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Word-Level Recursion in Spanish Compounds

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1 Introduction

In this paper, I investigate the relationship between phonological domains and syntactic structure by looking at the connection between the syntax and the phonology of compounds. Compounds are particularly interesting for a subpart of the syntax-phonology connection, the structure of words, because the components which make up a compound appear to be words but the compound itself also appears to be a word. The question, then, is: what can this structure of word-within-word tell us about the syntax-phonology relationship with respect to the creation of word-sized units and the calculation of the domain of word-level phonology?

The data investigated here is one particular type of exocentric compound in Spanish. Spanish exhibits some basic word-level phonological processes[1] which help to diagnose the boundaries of the phonological word. I propose that, through an explicit mapping between syntactic structure and phonological structure, these phonological boundaries reflect the syntactic structure of these compounds. Because the phonological domains appear to be recursive (or, at least, two nested levels), I argue that the syntactic structure must also be recursive.

2 Spanish Data

2.1 Spanish Word-Level Processes

Two phonological processes apply at the word-level in Spanish: diphthongization and epenthesis. Diphthongization applies (certain) mid vowels under stress, as shown in (1). Note that these same vowels are not diphthongized if stress does not fall on them, as shown by the derivationally or inflectionally related words in the "not diphthongized" column.

(1) Diphthongization of (certain) mid vowels under stress (Harris 1989)

Process: { /e/ →[ie] ; /o/ →[ue] }

Diphthongized		Not diphthongized (unstressed)	
c[ué]*lga*	"he/she hangs"	*c*[o]*lgámos*	"we hang"
p[ié]*nso*	"I think"	*p*[e]*nsámos*	"we think"
c[ié]*n*	"100"	*c*[e]*nténa*	"group of 100"
b[ué]*no*	"good"	*b*[o]*ndád*	"goodness"

The process of epenthesis adds an *e-* onto underlying *sC* clusters when these clusters are word initial, as shown in (2). Note that epenthesis does not apply to these same clusters when certain prefixes are added, shown in the "*sC* with prefix" column. Epenthesis is also applied to loan words beginning with *sC* clusters.

(2) Epenthesis of *e-* to initial *sC* clusters (Lema 1978; Harris 1987; Eddington 2001)

Epenthesis		*sC* with prefix
escribir	"write"	*inscribir* "inscribe"
esfera	"sphere"	*hemisferio* "hemisphere"
estreñir	"constipate"	*constreñir* "constrict, compel"
estrofa	"stanza"	*antistrofa* "antistrophe"
		sC in Loan Source
esmóquin	"smoking jacket"	< Eng. *smoking*
eskot	"Scott"	< Eng. *Scott*

[1] In this paper I ignore the issue of the precise formulation of the phonological processes as rules or constraints (or some other type of process) and instead focus on how the domain of application of these processes is calculated.

2.2 Overapplication of Word-Level Processes in Compounds

In compounds, these two processes "overapply", meaning that the processes apply despite the conditions for application not being surface true. In (3), word-level stress falls on the second member of the compound, but the mid vowel in the first member of the compound still undergoes diphthongization. Similarly, in (4), the epenthetic *e-* is still added to the *sC* cluster of the second member of the compound despite the fact that this *sC* cluster is not initial in the compound. Both overapplications may even occur in the same compound (5).

(3) Overapplication of diphthongization in compounds (Harris 1989)

c[ue]*lgacápas*	"coat-rack"	(**c*[o]*lgacápas*)
c[ie]*mpiés*	"centipede"	(**c*[e]*mpiés*)

(4) Overapplication of epenthesis in compounds

guardae̲spáldas	"bodyguard"	(**guardaspáldas*)
quitae̲smálte	"nail-polish remover"	(**quitasmálte*)

(5) Overapplication of both diphthongization and epenthesis in compounds

p[ue]*rcoe̲spín*	"porcupine"	(**p*[o]*rcospín*)
h[ie]*rbae̲strélla*	"buckhorn plantain"	(**h*[e]*rbastrélla*)

If we take the application of these word level processes as diagnostic of the word level, it appears that each member of a compound is its own word prior to compounding. However, if primary stress is also an indication of wordhood, then each compound is also a single word. That is, these compounds appear to have a nested word structure, as schematized in (6):

(6) Schematic of Word Levels in Compounds: $((X)_\omega (Y)_\omega)_\omega$

examples:	((colga)$_\omega$ (capas)$_\omega$)$_\omega$	((guarda)$_\omega$ (spaldas)$_\omega$)$_\omega$
	↓	↓
inner ω-level:	(c[ué]lga)$_\omega$ (cápas)$_\omega$	(guárda)$_\omega$ (e̲spáldas)$_\omega$
	↓	↓
outer ω-level: (stress resolution)	(c[ue]lgacápas)$_\omega$	(guardae̲spáldas)$_\omega$

Given that this is the phonological structure of the word for these compounds, the question to be asked is: what is the mechanism that creates this nested structure? There must be some transformation function from the syntactic structure to the phonological structure that indicates that these compounds have words embedded inside words.

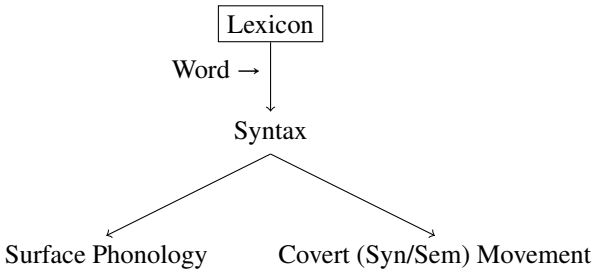
3 Theoretical Framework

To answer the question of what the syntactic and phonological structure is that results in the nested word structure of compounds is, we need a theoretical framework for generating word units. There are two major theory types when it comes to generating words. Some theories posit a special module of grammar, the Lexicon, which generates words. Other theories argue that there is no special word-generation lexicon, rather, words are built by the syntax. These theories have different predictions about the structure of compounds.

3.1 Theories with a Lexicon

Theories with a lexicon, such as Lexical Phonology (Kiparsky 1982; Mohanan 1986) and Stratal Optimality Theory (Kiparsky 2000; Bermúdez-Otero in prep.), as well as Prosodic Hierarchy Theories (Selkirk 1984; Nespor and Vogel 1986), have an architecture where the lexicon generates word, which are then inserted into the syntax, as shown in (7).

(7) Architecture of Grammar in Theories with a Lexicon



For these theories, a word is (i) the output of the lexicon, (ii) the unit of interface between the lexicon and the syntax, and (iii) the primitive or atomic unit of the syntax. Because the word is the interface unit, this architecture generally does not allow recursion (or nesting) of word structures (explicitly claimed by Bermúdez-Otero 2013).

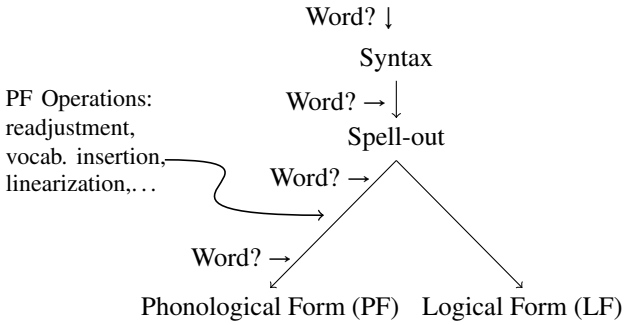
More importantly for the issue at hand, in these theories, compounding is usually just considered to be another level of the lexicon. That is, there is no claim to a relationship between the structure or order of the elements of the compound and the syntactic structure of the language. Furthermore, there is no claim to a relationship between the phonology of the compound and the phonology of other parts of the language. That is, if compounding is its own special part of a lexicon, the mechanism for combining elements into compounds need not be the same as the normal mechanism for combining elements in the language (i.e., the syntax), nor do the phonological processes applicable to compounds need to be the same as the normal phonological processes in the language (i.e., the word-level phonology).

3.2 Theories without a Lexicon

However, I argue that compounds are, in fact, combined by the general syntactic mechanisms and phonologized according to the word-level phonology applicable to other words in the language. These claims follow from a theory which builds words through the regular syntactic mechanism, which points to the architecture of a theory without a lexicon.

One such theory is Distributed Morphology (DM) (Halle and Marantz 1993, 1994; Embick 2010). One of the principles of DM is "syntax all the way down", meaning that the units of syntactic manipulation are *morphemes*, not *words*. As shown in (8), the syntax combines units and, at a certain point, these units are subject to spell-out, which sends them off to be phonologized (to PF) and be further manipulated by the semantics (to LF). However, since there is no interface at which "word" is a defining unit, this leaves the question of what a word is and where it is used in the architecture.

(8) Architecture of Grammar in Distributed Morphology



In fact, much research in DM has been devoted to showing that the unit of the word is both too big and too small for various properties of the morphosyntax and semantics, such as allomorphy, semantic resolution, and idiom meanings. For example, Embick (2010, 2013) argues that, for processes such as allomorphy, the relevant domains are those of phase-cycles on functional heads which are smaller than word size. Similarly, the domains for meaning storage and interpretation are sometimes smaller and sometimes larger than word size (see Marantz 1997). The general consensus in the

DM literature is that morphosyntactic properties are better described as relationships between morphemes rather than words. The word, then, is no longer a meaningful unit on the morphosyntactic side of derivation.

This, in turn, opens the question of whether the word exists as a unit on the phonological side. There are clear cases of phonological processes applying to word sized units (and not smaller or larger units), such as harmony and epenthesis processes in many languages. Additionally, most languages seem to have the general property of having a single main stress per word. These and other word-level processes are described extensively in work in the derivational theories of the morphology-phonology mentioned above (Lexical Phonology and Stratal Optimality Theory), as well as in Prosodic Hierarchy Theories. Thus, there seems to be pretty strong evidence that the word is a necessary unit on the phonological side of derivation.

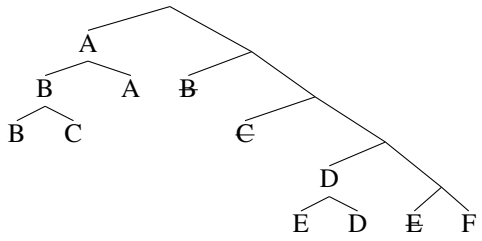
If we do not need a word unit in the morphosyntax, but we do need a word unit in the phonology, the question is: what is the corresponding syntactic structure to the phonological word? or, how is the word calculated by the phonology?

3.3 M-Word ⇒ ω-Word correspondence

In previous work (Shwayder 2014a,b), I have argued that the basic correspondence at the word level between the morphosyntax and the phonology is that the Morphosyntactic Word (M-Word) corresponds to the phonological word (ω-Word).[2] The M-Word is defined as a (potentially complex) head not dominated by a further head-projection (Embick and Noyer 2001). Note that, this is a derived rather than a primitive syntactic unit, although it is still defined as a purely syntactic relationship between heads.

As an example of this correspondence, take the tree in (9):

(9) Sample syntactic structure with M-Word ⇒ ω-Word correspondence



Morphosyntactic Structure

⇓

Linearization: [B C A]$_M$ [E D]$_M$ [F]$_M$

M-Word ⇒ ω-Word: (B C A)$_\omega$ (E D)$_\omega$ (F)$_\omega$

⇓

Phonological Grouping

In (9), the syntactic heads have been combined together into three complex heads (by any number of syntactic or morphological movement operations). These complex head structures are M-Words which correspond to the ω-Word boundaries of the phonology.

4 Analysis of Compounds

Using this syntax-phonology relationship proposed above, we can investigate the nature of compounds with respect to both their syntactic and phonological structures.

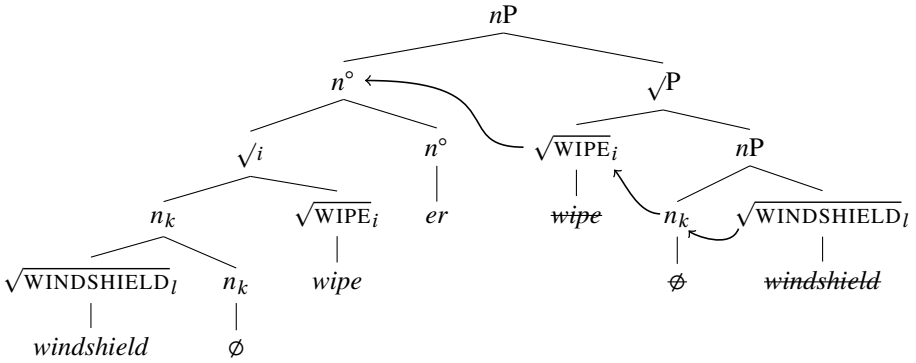
4.1 Previous DM Analysis of Endocentric Compounds

Harley (2009), working within the DM framework, suggests that endocentric compounds build actively in syntax. For example, Harley's structure for the compound *windshield wiper* is shown in

[2] There do seem to be some caveats and other cases, for which, see Shwayder (2014a,b). However, the basic M-Word ⇒ ω-Word correspondence covers the data presented in this paper.

(10). *Windshield wiper* is initially created by the *n*P *windshield* merging with the root $\sqrt{\text{WIPE}}$ to form a root phrase (as if it were the phrase *wipe windshield*). When this root phrase merges with its *n* head, syntactic movement raises the elements into one compound head.

(10) Structure for *windshield wiper* following Harley (2009)



Following the syntax-phonology correspondence proposed above, this sort of syntactic structure should result in the phonological structure shown in (11a), or, if some flavor of cyclic spell-out had spelled out the *n*P *windshield* first, the structure shown in (11b).

(11) a. Linearized morphological and phonological structure resulting from (10):
[$\sqrt{\text{WINDSHIELD}}$ n_k $\sqrt{\text{WIPE}}$ n°]$_{\text{M}}$ ⇒ (*windshield* + ∅+ *wipe* + *er*)$_{\omega}$

b. Same structure assuming cyclic spell-out of *windshield*:
[[$\sqrt{\text{WINDSHIELD}}$ n_k]$_{\text{M}}$ $\sqrt{\text{WIPE}}$ n°]$_{\text{M}}$ ⇒ ((*windshield* + ∅)$_{\omega}$ + *wipe* + *er*)$_{\omega}$

Note that neither phonological structure in (11) is same structure as the one posited for Spanish compounds in (6) above. However, it must also be noted that there are significant differences between the endocentric compounds discussed by Harley (2009) and the exocentric compounds presented here. For example, the order of the elements in the compound is reversed between endocentric and exocentric compounds (compare exocentric *pick-pocket* to endocentric *pocket-picker*). Additionally, in endocentric compounds, the head of the compound is active for both semantics (a *windshield wiper* is a type of *wiper*) and for allomorphy of the category defining head (compare *windshield wip-**er*** to *windshield technic-**ian*** or *windshield art-**ist***). In contrast, the members of exocentric compounds are not active for either semantics of allomorphy. That is, a *pick-pocket* is neither a type of *pick* nor a type of *pocket*, and there is no allomorphy of a category defining head sensitive to either member of the compound.

4.2 Analysis of Exocentric Compounds

Harley (2009) does suggest an alternative method for forming compounds of the XP-n type. These are compounds whose left member (in English) is an entire phrase, see examples in (12).

(12) Examples of XP-n type compounds

- These aren't your standard *stuff-blowing-up effects*. (Harley 2009)
- She gave me the *don't-ever-say-that-again look*.
- Clients will be seen on a *first-come-first-served basis*.

For XP-n compounds, Harley suggests that the XP phrase is derived syntactically as a phrase and then sent off to LF for interpretation (and, I posit, PF for phonologization). This phonologized and interpreted phrase is then "renumerated" for use in another workspace. Renumeration (based on Johnson 2004) is the process by which the derived semantic and phonological form of the phrase is

reinserted into the syntactic numeration (the set of objects from which the syntax chooses). Essentially, renumeration turns the spelled-out phrase into a pseudo-root.[3]

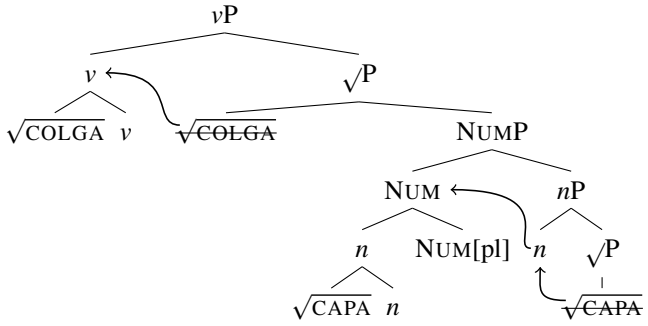
I propose that Harley's analysis of XP-n compounds also applies to exocentric compounds. That is, the components of the exocentric compound are built up in a separate syntactic tree or workspace before being repackaged as a pseudo-root and used in the syntactic space where they behave as a compound. In fact, Exocentric compounds look very much like phrases; They have the same word order as phrases and appear to have the same meaning as the phrase. For example, to return to the Spanish compounds discussed above, *cuelgacapas* "coat-rack" looks very much like the phrase *cuelga capas* "(it) hangs coats". I propose that this is because *cuelga capas* is initially built as a phrase by the syntax. When this phrase is turned into a compound, it is phonologized and then renumerated into a pseudo-root for use in another syntactic workspace.

I notate renumeration with a modified root symbol ($\sqrt[o]{}$) to mark that it may be different in some ways from a normal root. For the purposes here, however, it behaves identically to a normal root except that it has already undergone some phonologization.

The anaylsis of *cuelgacápas*, for example, is given in (13). Initially, the phrase *cuelga capas* is built in the syntax, as shown in (13a). This phrase is linearized and phonologized. Note that there are two M-Words in the phrase resulting in two ω-Words. When ω-Level phonology is applied, the first member of the compound, which is underlyingly *colga*, becomes *cuelga* by the normal diphthongization process of Spanish words.

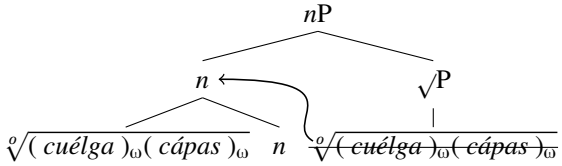
(13) Analysis of *cuelgacápas*

a. Initial Phrasal Derivation:



Linearization:	$[\ \sqrt{\text{COLGA}} \oplus v\ ]_{\text{M}} \frown [\ \sqrt{\text{CAPA}} \oplus n \oplus \text{NUM[pl]}\ ]_{\text{M}}$
Phonological Grouping:	(*colga* + ∅)$_{\omega}$ (*capa* + ∅+ *s*)$_{\omega}$
ω-Level Phonology:	(*cuélga*)$_{\omega}$(*cápas*)$_{\omega}$
Renumeration:	$\sqrt[o]{(\ \textit{cuélga}\ )_{\omega}(\ \textit{cápas}\ )_{\omega}}$

b. Use as a "pseudo-root" in another tree:



[3]There is an interesting side question to be investigated about whether renumeration involves storage into memory of the phrase in any real sense. That is, is renumeration a type of lexification of a phrase, or is it an active syntactic process?

Linearization:	$[\ \sqrt[0]{(\ cuélga\ )_{\omega}(\ cápas\ )_{\omega}} \oplus n\ ]_{M}$
Phonological Grouping:	$(\ (\ cuélga\ )_{\omega}(\ cápas\ )_{\omega} + \emptyset\ )_{\omega}$
ω-Level Phonology:	$(\ cuelga\ cápas\ )_{\omega}$
Output:	*cuelgacápas*

The entire phonologized phrase *cuélga cápas* is then renumerated for use as a pseudo-root in a separate syntactic workspace, as shown in (13b). In this workspace, the renumerated unit is combined with an *n* head to form the noun compound. This forms a single M-Word which corresponds to a single ω-Word. When the ω-Level phonology is applied to this grouping, stress is resolved, and the normal stress resolution rules of Spanish words resolve the two stresses to one stress, resulting in a single primary stress for *cuelgacápas*.

This analysis results in a recursion of the ω-Level phonology, consistent with the ω-Level groupings posited in (6) above. The first ω-Level applies to the components of a compound during initial phrasal derivation. At this point they are treated as separate words because they are separate words for the purposes of the initial phrasal derivation. The second ω-Level applies to the compound as a whole in second workspace because the renumerated root (plus the category defining head) is a single complex head and therefore a single ω-Word.

5 Discussion

There are a few further considerations to be made about the phrasal derivation analysis of the compounds presented above. First, some discussion must be given to the presence or absence of certain syntactic heads in the phrasal derivation. Second, this analysis provides and explanation for another phenomenon found in Spanish compounds, the coordinate *-i-*. Finally, a discussion of an alternate analysis in Prosodic Hierarchy Theory is discussed.

5.1 Default Heads

In the analysis of the compounds above, the phrase used to derive the compound is not a complete sentence in the sense that all syntactic heads which would normally be present are not. Rather, there is some sort of limit on what heads are attached to the structure before it was sent off for renumeration. For example, it must be noted that there are no (overt) TENSE or ASPECT heads and no verbal agreement marking on the verb of the phrase. To take the example of *cuelgacápas* used above, note that the verb appears as the stem *cuelga*. The same is true for English; English compounds which do not show tense or agreement information, e.g., **picks-pocket* or **picked-pocket*. I posit that the process of renumeration (at least for Spanish and English) is somehow restricted to bare *v*Ps, thus excluding higher heads from being included.

There does appear to be some functional heads appearing in the nouns of compounds, at least when the compounds are of the Verb-Noun type. That is, the *capas* of *cuelgacapas* seems to include a NUMBER head, as it appears to be plural on account of the final *-s*. However, in English compounds there is no plural marking allowed, e.g., **rats-catcher* or **pick-pockets*. I propose that each language has a default configuration of noun phrases which either does or does not include a NUMBER head. For Spanish, the NUMBER head is inserted by default, but for English there is no NUMBER head inserted. It must be noted, however, that the semantic information of number is not really carried by the compound. That is, *cuelgacapas* "coat-rack" does not inherently contain a plurality of coats. In fact, a single-hooked coat-rack, which is arguably only for one coat, is still a *cuelgacapas*. Note also that any other elements which must agree with these compounds (adjectives, determiners, and verbs) agree as singular.

Because there is not semantic information included in the default NUMBER head, I further posit that the exponent inserted for this head (if it is inserted) must be the default exponent. This may help to explain the cross-linguistic tendency for compounds to contain "linking morphemes" that look suspiciously like default NUMBER or CASE heads. For example, in German, many compounds take *-en-* (arguably a default plural marker) between members. One such example is *Schwanengesang*

"swan song, final performance". Note that the plural of *Schwan* "swan" is normally *Schwäne* not **Schwanen*. Further investigation along this line of study is needed.

5.2 Spanish Coordinate Compounds

The phrasal derivation analysis above provides an analysis for another type of compound in Spanish, the coordinate compound. These compounds generally take two adjectives (or occasionally nouns) and mean X-*and*-Y, or something with qualities of both adjectives. The mystery is that most[4] of these compounds appear with an *-i-* connecting the two parts, as shown in (14) (Clements 1992; Núñez-Cedeño 1992; Moyna 2011; Renner and Fernández-Domínguez 2011).

(14) Example of Spanish coordinate compounds

- *arqui̲banco* "chest-bench" = "bench with drawers"
- *azuli̲verde* "blue-and-green" or "bluish-green"
- *roji̲azul* "red-and-blue"
- *agri̲picante* "sour-and-spicy"
- *anchi̲corto* "wide-and-short"
- *tonti̲loco* "dumb-and-crazy"

This mysterious *-i-* can be explained if these compounds are also built through the phrasal derivation posited above. To take *azuliverde* "bluish-green" as an example, it is initially built as the phrase *azul y verde* "blue and green".[5] This phrase is phonologized and renumerated, as shown in (15).

(15) Derivation of *azuliverde*

Derivation as phrase X *and* Y	*azul y verde*
Phrasal Phonologization:	*azuliverde*
Renumeration:	$\sqrt[o]{\text{azuliverde}}$

This analysis equates the connecting *-i-* with the conjunction that connects the two elements of the compound during the phrasal part of the derivation.

It must be noted that there are some other types of compounds in Spanish that have a linking *-i-* which are not coordinate compounds. Although there is not space to deal with them in this paper, the prediction made by this analysis is that the *-i-* is a result of another default head or phrasal element that is generated in the initial phrasal derivation of the compound.

5.3 Clitic Group and Prosodic Hierarchy Theory

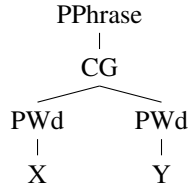
It must be pointed out that, while there are two applications of phonology which I have been treating as nested or recursive word levels, the phonological evidence on its own does not necessarily show that these are both applications of the same phonological level.[6] That is, the inner constituents of the compound are diagnosed with diphthongization and epenthesis while the outer constituent is diagnosed by stress. An alternate analysis of this data can be given using versions of Prosodic Hierarchy Theory that include the Clitic Group or Constituent Group (CG) level above the level of Prosodic Word (PWd) (see, e.g., Nespor and Vogel 1986; Hayes 1989; Vogel 2009). This analysis would posit that the members of a compound are Prosodic Words which are combined into a compound at the Constituent Group level, as schematized in (16).

[4]Further work needs to be done to determine if there is some semantic or morphosyntactic difference between the coordinate compounds that take a connecting *-i-* and those that do not.

[5]Orthographic *i* and *y* in Spanish are both pronounced /i/.

[6]Thanks to Taylor Lampton Miller for discussion on the Prosodic Hierarchy Theory analysis of the data.

(16) Prosodic structure for compounds using a Constituent Group



Under this analysis diphthongization and epenthesis are applicable at the PWd Level while primary stress is determined at the CG level.

I have two points of contention with this analysis. First, under the standard phonological analysis of Spanish, primary stress is necessary to trigger diphthongization. Although a different analysis may be possible, it would need to carefully distinguish between stress assigned at the PWd level and that at the CG level. Under the recursive word analysis I propose above, both the inner and outer constituents apply the same stress rules (which should trigger diphthongization in both levels, although this is vacuous in the case of the outer constituent).

Second, this Prosodic Hierarchy analysis tells us nothing about the relationship between the syntax and the phonology. That is, it merely stipulates that compounds are CGs. While this may follow in a theory of indirect reference between the phonology and the syntax (as Prosodic Hierarchy Theories are), it gives us no information about why compounds might be CGs. In contrast, the analysis proposed in this paper follows a direct reference theory of syntax to phonology. In direct reference theories, the structure of the syntax and the structure of the phonology must relate to each other in a particular way. Here, if compounds have recursive phonological word structure and we posit a single syntactic structure which corresponds to the phonological word (M-Word ⇒ ω-Word), we learn that there must be some recursive structure in the syntax which generates compounds (here, renumeration). We can then use this framework to explore other issues surrounding compounds from both the syntactic and phonological sides (such as default heads and the connecting *-i-*, as mentioned above).

6 Conclusion

In this paper, I presented an analysis of one type of Spanish compounds which show overapplication of word-level phonological processes. The analysis makes use of a direct-reference syntax-to-phonology connection, specifically the correspondence between M-Words and ω-Words. The result is that the recursion of the word-level phonology is a direct reflection of a recursion of the syntactic structure.

It follows from this analysis that different syntactic ways of making compounds (which may reflect different semantics) will resulting in different phonological groupings. Furthermore, the order of the elements of a compound must reflect a syntactic derivation (rather than an order determined arbitrarily in a lexicon) and the phonology of the compound must be the same as word-level phonology, albeit with nested structure (rather than a separate phonological level).

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