the conjunction *and*—intuitively, it has the same meaning in (5) as it has elsewhere in the language.

I propose that the desired semantics can be formulated through the use of phonological decomposition, which derives the meanings of *ortho* and *dontist* from the meaning of *orthodontist*: in a construction like (5), the coordinate word parts denote strings of sound, and the rest of the word is a function from sounds to word meanings. The ordinary interpretation of conjunction then allows these denotations to combine, and results in the correct meaning for the full NP *ortho and periodontists*.

The semantics necessary for interpreting coordination of parts of words is developed in section 2. Section 3 looks at phonological constraints on the coordination of word parts, which are important in ruling out certain configurations predicted possible by the semantics. Finally, section 4 compares the present approach to previous suggestions in the literature, which offered to explain coordination of parts of words as the product of a deletion rule.

2. A semantics for the coordination of word parts

2.1. Plurality and conjunction

Our semantics will have to capture the following difference: the NP *ortho and periodontists* can denote a pair of people, one of whom is an orthodontist and the other a periodontist, while *orthodontists and periodontists* cannot denote such a pair: it can either denote a pair of people who are each both an orthodontist and a periodontist, or a group of people of whom at least two are orthodontists and two periodontists. The source of the difference is the location of plural morphology: there is one plural morpheme on the entire NP *ortho and periodontists*, whereas in *orthodontists and periodontists* there is a plural morpheme on each conjunct.

I start by outlining some assumptions about the representation of plurality and conjunction that will be used in deriving the contrast between the above two NPs. The underlying theory of plurality and conjunction includes the following elements.

(6) Plurality is represented via a structured domain of individuals; plural objects are formed by a join operation $\oplus$, and are of the same type as singular individuals, namely type *e*. (Leonard and Goodman, 1940)

(7) Plural morphology is interpreted as semantic plurality: plural expressions only include pluralities in their extension. (see for example Chierchia, 1998)

(8) Coordination can receive a cumulative (plural-forming or “non-Boolean”) interpretation. (Link, 1983; Krifka, 1990)

The above claims are defended in Artstein (2001, 2002: chapter 3), where the argument is made based on the behavior of coordinate adjectives in languages that mark them with plural morphology. The assumptions about plurality (6) and (7) state that plural NPs like *orthodontists* and *periodontists* denote sets of strictly plural objects.

(9) $[\![\text{orthodontists}]\!] =$
$\lambda\alpha.\alpha \in \text{PL} \wedge \exists n \in \mathbb{N}, \alpha_1, \ldots, \alpha_n[\alpha = \alpha_1 \oplus \cdots \oplus \alpha_n \wedge \forall i \leq n[[\![\text{orthodontist}]\!](\alpha_i)]]$

$[\![\text{periodontists}]\!] =$
$\lambda\alpha.\alpha \in \text{PL} \wedge \exists n \in \mathbb{N}, \alpha_1, \ldots, \alpha_n[\alpha = \alpha_1 \oplus \cdots \oplus \alpha_n \wedge \forall i \leq n[[\![\text{periodontist}]\!](\alpha_i)]]$

(Throughout this paper I interpret natural language directly rather than through the use of a translation language. For conciseness and clarity I will often use variables and functional notation in my exposition, these are to be understood as part of the metalanguage and do not constitute a formal translation language. The symbol PL stands for the set of pluralities, that is individuals that are not atomic).

As for coordination, the assumption in (8) states that when *and* coordinates expressions of type *e* it can denote the join operation on the domain of individuals $\oplus$.

(10) $[\![\text{Bill and Martha}]\!] = [\![\text{Bill}]\!] \oplus [\![\text{Martha}]\!]$

Cumulative conjunction for common nouns (type *et*) is defined as follows: an object α is in the denotation of a coordinate common noun if it is the join of two objects α_1 and α_2, where α_1 is in the denotation of the first conjunct and α_2 is in the denotation of the second (Link, 1983; Krifka, 1990).

(11) $[\![\text{orthodontists and periodontists}]\!] =$
$\lambda\alpha.\exists\alpha_1, \alpha_2[\alpha = \alpha_1 \oplus \alpha_2 \wedge [\![\text{orthodontists}]\!](\alpha_1) \wedge [\![\text{periodontists}]\!](\alpha_2)]$

We thus get the desired reading for *orthodontists and periodontists*: there must be at least two orthodontists and two periodontists in any group denoted by (11); it may be the same individuals who are practitioners of both kinds, or different individuals (in the latter case the size of the group is greater than two).

2.2. Phonological decomposition

We now turn to the NP *ortho and periodontists*. The denotation of this NP can include groups consisting of just one orthodontist and just one periodontist, and we want to capture this in a similar fashion to the NPs *husbands of Mary and Jill* and *heavy and light sumo wrestlers*. In order to do so we must assign an interpretation to the word parts *ortho*, *perio* and *dontist*. My proposal is to derive the meanings for the word parts from the meanings of the complete words through phonological decomposition, in a manner similar to the account of focus below the word level (Artstein, 2002: chapter 2, 2004): the denotations of the word parts will form a function-argument structure that, when put together, will retrieve the meanings of the original words. The singular common nouns *orthodontist* and *periodontist* denote properties of individuals (type *et*). I will assume that *ortho* and *perio* simply denote strings of sounds, which are individuals of type *e*.

(12) a. $[\![\text{ortho}]\!] \in \mathrm{D}_e$: the string *ortho*.

b. $[\![\text{perio}]\!] \in \mathrm{D}_e$: the string *perio*.

That strings of sound are objects in our model, which are referred to by their own mention, is no great innovation. There exist predicates that apply exclusively to such meanings, as in the sentences *ortho is disyllabic* and *perio ends in a tense vowel*. My claim is that this is the same denotation that we see in *ortho and periodontists*.

Given the denotations of *ortho* and *perio*, the semantics will have to give *dontist* a functional meaning of type *eet*, like that of a transitive verb: it will take as its first argument an object whose meaning is a string of sounds, and return the meaning of the word which is the concatenation of that string with the string *dontist*.

(13) $[\![\text{dontist}]\!] \in \mathrm{D}_{eet}$: the function $h : \mathrm{D}_e \rightarrow \mathrm{D}_{et}$ such that for all $\alpha \in \mathrm{D}_e$, $h(\alpha) = [\![\alpha\text{dontist}]\!]$ if α*dontist* is a word and $[\![\alpha\text{dontist}]\!] \in \mathrm{D}_{et}$, undefined otherwise.

A few notes are in order regarding the above formula: *dontist* is an expression of English, and the symbol α stands for a denotation, that is an object in the model. The symbol α plays an additional role, however: the meanings of the coordinate word parts *ortho* and *perio* are identified with their phonological form, so in the cases of interest α is also an expression of English. Thus, the sequence α*dontist* stands for the concatenation of a meaning α, which is the phonological characterization of a linguistic expression, with the phonological characterization of the expression *dontist*. This is all that matters for the semantics; anticipating the discussion of the phonology in section 3, I will add that the concatenation operation does not refer to linear strings of segments, but is rather an operation on phonological structures, i.e. prosodic constituents.

With the above definition, the composition of *dontist* with *ortho* and with *perio* yields the expected results.

(14) a. $[\![\text{dontist}]\!]([\![\text{ortho}]\!]) = [\![\text{orthodontist}]\!]$

b. $[\![\text{dontist}]\!]([\![\text{perio}]\!]) = [\![\text{periodontist}]\!]$

We need not worry about the fact that the function denoted by *dontist* is undefined for many objects in the model that it could take as an argument. In this respect *dontist* is like any other function: the expression *Bill-dontist* is incoherent, because it is impossible to concatenate a person with a sound in order to form a word. This is similar to what happens with an expression like *kissed democracy*, which is incoherent because democracy isn't something that can be kissed, even though it is of the right semantic type for objects of *kiss*.

We now have the building blocks that derive the meaning of *ortho and periodontists*. Starting with the constituent *ortho and perio*, we notice that *and* operates here between two objects of type e, so the meaning of the coordinated constituent is the join of these objects, that is a plural object of type e (just like *Bill and Martha*).

(15) $[\![\text{ortho and perio}]\!] = [\![\text{ortho}]\!] \oplus [\![\text{perio}]\!] \in \mathrm{D}_e$

Now *dontists* has to apply to this object—it is, after all, of the right type. The meaning of plural *dontists* will be derived from the meaning of singular *dontist* by restricting its subject (the outer argument) to plurals and allowing a cumulative relation between its two arguments, as is the case with plural transitive verbs (Scha, 1981). We get the following meaning for plural *dontists*.

(16) $[\![\text{dontists}]\!] =$
$$\lambda\beta\lambda\alpha.\alpha \in \mathrm{PL} \wedge \exists n, m \in \mathbb{N}, \alpha_1, \ldots, \alpha_n, \beta_1, \ldots, \beta_m [\alpha = \alpha_1 \oplus \cdots \oplus \alpha_n \wedge \beta = \beta_1 \oplus \cdots \oplus \beta_m \wedge \forall i \leq n \exists j \leq m [[\![\text{dontist}]\!](\alpha_i, \beta_j)] \wedge \forall j \leq m \exists i \leq n [[\![\text{dontist}]\!](\alpha_i, \beta_j)]]$$

Applying the meaning of *dontists* in (16) to the meaning of *ortho and perio* in (15) will give us the meaning of the NP *ortho and periodontists*.

(17) $[\![\text{dontists}]\!]([\![\text{ortho}]\!] \oplus [\![\text{perio}]\!])$
$$\begin{aligned}
&= \lambda\alpha.\alpha \in \mathrm{PL} \wedge \exists n, m \in \mathbb{N}, \alpha_1, \ldots, \alpha_n, \beta_1, \ldots, \beta_m [\alpha = \alpha_1 \oplus \cdots \oplus \alpha_n \\
&\qquad \wedge ([\![\text{ortho}]\!] \oplus [\![\text{perio}]\!]) = \beta_1 \oplus \cdots \oplus \beta_m \\
&\qquad \wedge \forall i \leq n \exists j \leq m [[\![\text{dontist}]\!](\alpha_i, \beta_j)] \wedge \forall j \leq m \exists i \leq n [[\![\text{dontist}]\!](\alpha_i, \beta_j)]] \\
&= \lambda\alpha.\alpha \in \mathrm{PL} \wedge \exists n \in \mathbb{N}, \alpha_1, \ldots, \alpha_n [\alpha = \alpha_1 \oplus \cdots \oplus \alpha_n \\
&\qquad \wedge \forall i \leq n [[\![\text{dontist}]\!](\alpha_i, [\![\text{ortho}]\!]) \vee [\![\text{dontist}]\!](\alpha_i, [\![\text{perio}]\!])] \\
&\qquad \wedge \exists i \leq n [[\![\text{dontist}]\!](\alpha_i, [\![\text{ortho}]\!])] \wedge \exists i \leq n [[\![\text{dontist}]\!](\alpha_i, [\![\text{perio}]\!])]] \\
&= \lambda\alpha.\alpha \in \mathrm{PL} \wedge \exists n \in \mathbb{N}, \alpha_1, \ldots, \alpha_n [\alpha = \alpha_1 \oplus \cdots \oplus \alpha_n \\
&\qquad \wedge \forall i \leq n [[\![\text{orthodontist}]\!](\alpha_i) \vee [\![\text{periodontist}]\!](\alpha_i)] \\
&\qquad \wedge \exists i \leq n [[\![\text{orthodontist}]\!](\alpha_i)] \wedge \exists i \leq n [[\![\text{periodontist}]\!](\alpha_i)]]
\end{aligned}$$

We find that *ortho and periodontists* denotes the set of all plural objects that are composed of singular individuals where each such individual is either an orthodontist or a periodontist, and at least one such individual is an orthodontist and one is a periodontist. In particular, one such plural object is the join of the orthodontist Bill and the periodontist Martha. So our semantics succeeds in interpreting the NP *ortho and periodontists* at surface level.

The meaning in (16) can take an object of any cardinality, so it is not restricted to operating on coordinate structures of two terms. The meaning of the expression *ortho, perio and endo*, for instance, is the join of the meanings of the individual conjuncts: $[\![\text{ortho}]\!] \oplus [\![\text{perio}]\!] \oplus [\![\text{endo}]\!]$. Plugging this into the meaning of *dontists* in (16) we find that the meaning of *ortho, perio and endodontists* is the set of all plural objects composed of singular individuals where each such individual is either an orthodontist, a periodontist or an endodontist, with at least one individual of each specialty. This correctly captures our intuitions about sentences like *the Kandou sisters are ortho, perio and endodontists*.

2.3. Phonological decomposition of singular NPs

Coordination of parts of words is also possible in singular NPs; such coordinate structures can only apply to singular individuals (18), not to pluralities (19).

(18) Bill is an ortho and periodontist.

(19)*Bill and Martha are an ortho and periodontist.

(An anonymous reviewer points out that sentence (19) becomes fine if we add *respectively* at the end: *Bill and Martha are an ortho and periodontist, respectively*. This should be attributed to the semantics of *respectively*, as it does not fall out of the current analysis in a straightforward way. Extending the semantics to incorporate the adverb *respectively* would take us too far from the present discussion, so I leave this as a problem for future research).

The denotation of *dontist* in both (18) and (19) is the function (13), repeated below, derived by phonological decomposition.

(13) $[\![\text{dontist}]\!] \in \mathrm{D}_{eet}$: the function $h : \mathrm{D}_e \to \mathrm{D}_{et}$ such that for all $\alpha \in \mathrm{D}_e$, $h(\alpha) = [\![\alpha\text{dontist}]\!]$ if α*dontist* is a word and $[\![\alpha\text{dontist}]\!] \in \mathrm{D}_{et}$, undefined otherwise.

This meaning only takes strings of sounds as its first argument, not pluralities. But it should be able to take pluralities—morphologically, the expression *dontist* only specifies that its outer argument is singular. We thus need to allow a cumulative relation between the arguments, the same way as with plural *dontists*, and at the same time restrict the outer argument to singularities only (SG is a metalanguage symbol for the set of all singularities, that is atomic individuals).

(20) Let $\mathcal{D}$ be the definition of $[\![\text{dontist}]\!]$ in (13). Then
$[\![\text{dontist}]\!] = \lambda\beta\lambda\alpha.\alpha \in \mathrm{SG} \wedge \exists n,m \in \mathbb{N}, \alpha_1,\ldots,\alpha_n,\beta_1,\ldots,\beta_m[\alpha = \alpha_1 \oplus \cdots \oplus \alpha_n \wedge \beta = \beta_1 \oplus \cdots \oplus \beta_m \wedge \forall i \leq n \exists j \leq m[\mathcal{D}(\alpha_i,\beta_j)] \wedge \forall j \leq m \exists i \leq n[\mathcal{D}(\alpha_i,\beta_j)]]$

Since α in the above expression is necessarily singular we know that $n = 1$; the expression can thus be simplified as follows.

(21) Let $\mathcal{D}$ be the definition of $[\![\text{dontist}]\!]$ in (13). Then $[\![\text{dontist}]\!] = \lambda\beta\lambda\alpha.\alpha \in \text{SG} \wedge \exists m \in \mathbb{N}, \beta_1, \ldots, \beta_m [\beta = \beta_1 \oplus \cdots \oplus \beta_m \wedge \forall j \leq m\, [\mathcal{D}(\alpha, \beta_j)]]$

Notice that the cumulative relation in (21) does not depend on plural morphology—it obtains whenever a relation holds between two arguments, at least one of which is plural (see also Schwarzschild 1994: section 5.2 for cumulative relations in singular transitive verbs with plural objects).

The meaning (21), when applied to the plurality $[\![\text{ortho}]\!] \oplus [\![\text{perio}]\!]$, will give the correct meaning for the coordinate structure *ortho and periodontist*.

(22) $[\![\text{dontist}]\!]([\![\text{ortho}]\!] \oplus [\![\text{perio}]\!])$

$$\begin{aligned} &= \lambda\alpha.\alpha \in \text{SG} \wedge \exists m \in \mathbb{N}, \beta_1, \ldots, \beta_m [([\![\text{ortho}]\!] \oplus [\![\text{perio}]\!]) = \beta_1 \oplus \cdots \oplus \beta_m \\ &\qquad \wedge \forall j \leq m\, [\mathcal{D}(\alpha, \beta_j)]] \\ &= \lambda\alpha.\alpha \in \text{SG} \wedge \mathcal{D}(\alpha, [\![\text{ortho}]\!]) \wedge \mathcal{D}(\alpha, [\![\text{perio}]\!])] \\ &= \lambda\alpha.\alpha \in \text{SG} \wedge [\![\text{orthodontist}]\!](\alpha) \wedge [\![\text{periodontist}]\!](\alpha) \end{aligned}$$

This meaning applies to any individual who is both an orthodontist and a periodontist, but not to pluralities of any kind.

2.4. Alternatives to phonological decomposition

Phonological decomposition yields the correct reading for the NP *ortho and periodontists*. Is it possible to get this reading without such a process? In this section I will follow a number of intuitively appealing ideas, and show that when they are fully worked out, they amount to something very similar to phonological decomposition.

The first thing we notice is that the word parts *ortho*, *peri* and *(o)dontist* are morphemes, and as such they have lexical meanings and etymologies. However, I believe that these meanings are largely irrelevant. Many speakers can identify the morpheme *ortho* in words like *orthodontist*, *orthopedics*, *orthography* and *orthodox*, without knowing the etymological meaning of the root and what it contributes to each of these words. More importantly, the root meanings are not the kind of meaning that is associated with a model theoretic entity which can combine with the meaning of *and*. What matters, then, is the ability to recognize *ortho* as part of a bigger word, whose meaning is known; the meanings of the individual morphemes thus have to be derived from the meanings of the words they form.

One alternative to phonological decomposition would be to treat the words *orthodontist* and *periodontist* as idiomatically combining expressions, a term that Nunberg, Sag, and Wasow (1994) use for expressions like *pull strings*: the expression is idiomatic, yet speakers understand each of its constituents as making a distinct contribution to the idiomatic meaning. For instance, the word *strings* in the expression *pull strings* has a meaning roughly equivalent to "connections", and this meaning can act independently—it can be modified by an adjective (23a) or a relative clause (23b), it can be topicalized (23c), and it can be referred to by a pronoun (23d).

(23) a. pull high-ranking strings
b. Pat got the job by pulling strings that weren't available to anyone else. (Nunberg et al., 1994: 500)
c. Those strings, he wouldn't pull for you. (Nunberg et al., 1994: 501)
d. Kim's family pulled some strings on her behalf, but they weren't enough to get her the job. (Nunberg et al., 1994: 502)

We see that while the parts of *pull strings* have special meanings, the expression as a whole is compositional. Interpreting a word like *orthodontist* as an idiomatically combining expression would involve assigning the word part *dontist* a meaning roughly equivalent to "dental specialist", and giving the word part *ortho* a modifier meaning like "teeth straightener". Of course, these meanings will be restricted to the word parts when they occur in *orthodontist*, so we do not expect to find a word like **ortholinguist* meaning "a linguist who straightens teeth", just like we cannot use the word *strings* to mean "connections" outside the context of the expression *pull strings*.

I find a number of problems with this way of assigning meanings to word parts. The motivation for the analysis of certain idioms as compositional expressions is the observation that the parts can also carry the special meanings on their own, as in the examples in (23) above. But we do not find this behavior with word parts like *ortho*, *perio* and *dontist*, so there is less of a reason to think that these parts carry the same kind of special meanings.

Second, the analysis of Nunberg et al. (1994) relies on the concept of figuration, and idioms are explained as conventionalized uses of figurative language. We can see that this is true with an expression like *pull strings*: even though *pull* receives a specialized meaning in this expression, it retains the thematic structure of the standard lexical meaning of *pull*. Figuration also explains why near-synonyms are often interchangeable in idiomatically combining expressions (e.g. *hold a gun/pistol to one's head*). However, it is hard to see how the concept of figuration can apply to a word part: it seems intuitively wrong to consider "teeth straightener" to be a figurative meaning of *ortho*, when *ortho* does not have a meaning in the first place.

There still may be another way speakers assign meanings to parts of words, and this is through the use of word paradigms: while the lexical or etymological meanings of the morphemes that make up *orthodontist* and *periodontist* are not model theoretic entities, speakers may use the paradigm to extract suitable model theoretic denotations for the morphemes. We will see that following up on this idea leads to results that basically amount to phonological decomposition.

The idea behind this approach is that speakers use the phonological and semantic similarities of the words *orthodontist* and *periodontist* (as well as other words in this paradigm) to assign meanings to the morphemes: the morpheme *dontist* will receive the meaning component that is common to all the words in the paradigm—presumably something like “dental specialist”—while the morphemes *ortho* and *perio* will have the meaning components that are unique to *orthodontist* and *periodontist*, respectively. What could these meanings be? We can not treat *ortho* and *perio* as intersective modifiers, in a manner analogous to *heavy and light sumo wrestlers*, that is treat *dontist* like we would treat a common noun of type *et*, and *ortho* and *perio* like intersective adjectives of the same type, so that $[\![\text{ortho}]\!]([\![\text{dontist}]\!]) = \lambda\alpha.[\![\text{ortho}]\!](\alpha) \wedge [\![\text{dontist}]\!](\alpha)$. The reason is that under such a semantics, the composed predicate $[\![\text{ortho}]\!]([\![\text{dontist}]\!])$ would apply, for instance, to a person who is an orthopedist and a periodontist, but not an orthodontist; if Bill is such a person and Martha is a periodontist, then the sentence *Bill and Martha are ortho and periodontists* would be predicted to be true, contrary to intuition (thanks to Cécile Meier for pointing this out).

A second possibility is that the word parts receive meanings that combine through a more elaborate mechanism. For instance, if the part *perio* in *periodontist* is interpreted with a meaning like “gums”, then the relation between the meanings of the morphemes and that of the whole word would be like the relation of the meanings of *foot* and *doctor* to the meaning of *foot doctor*. It is not immediately clear what meaning would be assigned to the morpheme *ortho*, but presumably a suitable meaning could be found. However, the question of what the meaning of *ortho* should be points to a general problem with this approach to extracting meanings for word parts. While compound formation as in *foot doctor* is clearly a productive process with predictable results, its semantics is neither simple nor straightforward, as it involves many possible semantic relations which are determined by lexical knowledge and sometimes through extra-linguistic context (see Downing, 1977; Hoeksema, 2000). Extracting a morpheme meaning that will combine through compounding seems like a lot of work, apparently without significant benefits—the word part *perio* does not mean “gums” outside the context of *periodontist* (and related *periodontics*).

Another observation that casts doubt over a compounding analysis for the word parts is that coordination of parts of compositional compounds appears to be more difficult than that of word parts.

(24) foot and eye doctors

While the phrase (24) can truthfully apply to two people, one of whom is a podiatrist (foot-doctor) and the other an ophthalmologist (eye-doctor), it requires a strong supporting context (e.g. *Mama put the twins through medical school in the hope that they would become brain surgeons; consequently she was disappointed when they ended up as foot and eye doctors*). Without such a supporting context, speakers I have consulted are less likely to accept *Bill and Martha are foot and eye doctors* than they are to accept (2a) *Bill and Martha are ortho and periodontists*. I do not have an explanation for this difference, but it may have to do with the fact that compounding itself is semantically complicated and partly context-dependent.

A third way to assign meanings to morphemes in a paradigm is to give them functional denotations—the meanings of the morphemes *ortho* and *perio* will simply be functions that respectively map the denotation of *dontist* to the denotations of *orthodontist* and *periodontist* (see also Hoeksema 2000 for the application of such functional meanings in morphology). These will be meanings of type $(et)et$, the same semantic type as non-intersective adjectives like *former* and *current* as in (25) below.

(25) The Bush family gathered for dinner at their Texas ranch; the former and current presidents argued the whole time.

Extracting functional denotations for the word parts *ortho* and *perio* is simple and straightforward, and it does not suffer from the problems of an intersective type meaning or a compound meaning. But functional meanings are exactly what is employed by phonological decomposition, only in reverse—the way I have defined phonological decomposition, the coordinate parts are the arguments and the element outside the coordinate structure is the function. The reason for this choice is that it results in a simpler cumulative conjunction operation, since the coordinate parts are of a lower type; but phonological decomposition would also work if we chose function and argument the other way around.

It turns out, then, that when we work out the paradigms approach to extracting meanings for word parts, the results are essentially the same as phonological decomposition. It is difficult for me to see what word paradigms add here. The advantage of phonological decomposition is that it explicitly encodes the form of the word into the functional denotation, capturing the intuition that a coordinate structure like *ortho and periodontists* is only possible because the words *orthodontist* and *periodontist* share part of their phonological makeup—semantic similarity is not sufficient. If, however, it turns out that word paradigm meanings are needed, perhaps for some other part of the grammar, then phonological decomposition can be thought of as the semantic process that gives meanings to such word paradigms.

2.5. The applicability of phonological decomposition

We need to restrict phonological decomposition so that a meaning like that given to *dontist* in (13) would not be available in just any context. A meaning derived by phonological decomposition should only be available when a word part is in a construction where it actually forms part of a word, not when it stands alone. Strings of sound can denote themselves, so the following two sentences are practically synonymous.

(26) *Ortho* is disyllabic.

(27) The string *ortho* is disyllabic.

However, it is impossible to substitute an expression of the form *the string* ... for part of a word in a coordinate structure: the following sentence is plain gibberish (thanks to Caroline Heycock for drawing this to my attention).

(28)*Bill and Martha are the string *ortho* and the string *perio* dontists.

There are two ways to explain the ungrammaticality of (28): either *ortho* and *the string ortho* are not synonymous (they have different model-theoretic denotations), or the word part *dontists* in (28) cannot have the meaning (16) derived by phonological decomposition. The idea that *ortho* in a coordinate structure does not denote the string itself appears to be supported by the following contrast, which involves a periphrastic structure that serves to clarify the speaker's intent.

(29) Ortho—I mean the string—is disyllabic.

(30)*Bill and Martha are ortho—I mean the string—and periodontists.

But this is not strong evidence, because clarification periphrastics are generally not good between prenominal modifiers and their head nouns.

(31) This wood is orange—I mean the color.

(32)*This is an orange—I mean the color—tree.

(33)*This is an orange—I mean the color—and green tree.

It seems fairly clear that *orange* in the sentence *this is an orange tree* can denote a color—this is perhaps not the most salient reading, but precisely because of that we would expect that a clarification should be possible. Yet sentence (32) is ungrammatical, because of the position of the periphrastic sentence. This is also the reason for ungrammaticality in (30), so it does not constitute evidence against identifying the denotation of *ortho* with the string itself.

If *ortho* and *the string ortho* are indeed synonymous (and likewise for *perio*), then the ungrammaticality of (28) should be the result of phonological decomposition failing to apply to the word part *dontist*. I see a number of ways that this can be enforced: one is to rule out structures like (28) on the basis of syntax alone, for instance if word parts are of a syntactic category other than NP; this way the structure NP-*dontist* is simply not generated. An alternative would be to allow this syntactic configuration, but not give *dontists* the *eet*-type meaning necessary to interpret the structure. This views phonological decomposition as an active process, which assigns the functional denotations to word parts only in a particular configuration, when the word part in question is sister to another word part (or a conjunction of word parts). In this sense structures with phonological decomposition are similar to the idiomatically combining expressions of Nunberg et al. (1994) discussed in the previous section, since there too the parts only have their special meanings in the presence of one another. At the moment I do not have an argument in favor of one of the above proposals over the other.

A second place where phonological decomposition should not apply is when a morphological word is itself compositional, that is when the meaning of the word is independently predicted from the meanings of its parts. This explains why coordination is impossible in sentence (34), due to Alan Prince, as opposed to the perfectly coherent (35).

(34) *For our renovation project we need new black and floorboards.

(35) For our renovation project we need new blackboards and floorboards.

The coordinate structure *black and floorboards* is somewhat awkward phonologically (because of its stress pattern, see section 3.2), but this cannot be the sole cause of the ungrammaticality of (34) because both *black and whiteboards* and *side and floorboards* are markedly better (the latter only when it talks about boards that make the sides and floors, not the piece of furniture known as a sideboard). The ungrammaticality of (34) has the feeling of zeugma—the coordination of items that play different syntactic or semantic roles—as in the following contrast (Bauer, 1998: 75).

(36) ?We saw a landscape dotted with wind- and flour-mills.

(37) We saw a landscape dotted with wind- and water-mills.

The oddity of (36) is a consequence of the different semantic relations of *wind* and *flour* to *mill*. Bauer shows that the prohibition against zeugma applies to a variety of coordinate structures.

(38) He's a good father and husband / ?accountant

(39) ?He ran up the road and the flag.

(40) ?She left in a hurry and in a taxi / in tears

If this is the source of the ungrammaticality of (34) then the semantic relations of *black* and *floor* to *board* must be different. Now, the word *blackboard* is definitely not compositional: blackboards are not necessarily black, nor are they necessarily boards. A floorboard, on the other hand, is just a board which makes up a floor; there is no reason to think that the word *floorboard* is anything but a compositional compound. If we limit the process of phonological decomposition so that it does not apply to structures that are already compositional we get an explanation for why *black and floorboards* is indeed a case of zeugma—it requires two different senses of *board*: one is derived by phonological decomposition, the other is the familiar word. The restriction of phonological decomposition to opaque constructions also precludes phonological decomposition from saving sentences (38)–(40).

We conclude that phonological decomposition cannot apply to structures that are already compositional. The reason for this may be that phonological decomposition is an interpretive strategy that applies as a last resort, when the semantics has nothing else to work with; if an element already has a meaning, the additional work of phonological decomposition is unnecessary.

2.6. Coordinate parts with number marking

Let's look again at the underlying cause for the contrast between the NPs *ortho and periodontists* and *orthodontists and periodontists*: the former has one plural morpheme on the entire NP, whereas the latter has a plural morpheme on each conjunct. This leads to the following expectation: if each coordinate part were to bear plural morphology, then each of the conjuncts would correspond to a plural entity, and therefore coordination of parts should have the same meaning as coordination of whole words. This is borne out: a noun phrase like **orthodontists and pedists* is phonologically ill-formed because the coordinate parts bear main stress (see section 3.2), but we still have the intuition that it would not apply to a pair of one orthodontist and one orthopedist, but would rather require two practitioners of each profession.

We find grammatical instances of number marking on the coordinate parts in Hebrew. Number is usually marked on the heads of Hebrew compounds; number marking on the non-head—singular *sefer* and plural *šinayim* below—is irrelevant in determining the number of the compound (cf. Borer, 1988).

(41)

SINGULAR	PLURAL	
bet sefer	bat-**ei** sefer	'school' (lit. 'house-book')
rofe šinayim	rof-**ei** šinayim	'dentist' (lit. 'doctor-teeth')

In a small class of compounds, however, number is marked on both parts.

(42)

SINGULAR	PLURAL		
sgan aluf	sgan-**ei** aluf-**im**	'lieutenant colonel'	(*sgan-**ei** aluf)
tat aluf	tat-**ei** aluf-**im**	'brigadier general'	(*tat-**ei** aluf)

Hebrew compounds are considered to be morphological words because of their syntactic behavior, namely that they do not allow extraction (Borer, 1988). As far as the semantics goes, the compounds *sgan aluf* and *tat aluf* should be considered to have atomic meanings because of their opacity. The morpheme *sgan* is also an independent word meaning 'deputy', and *tat* is a prefix with a meaning similar to 'sub-'; in combination with *aluf*, both of the compounds denote ranks that are below *aluf* 'major general'. However, exactly what ranks these are and how they are ordered with respect to one another is completely conventional, and does not follow from the meanings of the individual morphemes. (There is another sense in which the terms *sgan aluf* and *tat aluf* may be thought to be compositional: parallel ranks in various security forces have a similar structure. Thus, *sgan aluf*, *sgan nicav*, *sgan gondar* and *sgan tafsar* are parallel ranks, respectively, in the Israeli Defense Force, National Police, Prison Service and Firefighting Service; the same goes for *tat aluf*, *tat nicav*, *tat gondar* and *tat tafsar*. While these terms are related, the lexical meanings of their word parts are like those of *ortho* and *perio*—meanings that do not have a straightforward model-theoretic interpretation.)

When compounds with number marking on both parts are coordinated, we find that coordination of parts requires that each conjunct correspond to a plural referent, just like coordination of full compounds. Both of the sentences below require there to be at least two lieutenant colonels and two brigadier generals at the party.

(43) etmol hayu ba-mesiba sgan-**ei** aluf-**im** ve-tat-**ei** aluf-**im**
yesterday were at.the-party deputy-**pl** general-**pl** and-sub-**pl** general-**pl**
"At the party yesterday there were lt. colonels and brigadier generals"

(44) etmol hayu ba-mesiba sgan-**ei** ve-tat-**ei** aluf-**im**
yesterday were at.the-party deputy-**pl** and-sub-**pl** general-**pl**
"At the party yesterday there were lt. colonels and brigadier generals"

Our semantics should now explain why the above two sentences receive the same meaning. Coordination of full NPs (43) works the same way as with *orthodontists and periodontists*; coordination of parts (44) will have to take the plural marking on the conjuncts into account.

We start, as before, by noting that the coordinate parts denote strings of sounds; these sounds include the plural morphemes, which are within the coordinate parts.

(45) a. $[\![\text{sgan-ei}]\!] \in D_e$: the string *sgan-ei*.

b. $[\![\text{tat-ei}]\!] \in \mathrm{D}_e$: the string *tat-ei*.

The element outside the coordinate structure receives a functional meaning of type *eet*, from sounds to common noun meanings.

(46) $[\![\text{aluf-im}]\!] \in \mathrm{D}_{eet}$: the function $h : \mathrm{D}_e \to \mathrm{D}_{et}$ such that for all $\alpha \in \mathrm{D}_e$, $h(\alpha) = [\![\alpha\text{aluf-im}]\!]$ if α*aluf-im* is a word and $[\![\alpha\text{aluf-im}]\!] \in \mathrm{D}_{et}$, undefined otherwise.

This will combine with the previous meanings to yield the desired results.

(47) a. $[\![\text{aluf-im}]\!]([\![\text{sgan-ei}]\!]) = [\![\text{sgan-ei aluf-im}]\!]$

b. $[\![\text{aluf-im}]\!]([\![\text{tat-ei}]\!]) = [\![\text{tat-ei aluf-im}]\!]$

Notice how we had to use the plural *aluf-im* rather than singular *aluf* in our phonological decomposition, unlike our use of singular *dontist* (example (13) in section 2.2, page 5). This is because the coordinate parts themselves contain plural morphemes, so their phonological concatenation with singular *aluf* would result in a non-word: if we had tried to combine the meanings in (45) with the *eet*-type meaning of *aluf*, we would not get a meaning that we could later build on.

(48) a. $[\![\text{aluf}]\!]([\![\text{sgan-ei}]\!])$: Undefined (no word **sgan-ei aluf*)

b. $[\![\text{aluf}]\!]([\![\text{tat-ei}]\!])$: Undefined (no word **tat-ei aluf*)

The significance of this is evident: whereas previously we introduced cumulativity through the derivation of plural *dontists* from singular *dontist*, such a move with *aluf-im* would be useless. Rather, we will have to define the cumulative inference of *aluf-im* with reference to its basic *eet*-type meaning.

The word part *aluf-im* should allow a cumulative relation between its two plural arguments (just like *dontists*): we add this cumulativity to the definition of *aluf-im*.

(49) Let $\mathcal{A}$ be the definition of $[\![\text{aluf-im}]\!]$ in (46). Then
$[\![\text{aluf-im}]\!] = \lambda\beta\lambda\alpha.\alpha \in \mathrm{PL} \wedge \exists n,m \in \mathbb{N}, \alpha_1,\ldots,\alpha_n,\beta_1,\ldots,\beta_m[\alpha = \alpha_1 \oplus \cdots \oplus \alpha_n \wedge \beta = \beta_1 \oplus \cdots \oplus \beta_m \wedge \forall i \leq n \exists j \leq m[\mathcal{A}(\alpha_i,\beta_j)] \wedge \forall j \leq m \exists i \leq n[\mathcal{A}(\alpha_i,\beta_j)]]$

The coordinate constituent *sgan-ei ve-tat-ei* denotes a plural object of type *e*, just like *ortho and perio*.

(50) $[\![\text{sgan-ei ve-tat-ei}]\!] = [\![\text{sgan-ei}]\!] \oplus [\![\text{tat-ei}]\!] \in \mathrm{D}_e$

Applying the meaning of *aluf-im* in (49) to the meaning of *sgan-ei ve-tat-ei* in (50) gives us the meaning of the NP *sgan-ei ve-tat-ei aluf-im*.

(51) $[\![\text{aluf-im}]\!]([\![\text{sgan-ei}]\!] \oplus [\![\text{tat-ei}]\!])$
$$= \lambda\alpha.\alpha \in \text{PL} \wedge \exists n, m \in \mathbb{N}, \alpha_1, \ldots, \alpha_n, \beta_1, \ldots, \beta_m [\alpha = \alpha_1 \oplus \cdots \oplus \alpha_n \wedge ([\![\text{sgan-ei}]\!] \oplus [\![\text{tat-ei}]\!]) = \beta_1 \oplus \cdots \oplus \beta_m \wedge \forall i \leq n \exists j \leq m [\mathcal{A}(\alpha_i, \beta_j)] \wedge \forall j \leq m \exists i \leq n [\mathcal{A}(\alpha_i, \beta_j)]]$$
$$= \lambda\alpha.\alpha \in \text{PL} \wedge \exists \alpha_1, \alpha_2 [\alpha = \alpha_1 \oplus \alpha_2 \wedge \mathcal{A}(\alpha_1, [\![\text{sgan-ei}]\!]) \wedge \mathcal{A}(\alpha_2, [\![\text{tat-ei}]\!])]$$
$$= \lambda\alpha.\alpha \in \text{PL} \wedge \exists \alpha_1, \alpha_2 [\alpha = \alpha_1 \oplus \alpha_2 \wedge [\![\text{sgan-ei aluf-im}]\!](\alpha_1) \wedge [\![\text{tat-ei aluf-im}]\!](\alpha_2)]$$

We find that *sgan-ei ve-tat-ei aluf-im* denotes the set of all plural objects that are the join of two objects, one of which is in the denotation of *sgan-ei aluf-im* and the other in the denotation of *tat-ei aluf-im*. Each such object will include at least two lieutenant colonels and two brigadier generals, as desired.

Performing phonological decomposition on the plural form *aluf-im* does not exclude the possibility of phonological decomposition on singular *aluf*, which could then be pluralized; this would allow the ungrammatical construction **sgan ve-tat alufim* 'deputy.sg and sub.sg general-pl', with the prediction that it denotes the set of pluralities which consist of one lieutenant colonel and one brigadier general. The ungrammaticality of this construction should be blocked on the syntactic grounds of number mismatch.

I now address a potential objection to my analysis above: one might claim that the NP *sgan-ei ve-tat-ei aluf-im*, with coordination of parts, receives the same interpretation as a coordination of full NPs because the conjoined elements are the heads of the compound, unlike the English example *ortho and periodontists*. I am actually not sure about the headedness of the above compounds, despite the formal similarity to construct states, and I think the fact that number is doubly marked by morphology may be an indication that the headedness relation is not straightforward. More importantly, coordination of singular terms shows a contrast between compounds of the type we were looking at and truly headed compounds. If it were a matter of conjoining heads, one might expect that conjunction of singular heads should be plural; this is what we see, for instance, in the following sentence (as mentioned above, the plurality of *šinayim* "teeth" does not affect the number marking of the compound).

(52)

etmol	hay-u	ba-mesiba	rofe	ve-rof-at	šinayim
yesterday	were-**pl**	at.the-party	doctor.m.**sg**	and-doctor-f.**sg**	teeth

"At the party yesterday there were a male dentist and a female dentist"

But when we coordinate parts of a singular compound of the type discussed throughout this section, the result is still singular, whereas coordination of singular compounds is plural. We thus see a contrast between (53) and (54), where the latter is ungrammatical because the singular subject does not agree with the plural verb.

(53) etmol hay-u ba-mesiba sgan aluf ve-tat aluf
yesterday were-**pl** at.the-party deputy.**sg** general.**sg** and-sub.**sg** general.**sg**
"At the party yesterday there were a lt. colonel and a brigadier general"

(54)*etmol hay-u ba-mesiba sgan ve-tat aluf
yesterday were-**pl** at.the-party deputy.**sg** and-sub.**sg** general.**sg**

Coordination of parts of a singular compound is fine when it can felicitously refer to a single individual, as in (55) (a single person cannot hold two ranks at the same time, but the coordinate structure *sgan ve-tat aluf* 'deputy.sg and sub.sg general.sg' does have the meaning of a single person with two ranks, as seen for example when talking about the same person at different times).

(55) dani hikir et matan vilnai betor sgan ve-tat aluf
Danny knew acc Matan Vilnai as deputy.**sg** and-sub.**sg** general.**sg**
"Danny knew Matan Vilnai as a lt. colonel and a brigadier general"

The reading of the singular NP *sgan ve-tat aluf* 'deputy.sg and sub.sg general.sg' in (55) is derived in exactly the same way as that of singular *ortho and periodontist* in section 2.3. The denotation of the part outside the conjunction, *aluf*, is a function of type *eet* derived by phonological decomposition.

(56) $[\![\text{aluf}]\!] \in \mathrm{D}_{eet}$: the function $h : \mathrm{D}_e \to \mathrm{D}_{et}$ such that for all $\alpha \in \mathrm{D}_e$, $h(\alpha) = [\![\alpha\text{aluf}]\!]$ if α*aluf* is a word and $[\![\alpha\text{aluf}]\!] \in \mathrm{D}_{et}$, undefined otherwise.

To this function we add a cumulative relation between the arguments, since morphology only specifies that the outer argument is singular.

(57) Let $\mathcal{B}$ be the definition of $[\![\text{aluf}]\!]$ in (56). Then $[\![\text{aluf}]\!] = \lambda\beta\lambda\alpha.\alpha \in \mathrm{SG} \wedge \exists m \in \mathbb{N}, \beta_1, \ldots, \beta_m[\beta = \beta_1 \oplus \cdots \oplus \beta_m \wedge \forall j \leq m\,[\mathcal{B}(\alpha, \beta_j)]]$

This meaning, when applied to the plurality $[\![\text{sgan}]\!] \oplus [\![\text{tat}]\!]$, will give the correct meaning for the coordinate structure *sgan ve-tat aluf* 'deputy.sg and sub.sg general.sg', allowing it to apply to singularities only, not pluralities.

(58)
$$
\begin{aligned}
&[\![\text{aluf}]\!]([\![\text{sgan}]\!] \oplus [\![\text{tat}]\!])\\
&= \lambda\alpha.\alpha \in \mathrm{SG} \wedge \exists m \in \mathbb{N}, \beta_1, \ldots, \beta_m[([\![\text{sgan}]\!] \oplus [\![\text{tat}]\!]) = \beta_1 \oplus \cdots \oplus \beta_m\\
&\qquad \wedge \forall j \leq m\,[\mathcal{B}(\alpha, \beta_j)]]\\
&= \lambda\alpha.\alpha \in \mathrm{SG} \wedge \mathcal{B}(\alpha, [\![\text{sgan}]\!]) \wedge \mathcal{B}(\alpha, [\![\text{tat}]\!])]\\
&= \lambda\alpha.\alpha \in \mathrm{SG} \wedge [\![\text{sgan aluf}]\!](\alpha) \wedge [\![\text{tat aluf}]\!](\alpha)
\end{aligned}
$$

To review what we have seen so far: the coordinate NP *ortho and periodontists* can apply to a pair consisting of one orthodontist and one periodontist. In order to capture this fact, the semantics must interpret the structure [ortho and perio]dontists. I have introduced the semantics of phonological decomposition, which assigns meanings to arbitrary word parts: the coordinate parts denote their own sounds, and the rest of the word denotes a function from sounds to word meanings. These denotations of word parts, together with the ordinary meaning of conjunction, combine to yield the correct interpretation of number. The semantics also gives the desired interpretation when number is marked on the coordinate parts, as in the Hebrew examples discussed in the last section.

3. Phonological constraints

Phonological decomposition allows us to interpret coordination of parts of words at surface level, yielding the correct interpretation for plural morphology on the conjuncts (or lack thereof). The semantics, however, does not make a distinction between grammatical strings like *ortho and periodontists* and ungrammatical ones like ?*cran and strawberries* or ?*peri and telescopes*. And indeed it should not: it is phonological rather than semantic factors that are responsible for the above contrast. This section explores the phonological constraints on the coordination of parts of words.

3.1. Phonology and etymology

Before I go into the details of the phonology, I want to address a concern that the contrast just mentioned may be the result of the words *orthodontist* and *periodontist* being in some sense more "compositional" than the words *cranberry* and *strawberry*. This may be true from a historical or etymological point of view; synchronically, however, there is no difference in compositionality. Speakers of English can readily identify the morphemes *-berry* and *-dontist*, since the words that contain them share some common aspects of meaning. But the morphemes *cran*, *straw*, *ortho*, and *perio* seem just about equally opaque. There is nothing more to the meaning of *cran* and *straw* other than the kind of berry they help signify. The term *orthodontist* is in common use, and it seems reasonable to assume that speakers learn it as a unit; the relation to words like *orthodox* and *orthography* is fairly obscure. The word *periodontist* is much less familiar, and it is not at all easy to arrive at its meaning, despite familiarity with the morpheme *peri* in words like *perimeter* and *periphery*. It appears that synchronically, the words *orthodontist* and *periodontist* are just as opaque as *strawberry* and *cranberry*.

So where do speakers get the intuition that *orthodontist* and *periodontist* are more compositional than *strawberry* and *cranberry*? I believe this is a phonological intuition, rather than a semantic one. Some speakers are more content with *boysen and huckleberries* than with ?*cran and strawberries*, even though it is hard to see in what sense it is more compositional. Furthermore, speakers are happy to accept *ortho and periodontists* even when they do not know exactly what a periodontist is, simply assuming it is some kind of dental specialist. This would be hard to explain if acceptability were tied to knowledge of the lexical meaning of the word part *perio*.

Another possibility is that compositionality is not an intuition about meaning, but rather an intuition about combinatorial properties: speakers are aware that the morphemes *ortho* and *peri* form a variety of compounds, whereas *cran* and *straw* are less productive in this sense (note, however, that in contemporary English, *cran* is used productively and rather transparently in compounds or blends like *cranapple* and *cran-grape*). The fact that *ortho* and *peri* belong to the scientific, learned vocabulary may also give speakers the impression that they are, or should be, more transparent, even if the speaker doesn't know why. But the combinatorial properties still do not explain the coordination facts. If it were the combinatorial properties alone that allowed coordination of parts, we should expect structures like ?*peri and telescopes* to be well formed, since the morphemes that make up *periscope* and *telescope* are identifiable as much as those of *periodontist* and *orthodontist*. Our conclusion regarding the intuition that coordination of parts is allowed by compositionality of lexical meaning, etymological compositionality, or even morphological structure is that the intuition is wrong; the difference between the well formed examples and the ungrammatical ones is due to the phonology.

3.2. Description of the prosodic facts

Phonological restrictions on structures with coordinated word parts have been extensively discussed in the literature on Dutch and German (Höhle, 1982; Booij, 1983, 1985; Wiese, 1992, 1996; Kleinhenz, 1997; Smith, 2000); I will defer the discussion of these languages until later in this section, and start by looking at English. Our first observation is that the coordinate parts must be separated from the rest of the word by a certain prosodic juncture. Okada (1999: 350) gives minimal contrasts such as the following.

(59) a.*physio and psychologies
b. physio and psychological

Semantic factors do not explain the contrast between the above examples. Nor can the contrast be attributed to morphological structure, as *physio* and *psycho* are identifiable morphemes in both examples. Rather, the contrast is a matter of prosodic (metrical) structure: a single foot may not span segmental material from both the coordinate and non-coordinate parts (in the following example the offending foot is underlined).

(60) a.*physio and psy(ˈcholo)(ˌgies)

b. (ˌphysio) and (ˌpsycho)(ˈlogi)cal

We can formulate a first approximation of the prosodic constraint on coordination of parts of words—material from the coordinate part and the part outside the coordinate structure may not be prosodified into one foot. An alternative way to state this is that there must be a foot boundary between the coordinate part and the rest of the word.

The above restriction still does not predict the ungrammaticality of ?*cran and strawberries*, since *cran*, *straw* and *berries* can all be parsed into separate feet. I think that this is desirable. While it is true that ?*cran and strawberries* is unacceptable to many (perhaps most) speakers, it is still markedly better than **physio and psychologies*. The requirement that the coordinate and non-coordinate parts be separated by a foot boundary just sets the minimum threshold—a coordinate structure that fails to pass it is completely ruled out. Structures that satisfy this requirement have varying degrees of acceptability, depending on other prosodic considerations.

An absolute requirement at the foot level combined with additional, weaker preferences is manifest in another English construction—expletive infixation (McCawley 1978; McMillan 1980; McCarthy 1982; thanks to Mark Steedman for pointing out the relevance of this construction). The main insight into the prosody of expletive infixation is given in McCarthy (1982): an infix, normally a swear word like *fuckin* or *bloody*, has to be attached adjacent to a foot boundary. This proposal correctly predicts that the only possible infixation site in the word *orthodontist* is between the feet (ortho) and (dontist): *orthobloodydontist*. However, McCarthy notes (p. 588) that expletive infixation is severely degraded even between two feet, if the infix follows the foot with primary stress. Thus, words like *ˈcranˌberry* and *ˈteleˌscope* will yield the rather marginal ?*cranbloodyberry* and ?*telebloodyscope*; these are definitely better than infixation into a foot as in **psychobloodylogy*, but still markedly worse than infixation before a foot with primary stress (*orthobloodydontist*, *psychobloodylogical*).

Like expletive infixation, coordination of parts of words is sensitive to the location of primary stress—it is strongly dispreferred when primary stress is on the coordinate parts. It is instructive at this point to look at the two coordinate structures ?*micro and telescopes* and ?*micro and telescopic*. The two expressions have a similar morphological and syntactic makeup, and both are at best marginal, bordering on ungrammaticality; but each structure is bad for a different reason. The problem with ?*micro and telescopes* is phonological, since primary stress falls on the coordinate parts (cf. *ˈmicroˌscopes*, *ˈteleˌscopes*, and also the marginality of ?*microbloodyscope*, ?*telefuckinscope*). There is no problem with the semantics—it is clear what this construction should mean and where such a meaning could be used (e.g. in place of the direct object of *our store sells microscopes and telescopes*). The opposite holds of ?*micro and telescopic*, which is well-formed phonologically (cf. *ˌmicroˈscopic*, *ˌteleˈscopic*, also *microbloodyscopic*, *telefuckinscopic*): here the problem is with the meaning of the coordinate structure—the meanings of *microscopic* and *telescopic* are rather unrelated, so it is hard to conceive of a situation where they can be coordinated. *Microscopic* means something like "very small", while *telescopic* means either "having to do with a telescope" or "having the shape of concentric tubes feeding into one another". Furthermore, when the adjectives are attributive and apply to the same object they normally appear in succession rather than coordinated (*a microscopic telescopic lens*, just like *a small telescopic lens* rather than ?*a small and telescopic lens*). The coordinate structure ?*micro and telescopic* sounds odd simply because it is hard to find a sensible use for it—the sentence ?*this gadget is micro and telescopic* makes as much sense as ?*this gadget is microscopic and telescopic*.

Another prosodic generalization is that the free conjunct—the one that is not adjacent to the complement word part outside the coordinate structure—invariably forms a prosodic word (the prosodic word is one element in a hierarchy of prosodic constituents, see for example Selkirk 1980, 1986; Nespor and Vogel 1982, 1986; these prosodic constituents typically constitute domains for the application of phonological rules, i.e. a particular rule is restricted to apply within a certain domain or at its edge). I know of two tests that can detect a prosodic word boundary in English: stem-final tensing and [r] intrusion. Stem-final tensing prohibits the reduction of non-low vowels to schwa (Chomsky and Halle, 1968; Halle and Mohanan, 1985), and applies at the end of a prosodic word (Booij and Rubach, 1987); intrusive [r] appears in certain dialects of English between a non-diphthongal vowel and a following vowel, when the two vowels are separated by a prosodic word boundary (McCarthy, 1993). The examples below—(61) for all English speakers and (62) for those speakers with [r] intrusion—show that the first conjunct in the coordinate structure is parsed as a prosodic word.

(61) orth[o^{w}] and periodontists (cf. orth[ə]dontist)

(62) mega[r] and gigabytes

The fact that *periodontists* may be pronounced with a schwa in (61) shows that the conjunct part in that word does not have to form a prosodic word. Coordination of parts of words thus requires that the coordinate parts be constituents that can be promoted to the status of a prosodic word, and that the free-standing conjunct actually be promoted to this status (cf. Smith 2000 for a similar observation on German, discussed below).

Promotion to a prosodic word also happens with expletive infixation. Many speakers pronounce *orthobloodydontist* with a schwa as in (63a), showing that (ortho) remains a foot; some speakers, however, find it necessary to tense the final vowel of (ortho) as in (63b), suggesting that they have promoted the constituent to the status of a prosodic word.

(63) a. orth[ə]bloodydontist
b. orth[o^w]bloodydontist

There is even a report of a tense [o] before the infix in *absofuckinlutely*, in the following posting to the Linguist list by Geoffrey Russom.

> I wonder whether anyone has observed a feature of expletive infixation as it appears in my dialect: the quite perceptible tensing of a normally unstressed vowel immediately preceding the infixed item. Thus I get “absolutely” as [aebs@lutli], where @ = schwa, but [aebso-EffING-lutli], with tense [o]. This may have something to do with the fact that I don’t reduce word-final underlying /o/ in my dialect.
>
> LINGUIST List 4.907, November 3, 1993
> http://linguistlist.org/issues/4/4-907.html

The choice of vowel, namely [o], is most likely influenced by the orthography, since there do not exist morphologically related forms where the schwa of *abs[ə]lutely* is pronounced as a tense vowel. However, the fact that the speaker wants to pronounce a tense vowel immediately before the infix is indicative of a prosodic word boundary.

To summarize the prosodic conditions on coordinate structures in English: there must minimally be a foot boundary between the coordinate and non-coordinate parts of a word; the free-standing conjunct must form a prosodic word; and coordinate structures are generally dispreferred if primary stress is on the conjuncts. In section 3.3 I will try to tie these observations with the grammar of English prosody; the remainder of this section looks at data from Dutch, German and Spanish.

Dutch and German show prosodic restrictions similar to English, except that they do not show a preference against stress on the coordinate parts. Booij (1985) gives many examples of possible and impossible coordinate structures in Dutch; representative examples are reproduced below.

(64) Coordination possible:

a. zicht- en tast**baar** ‘visible and tangible’

b. ont- en ver**wikkelingen** ‘developments and complications’

c. **regel**ordening en -toepassing ‘rule ordering and [rule] appreciation’

(65) Coordination impossible:

a.*blauw- en rod**ig** (blauwig en rodig = ‘blueish and reddish’)

b.*absurd- en banal**iteit** (absurditeit en banaliteit = ‘absurdity and banality’)

c.***be**varen en -rijden (bevaren en berijden = ‘sail and ride’)

d.***ge**hijg en -puf (gehijg en gepuf = ‘gasping and puffing’)

Booij formulates a rule that states that coordination is allowed when the element outside the coordinate structure, typeset in boldface above, forms a prosodic word (this is formulated in connection with a rule of phonological deletion, see section 4, but it can be equally well stated as a condition on surface representations). Prosodic word boundaries are determined in the word formation process: some affixes and all free morphemes are specified to be prosodic words, and this status is retained when they combine to form complex words, resulting in the structure of a prosodic word within a word (a similar intuition underlies the analysis of German in Höhle 1982, which is stated in terms of strong [#] and weak [+] morpheme boundaries: certain affixes and all words are marked by the strong [#] boundaries, and it is only these that allow coordination of parts).

While it may be the case that compound words indeed have the prosodic word within a word structure that Booij proposes, I do not see the coordination facts as supporting evidence. The examples in Booij (1985) where coordination is not allowed either have the coordinate and non-coordinate parts parsed into a single foot, as in (65a)–(65b), or have a non-coordinate part that is smaller than a full foot (65c)–(65d). On the other hand, Booij gives some examples where coordination of parts is allowed with non-compound words, where morphological structure does not lead us to expect an internal prosodic word boundary.

(66) a. mono- en dia**logen** ‘monologues and dialogues’

b. biblio- en dactylo**grafische** hulp ‘bibliographical and dactylographical assistance’

c. hydro- en aero**statica** ‘hydrostatics and aerostatics’

To explain these constructions, Booij has to stipulate that the words in (66) above have the structure of a prosodic word within a word, a stipulation not motivated by any other phonological or morphological consideration. If, however, the requirement on coordination in Dutch is the same as I have suggested for English, namely that there just be a foot boundary between the coordinate and non-coordinate parts, then all the data are accounted for. Since a prosodic word boundary entails a foot boundary, then all words that have internal prosodic word boundaries for independent reasons will also allow coordination of parts.

The situation in German may be more complicated. I know of at least some speakers who refuse to accept **Mono und Dialoge*, the German counterpart of Dutch (66a), even though there is a foot boundary between the coordinate and non-coordinate parts; a foot boundary may not be enough for these speakers. Höhle (1982) presents an analysis of the German coordination facts in terms of morphological boundaries. Vowel-initial suffixes in German fall into two classes: "non-cohering" suffixes form their own syllable, whereas "cohering" suffixes syllabify with the preceding stem. This can be shown through a number of tests: non-cohering suffixes trigger obstruent devoicing in the preceding consonant, cohering suffixes do not (67a); non-cohering suffixes retain the schwa of a preceding [ən] or [əl] coda, cohering suffixes force deletion of the schwa (67b)–(67c); and non-cohering suffixes may be preceded by a glottal stop, while cohering suffixes do not allow this (67d).

(67)		NON-COHERING	COHERING
	a.	far[p].echt 'colorfast'	far.[b]ig 'colored'
	b.	reg[ən].echt 'rainproof'	reg.[n]erisch 'rainy'
	c.	seg[əl].echt	Seg.[l]er 'yachtsman'
	d.	far[pʔ]echt 'colorfast'	*far[bʔ]ig / *far[pʔ]ig 'colored'

Coordination of parts of words is possible with non-cohering suffixes, but not with cohering ones, which is to be expected if the non-cohering suffixes not only form a separate syllable, but a separate foot. Now Höhle takes the difference in syllabification to be the result of different morphological boundaries: non-cohering suffixes are preceded by strong [#] boundaries, and it is these boundaries that allow coordination. Höhle notes (fn. 8, p. 91) that the phonological distinctions in (67) are absent before consonant-initial suffixes; consequently, determining the morphological boundary in such cases depends solely on data from coordination, and may in some cases lead to speaker variation and underdetermination.

I am not sure that it is necessary to refer to morphological boundaries (rather than prosodic ones) in order to account for the variation among German speakers. An alternative is that in German the minimal boundary for coordination of word parts is that of a prosodic word rather than a foot, and variation stems from different speakers having different prosodic representations for the same words. Variation may also be the result of different speakers requiring different boundaries—some speakers only allow coordination of parts of words with a prosodic word boundary, while others are content with a foot boundary. I leave the matter unresolved, pending further data.

The free-standing conjunct in German must form a prosodic word, the same as in English. This is demonstrated by Smith (2000): the prefix *be-* in *beladen* 'load' normally has a reduced vowel, but it can have a full vowel if it is placed under stress (68); in the coordinate structure *be- und entladen* 'load and unload', where *be-* is the free conjunct, it must have a full vowel (69).

(68) [bə.ˈlɑː.dn̩]; [ˈbeː.ˌlɑː.dn̩]

(69) [ˈbeː.ʔʊnt.ˈʔɛnt.ˌlɑːdn̩]; *[ˈbə.ʔʊnt.ˈʔɛnt.ˌlɑːdn̩]

Another example is the morpheme *farb* 'color' in *farblos* 'colorless', which in standard German forms its own syllable and thus ends in a voiceless [p], but in certain dialects may syllabify with the suffix, resulting in a voiced [b] (70). In the coordinate structure *farb- und ausdruckslos* 'colorless and expressionless' the free conjunct *farb* must end in a voiceless [p] (71).

(70) [ˈfaɐ̯p.loːs]; [ˈfaɐ̯.bloːs]

(71) [ˈfaɐ̯p.ʔʊnt.ˈau̯s.ˌdʀʊks.loːs]

These facts are explained if the free-standing conjunct has to form a prosodic word, subjecting it to a minimal word requirement (69) and prohibiting it from syllabifying with subsequent material (71).

We see that Dutch and German have prosodic restrictions on coordinate structures that are similar to those found in English. Similar structures are found in other languages too. Spanish, for instance, allows the coordination of word parts that combine with the adverbial suffix *mente*.

(72) a. decidida y atrevidamente 'decisively and boldly' (Suñer, 1975: 604)
b. queda y lentamente 'softly and slowly'

(73) a. directa o indirectamente 'directly or indirectly' (Zagona, 1990: 5)
b. inteligente y profundamente 'intelligently and profoundly'

The first conjuncts in the above examples are phonologically identifiable as word parts: in (72b), for instance, the conjuncts cannot both be adverbs, because only *quedo* 'softly' is a free-standing adverb form; *queda* must therefore be a word part of *quedamente* 'softly'. Spanish is consistent with the prosodic restrictions found in the other languages discussed above, since the suffix *mente* which stands outside the coordinate structures forms a trochaic foot.

3.3. The source of prosodic restrictions on coordination

The prosodic restrictions on coordination of parts of words are not arbitrary; we expect them to follow from the properties of the phonology and its relation to syntax. Recall our three observations regarding the prosodic restrictions in English (page 23): there must minimally be a foot boundary between the coordinate and non-coordinate parts of a word; the free-standing conjunct must form a prosodic word; and coordinate structures are generally dispreferred if primary stress is on the conjuncts. This section attempts to tie these observations to the grammar of English in general.

The requirement of a foot boundary between the coordinate and non-coordinate parts comes from the grammar of phonological decomposition itself. This requirement is not particular to coordinate structures, since the same holds of focus below the word level (Artstein, 2002: chapter 2, 2004). Recall that phonological decomposition splits the meaning of a lexical item into two components, each of which is assigned to part of the phonological representation. But the phonological representation itself is not just a string of segments—it has the structure of syllables and feet. The issue is not whether prosodic structure is specified in the underlying structure of lexical items (see e.g. Booij and Lieber, 1993) or if it is fully predictable; either way, it is clear that expressions have prosodic structure at a certain level of representation. A natural interpretation is that phonological decomposition assigns meanings to the prosodic constituents that make up a word, not to arbitrary stretches of the linear segmental representation. This immediately explains the observation that the split between the coordinate and non-coordinate parts of a word has to occur between two prosodic constituents. Furthermore, these constituents must be at least the size of a foot, because the free-standing conjunct must have the potential to form a prosodic word so it must minimally be a foot (the minimal size of a word in English); the element outside the coordinate structure must therefore be a prosodic constituent that can concatenate with a foot to form an expression of English, so a foot boundary also ensues between it and the adjacent conjunct.

As for the requirement that the free-standing conjunct should be a prosodic word, this is most likely a reflex of the English requirement that every morphological or syntactic word should form a prosodic word (Liberman and Prince 1977; Prince and Smolensky 1993; and references therein). This requirement holds only of lexical words, corresponding roughly to the open-class lexical items, not function words (Selkirk 1995 and references therein); Selkirk defines lexical words as morphosyntactic units, dominated by the categories N^0, V^0 or A^0 (fn. 2, p. 440). Do the word parts in a coordinate structure constitute lexical words that are subject to the prosodic word requirement? Well, they are definitely not function words, nor are they closed-class items. The question remains whether they are of the (morpho)syntactic category level of word, or of a lower level. The semantics does not give an answer one way or another: I have argued that for the correct semantic interpretation, coordination has to be at surface level, that is with a structure [A and B]C; but all that matters for the semantics is the geometry of the structure, not the category level labels.

We are seeking an explanation for the difference between the free standing word-part conjunct and the conjunct adjacent to the word part outside the coordinate structure, why the former has to be a prosodic word while the latter does not. The difference can arise from a number of sources. One possibility is that the two conjuncts are of different syntactic status, e.g. different category levels, and this would entail their different prosodic status. Alternatively—assuming that coordinated constituents must be of the same syntactic category level—coordinate word parts would either be of a category level word, or of a lower level (category levels below the word are proposed by Selkirk 1982 for the internal structure of words, but unlike that model, coordinate structures require that these levels interact with higher level syntax). If coordinate word parts are not syntactic words then we have to derive the prosodic word status of the free-standing conjunct from other aspects of the syntactic configuration, whereas if they are syntactic words we need to explain the failure of the other conjunct to get realized as a prosodic word.

At the moment I do not have a reason to choose in favor of one of the three approaches sketched above, so I leave the matter unresolved. If the coordinate parts are indeed syntactic nodes of the level word, then we have evidence for the violability of the requirement that lexical words should form syntactic words. This requirement is satisfied in all the English data presented in Selkirk (1995). Selkirk considers three configurations of lexical and function words: function words that precede a lexical word (*to London*), function words at the end of a phrase (*more than Sara can*), and object clitics (*feed us*). Each category of function words is prosodified differently, but in all cases the lexical word forms a prosodic word, as demonstrated by aspiration at the beginning (*in T^{h}oronto*) and [r] intrusion at the end (*more scary than a subpoena-r is*; *withdraw-r it*). The grammar enforces prosodification of a lexical word as a prosodic word by means of two Optimality Theory alignment constraints which align the left and right edges of a lexical word with the respective edges of a prosodic word; these constraints are never violated in English (they are violated in one dialect of Serbo-Croatian). If *perio* in *ortho and periodontists* is indeed a lexical word, then violation of these constraints would have to be forced by a higher-ranking constraint.

Finally, the preference against stress on the coordinate parts could either be a purely phonological phenomenon, or a consequence of the relation between syntax and phonology. A possibly related observation is that "right node raising" constructions also resist prominence on the coordinate parts. The following example, due to

Roger Schwarzschild, is rather marginal.

(74) [What happened to the whiskey?]
—?John drank and Mary spilled the whiskey.

However, it is not clear to me that the unacceptability of (74) has the same origins as that of ?*micro and telescopes*, because the origin of the prominence relations is different—in (74) the coordinate parts are expected to be prominent because of their discourse status (the rest of the sentence is given), while in ?*micro and telescopes* prominence on the coordinate parts is a consequence of default word stress.

What is the phonological force working against structures that have stress on the coordinate parts? This restriction is similar to the preference against expletive infixation following the main stress of a word, so we expect the two restrictions to have a similar source. McCarthy (1982: 588) suggests that in the case of expletive infixation, the preference is due to the fact that inserting a foot between the main stress and a following foot makes the main stress two feet removed from the end of the word, a pattern not found in ordinary English vocabulary. This does not explain the preference against stress on the coordinate parts: in a structure like ?*micro and telescopes* the first conjunct *micro* forms a prosodic word, so we do not get the atypical stress pattern of ?*ˈmicroˌfuckinˌscope*. Our conclusion is that either the two phenomena are not closely related, or that another explanation is needed for the expletive infixation case.

We should not be too quick to dismiss the connection between the restrictions on expletive infixation and coordination of parts of words. There are additional restrictions that appear to be common to both. The word *infixation* itself, for instance, appears to have the ideal prosodic structure for expletive infixation—two trochaic feet, with main stress on the second: (ˌinfik)(ˈsation). But expletive infixation is not allowed, and neither is coordination of parts of words.

(75)	a.	?infikfuckinsation	?infik and prefixation
	b.	?infixfuckin(s)ation	?infix and prefixation
	c.	?infifuckinxation	?infi and prefixation

The structures in (75a) are the ones predicted to be grammatical, the rest are shown just for the sake of completeness. One possible reason for the ungrammaticality of (75a) is that there is some sort of morphological interference, caused either by the proximity of the foot and morpheme boundaries or by the existing word *infix*, where the final [s] is part of the first and only foot. The restrictions on both expletive infixation and coordination of parts of words still require further study, in order to precisely map out the territory of the structures that are on the margins of grammaticality. All of these cases, however, are markedly better than constructions that break the foot structure. We also expect a correlation between the availability of expletive infixation and coordination of parts of words, even when we are not certain about the exact reason why a certain example is allowed or not (a possible exception to this last generalization: the word *infiltration* appears to allow expletive infixation, *infilfuckintration*, more readily than coordination, as in ?*the border suffered from various infil and penetrations in the last year*).

Our account of coordination of parts of words now consists of two parts: a semantic theory that assigns denotations to arbitrary word parts and interprets coordination at surface level, and a phonological component with restrictions on structures that can be coordinated. The final section of this paper compares this account to existing analyses that derive coordination of parts of words from the corresponding coordination of whole words through a deletion rule.

4. Surface coordination vs. deletion

The phonological observations from section 3.2 draw on previous analyses of similar constructions in Dutch and German, which preferred to view these constructions as resulting from a process of phonological deletion, rather than coordination at surface level (Höhle, 1982; Booij, 1983, 1985; Wiese, 1992, 1996; Kleinhenz, 1997; Smith, 2000). Our motivation for an analysis of surface coordination was the difference in meaning between NPs with coordinate word parts (*ortho and periodontists*) and coordinations of full NPs (*orthodontists and periodontists*). In this section I look at additional arguments that compare surface coordination with phonological deletion.

The rule of deletion, as it is put forward in Booij (1985) and Kleinhenz (1997), includes a syntactic component as well as a phonological component. Deletion itself is phonological—the deleted element is a prosodic word. But prosodic restrictions alone do not predict the following contrasts, since in each pair the two structures are identical in terms of prosodic structure.

(76) a. de land- en de tuinbouw (Dutch, Booij, 1985)
'the agriculture and the horticulture'

b.*de land- met de tuinbouw
'the agriculture with the horticulture'

(77) a. eine elf- und eine zwölfjährige (German, Kleinhenz, 1997)
an eleven and a twelve-year-old

b.*eine elf- bewundert eine zwölfjährige
an eleven admires a twelve-year-old

These examples lead Booij and Kleinhenz to conclude that the context for deletion must be syntactic: the deleted element has to be adjacent to a conjunction. Booij explicitly takes this to be evidence for the existence of rules that refer to both syntactic structure and prosodic structure, and thus go against a model like that of Selkirk (1980), which strictly separates the syntactic and prosodic domains.

A question which is not addressed is why this particular deletion rule should exist and not, say, a rule that allowed phonological deletion, under identity, subject to adjacency to a preposition. Indeed, if the deletion rule has nothing to do with the meaning of conjunction, then we should expect that a language should be possible where constructions like (76a) are bad, but constructions like (76b) are grammatical!

Surface coordination, as argued for in this paper, gives a straightforward answer to the above question, which follows from the meanings of parts of words. Phonological decomposition states that coordinate parts of words denote strings of sounds, which are individual objects (type *e*). These denotations are suitable arguments for the function denoted by *and*: when applied to two strings of sound it yields a plural object which is the join of the individual strings. However, strings of sound are not in the domain of the denotation of the preposition *with*, nor are they in the domain of the denotation of *admire*. It follows that parts of words are licensed in coordinate structures like (76a) and (77a), but not as the objects of *with* (76b) or *admire* (77b).

The above explanation is semantic, just like the explanation for the following contrast, which does not involve parts of words.

(78) big and small monkeys

(79)*big with small monkeys (cf. big monkeys with small monkeys)

(80)*big admire small monkeys (cf. big monkeys admire small monkeys)

The adjectives *big* and *small* can be coordinated to form a constituent with a coherent meaning, which can then modify *monkeys*. But *big* and *small* cannot combine with *with* and *admire* to form the constituents **big with small* and **big admire small*; also, *big* cannot be modified by the PP *with small monkeys*, nor is it a suitable subject for the VP *admire small monkeys*. These are all consequences of the respective meanings of *and*, *with* and *admire*. Indeed, it would seem odd to have an analysis that derived (78) from *big monkeys and small monkeys* through deletion of *monkeys*, and then stipulated somehow that this is not possible in (79) and (80). Phonological decomposition allows the same explanation for constructions above and below the word level. (Note that a higher order meaning could make sentences (79) and (80) work, for instance if the verb in (80) had the meaning $\lambda\alpha\lambda\beta\lambda\gamma.[\![\text{admire}]\!](\beta(\gamma),\alpha(\gamma))$, with $[\![\text{admire}]\!]$ the familiar verb denotation and α, β and γ of appropriate types. But the observation is that the expression *admire* is not associated with such a meaning, nor are verbs in general.)

Wiese (1992, 1996) also notes an empirical problem with a deletion rule phrased in syntactic terms: it does not cover the full range of data. The following examples from German show how parts of words appear as independent syntactic elements in structures that do not involve coordination (Wiese, 1996: 72).

(81) a. Sachsen entwickelte sich vom Herzog- zum Kurfürstentum.
'Saxony developed from a dukedom to an electorate.'

b. Formen wir den Aktiv- in einen Passivsatz um.
'We form the passive sentence from the active sentence.'

c. … übernahm zum Fraktions- auch noch den Landesvorsitz
'… taking over both the faction chair and the state chair.'

d. Weil Leitungs- von Mineralwasser unterschieden werden muß, …
'since tap water must be distinguished from mineral water, … '

Wiese proposes that these structures are the product of a purely phonological deletion rule: not only is the deleted element a prosodic word (ω), but the context is also phonological. A prosodic word may be deleted at the edge of a phonological phrase (ϕ), if an identical prosodic word is contained in an adjacent phonological phrase within the same intonational phrase (I). The environment for deletion can be summarized graphically as follows, where the underlined prosodic word is the one to be deleted.

(82) a. $[_{\mathrm{I}}\, [_{\phi} \cdots \underline{\omega_i}\, _{\phi}]\, [_{\phi} \cdots \omega_i \cdots {}_{\phi}]\, _{\mathrm{I}}]$

b. $[_{\mathrm{I}}\, [_{\phi} \cdots \omega_i \cdots {}_{\phi}]\, [_{\phi}\, \underline{\omega_i} \cdots {}_{\phi}]\, _{\mathrm{I}}]$

Unfortunately, the above proposal fails to distinguish between the pairs of examples in (76) and (77) above. An additional weakness is pointed out by Kleinhenz (1997): since either the first part or the second part of a word may be coordinated, a deletion rule as formulated in (82) would require arbitrary association of the conjunction itself, in order to ensure that the deleted element is adjacent to a phonological phrase boundary. The conjunction *und* would have to form a phonological phrase with the material that follows it in (83) but with the preceding material in (84).

(83) $[_{\phi}$Apfel~~saft~~$_{\phi}]$ $[_{\phi}$und Orangensaft$_{\phi}]$
apple and orange-juice

(84) $[_{\phi}$Ostersonntag und$_{\phi}]$ $[_{\phi}$~~Oster~~Montag$_{\phi}]$
Easter-Sunday and Monday

However, the only natural place for a pause is before the conjunction, so a prosodic structure as in (84) is highly unlikely.

To summarize our findings so far: a proposed deletion rule which syntactically specifies a conjunction environment cannot work because it prohibits the grammatical structures in (81), while a proposed deletion rule that only looks at prosody won't work because it allows the ungrammatical structures (76b) and (77b). Our surface coordination account is superior because it captures number contrasts that a deletion account misses (our original motivation), and it explains why parts of words occur in coordinate structures but not as objects of *with* or transitive verbs. We still need an explanation how a surface interpretation is possible for the non-coordinate structures in (81). I do not have an answer at the moment, but we should note that these structures have parallels at the phrasal level: parts of words are allowed where parts of NPs are allowed.

(85) a. Parliament developed from a unicameral to a bicameral institution.

b. We transform the active into the passive sentence.

c. . . . taking over both the faction and the state chair.

It appears, then, that however the above sentences are interpreted, this should generalize to the constructions with word parts.

So, if surface coordination is a better explanation than deletion, why was deletion proposed in the first place? It turns out that most of the arguments in favor of a deletion account rest on assumptions about the rigidity of syntax and semantics, and are no longer valid when we consider a syntax and semantics capable of manipulating and interpreting parts of words.

One argument for deletion is syntactic. Sentences (86) and (87) contain apparent instances of coordination of non-constituents: *een derde* and *een zesde* in (86), and *ein Dreigang* and *ein Sechsgang* in (87).

(86)	het verschil	tussen	een	derde-	en	een	zesdeklasser	(Dutch, Booij, 1985)
	the difference	between	a	third	and	a	sixth-former	

(87)	ein	Dreigang-	und	ein	Sechsgangfahrrad	(German, Kleinhenz, 1997)
	a	three-speed	and	a	six-speed-bicycle	

The proposed deletion rule saves the syntax from having to allow some nontraditional constituents that would be required in order to generate the above examples with surface coordination. But this argument is orthogonal to the issue of coordinating word parts. The word parts in (86) and (87) have their own meanings which combine in a compositional manner, so as far as the semantics is concerned there is no difference between these structures and phrasal coordination—phonological decomposition is not involved here. Syntactic theories that allow non-traditional constituent coordination have been developed both at the phrase level ("Right Node

Raising": Ades and Steedman, 1982; Steedman, 1985, 1987) and for the internal structure of words (Moortgat, 1987). But even if we reject these syntactic theories, concluding that (86) and (87) must involve deletion, it still doesn't follow that all cases of coordination of parts of words are instances of deletion, just like a syntactic theory that does not allow surface coordination for the NP *a yellow and a red cabinet* should not automatically rule out surface coordination in the NP *yellow and red cabinets*.

Another argument for deletion has to do with the semantics of number. Booij (1985) notes that the preposition *tussen* 'between' in (86) requires a plural complement, but on a surface interpretation its complement would be interpreted as singular because of the singular head *klasser*. I suggest that the reason (86) has a plural interpretation for an NP headed by a singular noun has to do with the fact that 'third former' and 'sixth former' in this construction do not refer to individuals, but rather to concepts. We observe the same in the phrasal domain: sentence (88) is much more readily understood as choosing between two concepts—kinds of cabinets rather than actual ones; sentence (89), where a concept interpretation is unlikely, is severely degraded.

(88) I must choose between a yellow and a red cabinet.

(89)*I am standing between a yellow and a red cabinet.

I do not have a full explanation for why concept terms allow an NP headed by a singular noun to receive a plural interpretation. This may have to do with concepts being one-of-a-kind, in the sense that there is only one concept 'a third-former' or 'a yellow cabinet'. Concept terms can even be syntactically plural while being morphologically singular.

(90) Concatenative and autosegmental phonology *are* interesting fields.

Sentences (88) and (90) show that the argument for deletion, like the previous one, is not particular to coordination of parts of words, but rather applies specifically to (86), and to (88) and (90) as well. Whatever analysis we give to the latter should generalize to the former; deletion of word parts due to their morphological status has not been motivated.

The next argument says that coordination of parts of words cannot be generated by the mechanism of syntactic composition because the conjuncts do not have to be free morphemes (91)– (93) or because they can be lexical items of different categories (94)–(95).

(91) schei- en natuurkunde 'chemistry and physics' (Dutch, Booij, 1985)
(literally: 'analysis and nature knowledge').

(92) wis- en sterrenkunde 'mathematics and astronomy' (Dutch, Booij, 1985)
(literally: 'sure and stars knowledge').

(93) Him- und Brombeeren 'raspberries and blackberries' (German, Kleinhenz, 1997)

(94) leer- en handboeken 'textbooks and handbooks' (Dutch, Booij, 1985)
(literally: 'learn and hand books').

(95) Verband Geburts- und andere-r Behinderte-r (German, Kleinhenz, 1997)
society birth and other-GEN handicapped-GEN

This is a matter of syntax, then—how are such structures generated at surface level. Moortgat (1987) offers a syntax that generates these structures, through a family of rules that convert stems of various syntactic categories into modifier bound morphemes: for instance, both *leer* 'learn (V)' and *hand* 'hand (N)' are converted to the category N/N; this way they can be conjoined. The semantics that Moortgat offers only works for transparent modifiers, and does not deal with the opaque cases (91)–(93); these cases can be handled by phonological decomposition as developed in section 2 above.

One last argument for deletion comes from Dutch "linking phonemes". When *wesp* 'wasp' forms a compound with *steek* 'sting', an additional schwa [ə] appears between the two morphemes: *wespesteek*; similarly, *zonsverduistering* 'sun-eclipse' contains a linking [s]. The linking phonemes are retained when such morphemes are coordinated.

(96) wespe- en bijesteken 'wasp and bee stings' (Booij, 1985)

(97) zons- en maansverduisteringen 'solar and lunar eclipses' (Booij, 1985)

Booij (1985) argues that deletion is the only possible source for the linking phoneme in the first conjunct, since coordinated words are inaccessible to morphological rules: the ordinal derived from the cardinal number *drie-en-zestig* 'sixty three' is *drie-en-zestigste* 'sixty third', where the first conjunct retains its cardinal form, rather than **derde-en-zestigste* (cf. *derde* 'third'). Indeed, this argument shows that the coordinate structures in (96) and (97) cannot be derived from the bare noun coordinations *wesp en bij* and *zon en maan* through a morphological operation like the one that derives the ordinal numbers from cardinal numbers. However, there is no reason to believe that coordination should be similar to this sort of morphological derivation. Coordination can simply operate on bound forms: Moortgat (1987: 47) incorporates the linking phoneme into his category-changing rules, noting that it "makes the left members formally recognizable as bound forms"; this is to be expected for the opaque cases in particular, because under the semantics proposed here only the bound morphemes have the right meaning (that is, the right sound) to combine with the meaning of the head.

This concludes the review of the arguments given in favor of the deletion analysis. As long as we have a syntax capable of manipulating word parts and the semantics developed above, a surface interpretation is possible. I have argued that coordination of parts of words is interpreted at the surface level, through the semantic process of phonological decomposition which assigns denotations to arbitrary word parts. Conjunction retains its ordinary meaning without additional machinery. Coordination of parts of words is subject to prosodic restrictions, which mandate a minimum size for constituents that can be coordinated. The analysis is superior to deletion proposals, both in its empirical coverage and in its explanation of why parts of words function as independent elements in coordinate structures but not in other grammatical constructions.

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