Morphology Within the Parallel Architecture Framework: The Centrality of the Lexicon Below the Word Level

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Abstract

The Parallel Architecture (PA) framework (Jackendoff 2002, 2007, Culicover & Jackendoff 2005) is one of the most complete constraint-based linguistic theories that encompasses phonology, syntax and semantics. However, it lacks a fully developed model of word formation. More recently, a theory called Relational Morphology (RM) (Jackendoff & Audring 2020) has been developed, that integrates into the PA. The current study shows how the Slot Structure model (Benavides 2003, 2009, 2010), which is compatible with the PA and is based on the dual-route model and percolation of features (Pinker 1999, 2006; Huang & Pinker 2010), can provide a better account of morphology than RM, and can also be incorporated into the PA, thus contributing to make this a more explanatory framework. Spanish data are used as the basis to demonstrate the implementation of the SSM. The current paper demonstrates two key problems for RM: inconsistent and confusing coindexation, and a proliferation of

schemas, and shows that these issues do not arise in the Slot Structure model. Overall, the paper points out significant drawbacks in the RM framework, while at the same time showing how the PA's morphological component can be enriched with the Slot Structure model.

Keywords: dual-route, slot structure, Relational Morphology, schema, lexical redundancy

1. Introduction

The Parallel Architecture (PA) framework (Jackendoff 2002, 2007, Culicover & Jackendoff 2005) is one of the most complete constraint-based linguistic theories that encompasses phonology, syntax and semantics, and sees each of them as generative components. However, it originated and developed without a fully formed model of morphology, and in particular lacked a detailed account of derivational morphology (word formation). More recently, Jackendoff & Audring (2020) (henceforth J&A) have developed a theory of morphology, Relational Morphology (RM), that integrates into the PA and that is based on schemas that have both a relational and a generative function. The current study shows how the Slot Structure model (SSM) (Benavides 2003, 2009, 2010), a constraint-based model of morphology that is compatible with the PA framework, can provide a better account of morphology—particularly derivational morphology—than RM, and can also be incorporated into the PA, thus contributing to make the PA a more explanatory framework. Spanish data are used as the basis to demonstrate the implementation of the SSM.

The current paper shows how percolation of both syntactic and semantic features, a central element of the SSM, is needed in morphology as a key mechanism to form new words (cf. Benavides 2003, 2009, Pinker 2006, Pinker 1999, Pinker & Ullman 2002, Huang & Pinker 2010). Through percolation (i.e. the transference of features in a derivational structure), as well as slot structure itself, the SSM clearly shows the contribution of affixes to derived words in word formation, in contrast to RM, as well as models based on Construction Morphology (Booij 2010, 2013), where the contribution of affixes is either non-existent or not clear.

The current paper takes elements of both Pinker's (1999, 2006) dual-route model and the PA and integrates them into the SSM. Importantly, everything RM accounts for via schemas in their relational role and generative role (unification) can be accounted for with the dual-route model and SSM, via combinatorial rules (unification) and associative or lexical redundancy rules (relational role). Furthermore, the present paper demonstrates two key problems for RM: inconsistent and confusing coindexation, and a proliferation of schemas, and shows that these issues do not arise in SSM.

In the PA framework there is no strict distinction between lexicon and grammar, so words and phrases are all stored in the lexicon in a common format, as pieces of structure. However, as the current study shows, a key distinction needs to be made between structures above and below the word level within the lexicon. The SSM, as incorporated into the PA framework, shows how it is advantageous to represent morphology as operating below the word level as its own subcomponent, as this clearly marks the distinction between the phrasal and the word-based components of the lexicon/grammar. Processing considerations point further to the centrality of the

lexicon below the word level. According to Jackendoff's (2013a) processing model, which is based on the PA, lexical items have to be fully-formed before being incorporated into phrasal structures. As shown in the current paper, this aspect is a key element of the SSM as integrated into the PA.
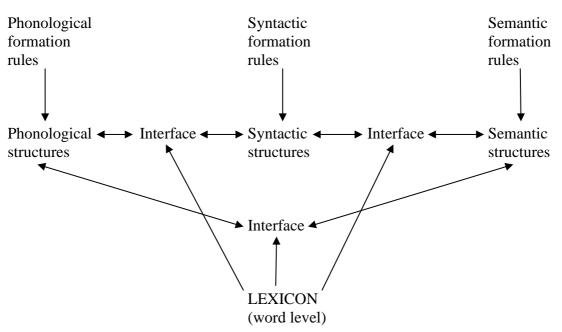
Overall, the current paper is an important contribution in that it points out significant drawbacks in the RM framework, while at the same time showing how the PA's morphological component can be enriched with SSM. It is important to emphasize that while the PA shares features with other constraint-based frameworks such as Head-Driven Phrase Structure Grammar (HPSG) (Pollard & Sag 1994, Crysmann 2021, Meurers 2001), Lexical Functional Grammar (LFG) (Bresnan 2001), Construction Grammar (Goldberg 2006), and Construction Morphology (Booij 2010, 2013) (cf. J&A; see § 3), the present paper focuses on a comparison between SSM and PA, in particular with respect to word formation (RM). A detailed comparison between either SSM or PA and the frameworks listed above would be material for a separate paper.

The author of the current paper is a native speaker of Spanish. The analysis developed throughout, including the interpretation of corpus results presented in § 3, is informed by the author's own intuitions.

The paper is organized as follows: § 2 presents an overview of the PA framework, while § 3 provides a detailed explanation of how the SSM works. In § 4, it is shown how SSM and RM integrate into the PA, and drawbacks of the RM model are discussed. In § 5, lexical redundancy rules are compared to relational rules in RM, to rules in realizational approaches, and to inheritance hierarchies such as those posited within HPSG. It is shown that lexical redundancy rules are either equivalent to or the precursors of all those approaches. Thus, all four types of relational mechanisms can be considered variants of each other. Further issues are discussed in § 6, including how idioms and compounds fit into the SSM.

2. The Parallel Architecture

The Parallel Architecture (Jackendoff 2002, 2007, 2013a,b, Culicover & Jackendoff 2005) is a framework for linguistic theory that consists of independent generative phonological, syntactic, and semantic components that interface with each other, as in (1). Note that while Jackendoff (2002) does not incorporate the lexicon as a component in representations that provide an overview of the entire PA architecture, such as (1), in Culicover & Jackendoff (2005) and Jackendoff (2007) the lexicon is seen as an interface component, as shown in (1). Furthermore, in Culicover & Jackendoff (2005) the PA is represented exactly as in (1), where "lexicon" refers to words, and "below the word level" refers to the interaction between bases and affixes. This is a representation that is more compatible with an analysis where the lexicon below the word level is central, and where morphology interfaces with the phrasal components via the word level, as discussed in the current study.
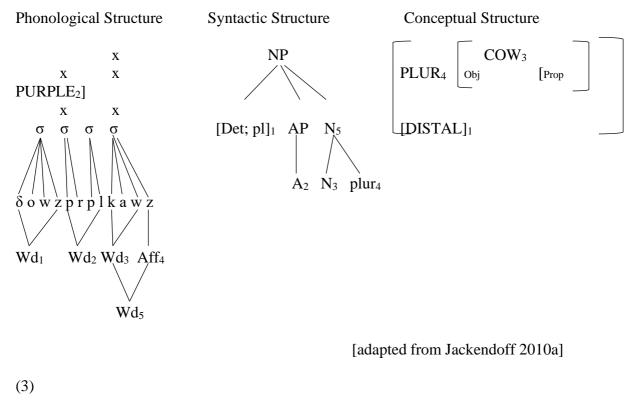
(1) The Parallel Architecture

Phonological   Syntactic   Semantic
formation   formation   formation
rules   rules   rules

Phonological ←→ Interface ←→ Syntactic ←→ Interface ←→ Semantic
structures   structures   structures

                    Interface

                LEXICON
                (word level)

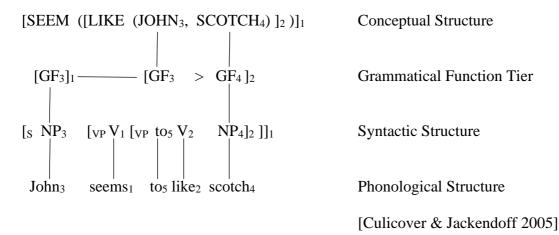[Jackendoff 2007, Culicover & Jackendoff 2005]

As noted by Culicover & Jackendoff (2005), a word is a triplet of phonological, syntactic and semantic structures (see 5 below) that acts as an interface constraint and plays an active role in the construction of sentences (see § 4). Each component in (1) consists of independent subcomponents called *tiers*, each with its own primitives and principles of combination. Just as the main components are linked via interface rules (1), the tiers are correlated with each other by interface rules as well (see (3) below). Phonological structure (2) consists of at least prosodic, syllabic, segmental, and morphophonological tiers, while syntax is composed of a phrase structure (or constituent structure) tier (2, 3) and a grammatical function (GF) tier (3).

(2)

Those purple cows

Phonological Structure   Syntactic Structure   Conceptual Structure

$$
\begin{array}{ccc}
 & \text{x} & \\
\text{x} & \text{x} & \\
\text{PURPLE}_2] & & \\
\text{x} & \text{x} & \\
\sigma \quad \sigma \quad \sigma \quad \sigma & &
\end{array}
$$

ð o w z p r p l k a w z

Wd$_1$ Wd$_2$ Wd$_3$ Aff$_4$

Wd$_5$

Syntactic Structure:

NP

[Det; pl]$_1$ AP N$_5$

A$_2$ N$_3$ plur$_4$

Conceptual Structure:

$$
\left[\text{PLUR}_4 \left[\begin{array}{cc} \text{COW}_3 & \\ \text{Obj} & [\text{Prop} \end{array} \right] \right]
$$

[DISTAL]$_1$

[adapted from Jackendoff 2010a]

(3)

John seems to like scotch

[SEEM ([LIKE (JOHN$_3$, SCOTCH$_4$)]$_2$)]$_1$ Conceptual Structure

[GF$_3$]$_1$ ———————— [GF$_3$ >   GF$_4$]$_2$ Grammatical Function Tier

[$_S$ NP$_3$ [$_{VP}$ V$_1$ [$_{VP}$ to$_5$ V$_2$ NP$_4$]$_2$]]$_1$ Syntactic Structure

John$_3$ seems$_1$ to$_5$ like$_2$ scotch$_4$ Phonological Structure

[Culicover & Jackendoff 2005]

Semantics (also called Conceptual Structure in PA terminology) consists of several tiers as well, including a descriptive tier (labeled CS, short for Conceptual Structure, and also called *propositional structure*), shown in (2) and also as the top tier in (3); a referential tier, an information structure tier, and other possible tiers pertaining to conversation, narrative, and discourse in general (Jackendoff 2002), all of which form part of pragmatics. Thus, in PA there is no strict dividing line between semantics and pragmatics. Furthermore, while in PA semantics is seen as providing the part of

conceptual structure of an utterance that is directly related to linguistic expression, (Jackendoff 2010a), there is no distinction between semantics and conceptual structure (Jackendoff 2002).

(4) shows a full sentence that illustrates the linking (interfacing) between structures. Note that the particle *to* has no instantiation in semantics. All the other lexical items in the sentence have a counterpart in semantic structure.

(4)   Sample sentence

Al likes to swim

Phonology: $æl_1$ $layk_2$-s_3 tuw_4 $swim_5$

Syntax: [s [NP N]$_1$ [VP [V V$_2$+[pres+3sg]$_3$] [VP to$_4$ V$_5$]]]

Semantics: [State PRES$_3$ [State LIKE$_2$ ([Person AL]$^a_1$, [Event SWIM$_5$ ([a])])]]
                                              [adapted from Jackendoff 2010a]

According to the PA, lexical items are stored associations of phonological, syntactic, and semantic information (Conceptual Structure), as shown in (5-7), that function as interface rules, establishing correspondences among all three components, as shown in (1).

(5)   Lexical entry of *cat*

Phonology   Syntax   Semantics

Wd$_i$ [N; 3 sing]$_i$ CAT$_i$

kæt   [Jackendoff 2007]

(6)   Lexical entry of plural suffix -*s*

Semantics: [PLUR$_i$ (X$_j$)]

Syntax: [N N$_j$ Af$_i$]

Phonology: [Wd Wd$_j$ /z/s/əz/$_i$]   [adapted from Jackendoff 2007]

(7)   Lexical entry of *cats*

Semantics: [PLUR ([CAT])]

Syntax: [Npl N, pl]

Phonology: /kæt/ /s/   [Jackendoff & Audring 2019]

Extracting the contribution of the word *cat* to (7), we get the *schema* for the English regular plural (8), in the style of Construction Morphology (Booij 2010). This schema, which represents a more abstract lexical entry, contains variables at all three levels, indicated by underlines. The variables are instantiated by lexical items.

(8)   Schema of plural suffix -*s*

Semantics: [PLUR ($\underline{X}$)]

Syntax: [Npl $\underline{N}$, pl]

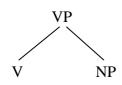Phonology: /$\underline{\ldots}$/ /z/   [Jackendoff & Audring 2019]

Put another way, the entry for *cats* (7) is the result of the unification of *cat* (5) and the plural suffix -*s* (8) (cf. J&A). *Unification* is a type of process or rule whereby pieces of structure stored in the lexicon are "clipped together" such that variables in schemas (8) are instantiated by other items (5) (J&A, see Shieber 1986). Unification is the single procedural rule in the PA framework; all other rules or structures are presented in a declarative, non-procedural format (Jackendoff 2002, Jackendoff & Audring 2019, J&A).

In the PA, idioms and phrase structure rules (9a) are also represented as pieces of stored structure, as in (9b), and are listed in the lexicon along with lexical items (words, affixes) in a common format. Thus, in the PA there is no strict distinction between lexicon and grammar. Grammar "rules" are pieces of stored structure, such as the lexical items above and (9b, 10), that act as constraints that can be used to check the well-formedness of structures. For example, the treelet in (10) can be used to check the well-formedness of part of a sentence. Note that (9b) is also considered a schema (Jackendoff & Audring 2019). Thus, schemas are representations at both the phrasal and lexical levels, and can also be expressed as treelets, as in (10).

(9)   Rules and schemas

a. VP → V NP

b. [VP $\underline{V}$ $\underline{NP}$]

(10)   Schema as a treelet

As in Construction Grammar, the PA (Jackendoff & Audring 2019) encodes rules of grammar as schemas: pieces of linguistic structure containing variables, but otherwise in the same format as words; that is, the grammar is part of the lexicon. Hence, as noted above, there is no principled distinction between the formalisms for words and for rules, which according to Jackendoff & Audring (2019) represents a

simplification of the repertoire of theoretical constructs. Except for unification, all morphological patterns in the PA are stated in terms of declarative schemas. Schemas are discussed in more detail in § 4.

Finally, Jackendoff (2010a, 2013a) provides several justifications for why the PA may be preferable to other models, in particular the Minimalist Program (Chomsky 1995) (and more generally mainstream generative grammar, also referred to as the classical architecture). Some of them are briefly discussed here to complete the sketch of the PA framework. Jackendoff begins by emphasizing the generative capacity of the semantic component (conceptual structure) in PA, and cites this as an advantage when compared to both the Minimalist Program and Cognitive Grammar (Langacker 1987), which represent extremes. In the Minimalist Program the combinatorial properties of semantics (and phonology) are derived from syntax, which means that there are no independent formation rules for the semantic component, and this puts the syntactic component under constant pressure for greater complexity to reflect the richness of semantic structure. On the other hand, in Cognitive Grammar all (or most) syntactic structure is derived from semantics, which eliminates or minimizes syntactic formation rules. According to Jackendoff, the PA strikes the proper balance between these two extremes.

The PA also distinguishes itself from other influential theoretical frameworks in the incorporation of both semantic and pragmatic tiers. Neither the Minimalist Program nor HPSG (Pollard & Sag 1994), for example, organize linguistic structure in tiers; and while HPSG integrates pragmatics into linguistic representations, the Minimalist Program does not postulate a component devoted to pragmatics.

Furthermore, according to Jackendoff (2013a), the PA is preferable to the classical architecture in that in PA competence (knowledge of linguistic structure) is put to work directly in performance (language processing), making the theory lend itself to a more direct relation between competence and performance than the classical architecture does (see also Jackendoff 2015). For example, in the PA, principles of grammar are used directly by the processor and, unlike the classical architecture, there is no movement metaphor involved in the formation of linguistic structures. These consequences for processing follow from the fact that the classical architecture is both derivation-based (the structure of a sentence is produced through a step-by-step algorithmic process) and inherently directional. In contrast, the PA is constraint-based and logically nondirectional. Jackendoff argues that because of this difference in directionality, while the PA grammar is not inherently biased toward either perception or production, the classical architecture is inherently biased against both.

Finally, while the classical architecture maintains a strict formal distinction between the lexicon and rules of grammar, in the PA, as seen above, there is no strict distinction between lexicon and grammar; words and phrases are stored in the lexicon in a common format. According to Jackendoff, these features of the classical architecture stand in the way of making a robust connection from linguistic theory to theories of processing.

3. The Slot Structure Model (SSM)

The SSM is an approach to morphology based in part on Lexical Conceptual Structure (LCS) (Jackendoff 1990, 2002, Rappaport & Levin 1988, 1992) that explains the

process of [base+affix] unification in regular word formation in Spanish (e.g. *demoli+cion* [*demolición* 'demolition']) and other languages, and is crucially based on the notion of lexical entries instantiated in a slot structure. Employing the mechanisms of subcategorization/selection (subcat/select) and percolation, already available in the generative framework (cf. Lieber 1992, 1998, Pinker 2006, Pinker 1999, Pinker & Ullman 2002, Huang & Pinker 2010), the model unifies all the processes that take place during the formation of a complex word (e.g. *plega+ble* [*fold+able*] 'foldable').

It is important to note that, as mentioned above, unification is the single procedural rule in the PA framework. J&A note that, as such, it manipulates pieces of structure, turning an input (the elements being combined) into an output structure. These two terms, *input* and *output*, are used frequently in what follows, due to the role of unification as a procedural rule. (Note that J&A also use the terms *input* and *output* when discussing the generative role of schemas.) Likewise, the terms *derived*, *derivative*, and *derivation* refer to the outcome of the process of unification.

Crucial to the SSM is that percolation, subcat/select, and slot structure, acting in concert determine the structure and content of the lexical entries of derivatives (i.e. words formed by morphological derivation, such as *demoli+ción*) and allow for predictions to be made about the behavior of groups of features in the formation of a word. Percolation in particular, as shown by Pinker (1999) and Pinker & Ullman (2002), is key to account for compositionality in word formation. Huang & Pinker (2010) call percolation *information-inheritance* and stress the need for this mechanism in morphology, both in inflection and word formation. For example, percolation is needed to explain why certain verbs and nouns that presumably should be irregular, are consistently regularized by speakers (e.g. **flied** *out instead* of **flew** *out*; **ringed** *the city* instead of *rang*; *low lifes* rather than *low lives; *wolfs* (instances of wolfing down food) rather than *wolves).

With these and many other examples, as well as with corpus studies and psycholinguistic/neurolinguistic experiments, Pinker (1999, 2006), Huang & Pinker (2010) and Pinker & Ullman (2002) show empirically that when an affix is a part of a complex structure (sometimes acting as the head), percolation is inherently involved (in both inflection and word formation). Importantly, as seen below, there is no ordering in the application of percolation; thus, word formation in the SSM, just as the PA framework in general, is constraint-based and non-procedural, except for unification.

In addition to accounting for regular derivation, the SSM adequately accounts for regular inflection (e.g. *libro+s* 'book+s', *beb+o* [drink-1sg, pres.] 'I drink') (see § 3), as well as the regular derivational morphology of several languages genetically unrelated to Spanish (Mam, Turkish, Swahili) (see § 3), which suggests that the notions of percolation, subcat/select, slot structure and the LCS may be universal constructs. While the original formulation of the SSM (Benavides 2003, 2009) was supported by the analysis of over 1,250 derivatives (types) formed with more than fifty productive Spanish affixes, recently a corpus study was conducted to gather data on the Spanish suffix *-ble* in order to illustrate how the SSM works with a suffix that is mostly regular, but which presents some irregularity and polysemous variants (see § 3).

The SSM is a concatenative approach that accounts for regular morphology, but it accounts for irregular morphology as well through the adoption of Pinker's

(2006, 1999) dual-route model (also known as the dual-process model or words-and-rules theory; see also Pinker & Ullman 2002, Huang & Pinker 2010). The dual-route model posits that while regular forms (e.g. *work+er*, Sp. *completa+mente* 'completely') are computed by combinatorial rules, irregular, semiproductive, or unpredictable forms (e.g. *strength*, *salut+at+ion* vs. **salut+ion*, Sp. *resoluble* vs. **resolvible* (reg.) 'solvable') have to be memorized and are stored in a sort of analogical (associative, relational) network that is a part of the lexicon and implements lexical redundancy rules. Thus, when speakers hear or produce a complex word, they first attempt to form a derivative via the regular route (using SSM principles, see below), but if an irregular form already exists for that concept, the regular route is blocked and the irregular form stored in the lexicon takes over. The search for the stored form and the operation of the rule work in parallel, until one of them "wins."

For example, say a child wants to express the concept of "strongness" with a single word, but has heard the word "strength" only a few times. The child will first attempt to form a derivative using the regular, combinatorial rule (*strong+ness*). However, during this process the child may recall that the concept of "strongness" is already expressed by the (irregular) word *strength*, and will then utter this noun. That is, the regular route is blocked because of the existence of an irregular form stored in the lexicon. On the other hand, say, when the child tries to express the concept of "softness" and there is no irregular form that already exists for that concept, the regular route completes its course and the regular word *softness* is uttered. Note that no additional apparatus is needed by the SSM to implement this procedure.

Alegre & Gordon (1999) provide evidence that supports the dual-route model as applied to derivational affixation. Their results suggest that derivational morphology, much like inflectional morphology, shows dissociations between rule-based and associative generalization mechanisms. They found that words formed with certain (less productive) suffixes (*-ion*, *-al*, *-ity*, *-ous*, *-ic*) exhibit cluster (or gang, i.e. associative) effects, just like irregular inflected words (e.g. *ring-rang*, *sing-sang*, *drink-drank* generalize to *spling-splang*), while words formed with more productive suffixes (*-ize*, *-en*, *-ness*, *-able*, *-ment*, *-er*), much like regular inflection do not display such effects.

In addition, Vannest, Polk & Lewis (2005) found that decomposable (i.e. regular) derived words in English (formed with the suffixes *-ness*, *-less*, *-able*) showed increases in activity in regions of interest (Broca's area and the basal ganglia) relative to nondecomposable (i.e. irregular) suffixed words (formed with *-ity*, *-ation*), suggesting that, in accordance with the dual-route model, while regular forms are accessed from the mental lexicon as separate morphemes (base and affix), irregulars are accessed as whole units.

In Pinker's (2006, 1999) and Jackendoff's (2002, 2013b) concatenative approach, affixes are bound morphemes that have their own lexical entry with semantic, syntactic and phonological information. In addition, Jackendoff (2002, 2010) notes that there is psycholinguistic and neurolinguistics evidence for the concatenative approach to regular morphology, including the dual-mechanism analysis (items with regular morphology are produced by rule, while items with irregular morphology have to be listed). Furthermore, as Culicover & Jackendoff (2005) and Jackendoff (2002) observe, even though realizational approaches such as "lexeme based" or "word-and-paradigm" theories (cf. Anderson 1992, Beard 1995), where morphological rules are seen as operations on words, account well for irregular

phenomena (as does the dual-route model), by positing an individual rule per affix (which implies a fully inflected word per affix) they force the implication that entire inflectional paradigms consisting of thousands of forms (e.g. the verbal paradigms of Turkish) are stored in the lexicon inflected for every word (see examples of these lexical rules in § 4). As Pinker (1999) notes, in Turkish, Bantu, and many Native American languages there can be hundreds, thousands, or even millions of conjugated forms for every verb, for different combinations of tense, person, number, gender, mood, case, and so on, and speakers could not possibly have memorized them all in childhood.

　　　　In a similar vein, Hankamer (1989) found that parsing must be involved in the recognition of morphologically complex words and argued that the full-listing model (the word and paradigm theory) is untenable and cannot be an adequate model of natural language word recognition. He notes that in Turkish, the number of forms corresponding to a single noun or verb root (as in a paradigm) is considerably larger than would be consistent with the assumption that all forms are listed in a mental lexicon. In addition, as noted by Spencer (1991), realizational rules such as the ones discussed above, as well as Aronoff's (1976, 1994) lexical rules (see below), are once-only rules; once a word has been formed, it cannot be unformed, regardless of whether the word is new or unknown to most speakers. That is because they are entirely word-based, so both their input and output is a word that cannot be broken down into parts that can be stored or analyzed separately. Thus, all outputs of lexical rules have to be stored, and in this they share a disadvantage with rules in the word and paradigm approach, with all the drawbacks outlined above (see more below). This is in contrast to concatenative morphology, where, while frequent regular forms may be redundantly stored in the lexicon (Jackendoff 2013a, Plag & Baayen 2009) (see § 4), derivatives can be formed on the fly and be used just for the needs of the moment, without having to be stored.

　　　　Aronoff's (1976) lexical rule shown in (11) is one of the first realizational rules in the morphological literature (Aronoff calls them word formation rules (WFRs)). This model treats affixes as rules, that is, WFRs are lexical rules that attach an affix to a base making reference to, and affecting the morphosyntactic, semantic and phonological information of the base. The affix introduced by the WFR is an operation on the base and is not considered a lexical item. The restrictions on the attachment of the affix, as well as the syntactic and semantic operations are expressed as part of the rule in the form of conditions or statements, as shown in (11).

(11)　　Aronoff's WFR for *-able*
　　　　a. [read]V $\rightarrow$ [[read]V + able]A
　　　　　　Condition: The base [X] is transitive
　　　　　　Syntax: The object argument of [X] corresponds to the subject of [Xable]
　　　　　　Semantics: 'capable of being read'
　　　　　　　　　　　　　　　　　　　　　　[adapted from Aronoff 1976]

Note that while the category change is reflected in the rule itself, changes in argument structure have to be stated; they do not follow from other principles or structures. Each WFR has to be stated separately for each affix.

According to Spencer (1991), one of the main justifications for realizational approaches is multiple exponence, that is, the expression of a feature (or function, say [Plural]) by several affixes or exponents (i.e. the form, say plural suffixes). For example, *-s*, *-ae*, *-a*, and *-en* are seen as the affixes expressing plural in *cats*, *algae*, *paramecia*, and *oxen*, respectively, and [Plural] is also expressed in umlauting, such as in *foot-feet* and *goose-geese*. The same can occur with word formation. For instance, the feature [+Nominalization] can be expressed with the suffixes *-tion* and *-ing*, as in *destruction of the city* and *writing of the book*, respectively (see also Montermini 2019.)

However, as seen from the description of the dual-route model above, there is no need to posit more than one, default, regular affix for the plural (*-s*) or rules that convert *foot* to *feet*. All plurals not formed with *-s* (e.g. *paramecia*, *oxen*, *feet*) are irregular and thus are stored in an associative network along with their singular forms (or roots), just as *sang* and *sung* are stored with their root *sing*. Some of the forms with irregular endings (*algae*, *paramecia*) were in fact inherited as wholes form Latin or Greek along with their roots (*alga*, *paramecium*). As for derivational affixes such as *-tion* and *-ing*, they can be considered synonymous when they both bring about a nominalization, and if each one has more than one function or meaning, they are considered polysemous or homonymous (see § 3.9). Conversion is also seen as a justification for realizational models, and in § 3.8 it is shown that conversion is also accounted for in a way that is consistent with the principles underlying the SSM/dual-route approach.

More recently, J&A express a similar objection to realizational rules. They hold that a lexicon that contains full paradigms of all inflectable words is suspicious from a psycholinguistic perspective. According to J&A, in addition to the implication that speakers of massively inflected languages (such as Turkish, Archi or Dalabon) store millions of forms for every verb, the question arises of how all those forms got there. If what one stores is entire paradigms, then at the first encounter with a single inflected form of a novel verb, one must generate all the other hundreds or thousands of forms on the spot, to be stored away in case one might encounter them someday. For J&A this too seems improbable. In addition, Schiller & Verdonschot (2019) note, from a neurolinguistics perspective, that a full-form (i.e. whole-word) representation of morphologically complex words yields substantial problems and maybe is to be considered implausible. In contrast, in concatenative models, when one learns a new base form (say, a verb), one can generate any productive form online by freely combining the base with a stored inventory of affixes.

Furthermore, the psycholinguistic and neurolinguistic studies mentioned above provide evidence for the parsing of morphologically complex words, and provide strong support for the view of affixes as lexical items that combine with lexical bases and contribute their information to the resulting derivatives.

The arguments against realizational rules presented above are particularly strong if the goal is to explain linguistic phenomena in mentalist terms, as does the PA (cf. Jackendoff 2010a, 2015, J&A). Approaches based on lexical rules and paradigms may work with a significant amount of data, but if they are not psychologically plausible (e.g. the implausibility of storing millions of forms for every verb), they do not provide a realistic explanation of the phenomena. This of course does not mean that they should be disposed of, because they contribute to the linguistic debate, but

this has to be an important factor to keep in mind when comparing them with concatenative approaches such as SSM.

Jackendoff (2013a) observes that his analysis of affixation, based on the use of diacritics, preserves Pinker's (1999) dichotomy between regular affixation and irregular forms. As in Pinker's account, in Jackendoff's (2013a) model irregular forms must be listed individually, whereas regular forms are constructed by combining with a base. In other words, Jackendoff's (2013a) is a dual-process model as well. The only difference is that while Pinker (1999) conceives of the regular plural as a procedural rule ("To form the plural of a noun, add -*s*"), in Jackendoff's account, the regular plural is at once a lexical item, an interface rule, and a rule for combining an affix and a base (unification), depending on one's perspective. (In Pinker 2006 there is no longer a specific "add -*s*" rule, only unification.) Semiproductive (i.e. irregular) affixes are marked with a diacritic to signal their irregularity. For example, a diacritic labeled *open* is used for productive forms, and one labeled *closed* for nonproductive or irregular ones. (In J&A, productive variables within schemas are marked *open* and nonproductive ones are marked *closed*.) Thus, Jackendoff's (2013a) processing model is compatible with the dual-route model.

The details and application of the SSM are explained in the following sections.

3.1 Slot Structure

Arranging features in a lexical entry in the form of a slot structure rather than just listing the features, allows predictions to be made about the behavior of groups of features during and after derivation. It will be seen that the slot structure of bases and affixes as proposed here is a crucial factor in the derivational process because it helps determine the structure of the lexical entries of outputs (derived words). The information contained in lexical items is organized into groups of features that act as information blocks that percolate as units to the branching node. This arrangement of blocks of information located within their respective slots constitutes the "slot structure" of each lexical item.

It is generally assumed (cf. Grimshaw 1990) that verbs, adjectives and some nouns have argument structures. Since these lexical items subcategorize and select for arguments, they must have, in addition to blocks that contain their ontological, categorial, and core semantic information (see below), blocks that contain syntactic subcategorization and selectional information. Inasmuch as verbs, adjectives, nouns and affixes differ idiosyncratically in their featural content and argument structure, they must also differ in their slot structure. Thus, the idiosyncratic information contained in lexical items is what determines their slot structure.

The idea of a slot structure containing idiosyncratic information is compatible with the notion of an LCS. The LCS is the place in the lexical entry of an item where the syntactically relevant semantic content of the item is encoded (cf. Rappaport & Levin 1988, Jackendoff 1983, 1990, Speas 1990). The LCS is defined as the decomposition of the meaning of a word into conceptual primitives (e.g. primitive predicates such as CAUSE and GO) which are related to arguments that occupy slots and are also characterized by means of conceptual primitives (e.g. ontological categories such as [THING] and [EVENT]). As Kornfilt & Correa (1993) point out, the LCS captures the core aspects of the meaning of a lexical item (that is, its core meaning), not the whole range of meaning associated with the item (i.e., encyclopedic information is not included in the LCS). For example, (12) is the LCS of the verb *put*.

(12)   LCS of *put*

PUT: $[_{EVENT}CAUSE ([_{THING}], [_{EVENT}GO ([_{THING}], [_{PLACE}AT [_{PLACE}]])])]$
                                                        [adapted from Jackendoff 1990]

The organization of lexical entries as slot structures proposed in this study is a natural extension of formulations of the LCS such as in Rappaport & Levin (1988), where arguments occupy slots, as well as of Grimshaw's (1990) use of slots that store argument and aspectual information. If some lexical information (i.e. argument structure) is stored in slots, it is not implausible to propose that all (non-encyclopedic) lexical information, including conceptual primitives, may be stored in such slots as well. Since non-semantic information (e.g. categorial features such as Noun, Verb) is stored in lexical entries as well, it is natural to assume that this information is also stored in slots. Thus, slot structure contains the LCS and other idiosyncratic information stored in lexical entries.

In SSM, the LCS is represented in the form of semantic features within feature blocks which may percolate, along with blocks containing morphosyntactic features, to the mother node in a derivative. The percolation of feature blocks from a head and a nonhead to a branching node (as illustrated below) explains the layering of meaning as well as the addition or deletion of semantic primitives and slots that Lieber (1992) describes as taking place in the LCS when affixation occurs. Lieber's (1992) own notions of Head and Backup Percolation (as modified below) can handle the percolation of all types of features, including semantic features and those related to argument structure.

3.2. Composition of Slot Structure

What follows is a description of the contents of the slots and blocks that make up slot structure, and how these components are organized in a lexical entry.

CATEGORIAL Slot

The CATEGORIAL slot contains a block with the ontological and syntactic categories of bases and suffixes. These two types of features have been placed together in this slot given the close link between the two. Although a considerable number of nouns can be characterized by the feature [THING], this is not so with most abstract nouns. Nouns such as *crisis*, for instance, might best be defined by the feature [STATE], while nouns such as *jump* could take the category [EVENT] (cf. Jackendoff 1983). Nevertheless, there is a strong tendency for there to be a direct correspondence between syntactic category and ontological category. Grimshaw (1981) hypothesizes that certain semantico-cognitive categories such as "object" (THING) and "action" have a Canonical Structural Realization (CSR), the assignment on a one-to-one basis of a syntactic category to a word of a certain semantico-cognitive type (what Jackendoff (1983) terms "ontological category"). Thus, "objects" are prototypically assigned the category N, "actions" are assigned the category V, and "paths" or "directions" are assigned the category P. As Jackendoff (1990) points out, the CSR applies in the unmarked case. The CATEGORIAL slot instantiates the CSR (see Jackendoff 1990 for a similar definition of the CSR).

CORE Slot

The CORE slot contains a block with the core semantic features of bases and suffixes, which include classemes, semes, general features, and primitive predicates. The most common types of semantic features discussed in the literature on componential semantics are "classemes" and "semes." Traditionally, the following features have been considered the typical classemes: [±concrete], [±animate], [±human], [±adult], [±male], [±female]. Binary features such as the following have traditionally been called "semes": [±has a back], [±has four legs], [±is made of wood], [±has stripes]. (cf. Coseriu 1977, Lyons 1977, Katz & Fodor 1963). Classemes and semes do not appear to be sufficient to characterize the meanings of the items involved in derivation. It seems necessary to recognize "general features" such as Abundance, Similarity, Contusion, Occupation, Habitual, Collective, Repetition, Support/Follower, Having, Container, Location, and Instrument as features that designate abstract semantic notions that form part of the core meaning of a significant number of derivational suffixes and other lexical items.

Note that the term "general features" is used for ease of reference and not as a formal term. What I am calling "general features" are features which have been used in lexical semantics, but which have not been given a specific label as a group (they are usually called "semantic notions," "concepts" or "meanings" (see Jackendoff 1983). No consensus has been reached in the literature as to a particular classification of these features, and this study does not attempt a formal classification either. Finally, as noted above, primitive predicates are features such as CAUSE and GO which are associated with arguments in LCS (cf. Jackendoff 2002).

ARGUMENT Slots

The ARGUMENT slots contain blocks with the syntactic selectional information of verbs, adjectives, nouns that take arguments, and certain suffixes. Since this model makes a semantic rather than syntactic distinction between arguments, the external and internal arguments will be labeled ARGUMENT I and ARGUMENT II, respectively.

Aspectual features (e.g. TELIC, INCHOATIVE) (cf. Levin 1993) have been employed in the literature to characterize lexical aspect, that is, Aktionsart, and event structure, including the beginning, duration and endpoint of an event. Dowty (1979), Grimshaw (1990), and Pustejovsky (1992, 1995), for example, employ features such as ACTIVITY, PROCESS, STATE, RESULT, CHANGE OF STATE to decompose the meanings of verbs in order to distinguish event types such as "accomplishments," "achievements," "activities," and "states" (cf. Tenny 1994, Vendler 1967).

Since this study incorporates a modified version of Grimshaw's (1990) notion of "aspectual prominence" in the analysis of derivation, aspectual features are seen to play an important role in lexical entries, and in derivation in general. The derived form contains an aspectual feature that is different from the aspectual feature of the base. Consider for instance the suffix *-ecer* in *palid+ecer* 'to become pale', which has the feature CHANGE OF STATE, a feature that is different from the feature STATE of its base *pálido* 'pale'.

Other cases where the relevance of aspectual features in derivation can be observed is in forms such as *infl+able* 'inflatable' from *inflar* 'inflate' and *pleg+able* 'foldable' from *plegar* 'fold', where an aspectual feature that appears in the base is no longer present in the derivative. For instance, *inflar* in *infl+able* has two arguments,

the agent, associated with the ACTIVITY of inflating, and the patient (e.g. a ball), associated with the STATE of being inflated (cf. Grimshaw 1990). In *infl+able*, however, where reference is made only to the patient (the ball), the aspectual feature associated with the agent of *inflar* (ACTIVITY) is not a part of the lexical entry. Examples where aspectual features are relevant are presented in derivational trees below.

The arrangement of ARGUMENT slots proposed in this model coincides with, and is based in part on Grimshaw's (1990) theory of argument and aspectual prominence, which makes a semantic distinction between what are traditionally called external and internal arguments. Grimshaw suggests that argument structure is organized on the basis of a scale (or template) of argument prominence and a scale of aspectual prominence. The argument scale is characterized by the relative prominence of arguments in argument structure, the most prominent argument being the external argument. According to Grimshaw, argument structure is a lexico-syntactic representation assembled from a set of elements identified by the LCS.

According to Grimshaw, aspectual prominence is determined by event structure. An event structure is commonly composed of two subevents, the first (or initial) and more prominent subevent being an activity or a process, the second (or final) and less prominent subevent a state or change of state. For Grimshaw, the argument and aspectual prominence scales are related in that each one of the arguments in argument structure is associated with a subevent in event structure (cf. Pustejovsky (1992, 1995), Tenny 1994, and Smith 1991 for more elaborate views of event structure). The argument linked to the initial subevent tends to be more prominent (usually the external argument) than the argument linked to the second subevent (e.g. the internal argument). Grimshaw argues that each argument linked to a subevent occupies a slot in the aspectual prominence scale. This strong association between argument and aspectual structure is adopted here and reflected in the derivational trees presented below.

Rappaport & Levin (1992) likewise support a semantic distinction between the external and internal arguments of a predicate on the basis of an apparent strong link between the external argument and a prominent event position. And, like Grimshaw, Pustejovsky (1995) favors the inclusion not only of argument structure but also event structure into the representation of lexical entries.

While there have been critiques of Grimshaw's (1990) theory of argument structure (cf. Zaenen & Goldberg 1993) and there are more recent proposals on the relationship between argument structure and aspectual structure (e.g. Croft 2009), including those based on a syntactic analysis of morphological processes (Harley (2012a, 2012b, 2015), Borer (2005a, 2005b, 2013), for the purposes of the present study, Grimshaw's (1990) model works well as an approach that contributes to explain the function of lexical entries in word formation and other processes, and, more importantly, does not lead to any contradictions.

Dowty's (1991) theory of thematic proto-roles helps support the semantically-based distinction between external and internal argument proposed by Grimshaw. Dowty argues that theta-roles are not primitives, and proposes that the only theta-roles are two fuzzy, non-discrete conceptual categories called Proto-Agent and Proto-Patient, each of which is characterized by a cluster of properties related to the event denoted by the predicate, as shown in (13).

(13)   Contributing properties for the Proto-Agent
        a. volitional involvement in the event or state
        b. sentience (and/or perception)
        c. causing an event or change of state in another participant
        d. movement (relative to the position of another participant)

        Contributing properties for the Proto-Patient
        e. undergoes change of state
        f. causally affected by another participant
        g. stationary relative to movement of another participant
                                            [adapted from Dowty 1991]

        Arguments differ in the degree to which they bear each proto-role, as determined by the Argument Selection Principle, presented in (14).

(14)   Argument Selection Principle (ASP)

        The argument with the greatest number of Proto-Agent properties will be the subject (ARGUMENT I), while the argument with the most Proto-Patient properties will be the direct object (ARGUMENT II).
                                            [adapted from Dowty 1991]

        Dowty argues that theta-role hierarchies follow from his two proto-role definitions (13). Proto-Agent-like arguments, that is, arguments (such as Agent, Causer or Experiencer) which have Proto-Agent properties will tend to be higher in the hierarchy than Proto-Patient-like arguments (e.g. Theme). Dowty also claims that the unergative/unaccusative distinction in verbs corresponds semantically to the Proto-Agent/Proto-Patient division, with unergative arguments tending to be Proto-Agents (e.g. the argument of *swim*), and unaccusative arguments Proto-Patients (e.g. the argument of *arrive*).

PARTICIPANT Slot
        According to Grimshaw (1990), participants are the entities related to a predicate. However, not all entities are equally important. While arguments are participants that stand in a grammatically significant relationship to predicates, participants per se are entities implied by the situations in which the predicates are used, but are not as grammatically important as arguments. For example, as Grimshaw notes, even though the noun *exam* has no arguments, the existence of a participant—the person who created the exam—is implied. Grimshaw further notes that the LCS defines the set of participants (arguments included) involved in the meaning of a lexical item. Thus, the PARTICIPANT slot may be said to be a part of the LCS. The PARTICIPANT slot in the present model contains a block with information relative to the participants associated with a lexical item.

SUBCAT/SELECT Slot

The SUBCAT/SELECT slot contains a block with the morphological syntactic and selectional features of a suffix. Since suffixes are the items that subcategorize for the bases they attach to, it is suffixes, and neither bases nor derivatives, that have a SUBCAT/SELECT slot.

3.3. Sample Lexical Items

The sample entries below illustrate the lexical entries of verbs and suffixes whose featural content has been arranged in the slot structure described above. Note that although the slots in each lexical entry have been numbered, no ranking is implied. The slots have been arranged in an arbitrary order which, for ease of exposition and for the sake of consistency, is the order assigned to all lexical entries in the remainder of this study.

Two sample lexical items instantiating slot structure are shown below; (15) is the lexical entry of a transitive verb, and (16) shows the lexical entry of a derivational suffix. More lexical items are illustrated in the derivations shown in § 3.4. Note in (16) that the information in the SUBCAT/SELECT slot indicates that the suffix attaches to bases that have those semantic and syntactic features.

(15)   Sample verb

beber 'drink'

1 CATEGORIAL
    [EVENT]
    [+V, -N]

2 CORE   [+ingestion]

3 ARGUMENT I
    ACTIVITY
    Agent

4 ARGUMENT II
    CHANGE OF STATE
    Theme
    [+liquid]

(16)   Sample suffix

-izar 'cause'

1 CATEGORIAL
[EVENT]
[+V, -N]
2 CORE
CAUSE
3 SUBCAT/SELECT
[PROPERTY]__
[STATE]__
[+N]__
4 ARGUMENT I
Causer
5 ARGUMENT II
CHANGE OF STATE

In the next sections the implementation of the SSM is demonstrated.

3.4. Derivations

3.4.1. Modified Feature Percolation Conventions

Before showing derivational trees that illustrate how the SSM works, it is necessary to discuss percolation in some detail. Lieber's (1992) Percolation Conventions are taken as the basis for percolation in the SSM. The major modifications to Lieber's (1992) Percolation Conventions made in the present model consist of the incorporation of semantic features, and the organization of lexical information into slot structures. Because of this, the Modified Feature Percolation Conventions proposed here (17) involve a re-definition of the features that are allowed to percolate by Head and Backup Percolation, in answer to Lieber's (1992:77) question of "what features percolate, [and] where features are allowed to percolate from."

(17)   Modified Feature Percolation Conventions

a. Head Percolation: The affix (the head) percolates its non-subcat/selectional information (i.e. its CATEGORIAL, CORE and ARGUMENT slots and blocks) to the branching node.

b. Secondary Percolation: All the information blocks of the base (i.e. the CATEGORIAL, CORE, ARGUMENT, and PARTICIPANT blocks) percolate to the branching node and attempt to occupy slots. Once a slot has been occupied, a percolating information block may occupy that slot as long as it has compatible features (i.e. either morphosyntactic or semantic). If a percolating block does not find an empty or compatible slot, it may not occupy any slots in the output, and is discarded.

First, notice that Backup Percolation has been relabeled Secondary Percolation. The term "backup" implies that certain features percolate after other

features (head features) have percolated. However, as conceived in (17), the process of percolation does not imply any ordering in its application, but rather reflects the idea that Head Percolation takes precedence over the percolation of features from the base (Secondary Percolation).

Second, the notion of "compatible features" encoded in Secondary Percolation needs to be elaborated on. Aside from having to belong to the same type (morphosyntactic or semantic), features are compatible if they can coexist in a single slot without contradicting or canceling each other out. For example, since an entity cannot be both an [EVENT] and a [THING], nor a noun and a verb at the same time, the CATEGORIAL blocks of a base and a suffix cannot occupy the same slot. On the other hand, since the features that may be stored in the CORE slot (classemes, semes, general features, and primitive predicates) do not necessarily contradict each other, features from different CORE blocks may coexist in the same slot. Thus, "doubly-filled" slots (as when two CORE blocks occupy the same slot in a derivative) are allowed when there is feature compatibility.

Dowty's (1991) Argument Selection Principle (ASP) is incorporated into Secondary Percolation. Recall that the ASP states that the argument with the greatest number of Proto-Agent properties will be ARGUMENT I, while the argument with the most Proto-Patient properties will be ARGUMENT II. Thus, assuming that the ASP is encoded in Secondary Percolation, Proto-Agent-like arguments, being more compatible with an ARGUMENT I, will occupy the ARGUMENT I slot, while Proto-Patient-like arguments, being more compatible with an ARGUMENT II, will fill the ARGUMENT II slot. In this way, the ASP can be viewed as a refined form of the compatibility specified for Secondary Percolation.

Secondary Percolation entails that the CORE, ARGUMENT, and PARTICIPANT blocks of the base may occupy slots in the output after having percolated. The CATEGORIAL block of the base will not occupy the CATEGORIAL slot of the output because that slot is already filled by the CATEGORIAL block of the affix. The CATEGORIAL block of the base cannot occupy any other slots (i.e. the CORE or ARGUMENT slots) because of feature incompatibility. The CATEGORIAL block of the base therefore cannot occupy a slot in the output and is discarded. If the slot structure of the suffix provides only one or no ARGUMENT slots, some of the ARGUMENT blocks of the base will not find any slots to occupy and will be discarded as well.

Head Percolation entails that the affix imposes its slot structure on the output, with the final location of each block in the derivative being dictated by this slot structure. That is, once head features percolate (within information blocks), they determine what features of the base and affix will occupy what slots in the branching node. The slot structure of the affix (the head) thus constrains the possible lexical content (i.e. slot structure) of the output. The changes in argument structure (e.g. suppression of an argument) are included in the changes brought about by the imposition of the slot structure of the affix on the output. Thus, there is no need to explain this suppression by employing rules which state, for example, that the affix "absorbs" or "binds" an argument. The suppression of arguments follows from the operation of percolation on slot structure. Head Percolation thus allows for predictions to be made about the feature composition and slot structure of the derivative, making the notion of "head" in this concatenative model a central concept.

Crucially, a head is characterized by the fact that it imposes its categorial features on the output, and affects argument structure by adding arguments or contributing to their suppression. It follows that the nonhead in a derivative can neither impose its categorial features on the output nor bring about changes in argument structure. In addition, the notion of head and the mechanism of Head Percolation give rise to the prediction that the features of the nonhead (the base) do not overrule the features of the head (the affix) in the output. In sum, the whole process just described can be conceived of as the percolation of both morphosyntactic and semantic information in parallel fashion from the head and nonhead to the branching node, with the features of the head preempting those of the nonhead.

The application of feature percolation is demonstrated with derivational trees in the following section.

3.4.2. Derivational Trees

The trees in this section show derivations with Spanish bases and suffixes. They demonstrate that when the information in the lexical entries of bases and affixes is organized into slot structures, predictions can be made about the organization of information in derivatives, including their argument structure.
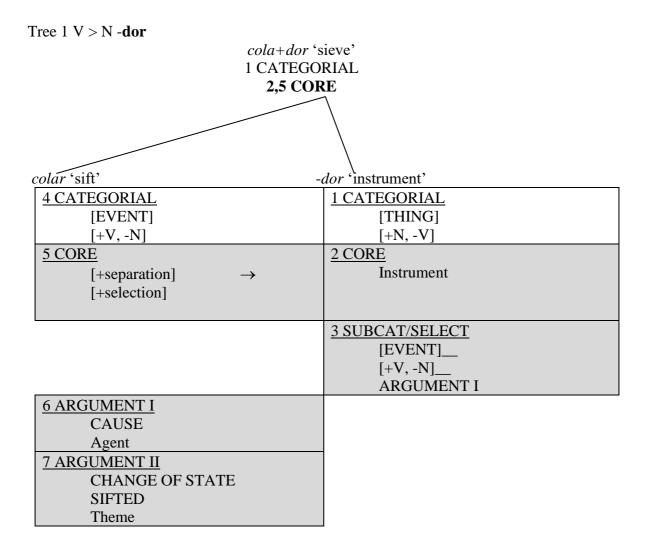
3.4.2.1. Suppression of Arguments

What follows is a description of Tree 1, a derivation with the suffix *-dor*. The slots in the output that contain information blocks that have percolated to the branching node by Head Percolation have been set in boldface. To facilitate interpretation, arrows have been placed in lexical entries to indicate the filling of a given slot in the output by a given block. For example, in Tree 1, the arrow in the CORE block of the base signals that that block occupies the CORE slot in the output.

As noted above, the LCS, which contains semantic information and from which argument and aspectual structure derive, is itself contained within slot structure. In the derivational trees, the shaded areas represent the LCS of each lexical item. The CATEGORIAL slots, which contain syntactic information, are a part of slot structure but not of the LCS. The slots in each lexical entry are ordered vertically rather than horizontally in order to facilitate the representation of the unification of the lexical entries of the base and suffix. Slots for arguments that are empty have been labeled but not numbered. In order to make clearer the relation between the conventional (horizontal) LCS representation and the vertical one illustrated in the trees below, consider the LCS (in simplified notation) of *colar* 'sift' in (18) as compared to the LCS in Tree 1.

(18)   colar 'sift': [x CAUSE [y BECOME SIFTED]]

The first subevent, with its accompanying argument, [x CAUSE], corresponds to block 6 in the tree, while the second subevent, [y BECOME SIFTED], corresponds to block 7. Block 5, the CORE block, as its name indicates provides the core meaning of *sift*. Features such as CHANGE OF STATE, in slot 7, represent the association between arguments and aspectual features. The terms Agent and Theme are used merely as labels for arguments. The same relation between the horizontal LCS and the vertical LCS should be interpreted for the remaining trees below.

Tree 1 V > N -**dor**

cola+dor 'sieve'
1 CATEGORIAL
2,5 CORE

colar 'sift'   *-dor* 'instrument'

4 CATEGORIAL [EVENT] [+V, -N]	1 CATEGORIAL [THING] [+N, -V]
5 CORE [+separation] → [+selection]	2 CORE Instrument
	3 SUBCAT/SELECT [EVENT]__ [+V, -N]__ ARGUMENT I

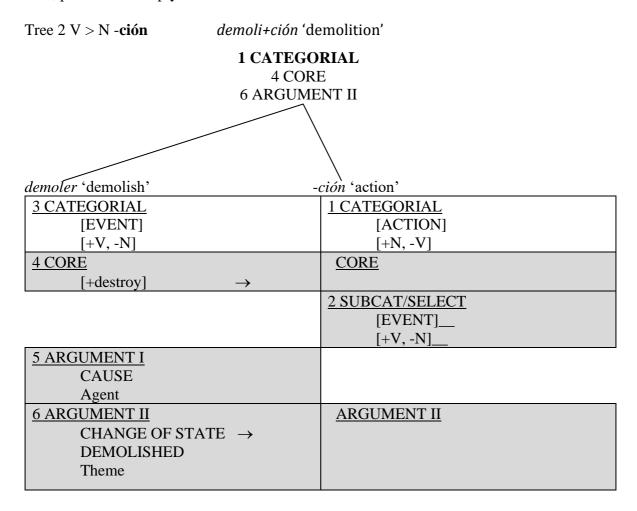| 6 ARGUMENT I CAUSE Agent |
|---|
| 7 ARGUMENT II CHANGE OF STATE SIFTED Theme |

Since the verb (*colar*) is an event composed of two subevents, each one of the two ARGUMENT blocks of the base represents an argument associated with a subevent. Even though the two ARGUMENT blocks percolate to the branching node by Secondary Percolation, they cannot occupy slots in the output because the output, being a noun without an argument structure, does not have ARGUMENT slots. The failure of the two ARGUMENT blocks of the base to find slots in the output represents the operation where the LCS of the suffix completely "deletes" or "suppresses" the argument structure of the base. This is one of the ways in which Head and Secondary Percolation determine the interaction between the LCSs of the lexical items that participate in a derivation, and determine the argument structure of the output. Note further that the CORE slots of the base and suffix contain the non-argumental semantic features of the LCS, to give the meaning 'instrument for sifting', which is the core definition of a sieve. Notice as well that the derivative, *colador*, now has the categorial features of the suffix (Noun), due to Head Percolation.

The question may arise whether the noun *colador* (or its equivalent in Hispanic America, *coladora*) actually lacks nominal arguments (as shown in the tree above), unlike, say, *driver*, which can appear in phrases such as *driver of a truck*, retaining the ARGUMENT II from the base, expressed as a prepositional object. A search in the Web/Dialects section of the Corpus del Español (CDE, Davies 2002-), which contains

2 billion words of Spanish taken from web pages, showed no instances of *coladora* with a prepositional object, and while *colador* 'sieve' did appear in the corpus in phrases such as *colador de café* 'coffee strainer', they were very few; the vast majority of examples were cases where the noun that follows the preposition is a modifier, not an argument, of the main noun (e.g. *colador de metal* 'metallic sieve'). Although one can find forms such as *colador(a) de café* from a Google search, given the corpus results it seems that the word *colador(a)* without arguments is the standard form. (See more details on the use of the Web/Dialects corpus to gather other data in § 3.)

Finally, notice in Tree 1 how the SUBCAT/SELECT block specifies that the suffix may only attach to verbs that have an ARGUMENT I block. This ensures that derivatives formed with, say, unaccusative verbs are ungrammatical (e.g. **caedor* 'instrument for falling' < *caer* 'to fall' or **gotea+dor* 'instrument for dripping or for producing drops' < *gotear* 'to drip').

Tree 2 represents a complex event nominal derivative. Notice that the suffix, -*ción*, provides an empty ARGUMENT II slot but no ARGUMENT I slots.

Tree 2 V > N -**ción**   *demoli+ción* 'demolition'

1 CATEGORIAL
4 CORE
6 ARGUMENT II

demoler 'demolish'   -*ción* 'action'

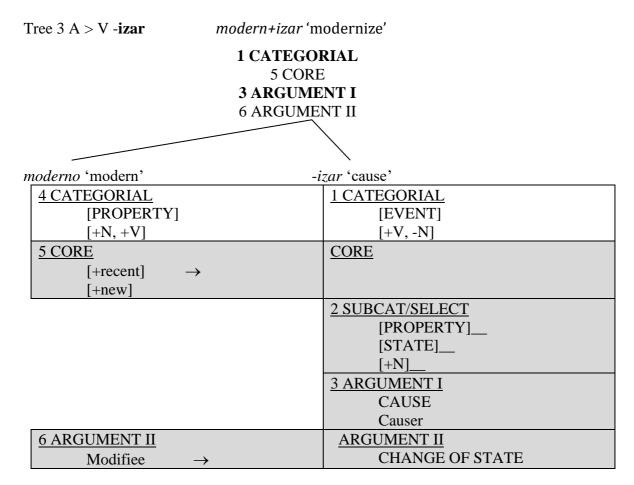| 3 CATEGORIAL
    [EVENT]
    [+V, -N]
	1 CATEGORIAL
	    [ACTION]
	    [+N, -V]

4 CORE [+destroy] →	CORE

	2 SUBCAT/SELECT
	    [EVENT]__
	    [+V, -N]__

5 ARGUMENT I
    CAUSE
    Agent	

6 ARGUMENT II
    CHANGE OF STATE   →
    DEMOLISHED
    Theme
	ARGUMENT II

Since the ARGUMENT II of the base remains Proto-Patient-like in the output, according to the ASP this argument must fill the ARGUMENT II slot of the output. Since the branching node does not have any more ARGUMENT slots, the ARGUMENT I block of the base cannot occupy a slot in the output and is discarded.

Thus, after the unification of LCSs, only one argument occupies a position in the output.

Deverbal nouns such as *demoli+ción* 'demolition' and *entrena+miento* 'training' (from *entrenar* 'train') lead to questions about the status of *by* phrases and possessive subjects in nominal derivatives. Following Grimshaw (1990), I adopt the position that the *by* phrase in constructions such as *The destruction of the city by the enemy*, and the possessive in *The enemy's destruction of the city* are both "a-adjuncts" (argument adjuncts). This explanation also accounts for cases such as *mi demolición de la nave* 'my demolition of the ship' and *su adaptación de la novela* 'his/her adaptation of the novel', where the possessive adjective (*mi*, *su*) acts as an a-adjunct, paralleling the possessive constituent in *The enemy's destruction of the city*. For Grimshaw, a-adjuncts have an intermediate status between arguments and adjuncts. She argues that while a-adjuncts resemble arguments in that they provide information about positions in argument structure, they are like adjuncts in that they fail to satisfy argument structure positions and are not theta-marked. Grimshaw explains that since a-adjuncts are in effect not required in order to satisfy argument structure, they occur optionally. Thus, in Tree 2, the derivative, *demolición*, is shown as not having inherited the ARGUMENT I from the base.

3.4.2.2. Addition Accompanied by Transference of Arguments
Next consider the derivation in Tree 3, with the suffix *-izar*. Here the suffix provides a filled ARGUMENT I slot to the output, and the base ARGUMENT II block fills the ARGUMENT II slot of the output.

Tree 3 A > V **-izar**   *modern+izar* 'modernize'

<div align="center">

1 CATEGORIAL
5 CORE
3 ARGUMENT I
6 ARGUMENT II

</div>

moderno 'modern'   *-izar* 'cause'

4 CATEGORIAL
    [PROPERTY]
    [+N, +V]
	1 CATEGORIAL
	    [EVENT]
	    [+V, -N]

5 CORE
    [+recent]   →
    [+new]
	CORE

	2 SUBCAT/SELECT
	    [PROPERTY]__
	    [STATE]__
	    [+N]__

	3 ARGUMENT I
	    CAUSE
	    Causer

6 ARGUMENT II
    Modifiee   →
	ARGUMENT II
	    CHANGE OF STATE

The single argument of the base, an ARGUMENT II, occupies the ARGUMENT II slot in the output because it remains Proto-Patient-like in the output (see below). This is a case where, on unifying, the LCSs of the base and suffix each contribute one argument to the derivation. Again, Head and Secondary Percolation determine the interaction between LCSs.

Giorgi & Longobardi (1991) distinguish between predicative and referential adjectives based in part on the entities (arguments or otherwise) that they are associated with. They note that while predicative adjectives (e.g. *elegant*, *nice*) predicate a property of the noun they modify, referential adjectives (e.g. *German*) express an external argument of the noun they accompany. According to Giorgi & Longobardi, while referential adjectives may be arguments in themselves, the entity associated with a predicative adjective is best seen as a "modifiee" rather than an argument per se. For example, while in *the elegant dress* the noun *dress* is a modifiee, in *the German invasion of Greece* the adjective *German* acts as an (agentive) argument of the noun *invasion*. Because *moderno* is considered a predicative adjective, its single argument is considered a Modifiee, rather than a more agent-like argument as in referential adjectives, and thus is considered Proto-Patient-like, as illustrated in Tree 3.
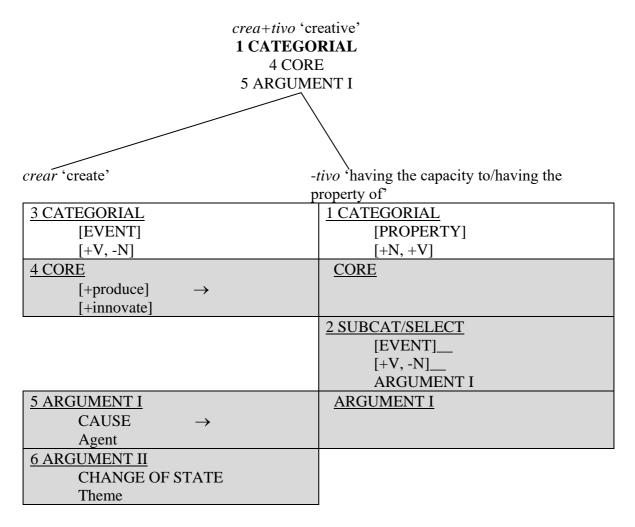
Notice in Tree 3 that the information contained in the SUBCAT/SELECT block indicates that the suffix *-izar* may attach to both nouns ([+**N**, -V]) and adjectives ([+**N**, +V]), as well as to bases which are either [PROPERTY]s or [STATE]s. Since in both types of derivation *-izar* has the same meaning (causation), it can be considered a single affix. However, *-izar* has other meanings (cf. Plag 1997 regarding English *-ize*), so this could be one of several polysemous affixes.

3.4.2.3. Transference of Arguments

In Tree 4, after the unification of LCSs, only one argument occupies a position in the output; it is the only position made available by the slot structure of the suffix. The ARGUMENT II block cannot occupy any slots in the output because there are none available, and is discarded. The ARGUMENT I block of the base remains Proto-Agent-like and occupies (i.e. is transferred to) the fully compatible ARGUMENT I slot of the output.

Note that two possible meanings have been given for *-tivo* in the tree below ('having the capacity to/having the property of'). In addition, in other complex forms such as *educa+tivo* 'educational,' the meaning for the suffix seems to be, more exactly, 'related to.' As with *-ize* above, *-tivo* could be one of several polysemous affixes, including the one that attaches to nouns (cf. *depor+tivo* 'related to sports' < *deporte* 'sport').

Tree 4 V > A -**tivo**

<div align="center">

crea+tivo 'creative'
1 CATEGORIAL
4 CORE
5 ARGUMENT I

</div>

crear 'create'   *-tivo* 'having the capacity to/having the property of'

3 CATEGORIAL [EVENT] [+V, -N]	1 CATEGORIAL [PROPERTY] [+N, +V]
4 CORE [+produce] → [+innovate]	CORE
	2 SUBCAT/SELECT [EVENT]__ [+V, -N]__ ARGUMENT I
5 ARGUMENT I CAUSE → Agent	ARGUMENT I
6 ARGUMENT II CHANGE OF STATE Theme	

Note that the same type of derivation occurs with other suffixes which have other functions in addition to their adjectival role, such as *-dor*, which is agentive (e.g. *cazador* 'hunter' < *cazar* 'hunt'). For example, *ganador*, as in *equipo ganador* 'winning team' can be considered an adjective (another example is *pregunta reveladora* 'revealing question'). Just like *líder* 'leader' in *líder creativo* 'creative leader', the word *equipo* 'team' in *equipo ganador* is the subject of the input verb (*ganar*) that remains in the output (*ganador*), after the object of that verb has been suppressed. This is one way of accounting for this type of formations; that is, to consider *-dor* an adjectival suffix, with the same function as *-tivo*. This would be a case of homonymy or polysemy, as *-dor* has other functions, for example as an instrument or agentive suffix (as seen above). For *ganador*, as in Tree 4, the ARGUMENT II of *ganar* 'win' is suppressed and the ARGUMENT I (*equipo*) is the only argument that percolates to the branching node.

A second option is to see it as a case of conversion (see § 3.8), where the noun *ganador* is converted into an adjective. However, in the *Diccionario de la Lengua Española* (DLE), only the adjectival sense is listed for *ganador*, and for *revelador* the adjectival sense is listed first, with a second sense being an agentive formation with a technical meaning. This suggests that the adjectival function for *-dor* is the best

explanation. Note as well that in *winning team*, the suffix *-ing* gives *win* the function of an adjective, lending support to the view that *-dor* is an adjectival suffix in addition to being agentive. This in turn leads to seeing *-ing* as a polysemous (or homonymous) suffix (see § 3.9).

The list in (19) summarizes the operations on argument structure that result from derivation, and which have been illustrated in the trees above. (As in the derivational trees, the arrows indicate transference by percolation of a base argument to a slot in the output.)

(19)   Summary of operations on argument structure

Suppression of one or more arguments (Trees 1, 2, 4)
Addition of an argument (by the suffix) (Tree 3)
ARGUMENT II → ARGUMENT II (Tree 2, 3)
ARGUMENT I → ARGUMENT I (Tree 4)

In the following subsections, more derivational trees are presented, each of which instantiates at least one of these operations.

3.5. Other Affixes, Other Languages

The model illustrated above accounts for derivational suffixation, and it has been extended, using the exact same tools and mechanisms, to other types of affixes (in Spanish and other languages), namely, derivational prefixes, passives, causatives, applicatives, expressive suffixes (e.g. diminutives), inflectional affixes, and parasynthetics. Just to give a general idea of the differences between the lexical entries of derivational suffixes, on the one hand, and those of derivational prefixes and inflectional suffixes, it can be noted that, unlike derivational suffixes, neither inflectional suffixes nor most derivational prefixes change the category or the argument structure of the base they attach to (cf. Lieber 1992) by imposing their own slot structure. This is especially true for inflectional affixes, which are never heads. There is a small minority of derivational prefixes which do act like heads, much like derivational suffixes, such as *pro-* in *proamnistía* 'pro-amnesty', which imposes its category (Adjective) over that of the base (usually a noun) on the output, and contributes an argument (e.g. *activistas proamnistía* 'pro-amnesty activists'). Examples with derivational trees are shown below.

In the previous section it was shown how the proposal developed in this study applies to regular derivational suffixation in Spanish. In this section, the proposal is extended to other types of affixes (in Spanish and other languages), namely, derivational prefixes, causatives, applicatives, expressive suffixes, and inflectional affixes. The chapter also demonstrates the application of the proposal to derivational suffixation in languages genetically unrelated to Spanish.
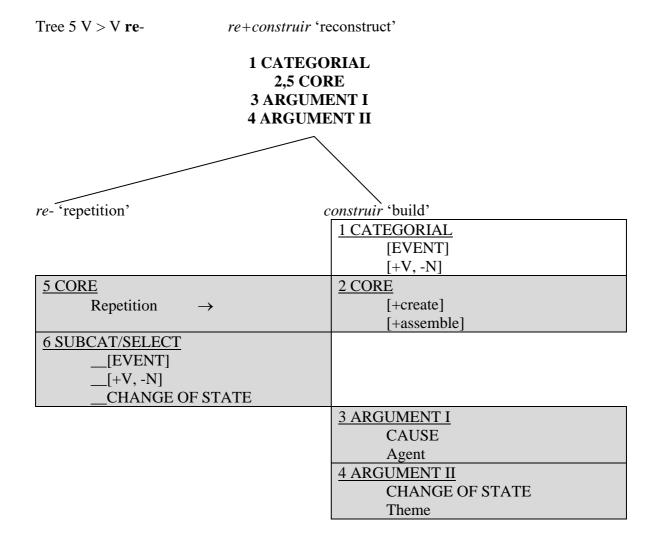
The discussion focuses on how the various types of affixes are differentiated by the information contained in their lexical entries, and the role that these entries play in generating complex words. Recall that a head is characterized by the fact that it imposes its categorial features on the output. In what follows several affixes are presented which do not change the category of the base, and thus are not considered heads. It is the category of the base that determines the category of the output, so the base is considered the head of the complex word in such derivations.

3.5.1. Derivational Prefixes

Only a few derivational prefixes change the syntactic or ontological category of their base (cf. Lang 2013, Scalise 1984). For those prefixes that do not change category, it is reasonable to infer that they do not contain any categorial information. For example, the prefix *co-* attaches to nouns that are [THING]s and yields output nouns that are [THING]s as well (e.g. *co+autor* 'co-author', *co+piloto* 'co-pilot'), and the prefix *des-* attaches to verbs that are [EVENT]s and yields output verbs that are also [EVENT]s (e.g. *des+acelerar* 'decelerate' < *acelerar* 'accelerate', *des+amarrar* 'untie' < *amarrar* 'tie'). Because these prefixes do not change the syntactic or ontological category of the base, they are not considered heads.

Certain prefixes may attach to more than one word class. If they have different, unrelated meanings, they can be considered homonymous. For example, the reversative prefix *des-*, which attaches to verbs (e.g. *des+acelerar* 'decelerate') has as its homonym the negative *des-*, which attaches to adjectives (e.g. *des+contento* 'unhappy' < *contento* 'happy'). Even though the two items *des-* attach to [+V] bases (verbs and adjectives), they are homonymous because of their difference in meaning. In contrast, if a prefix with a single meaning attaches to more than one word class, that prefix is considered a single item. For instance, although the prefix *co-* may attach to both nouns (e.g. *co+piloto* 'co-pilot') and verbs (e.g. *co+habitar* 'reside with' < *habitar* 'reside'), *co-* is considered a single prefix because in both cases it contributes the meaning Accompaniment.
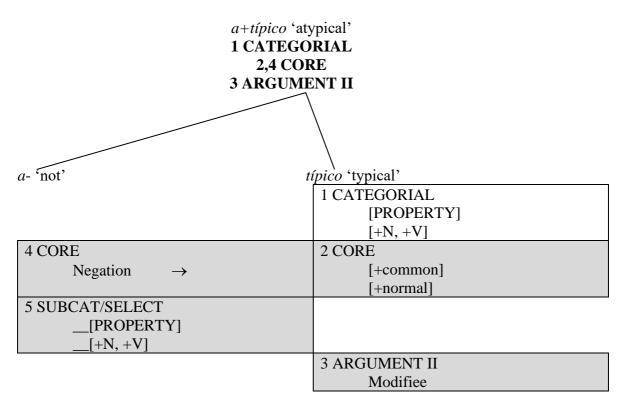
The derivation in Tree 5 shows a prefix that does not change the category of the base, and thus the base is the head of the complex word. The prefix does add semantic information (CORE block) to the output via Secondary Percolation.

Tree 5 V > V **re-**   *re+construir* 'reconstruct'

1 CATEGORIAL
2,5 CORE
3 ARGUMENT I
4 ARGUMENT II

re- 'repetition'   *construir* 'build'

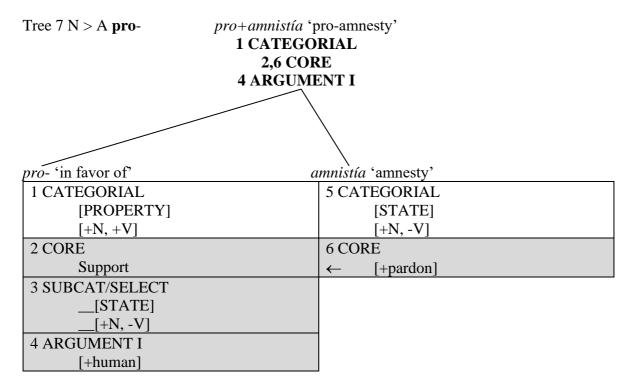|	
	1 CATEGORIAL 　　[EVENT] 　　[+V, -N]
5 CORE 　　Repetition　　　→	2 CORE 　　[+create] 　　[+assemble]
6 SUBCAT/SELECT 　　__[EVENT] 　　__[+V, -N] 　　__CHANGE OF STATE	
	3 ARGUMENT I 　　CAUSE 　　Agent
	4 ARGUMENT II 　　CHANGE OF STATE 　　Theme

Notice that the prefix does not affect the argument structure of the base. That is, the prefix neither adds an argument to the output nor contributes to the suppression of an argument of the base. This suggests that the prefix is not a head, since a head is characterized by the property that it imposes its slot structure on the output, thereby affecting argument structure.

As in Tree 5, in Tree 6 the prefix contributes only core information via Secondary Percolation, and does not affect the argument structure of the base (the head).

Tree 6 A > A **a-**

a+*típico* 'atypical'
1 CATEGORIAL
2,4 CORE
3 ARGUMENT II

a- 'not'   *típico* 'typical'

	1 CATEGORIAL [PROPERTY] [+N, +V]
4 CORE Negation $\rightarrow$	2 CORE [+common] [+normal]
5 SUBCAT/SELECT __[PROPERTY] __[+N, +V]	
	3 ARGUMENT II Modifiee

Unlike the prefixes in the two previous trees, the prefix in Tree 7 is the head and yields an output with both syntactic and ontological categories different from those of the base. The features of the base percolate via Secondary Percolation.

Tree 7 N > A **pro-**   *pro+amnistía* 'pro-amnesty'
                                1 CATEGORIAL
                                2,6 CORE
                                4 ARGUMENT I

pro- 'in favor of'   *amnistía* 'amnesty'

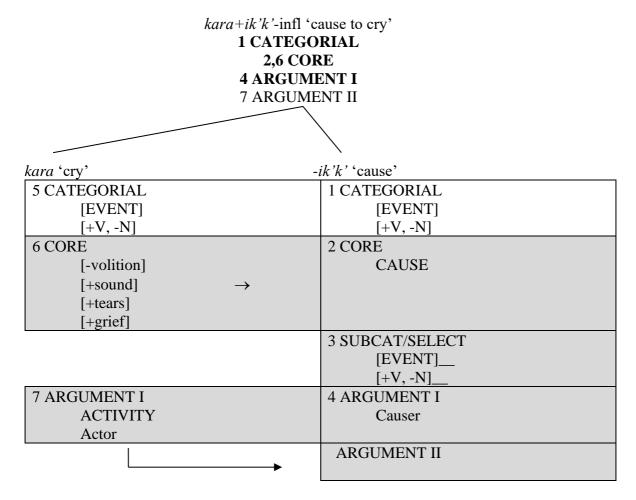| 1 CATEGORIAL [PROPERTY] [+N, +V]	5 CATEGORIAL [STATE] [+N, -V]
2 CORE Support	6 CORE $\leftarrow$ [+pardon]
3 SUBCAT/SELECT __[STATE] __[+N, -V]	
4 ARGUMENT I [+human]	

The prefix contributes a Proto-agent-like (and therefore ARGUMENT I) argument to the output, and the CORE block of the base occupies the compatible CORE slot contributed by the prefix to the output. Note that several participants could well be associated with the base *amnistía* (e.g. the people granting or benefiting from the amnesty). However, these participants are not relevant for the derivation and are therefore not represented.

3.5.2. Causative Suffixes

The core semantic information of causative affixes consists of the single primitive predicate CAUSE, which is associated with two arguments, a causer and a causee. The subcategorization information of causatives may make reference to both transitive and intransitive verbs. Causatives typically attach to bases that are [EVENT]s, but in certain languages (e.g. Malayalam, Madurese) they also attach to bases characterized by the ontological categories [PROPERTY] or [STATE]. In all cases, causatives yield [EVENT] outputs, which indicates that the causative affix contains the ontological category [EVENT] in its CATEGORIAL block (cf. Jackendoff 1983). Since [EVENT]s prototypically correspond to verbs, it stands to reason that the syntactic category of causatives is that of verb.

Tree 8 illustrates a derivation involving a causative suffix attaching to an intransitive verb.
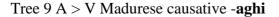
Tree 8 V > V Malayalam causative -**ik'k'** (cf. Marantz 1984)

kara+ik'k'-infl 'cause to cry'
1 CATEGORIAL
2,6 CORE
4 ARGUMENT I
7 ARGUMENT II

kara 'cry' · *-ik'k'* 'cause'

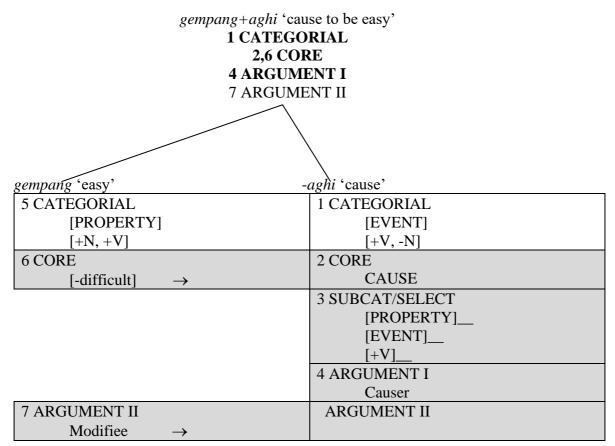| 5 CATEGORIAL [EVENT] [+V, -N]	1 CATEGORIAL [EVENT] [+V, -N]

6 CORE
  [-volition]
  [+sound]   →
  [+tears]
  [+grief]
	2 CORE
	  CAUSE

	3 SUBCAT/SELECT
	  [EVENT]__
	  [+V, -N]__

7 ARGUMENT I
  ACTIVITY
  Actor
	4 ARGUMENT I
	  Causer

→	ARGUMENT II

There are no changes in ontological category, but there is an important effect on argument structure that is typical of causative constructions. Since the ARGUMENT I of the base has fewer Proto-Agent-like properties in the output, it is Proto-Patient-like in relation to the ARGUMENT I contributed by the suffix. In other words, since the ARGUMENT I of the suffix, being a causer is more strongly Proto-Agent-like than the ARGUMENT I of the base (an agent), the argument contributed by the suffix occupies the ARGUMENT I position in the output, relegating the ARGUMENT I of the base to the less Proto-Agent-like ARGUMENT II position in the ouput.

The generalization, based on the ASP, seems to be that even though a strong Proto-Agent-like argument (e.g. a causer) may demote a somewhat less Proto-Agent-like argument to an ARGUMENT II position, it seems unlikely that a Proto-Patient-like argument (of the base) may acquire enough Proto-Agent-like properties to demote a Proto-Agent. However, the prohibition (*ARGUMENT II → ARGUMENT I) may be due to a broader generalization that results from Head Percolation and the notion of "head." Since the information of the nonhead (the base) may not override that of the head (the affix), an ARGUMENT II contributed by the base may not overrule an ARGUMENT I (or any other argument) contributed by the affix. As shown in the trees, the arguments of the base may only occupy empty argument slots in the output. Thus, the Modified Feature Percolation Conventions predict the prohibition of a semantic promotion from ARGUMENT II to ARGUMENT I in derivation.

Tree 9 illustrates a construction in which a causative suffix attaches to an adjective characterized by the category [PROPERTY]. The suffix may also attach to verbs, which is reflected in its SUBCAT/SELECT block.

Tree 9 A > V Madurese causative -**aghi**

gempang+aghi 'cause to be easy'
1 CATEGORIAL
2,6 CORE
4 ARGUMENT I
7 ARGUMENT II

gempang 'easy'   *-aghì* 'cause'

5 CATEGORIAL
    [PROPERTY]
    [+N, +V]
	1 CATEGORIAL
	    [EVENT]
	    [+V, -N]

6 CORE
    [-difficult]   →
	2 CORE
	    CAUSE

	3 SUBCAT/SELECT
	    [PROPERTY]__
	    [EVENT]__
	    [+V]__

	4 ARGUMENT I Causer
7 ARGUMENT II Modifiee →	ARGUMENT II

The ontological category of the suffix ([EVENT]), takes precedence over the ontological category of the base. The Modifiee, which is Proto-Patient-like, occupies the compatible ARGUMENT II slot of the output.

When a causative affix attaches to a transitive base, different effects on argument structure may arise. In Chichewa, for example, the subject of the base becomes a direct object, while the direct object of the base becomes an indirect object (or second object), as shown in (20).
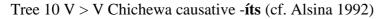
(20)   Nungu   i-na-phík-íts-a   kadzidzi   maungu.
          9porcupine   9s-ps-cook-CAUS-fv   1aowl-OBJ   6pumpkins-OBJ
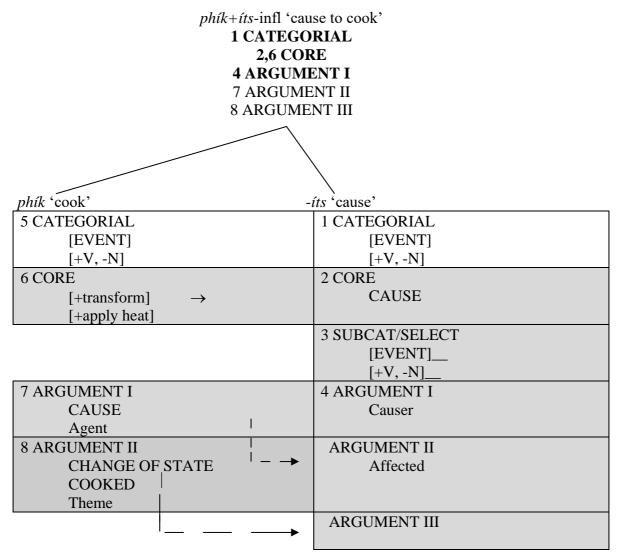   'The porcupine made the owl cook the pumpkins'   [Alsina 1992]

A different situation that arises when a causative affix attaches to a transitive verb is one where, as illustrated in (21) with the same Chichewa suffix, the direct object of the base remains a direct object, while the subject of the base becomes an oblique.

(21)   Nungu   i-na-phík-íts-a   maungu   kwá
          kádzidzi.
          9porcupine   9s-ps-cook-CAUS-fv   6pumpkins-OBJ   to
          1aowl-OBL
          'The porcupine had the pumpkins cooked by the owl'   [Alsina 1992]

On the basis of insights drawn from Ackerman & Moore (1999), I account for these facts as follows. There is a single representation for the causative affix, which contributes a Causer and has two other (empty) argument slots, one for ARGUMENT II, which will be specified as storing the "most affected" argument (of the base), and an ARGUMENT III slot. Pragmatic factors will determine whether the ARGUMENT I or ARGUMENT II of the base, whichever is most affected, will occupy the ARGUMENT II slot (the "most affected" slot) in the output. The other argument of the base, the one that did not occupy the ARGUMENT II slot of the output (which could be an ARGUMENT I or ARGUMENT II), will fill the ARGUMENT III slot; the syntax will determine whether that argument will be marked as an oblique, an indirect object or a second object.

Tree 10 is a representation of what occurs in (20). The ARGUMENT I of the base occupies the ARGUMENT II slot of the output, while the ARGUMENT II of the base fills the ARGUMENT III slot of the output and is marked as a second object by the syntax. (The broken arrows are meant to indicate that arguments have occupied slots due to pragmatic factors and not as a direct result of Secondary Percolation.)

Tree 10 V > V Chichewa causative -**íts** (cf. Alsina 1992)

phík+íts-infl 'cause to cook'
1 CATEGORIAL
2,6 CORE
4 ARGUMENT I
7 ARGUMENT II
8 ARGUMENT III

phík 'cook'   *-íts* 'cause'

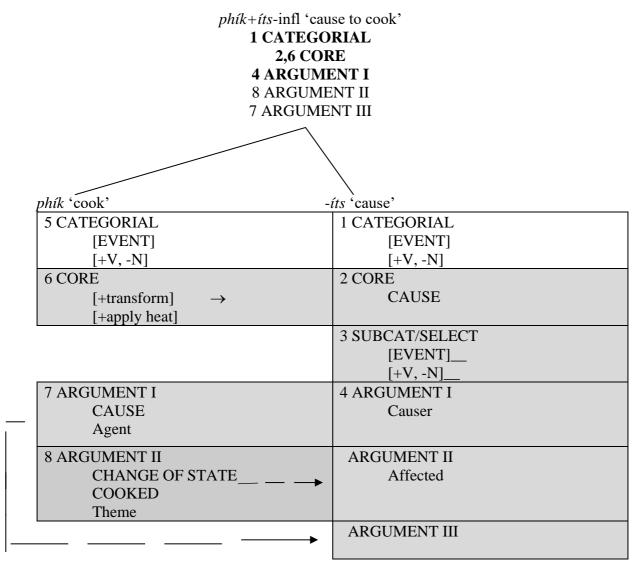|	

5 CATEGORIAL
    [EVENT]
    [+V, -N]
	1 CATEGORIAL
	    [EVENT]
	    [+V, -N]

6 CORE
    [+transform]   →
    [+apply heat]
	2 CORE
	    CAUSE

	3 SUBCAT/SELECT
	    [EVENT]__
	    [+V, -N]__

7 ARGUMENT I
    CAUSE
    Agent
	4 ARGUMENT I
	    Causer

8 ARGUMENT II
    CHANGE OF STATE
    COOKED
    Theme
	ARGUMENT II
	    Affected

	ARGUMENT III

Ackerman & Moore (1999) rank the arguments of causative constructions such as the one here in terms of their degree of affectedness. The ARGUMENT II is the most affected and therefore the most Proto-Patient-like, the Causer is the least affected and least Proto-Patient-like, and the ARGUMENT III has a degree of affectedness that is intermediate between that of the Causer and the ARGUMENT II (this is compatible with Dowty's (1991) ASP).

The causative in (21) is illustrated in Tree 11, where the ARGUMENT II of the base occupies the ARGUMENT II slot of the output, while the ARGUMENT I of the base occupies the ARGUMENT III slot and is marked as an oblique by the syntax.

Tree 11 V > V Chichewa causative -**íts** (cf. Alsina 1992)

phík+íts-infl 'cause to cook'
1 CATEGORIAL
2,6 CORE
4 ARGUMENT I
8 ARGUMENT II
7 ARGUMENT III

phík 'cook'   -*íts* 'cause'

5 CATEGORIAL [EVENT] [+V, -N]	1 CATEGORIAL [EVENT] [+V, -N]
6 CORE [+transform] → [+apply heat]	2 CORE CAUSE
	3 SUBCAT/SELECT [EVENT]__ [+V, -N]__
7 ARGUMENT I CAUSE Agent	4 ARGUMENT I Causer
8 ARGUMENT II CHANGE OF STATE__ __ → COOKED Theme	ARGUMENT II Affected
	ARGUMENT III

The situation in Choctaw is somewhat different. Davies (1981) has shown that in Choctaw, regardless of whether the causative affix attaches to a transitive or an

intransitive verb, the causee invariably ends up being the direct object in the output, as
(22) illustrates.

(22)   a.   Hattak-at   sa-bali:li-chi-tok.
                man-NOM   1ACC-run-CAUS-PST
                'The man made me run'

        b.   Hattak-at   sa-chi-bashli-chi-tok.
                man-NOM   1ACC-2ACC-cut-CAUS-PST
                'The man made me cut you'   [Davies 1981]

The causative suffix (-*chi*) attaches to an intransitive verb in (22a) and to a transitive
verb in (22b). In both cases, the causee, 'I', is marked as a direct object. When the
suffix attaches to transitive verbs (18.3b), the direct object of the base is marked as a
second object (2ACC).
        This type of derivation is illustrated in Tree 12, where the ARGUMENT II slot
of the Choctaw causative suffix (in this case attached to a transitive verb) is specified
for a Causee. The ARGUMENT II of the base occupies the ARGUMENT III slot in
the output and is marked as a second object by the syntax, as may occur in Chichewa.
Tree 12 V > V Choctaw causative -**chi** (cf. Davies 1981)

bashli+chi-infl 'cause to cut'
1 CATEGORIAL
2,6 CORE
4 ARGUMENT I
7 ARGUMENT II
8 ARGUMENT III

bashli 'cut'   *-chi* 'cause'

5 CATEGORIAL [EVENT] [+V, -N]	1 CATEGORIAL [EVENT] [+V, -N]
6 CORE [+incision] → [+separation]	2 CORE CAUSE
	3 SUBCAT/SELECT [EVENT]__ [+V, -N]__
7 ARGUMENT I CAUSE Agent	4 ARGUMENT I Causer
8 ARGUMENT II CHANGE OF STATE CUT Theme	ARGUMENT II Causee
	ARGUMENT III

Thus, the lexical entry for the causative suffix in Choctaw is more restrictive than the one in Chichewa, since, while the Chichewa suffix allows either the ARGUMENT I or ARGUMENT II of the base to fill the ARGUMENT II slot of the output, the Choctaw suffix only allows the ARGUMENT I of the base to do so.

3.5.3. Applicative Affixes
The fact that applicatives only attach to verbs and do not change the syntactic or ontological category of their base suggests that they do not contain categorial information. Applicatives also lack core semantic information. The contribution of applicatives to the output is an argument that is either a beneficiary, a goal, a location or an instrument. The subcategorization information of applicatives in certain languages (e.g. Chimwi:ni) requires transitive verbs, but in other languages applicatives may subcategorize for intransitives as well. For example, as shown in (23), the Ainu applicative prefix *e-* attaches to an intransitive verb.

(23)   Ainu applicative prefix
        Poro   cise   e-horari.
        Big   house   APPL-live
        'He lives in a big house'   [Shibatani 1990]

The argument contributed by an applicative affix behaves as a direct object. Note, for example, how the Chimwi:ni applicative suffix *–il* in (24) contributes a Beneficiary that, like a direct object (24a), may be passivized (24b). In contrast, the indirect object (24c) may not be passivized. (Note that SP stands for "subject pronoun," OP for "object pronoun.")

(24)   Beneficiary (-il)
        a.   Hamadi   ɸ-wa-pik-il-ile   wa:na   cha:kuja.
                Hamadi   SP-OP cooked-APPL   children   food
                'Hamadi cooked food for the children'

        b.   Wa:na   wa-pik-il-ila   cha:kuja   na   Hamadi.
                children   SP was cooked-APPL   food   by   Hamadi
                'The children had food cooked for them by Hamadi'

        c.   *Cha:kuja   sh-pik-il-ila   wa:na   na   Hamadi.
                                SP
                'Food was cooked for the children by Hamadi'
                                        [Kisseberth & Imam Abasheikh 1977]
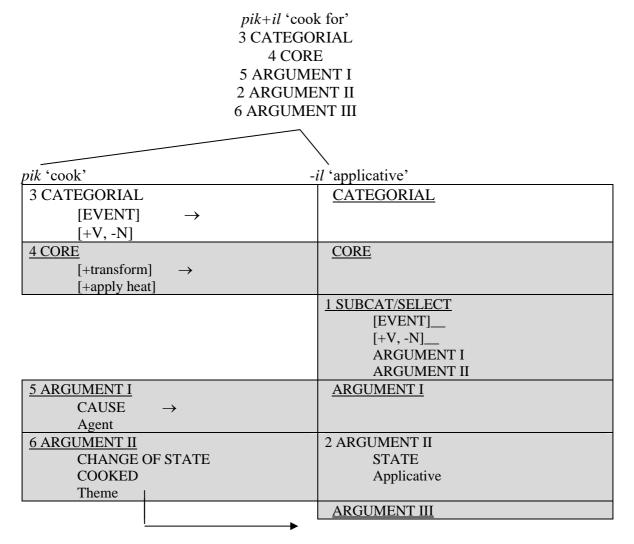
The same applicative affix in a particular language may contribute different types of argument to the output, in a process that appears to depend, again, on pragmatic factors. For instance, when *knife* is the entity associated with the verb *cut*, the argument contributed by the Chimwi:ni suffix *–il* is an Instrument (25a). On the other hand, when the entity is *child*, the argument is a Beneficiary (25b).

(25)   a.   Instrument
              Chisu, Nu:ru   ɸ-tilang-il-ile: nama.
              knife   Nuru   SP cut-APPL   meat
              'The knife, Nuru cut meat with (it)'

        b.   Beneficiary
              Mwa:na,   Nu:ru ɸ-m-tilang-il-ile: nama.
              child   Nuru SP-OP cut-APPL   meat
              'The child, Nuru cut the meat (for him)'
                                    [Kisseberth & Imam Abasheikh 1977]

       While a knife is more likely to be an instrument when associated with *cut*, a child is more likely to be a beneficiary (when associated with the same verb). Thus, pragmatics determines what type of argument (e.g. Instrument or Beneficiary) is assigned to the entities (e.g. a utensil or a human) that are associated with a particular verb. Tree 13 shows an applicative suffix that, as is typical, contributes an ARGUMENT II to the output (in this case a Beneficiary).

Tree 13 V > V Chimwi:ni applicative -**il** (cf. Kisseberth & Imam Abasheikh 1977)

<div align="center">

pik+il 'cook for'
3 CATEGORIAL
4 CORE
5 ARGUMENT I
2 ARGUMENT II
6 ARGUMENT III

</div>

pik 'cook'	*-il* 'applicative'
3 CATEGORIAL 　　[EVENT]　　→ 　　[+V, -N]	CATEGORIAL
4 CORE 　　[+transform]　→ 　　[+apply heat]	CORE
	1 SUBCAT/SELECT 　　[EVENT]__ 　　[+V, -N]__ 　　ARGUMENT I 　　ARGUMENT II
5 ARGUMENT I 　　CAUSE　　→ 　　Agent	ARGUMENT I
6 ARGUMENT II 　　CHANGE OF STATE 　　COOKED 　　Theme	2 ARGUMENT II 　　STATE 　　Applicative
	ARGUMENT III

The applicative suffix contributes to the output two empty ARGUMENT slots which are filled by the ARGUMENT blocks of the base. The ARGUMENT I block of the base fills the ARGUMENT I slot of the output, while the ARGUMENT II of the base occupies the ARGUMENT III slot of the output (indirect or second object).

Note that in languages in which applicative affixes may attach to either transitive or intransitive bases (e.g. Ainu) the SUBCAT/SELECT block needs to be specified only for ARGUMENT I.
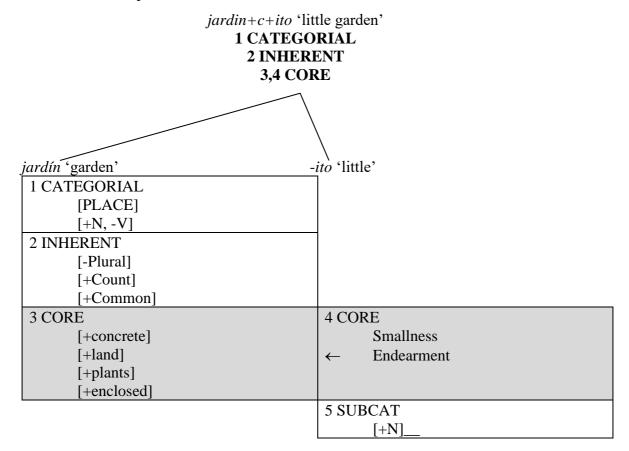
Despite lacking categorial information, applicatives are head-like in that they provide the slot structure of the output (as seen in Tree 13, affecting argument structure.

3.5.4. Expressive (or Evaluative) Suffixes

As with applicatives and the majority of derivational prefixes, expressive suffixes do not change the category of the base, which again suggests that they do not contain any categorial information and thus are not heads. In some languages expressive suffixes appear to have morphosyntactic features (e.g. *-chen* in German for gender), but in others they do not (e.g. *-it-o/a* in Spanish). The semantic content of expressive suffixes is emotive rather than referential (hence their name), and involves concepts such as "smallness" or "bigness" frequently in connection with notions such as "endearment" or "unpleasantness" which usually serve pragmatic rather than strictly semantic purposes (Lang (2013), Scalise (1984), Körtvélyessy 2014).

The subcategorization information of expressive suffixes normally makes reference to nouns and adjectives. As Lázaro Mora (1993) observes, expressive suffixes usually select for concrete objects (cf. *sill+ita* 'little chair' < *silla* 'chair' vs. **concept+ito* 'little concept' < *concepto* 'concept') or physically visible properties (e.g. *flac+ito* (*flaquito*) 'very skinny' < *flaco* 'skinny'). This, however, is more a tendency than a strict selectional requirement. In general, as Scalise (1984) notes, expressive suffixes have lax selectional restrictions.

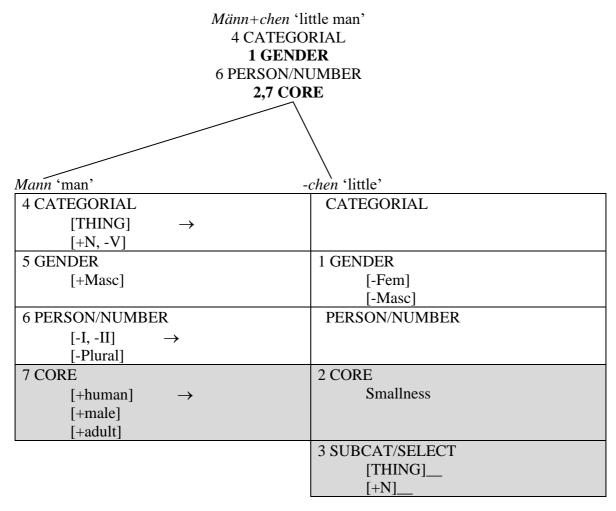In Tree 14 the base is the head. The suffix contributes expressive meaning to the output.

Tree 14 N > N Expressive suffix **-ito**

jardin+c+ito 'little garden'
1 CATEGORIAL
2 INHERENT
3,4 CORE

jardín 'garden'   *-ito* 'little'

1 CATEGORIAL
[PLACE]
[+N, -V]
2 INHERENT
[-Plural]
[+Count]
[+Common]

3 CORE	4 CORE
[+concrete]	Smallness
[+land]	← Endearment
[+plants]	
[+enclosed]	

	5 SUBCAT
	[+N]__

Although the suffix *-ito* does not always imply endearment, it can in any situation if the speaker wishes to convey that meaning, which, as noted above, is pragmatic rather than semantic. For example, if somebody is referring solely to the physical dimensions of a garden, *jardin+c+ito* lacks the meaning of endearment. However, if a person refers to their garden as *mi bello jardin+cito* 'my beautiful little garden', that person is conveying endearment in *jardin+cito*.

Unlike the situation in Spanish, expressive suffixes in German and other languages (e.g. Russian *-ushka* as in *bab+ushka* 'grandmother-DIMIN.) have head-like properties (cf. Lieber 1992) because some of their features take precedence over those of the base. In Tree 15, for example, the slot structure of the diminutive German suffix *-chen* percolates via Head Percolation, and its features for gender take precedence over those of the base in the output.

Tree 15 N > N Expressive suffix -**chen**

Männ+chen 'little man'
4 CATEGORIAL
1 GENDER
6 PERSON/NUMBER
2,7 CORE

Mann 'man'   *-chen* 'little'

4 CATEGORIAL
    [THING]   →
    [+N, -V]
	CATEGORIAL

5 GENDER
    [+Masc]
	1 GENDER
	    [-Fem]
	    [-Masc]

6 PERSON/NUMBER
    [-I, -II]   →
    [-Plural]
	PERSON/NUMBER

7 CORE
    [+human]   →
    [+male]
    [+adult]
	2 CORE
	    Smallness

	3 SUBCAT/SELECT
	    [THING]__
	    [+N]__

Since the gender features of the base and the output contain contradictory (and therefore incompatible) information, the GENDER block of the base, having percolated via Secondary Percolation, is discarded. The PERSON/NUMBER block of the base occupies a compatible (empty) slot in the output. In contrast to what happens with the nonhead-like Spanish suffix *-ito* (Tree 14), in Tree 15 it is the CORE block of the base that occupies the already filled (but compatible) CORE slot contributed by the suffix to the output. (The GENDER and PERSON/NUMBER slots are subdivisions of the INHERENT slot, whose properties are discussed in the following section.)

3.5.5. Inflectional Affixes
Following Halle (1973), Selkirk (1982), Spencer (2016) and ten Hacken (2014), in this study derivation and inflection are taken to be distinct but similar morphological processes. As noted by Spencer (2016), it is generally accepted that the same morphological devices are seen in inflection as in derivation cross-linguistically, which strongly suggests that inflectional and derivational processes should be described using common machinery, such as affixation. Halle (1973) and Selkirk (1982) assume their view on the grounds that both inflectional and derivational affixes are bound morphemes which contain syntactically relevant information and attach to

words to form other (complex) words. They argue that because of this similarity in behavior, both inflection and derivation should be dealt with in the same module of the grammar, morphology. Jensen & Stong-Jensen (1984), DiSciullo & Williams (1987), Jackendoff (1997) and Krieger (1994) are in agreement with this view. Although the system that has been developed in this study concentrates on derivation, it is able to account for inflection, as seen in the remainder of this section.

Following Booij (1995) and Rainer (1995), inflectional affixes in this study are subdivided into "contextual" and "inherent" (this distinction is also used by Arkadiev & Klamer (2019) and Luís (2019)). According to Booij (1995), contextual affixes are those that are critically required by the syntax, that is, affixes without which the syntax would not be able to generate well-formed sentences. These include affixes involved in subject-verb agreement (e.g. the Finnish third person singular suffix *-uu* as in *as+uu* '(he) lives') and case (e.g. Turkish *-i* as in *ev+i* 'house-ACC'). Inherent affixes, on the other hand, are those which are not critically required by the syntax, and include number and gender markers for nouns (e.g. the Spanish suffix *-s* as in *bosque+s* 'forests' < *bosque* 'forest'), tense and aspect affixes (e.g. the English past suffix *-ed* as in *work+ed*, and the English progressive suffix *-ing* as in *work+ing*), infinitives (e.g. the Spanish suffix *-ar* as in *habl+ar* 'talk'), participles (e.g. the Spanish suffix *-ido* as in *serv+ido* 'served' < *servir* 'serve'), possessives (e.g. the English suffix *-s* as in *Jane's*), and comparative and superlative affixes (e.g. the English suffixes *-er* and *-est* as in *sweet+er* and *sweet+est.*).

Aside from the differing relevance for syntax of the two classes of inflectional affixes, Booij and Rainer base their classifications on the argument that contextual affixes are prototypically inflectional, while inherent affixes share a number of properties with derivational affixes. The main argument in this line of reasoning is that inherent affixes, much like derivational affixes affect the inherent (semantic) qualities of the entity represented by their base (hence their name), while contextual affixes have it as their main function to signal relations of their base to other constituents in the sentence, without altering the inherent qualities of either their base or other constituents.

For example, Booij holds that plural affixes (e.g. Dutch *-en* as in *bier+en* 'types of beer') contribute semantic content (cf. Jackendoff (1997)) and bring a semantic change to the base, while case markers simply establish a relation between constituents in the sentence without semantically altering the constituents. For instance, in the Turkish sentence in (26) the case markers determine the relationships between the marked nouns and the verb without altering the inherent meaning of any word.

(26)   Case markers in Turkish
        Adam   ev-i   Ahmed-e   gösterdi.
        Man.NOM   house-ACC   Ahmed-DAT   showed
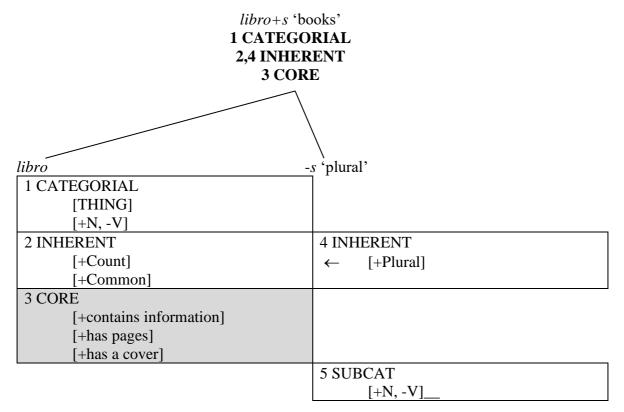   'The man showed the house to Ahmed'

Inflectional affixes lack an ontological category, a syntactic category, core semantic information, and selectional frames. Depending on the type of inflectional affix, their subcategorization frames may make reference to all major syntactic categories and to (inherent) features such as [±Count] (e.g. the English plural suffix *-s* attaches to [+Count] bases). Since they lack categorial information, inflectional affixes never change the category of their base, and are not considered heads (cf.

Lieber 1992). The fact that inflectional affixes do not affect argument structure is an additional reason for not considering them heads.

3.5.5.1. Inherent Inflectional Suffixes

As mentioned above, inherent suffixes include number markers for nouns, tense and aspect affixes, infinitives, participles, possessives, and comparative and superlative affixes. In order to account for the place in a lexical entry where inherent features are stored, I have incorporated the INHERENT slot, as seen in Tree 16.

Tree 16 Inflectional suffix -**s**

libro+s 'books'
1 CATEGORIAL
2,4 INHERENT
3 CORE

libro   *-s* 'plural'

1 CATEGORIAL
    [THING]
    [+N, -V]	

2 INHERENT
    [+Count]
    [+Common]
	4 INHERENT
	  ← [+Plural]

3 CORE
    [+contains information]
    [+has pages]
    [+has a cover]	

	5 SUBCAT [+N, -V]__

       Via Secondary Percolation, the INHERENT block of the suffix occupies the INHERENT slot contributed by the base, which contains compatible features.
       Following Jackendoff (1997) and Culicover & Jackendoff (2005), the view is taken here that inflectional affixes are not considered heads of larger functional categories, complete with specifiers and complements in syntactic tree representations, but rather bound lexical items stored in the lexicon along with other lexical items.

3.5.5.2. Contextual Inflectional Suffixes

As noted above, contextual suffixes include those involved in subject-verb agreement and case. Given that these suffixes contain phi features (such as for gender and number) and case features, I have postulated two new information slots, the PHI and CASE slots, to be included in the lexical entries of contextual suffixes. The suffix in Tree 17 percolates its CASE block into the empty CASE slot of the output by means of Secondary Percolation.

Tree 17 Turkish case suffix **-i**

ev+i 'house-ACC'
1 CATEGORIAL
2 INHERENT
4 CASE
3 CORE

ev 'house'   *-i* 'accusative'

1 CATEGORIAL [THING] [+N, -V]	
2 INHERENT [+Count] [+Common]	
CASE	4 CASE ← ACC
3 CORE [+building] [+domestic]	
	5 SUBCAT [+N, -V]__

   The three new slots introduced, namely, the INHERENT, PHI, and CASE slots, are relevant only in processes involving inflection.

3.6. Derivational Suffixes in Other Languages

Since a highly valued model should be applicable cross-linguistically, this section provides examples of how the SSM applies to derivation in several languages genetically unrelated to Spanish, namely Mam, Turkish and Swahili. It is shown that these languages, like Spanish, have both content and function suffixes and, overall, have a derivational component closely resembling that of Spanish.

3.6.1. Mam

Mam, a Mayan language, has a large class of derivational affixes (up to seventy-seven) which yield outputs with a word class, meaning, or both, different from those of the base they attach to (England 1983). According to England, these affixes contribute meanings such as "repetitive," "instrumental," "locative," "remainder," "abstract," "facility," "measure," and "direction," strongly reminiscent of the labels used in this study for general features (e.g. Instrument) and other features (e.g. the classeme [-concrete]="abstract"). The vast majority of Mam bases are [EVENT]s, followed by [PROPERTY]s. A few bases are [THING]s. According to their contribution in meaning, Mam derivational suffixes may be sub-divided into content suffixes, with

meanings such as Repetition and Location) and function suffixes, with meanings such as [STATE] and [ACTION].

Tree 18 illustrates a derivation with the content suffix *-b'aajal*.

Tree 18 V > A **-b'aajal**   *txik+b'aajal* 'easy to cook'

1 CATEGORIAL
2,5 CORE
7 ARGUMENT II

txik 'cook'   *-b'aajal* 'easy'

4 CATEGORIAL [EVENT] [+V, -N]	1 CATEGORIAL [PROPERTY] [+N, +V]
5 CORE [+transform] → [+apply heat]	2 CORE Facility
	3 SUBCAT/SELECT [EVENT]__ [+V, -N]__ ARGUMENT I ARGUMENT II
6 ARGUMENT I CAUSE Agent	
7 ARGUMENT II CHANGE OF STATE → COOKED Theme	ARGUMENT II

As with derivatives formed with *-ción* and *-ble*, the ARGUMENT II of the base occupies the ARGUMENT II slot in the output, and the ARGUMENT I is discarded.

Tree 19 shows a derivation with the function suffix *-il*.

Tree 19 A > N -**il**   *yaab'+il* 'sickness'

1 CATEGORIAL
2,5 CORE

yaab' 'sick'   *-il* 'state of being'

4 CATEGORIAL [STATE] [+N, +V]	1 CATEGORIAL [STATE] [+N, -V]
5 CORE [-healthy] →	2 CORE
	3 SUBCAT/SELECT [PROPERTY]__ [+N, +V]__
6 ARGUMENT II Modifiee	

The argument of the base is discarded because the output has no available slots.

3.6.2. Turkish

Turkish, an Altaic language, has close to forty derivational suffixes, most of which form deverbal nouns, denominal verbs and deverbal adjectives Lewis (1967). According to Lewis, the suffixes contribute meanings such as "occupation," "result," "action," "instrument," "abstract," "intensive," "agent," and "inchoative," which, again, coincide with some of the features used in the current study. As in the case of Mam, there are content and function suffixes in Turkish.

Tree 20 illustrates a derivation with the content suffix *-ak*.

Tree 20 V > N -**ak**   *dur+ak* 'stopping-place'

1 CATEGORIAL
2,5 CORE

dur 'stop'   *-ak* 'place'

4 CATEGORIAL [EVENT] [+V, -N]	1 CATEGORIAL [THING] [+N, -V]
5 CORE [+change] → [-movement]	2 CORE Location
	3 SUBCAT/SELECT [EVENT]__ [+V, -N]__
6 ARGUMENT I [+concrete]	

Tree 21 illustrates a derivation with the function suffix *-les*.

Tree 21 A > V **-les**   *serin+les* 'become cool'

1 CATEGORIAL
2,5 CORE
6 ARGUMENT II

serin 'cool'   *-les* 'become'

4 CATEGORIAL [STATE] [+N, +V]	1 CATEGORIAL [EVENT] [+V, -N]
5 CORE [-warm] →	2 CORE
	3 SUBCAT/SELECT [STATE]__ [+N, +V]__
6 ARGUMENT II Modifiee →	ARGUMENT II CHANGE OF STATE

3.6.3. Swahili

According to Myachina (1981) and Polomé (1967), Swahili, a Bantu language, has derivational suffixes with meanings such as "instrument," "habitual," "occupation," and "abstract." Like Mam and Turkish, Swahili has both content and function suffixes.

Tree 22 illustrates a derivation with the content suffix *-aji*.

Tree 22 V > N **-aji**   *m+wind+aji* 'professional hunter'

1 CATEGORIAL
2,5 CORE
7 ARGUMENT II

winda 'hunt'   *-aji* 'profession'

4 CATEGORIAL
    [EVENT]
    [+V, -N]
		1 CATEGORIAL
		    [THING]
		    [+N, -V]

5 CORE
    [+pursue]   →
    [+kill]
		2 CORE
		    [+human]
		    Occupation

		3 SUBCAT/SELECT
		    [EVENT]__
		    [+V, -N]__

6 ARGUMENT I
    ACTIVITY
    Agent		

7 ARGUMENT II
    CHANGE OF STATE   →
    HUNTED
    Theme
		ARGUMENT II

Tree 23 illustrates a derivation with the function suffix *-u*. Since there are no ARGUMENT slots in the output, the single argument of the base is discarded.

Tree 23 A > N **-u**   *u+tuliv+u* 'calmness'

1 CATEGORIAL
2,5 CORE

tulia 'calm'   *-u* 'state of being'

4 CATEGORIAL
    [PROPERTY]
    [+N, +V]
		1 CATEGORIAL
		    [STATE]
		    [+N, -V]

5 CORE [-agitation] →		2 CORE

		3 SUBCAT/SELECT
		    [PROPERTY]__
		    [+N, +V]__

6 ARGUMENT II Modifiee		

This section has shown that the morphosemantics of several languages unrelated to Spanish, namely Mam, Turkish and Swahili, closely resembles that of Spanish. The model proposed for Spanish in this study is applicable in its entirety to the derivational morphology of these languages, which suggests that the mechanisms of percolation and subcat/select, as well as the notion of slot structure, may be universal constructs.

3.7. Critiques of the Notion of Head

Those who question the notion of head in morphology do so based on a view of percolation that does not take into account the detailed analysis of heads and percolation in the dual-route model. For example, Bauer (1990) says that if heads have a role to play, this role needs to be defined much more carefully than has been the case until now. However, as shown throughout this section, the notions of head and percolation have been updated and refined, and together they explain morphological phenomena in a comprehensive way. Zwicky (1985), for his part, criticizes morphological percolation on the basis of its parallelism to syntactic percolation and headship. For example, he holds that if the notion of percolation in morphology is to retain its appeal, the notion of head in syntax needs to be modified in certain ways. However, the mechanism of percolation in the dual-route model and SSM does not derive from syntax; it is based strictly on morphological structures and principles.

3.8. Conversion

The analysis of conversion adopted here is based on Lieber (2004), who defines conversion as the creation of words of one lexical category from words of another lexical category, with no overt formal change. In English, conversion can create nouns from verbs (*to throw – a throw*), verbs from nouns (*a boot – to boot*), and verbs from adjectives (*cool – to cool*). In Spanish, the status of conversion is less clear due to the fact that verbs have a conjugation class ending (*-ar*, *-er*, *-ir*), so it could be argued that this ending acts as a typical derivational suffix to form new words. For example, what in English is the pair [*archive*-N] – [*archive*-V], in Spanish it is [*archivo*-N] – [*archivar*-V], where it can be said that the *-ar* ending in the latter word created a verb from the noun *archivo*.

For Lieber (2004), conversion is a type of coinage or, more specifically, relisting, which occurs when an item already listed in the lexicon is re-entered as an item of a different category. As Valera (2014) observes, syntactic and semantic properties associated with formal identity between the original word (base) and the derivative (the newly created word) justify the interpretation that the same form now is a different lexeme. Agreeing with Plag (1999), Lieber (2004) points to the wide range of meanings of verbal conversion as making it unlike most suffixes and thus not likely to be zero-affixation. Lieber (2004) lists 13 meanings for conversion from nouns or adjectives to verbs (such as locative, causative or instrumental), noting that even polysemous suffixes (such as *-ize*) do not usually have so many meanings. The range of meanings of words produced by conversion is actually more compatible with that of simplex words. In addition, Valera (2014) lists up to six arguments that have been raised against the zero-derivation approach, including the zero-affixes' different behavior compared to their supposed explicit counterparts.

More important is the fact that meaning change in conversion tends to be idiosyncratic, sometimes unpredictable, and needs to be interpreted in context, thus making it strongly sensitive to pragmatics (Lieber 2004). For example, if we were to convert *desk* to a verb, it could to refer to people or things (*desk an employee*, *desk a document*), and it could mean either putting someone at a desk, putting something in/on a desk, or doing something with the desk itself. Acquaviva (2016) agrees, noting that conversion involves shifts in meaning that can be quite unpredictable. Furthermore, as Lieber (2004) points out, conversion is productive but not systematic or consistent in meaning. This contrasts, for example, with suffixation with *-ble* in Spanish or *-able* in English, where the meaning of possibility contributed by the suffix appears in the vast majority of derivatives (see results of corpus study with *-ble* below). Whatever the process for conversion, given its unpredictability and idiosyncratic nature, words produced this way have to be stored in the lexicon and associated via lexical redundancy rules (cf. Lieber 2004).

3.9. Polysemy and Homonymy

There is an extensive literature on the polysemy of words, much of which has served as the basis for positing affix polysemy (cf. Schulte 2015, Lehrer 2011, Lieber 2004, Plag 1997, 1999). There have traditionally been two ways of analyzing polysemous items: the one representation hypothesis, also known as unitary meaning, and the sense enumeration view, where individual polysemous senses are represented separately, and may be arranged in different ways. Rainer (2014) calls the latter *low-level patterns*. Representing the unitary view in morphology, Plag (1997, 1999), for example, proposes a single representation for *-ize* from which all the meanings of its derivatives arise, including causative, resultative, locative, ornative, inchoative, performative, and similative. Lieber (2004) proposes something similar, with a different notation. Representing the sense enumeration view, Lieber (1998) expresses the meanings of *-ize* derivatives with four different LCSs, each representing a different polysemous meaning (although some of them may be homonymous).

Rainer (2014) holds that many researchers have tried to make polysemy disappear by portraying it as an automatic consequence of abstract unitary meanings (e.g. Pustejovsky 1995 for word polysemy). He adds, however, that we should always avoid postulating unnecessary entities, and that psycholinguistic studies as well as observation show that speakers cope well with massive polysemy. Apparently it is preferable for speakers to have many low-level patterns that can be immediately applied in comprehension and production. These patterns may form complex constellations, networks, radial structures, or chains of senses, some of which may show a relationship of subsumption under more abstract patterns. Nevertheless, according to Rainer (2014), the low-level patterns are needed in order to be able to account for all kinds of distributional restrictions.

Simplex words can have many polysemous senses. For instance, there are 13 senses of *to see* listed in the Meriam-Webster online dictionary, including transitive and intransitive uses, and most of the senses are listed with sub-senses. This is an example of what Rainer (2014) calls massive polysemy. There can be affixes with many polysemous and/or homonymous senses as well. For example, Lehrer (2011) posits seven senses each for the English suffixes *-er* and *-ship*, organized in a radial structure, with the Agent sense in the center of the structure for *-er*, and State of Being for *-ship*. Schulte (2015) presents semantic maps of senses or readings (such as

"action," "collective," "location") related to one another that visually represent the polysemy of the English suffixes *-age* and *-ery*. If speakers can handle the massive polysemy of simplex lexical items, they should be able to handle affix polysemy as well, regardless of how it is structured.

In the case of Spanish *-ble*, up to three polysemous suffixes could be posited (see corpus study below), which is a low number compared to the seven senses each for the English suffixes *-er* and *-ship* proposed by Lehrer (2011).

Regarding homonymy, just as words, affixes which have the same spelling or pronunciation but have different, unrelated meanings, are considered homonymous. Examples of homonymous suffixes in Spanish are shown in (27).

(27)

    -era

        Location (e.g. *pajar+era* 'aviary' < *pájaro* 'bird')
        Instrument (e.g. *espinill+era* 'shin guard' < *espinilla* 'shin')

    -ería

        Location (e.g. *joy+ería* 'jewelry store' < *joya* 'jewel')
        Occupation (e.g. *jardin+ería* 'gardening' < *jardín* 'garden')

    -oso

        Abundance (e.g. *pec+oso* 'very freckled' < *peca* 'freckle')
        Having (e.g. *aren+oso* 'sandy' < *arena* 'sand')

Returning to the suffix *-ing*, briefly discussed in § 3.4, according to Pinker (1999) this suffix has four functions: progressive participle (They are *opening* it), present participle (They tried *opening* it), gerund (Their incessant *opening* of the boxes), and verbal adjective (A quietly- *opening* door). Depending on whether one thinks they are related or not, *-ing* may be considered either a polysemous or homonymous suffix. Regardless, individual versions of polysemous and homonymous affixes work exactly the same way as the affixes for which trees have been shown throughout this section. Each has its own lexical entry that undergoes unification and percolation when participating in the formation of a word.

3.10. Corpus Study: Spanish Suffix -ble

A corpus study was conducted in order to analyze forms with the Spanish suffix *-ble*, to provide a wider empirical basis for the SSM in the context of the current study. Derivatives with *-ble* are mostly regular, but there are some irregular formations and polysemous variants, which are discussed below. The corpus used is the Corpus del Español (CDE, Davies 2002-). The CDE consists of two corpora: an online corpus that consists of more than 100 million words in more than 20,000 Spanish texts from the 1200's to the 1900's, in four registers (oral, news, fiction, and academic), labeled "Genre/Historical"; and a web-based corpus, labeled "Web/Dialects," containing 2 billion words of Spanish taken from 2 million web pages from 21 different Spanish-speaking countries, from the past 3-4 years. Only data from the latter corpus were used for the current study. While the Genre/Historical corpus has an oral component, which the Web/Dialects corpus lacks, we decided to conduct the study using the latter due to the large difference in size between corpora; the Web/Dialects corpus is 20 times as large as the Genre/Historical corpus.

Overall, a set of 1,866 types (3,442,943 tokens) was examined in the current study. Close to 8% of the types (142/1,866) are irregular. The meaning of each derivative was determined on the basis of either the context in which the word appeared in the corpus concordances or the definitions given in the *Diccionario de la Lengua Española* (DLE), or both, when there was doubt in one or the other source. Note that not all tokens were examined individually, given the large number of tokens, especially for some of the word forms. For example, the word *posible*, a patrimonial (see below), has 678,591 tokens in the corpus, and the regular *aplicable* has 23,179 tokens. A sample of tokens chosen randomly was examined for each type.

Tree 24 shows a regular derivation with *-ble* that is representative of the 92% of regular forms that were found in the corpus. The suffix contributes a meaning of possibility (as in Riehemann 1998 for the similar German suffix *-bar*, see below) and attaches to transitive verbs. Note that *plegable* is fully compositional and does not have any additional meanings.

Tree 24 V > A -**ble**   *plega+ble* 'foldable'

1 CATEGORIAL
2,5 CORE
7 ARGUMENT II

plegar 'fold'   *-ble* 'possibility'

4 CATEGORIAL
   [EVENT]
   [+V, -N]
	1 CATEGORIAL
	   [PROPERTY]
	   [+N, +V]

5 CORE
   [+bend]   →
   [+make compact]
	2 CORE
	   Possibility

	3 SUBCAT/SELECT
	   [EVENT]__
	   [+V, -N]__
	   ARGUMENT I
	   ARGUMENT II

6 ARGUMENT I
   CAUSE
   Agent	

7 ARGUMENT II
   CHANGE OF STATE   →
   FOLDED
   Theme
	ARGUMENT II

In what follows, corpus examples are presented for derivatives with *-ble* that have some type of irregularity, either phonological, semantic or syntactic, as well as polysemous forms. Before that, it is important to discuss *-ble* formations where the

suffix does not seem to be separated from the base. Note in what follows that glosses are not provided for words that are clearly cognates (e.g. *tangible*).

There are forms found in the corpus ending in *ble* that seem to have a meaning of possibility but for which it is not clear what their base may be or whose base seems to be a bound root (e.g. *probable*, *susceptible, visible*, *tangible*, *factible* 'feasible', *comestible* 'eatable'). Most of these are patrimonial words, that is, words inherited from Latin as part of the natural development of the language. Some of the most frequent *-ble* forms found in the corpus are patrimonials. Others are cultured borrowings, also from Latin, which were introduced in Spanish (and other Romance languages) by elites in the process of elaboration of vernaculars and which have now been integrated into everyday usage (cf. Pountain & Wislocka Breit 2021). For example, Latin *frigidus* 'cold' became both the patrimonial (popular) *frío* in Spanish and *froid* in French, and the cultured *frígido* in Spanish and *frigide* in French. Some of the words of cultured origin are not only widely shared among Romance languages (cf. Portuguese *frígido* and Italian *frigido*), but have also been adopted by other Western European languages, especially English (cf. *frigid*).

Both patrimonial and cultured words ending in *ble* came into Spanish as wholes from Latin, with the ending *bilis*, as registered in the DLE (e.g. *visibilis*, *tangibilis*, *responsabilis, indelebilis*). Some of these words have one or more meanings in addition to the meaning of possibility. For example, *punible* 'punishable' has a meaning of "worthy" or "deserving of" in addition to possibility, and *aceptable* has the regular meaning of 'capable of being accepted' and also the meanings 'worthy of being accepted' and 'barely acceptable'. Others do not have a meaning of possibility at all (e.g. *saludable* 'healthy', *sociable*). Since these *ble* forms, whether cultured or patrimonials, came from Latin as wholes, they are thought to be interpreted as monomorphemic words by speakers, and are thus not considered regular, compositional derivatives. Thus, they have to be stored as part of the associative network and are subject to lexical redundancy rules. Speakers surely are aware of the meaning of possibility in these words, but they do not appear to parse the words into their two elements.

This seems to be true in general for formations with bound roots. For example, Olsen (2014) points out that words with bound roots such as *identity* and *specify*, much like patrimonials in Spanish, were borrowed into English in their complex forms from Latin (and French), where they originated as derivations. However, speakers do not need to have access to this knowledge to be able to understand and use these words. Archibald & Libben (2019) mention a similar case, with the words *refill* and *research*. While the decomposable *refill* is semantically transparent for most native speakers of English, *research*, despite the fact that diachronically it contains an intensifying prefix *re-*, is not perceived by speakers as semantically transparent. Hay (2001) provides experimental evidence that words with bound roots (e.g. *business*, *transfer*) are perceived as less clearly structured than words with lexical bases (e.g. *dishorn*, *meekly*). This evidence strongly suggests that words with bound roots, such as the *ble* Spanish patrimonials, are not represented in the mind of speakers the same way as regular, compositional derived forms, and thus have to be stored as wholes.

Some of the *-ble* derivatives which clearly have a base and suffix seem to have acquired metaphorical senses or an additional idiosyncratic meaning once they were formed with *-ble*. Evidence for this are words such as *apreciable*, which has the compositional meaning of 'capable of being appreciated', and also the meaning

'worthy or deserving of being appreciated', and *lavable* 'washable' < *lavar* 'wash'), which means not only 'that can be washed', but has the added meaning of '(being washed) without suffering harm in the process'. English *readable* may also be in this category, as it is parsable into *read* and *-able* and means "capable of being read," yet it also has the meaning of "easy to read." Since it is likely that these words acquired their idiosyncrasies once formed, the suffix is not responsible for their additional meaning. It is reasonable to believe that these words were first used compositionally and then, with frequent use, they were stored and then acquired their idiosyncratic meaning, some of them through semantic drift applying to the entire word. They are now polysemous words, with two or more senses each. Because of their idiosyncratic meanings, forms such as these are also stored in the associative network and are subject to lexical redundancy rules.

In fact, some of these words may have acquired their additional meanings due to the operation of lexical redundancy rules, by analogy. For example, the regular *apreciable* may have acquired its meaning of "worthy or deserving of being appreciated" by analogy to the already stored patrimonials *punible* and *condenable*, which have this meaning of "deserving of." Likewise, English *translatable*, which has the regular meaning of "capable of being translated," could have acquired its additional meaning of "easy to translate" by analogy to *readable*.

In order to discuss other *-ble* forms found in the corpus study that may be irregular, it is helpful to compare this study with Riehemann (1998), who conducted a corpus study where a set of 1,226 derivatives (types) with the suffix *-bar* were examined. This suffix is quite similar in meaning and function (adjectival) to Spanish *-ble* and English *-able*. Similarly to our corpus results, Riehemann (1998) found that 7% of *-bar* derivatives were irregular. In addition to finding *-bar* derivatives with idiosyncratic meanings, she found forms that are irregular due to the fact that they do not attach to transitive verbs. The suffix can attach to verbs with dative objects (*entrinnen* (+ Dat) 'escape') > *unentrinnbar* 'inescapable'), to verbs with prepositional objects (*verfügen über* 'have at one's disposal') > *verfügbar* 'available'), and to intransitive verbs (*brennen* 'burn' > *brennbar* 'flammable').

Similar examples were found for Spanish in the corpus, among the forms counted as irregular (e.g. *acceder a algo* 'have access to something' > *accesible*; *atribuirle algo a alguien* 'attribute something to somebody' > *atribuible*; *funcionar* 'function' (intransitive) > *funcionable*). However, in SSM these forms do not each require a new lexical entry for *-ble*. As in Tree 1 (for *-dor*), the SUBCAT/SELECT block for *-ble* in Tree 24 can be specified to select only an ARGUMENT I, and this entry would cover both the regular forms and all these apparently irregular cases. Nothing else in the lexical entry for *-ble* needs to change, and Dowty's ASP applies as part of percolation. The most Proto-Patient argument of the base becomes the modifiee (or subject, to use Riehemann's 1998 term) of the *-ble* adjective. For example, with *accesible*, the object of the preposition of the base (e.g. *la información* in *Yo accedo a la información*) percolates to the branching node by Secondary Percolation, and the ARGUMENT I of the base, *Yo*, is discarded, giving *información accesible*. For derivatives with intransitive bases, the single argument of the base percolates. It must be kept in mind that very few forms were found in the Spanish corpus based on intransitives, and the vast majority, if not all, are patrimonial (e.g. *perdurable*, *durable*, *fatigable*, *mutable*).

Given this, it can be argued that *-able* is not polysemous at all, because it can be represented with a single entry. As seen above, all other forms ending in *ble* are either patrimonials, are formed with bound roots or have idiosyncratic meanings, and need to be stored. The Spanish suffix *-izar* may be similar. As Lieber (2004) and Plag (1999) show, the English suffix *-ize* has several polysemous forms, some of whose meanings (causative, locative) are shared by Spanish *-izar* (cf. Lang 2013). A quick search in the Web/Dialects corpus shows that while there are many compositional *-izar* formations (*modernizar*, *agilizar* 'speed up, expedite' from *ágil* 'agile'), patrimonials seem to comprise a significant portion of the words ending in *izar* (e.g. *cauterizar*, *sintetizar*), and in this sense *-izar* may be very similar to *-ble*.

3.11. Comparison of SSM to Derivational Approaches Based on Coindexation
The next section explores how the SSM can be incorporated into the Parallel Architecture, and compares it to the RM. Before moving on, it is relevant to discuss how the SSM compares favorably with morphological approaches based on coindexation (or binding) (e.g. Lieber 2004). This comparison is important because coindexation approaches are current and influential, and they aim to account for regular word formation processes. First, derivations representative of the coindexation approach, such as (28), do not show how a verb (*drive*) has become a noun after attachment of the suffix *-er*. In contrast, in the SSM, as seen from the derivational tree in (29), percolation from the head (the suffix) ensures that the derivative is a noun, because of the contribution of the N feature from the suffix and the suppression of the V feature from the base.

(28)   Derivation of *driver* based on a coindexation approach

      -er   drive
      [+material, dynamic ([$_i$], [+dynamic ([$_i$], [   ])])]   [Lieber 2004]

(29) SSM derivation for *driver*   *driv+er*

1 CATEGORIAL
4 CORE
6 ARGUMENT II

drive   *-er* 'Person'

3 CATEGORIAL [EVENT] [+V, -N]	1 CATEGORIAL [THING] [+N, -V]
4 CORE DRIVE →	CORE PERSON
	2 SUBCAT/SELECT [EVENT]__ [+V, -N]__
5 ARGUMENT I Agent	
6 ARGUMENT II VEHICLE → Theme	ARGUMENT II

More importantly, in (28) it is not shown that the first argument of the base disappears after affix attachment and is no longer an argument of the derivative (cf. **Peter driver of the truck*; **driver of the truck by Peter*); the argument still appears as a part of the coindexed representation (the subscripted argument of *drive* in 28), so it has to be stipulated that the argument is no longer visible to syntax because it has been "absorbed." By contrast, in (29) percolation and slot structure jointly ensure that the argument (ARGUMENT I) is suppressed. Furthermore, Lieber (2004) makes the key claim that the semantics of word formation involves the creation of a single referential unit out of two distinct semantic skeletons (LCSs). In Lieber's (2004) model, the primary mechanism for creating a single referential unit is the coindexation of semantic arguments (as in 28). This means that, after derivation, the resulting word should be a separate, independent lexical unit. However, in her representation of *driver* and other derived forms, Lieber (2004) presents the derivative as still having an argument of the base (28), which means that the derivative has information from another (lexical) unit, and thus is not a single referential unit.

As seen in the derivational trees above, in the SSM the changes in argument structure (e.g. suppression of an argument) are included in the changes brought about by the imposition of the slot structure of the affix on the output. Thus, there is no need to explain argument suppression by employing a rule which states that the affix "binds" or "absorbs" an argument. The use of such a type of binding rule occurs, explicitly or implicitly, in approaches based on coindexation (e.g. Lieber 2004), which represents a drawback, as compared to the SSM.

For another comparison, HPSG formalisms of word formation, such as Krieger (1994; see also Gerdemann 1994 and Kathol 1994), where percolation is not involved,

manifest exactly the same drawback as the coindexation approaches; they do not show that (or how) one of the arguments has been suppressed, since both arguments remain as a part of the representation of the derived form. While in both HPSG and the PA there is unification, neither unification nor the morphological principles of HPSG (cf. Krieger 1994) account for the suppression of arguments (or categorial features) in the extremely complex lexical entries that result from word formation in the HPSG formalism. It seems that percolation and slot structure are needed. Even though there is unification of features as part of the process of percolation, percolation goes beyond unification and the instantiation of variables, and allows for some features to override and suppress other features, as seen in the derivational trees above.

Other HPSG approaches to morphology, such as Rieheman's (1998), which are based on constructional schemas, and Crysmann & Bonami (2016), Crysmann (2021), and Meurers (2001), which are based on lexical rules and thus are realizational and see affixes as exponents and not as independent lexical objects (see below), exhibit the same drawbacks as the approaches based on coindexation, by not seeing the affix as the driver of derivation and key contributor of both syntactic and semantic information.

In sum, percolation and slot structure are essential in that they jointly determine the structure and content of a derivative and make clear the syntactic and semantic contribution of the affix to the derived word. In addition, they both allow for several key predictions to be made. First, the slot structure of the head, given Head Percolation, predicts what is possible and impossible in a derived form by determining the slot structure of the output. That is, predictions can be made about how information is projected to the output. For example, knowing the slot configuration of an affix allows one to predict which information blocks of the base will form part of the output, and which will be discarded. Thus, the predictions also help to formally differentiate between affixes.

Second, since the head imposes its slot structure on the output (in the process affecting argument structure by adding arguments or contributing to their suppression), the information that the head contributes to the output cannot be overridden by the information contributed by the base. A particular instance of this is the prediction of the impossibility of constructions where the base (the nonhead) has imposed its categorial features on the output (e.g. *Base]N + Suffix]A > Output]N).

Finally, percolation and slot structure jointly determine and help explain in a principled way why certain combinations of features are allowed or disallowed in the derived form. Thus, for instance, a derivative with two or more ontological or syntactic categories would be prohibited, as would be derived forms containing more arguments than the ones contributed by the base and affix. Likewise, derived words may have no more core semantic features than the ones contributed by the base and affix. (Note, however, that semantic drift, extension or pragmatic factors may contribute to add idiosyncratic semantic content to derivatives, as seen above.)
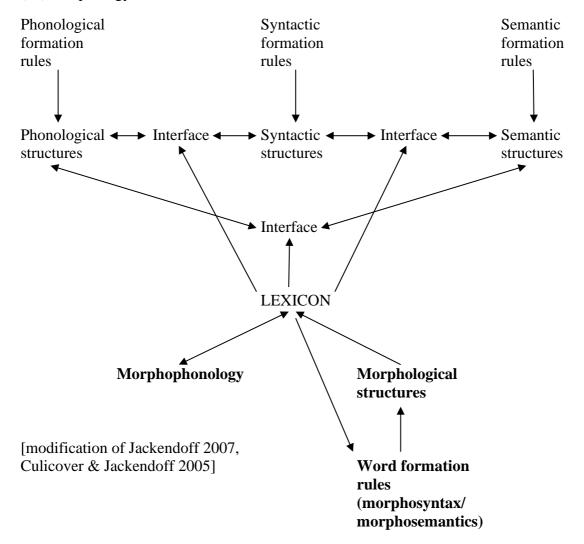
There are other aspects of the SSM that do not derive from any basic principles and are not predictive. For example, the fact that some affixes do not change the lexical category of the base. In these cases, the mechanisms and representations of SSM simply reflect these phenomena.

4. Morphology within the Parallel Architecture

4.1. The Slot Structure Model (SSM)

The SSM integrates into the PA via the lexicon, as in (30). Below the word level, the lexicon constantly provides lexical items (e.g. Sp. *cazar* 'hunt', *-dor* 'PERSON-Occupation') as raw material for the word formation rules (WFRs) discussed in the previous section. Fully-formed structures created by WFRs (e.g. *caza+dor* 'hunter') in turn become a part of the lexicon. When needed in a sentence, they separate into their respective components to participate at the interfaces, and instantiate into variables when necessary, in accordance with PA principles. Once an item is in place in a given tier, it can interface with elements in other tiers (see § 2). Note that the morphological component, which is located below the Lexicon in the diagram, does not interface directly with phrasal syntax or semantics. It does so via the lexicon. It is in this sense that the expression "below the word level" is used. Morphology is what occurs inside the lexicon, below the word level. Note as well, however, that lexical/morphological structures are of the same type as phrasal structures; thus, the non-distinction between lexicon and grammar in the PA is retained.

(30) Morphology within the Parallel Architecture

[modification of Jackendoff 2007, Culicover & Jackendoff 2005]

Taking the sentence *I saw the driver of the truck* as an example, the semantic, syntactic, and phonological elements of the derivative *driver* in (29) (shown in 31), including ARG II, *the truck* (the object of the preposition), each plug into their respective structures and establish connections (or correspondences) in the sentence.

(31) Lexical entry of *driver*

CATEGORIAL
[THING]
[+N, -V]
CORE
DRIVE-PERSON
ARGUMENT II
VEHICLE
Theme

The details of morphophonological processes are beyond the scope of the current study. What is important from (30) is that morphophonological structures are formed in parallel to morphological structures (by rules where percolation plays no role), and the outputs of morphophonological processes become a part of the lexicon. This is compatible with lexical phonology (Kenstowicz 1994), in which rules are sensitive to the morphological and lexical environment (i.e. morphophonology), in contrast to the postlexical phonological component, which applies across word boundaries at the phrase and sentence level. Lexical phonology accounts for the interaction between morphology and phonology in the process of word building.

In addition, the view that morphophonological structures are formed in parallel to morphological structures, as in (30), is also compatible with how phonology works in RM. As noted by J&A, relations between (morphological) alternations, such as the voicing alternation in Dutch between *paard* (/[pa:rt]/) 'horse' and *paarden* (//[pa:r][d/ən]/) 'horses', are captured by nonproductive schemas, which, as seen in § 5, are equivalent to lexical redundancy rules.

4.2. Relational Morphology (RM)

RM, the morphological theory developed by J&A, is based on the premises of the PA but draws heavily from the closely related approach of Construction Morphology (Booij 2010), which in turn is based on the traditional notion of a grammatical *construction*, that is, a pairing of form and meaning. While Culicover & Jackendoff (2005) take morphology to be the extension of the PA below the word level, much as in the model shown in (30), in J&A morphology is conceived of as in (32), where the grammar of words runs in parallel with the grammar of phrases. Note from (32) that while in the PA there is no distinction between lexicon and grammar, there is a distinction between phrasal structures and morphological structures.

(32)   Morphology in the Parallel Architecture

Phrasal phonology   ←→   Phrasal syntax   ←→   Phrasal semantics

Word phonology   ←→   Morphosyntax   ←→   Word semantics

[Jackendoff & Audring 2019, J&A]

In this model, morphology is not seen as being located below the word level. However, it is advantageous to represent morphology below the word level as its own subcomponent to clearly mark the distinction between the phrasal components and the word-based components of the grammar. Furthermore, in the model shown in (32), affixes are found in morphosyntax and word phonology but their content or contribution is not found in word semantics (or in any of the phrasal components), leading to an interesting asymmetry (see below).

In RM, lexical items are instantiations of schemas. The lexical entries of *hard* and the derivative *harden* are illustrated in (33), while (34) shows a schema of the suffix *-en*. These schemas are relational and perform the same function as lexical redundancy rules (see Jackendoff & Audring 2019, J&A; see § 5). Notice in (33, 34) that the affix is not reflected in the semantics of the derivative. The affix does not contribute semantically to the derivation, it only provides syntactic and phonological information (index 3). In this model, while (free) lexical items are signs, affixes and bound morphemes in general are not considered signs. That is, affixes are not lexical items; they do not exist independently, only as part of a schema. The schema itself provides the semantics for the derivative. In other words, in RM the semantics is a property of the schema (the construction) as a whole, not of the affix (see Booij 2010, 2013, Booij & Audring 2015).

(33)   Lexical entries

hard   *harden*
a. Semantics: $HARD_1$ b. Semantics: $[BECOME (HARD_1)]_2$

Syntax: A_1 Syntax: $[_V A_1 \text{ aff}_3]_2$

Phonology: $/hard/_1$ Phonology: $/ /hard/_1 /ən/_3 /_2$
                                        [J&A, Jackendoff & Audring 2019]

(34)   Schema of suffix *-en*

Semantics: $[BECOME (MORE \underline{X}_x)]_y$

Syntax: $[_V \underline{A}_x \text{ aff}_3]_y$

Phonology: $//\underline{\dots} /_x /ən/_3 /_y$

[J&A, Jackendoff & Audring 2019]

In Construction Morphology, affixes (and bound morphemes in general) function as morphological 'markers' of constructions (Booij 2013), an approach that is very similar to word-and-paradigm (or realizational) models such as those of Anderson (1992) and Beard (1995), (and earlier, Aronoff 1976, 1994) where affixes are seen as (phonological) 'cues' or exponents that mark different types of lexical rules or processes. Since in these word-and-paradigm models the suffixes themselves are detached from the operations they participate in, suffixes are also not seen as adding information to a derivation. Thus, the semantic contribution of the suffix is not clearly shown or captured the way it is in concatenative models.

An example of a rule, as in realizational approaches such as "lexeme based" or "word-and-paradigm" theories (cf. Anderson 1992), is shown in (35a). More recent versions of word-and- paradigm approaches, such as Paradigm Function Morphology (Stump 2019), continue to use very similar rules as Anderson's (1992), as seen in (35b).

(35)   a. Rule in a word-and-paradigm model (adapted from Anderson 1992 and Spencer 1991)

[+past]

/X/ → /X + ed/

(walk → walked)

b. Rule in Paradigm Function Morphology (adapted from Stump 2019)

[finite past]: X → Xd (talk → talked)

Moreover, since in the word-and-paradigm approaches derivation is implemented in the form of lexical rules and therefore they do not contemplate the morphological category Affix (affixes are seen as formal markers, as noted above), they miss the generalization that a given base and a given affix can form a word of a different category. As noted by Pinker (1999) and Jackendoff (2002), this inability of models based on lexical rules to capture such generalizations is due to the fact that they lack variables (such as Af, V, N, A), which can stand for entire classes of items. The generalizing power of concatenative models comes precisely from their ability to combine variables to produce an output.

Furthermore, as Culicover & Jackendoff (2005), Jackendoff (2010a), and Jackendoff (2002) point out, even though word-and-paradigm theories (Anderson 1992, see also Blevins 2006 for a similar word-based model) account well for semiproductive or irregular phenomena (as does the dual-route model), as noted in § 3, by positing an individual lexical rule (or construction) per affix they force the implication that entire inflectional paradigms consisting of thousands or millions of forms (e.g. the verbal paradigms of Turkish or Navajo) are stored in the lexicon inflected for every word (see Pinker 1999), which for Jackendoff (2002) stretches plausibility. More recent and sophisticated paradigm-based accounts, such as in Blevins, Ackerman, and Malouf (2019), and Stump (2019) are also realizational and thus are also subject to the same attribution of implausibility regarding the storage of large numbers of forms (in the form of paradigms). In contrast, in concatenative models, one can generate any productive form online by freely combining the base

with a given affix from a stored inventory of bound morphemes (Jackendoff 2002, 2010a, Culicover & Jackendoff 2005). While frequent regular forms may be redundantly stored in the lexicon (Jackendoff 2013a, Plag & Baayen 2009), the demands on mental storage are meager compared to those for the word-and-paradigm approaches.

Schemas in general are compatible with general principles of construction grammar, where, according to Goldberg & Jackendoff (2004), verb meaning is distinguished from the construction that a verb may appear in. Thus, there is a constructional meaning that is distinct from verbal meaning. For example, in the resultative sentence *John watered the plants flat*, "John caused the plants to become flat*"* is the meaning contributed by the construction, and "John watered the plants" is the meaning contributed by the verb *to water* itself. Note that it is necessary for the construction to contribute meaning, because verbal meaning by itself is not enough to account for the meaning of the sentence. This is in contrast to the sentence *John watered the plants*, where the verb does account for the meaning of the sentence. For another example, in the sound+motion construction, as in *The car squealed around the corner*, the meaning of motion (or GO) is provided by the construction, as it cannot be provided by the verb *to squeal*. Constructional meaning is comparable to the schema meaning in (24, 25). The key difference is that in RM, unlike a verb in sentences or clauses, the derivational suffix does not contribute any meaning.

This brings us to the asymmetry in RM mentioned above. While word formation in RM is concatenative in phonology and syntax (24b), it is not concatenative in semantics. In addition, while phonology and syntax are coindexed in the schema (25) and the derivative (24b), there is no mapping between phonology and syntax (form), on the one hand, and semantics (meaning). Thus, there is no direct mapping between form and meaning, as there should be in a construction. These are important inconsistencies in RM. In contrast, in a full lexical item (such as those in 5-7 and 24a, the base *hard*) there is a clear mapping from form (phonology and syntax) to meaning.

A way to visualize the lack of mapping between form and meaning in RM is as in (36), which shows the lower part of (32). It illustrates that in schemas and derived forms, while the link between phonology and morphosyntax is retained, the link to semantics is lost. Since the semantics is delinked, this is no longer a triplet of linked structures, as per the definition of a lexical entry in the PA. This problem does not arise in the SSM because there are no schemas, only lexical entries.

(36)   Links in schemas and derived forms:

        Word phonology   ←→   Morphosyntax   Word semantics

J&A note in an appendix (pp. 129-30) that, intuitively, on grounds of uniformity, one might expect the link between morphosyntax and phonology in an affix schema to extend to semantics as well. To solve this problem, they discuss several notational variants for coindexed schemas, noting that the issue boils down to the fact that the semantic structure associated with the affix is not always a coindexable constituent. They conclude that, given the difficulties associated with the alternatives, the notation adopted throughout their book (as shown in the schemas above) appears to be a reasonably optimal combination of rigor and practicality. However, this gives

rise to the very important problem, discussed above, of a model based on constructions—which are by definition a pairing of form and meaning—where schema representations do not have a link between form and meaning. In contrast, this is not a problem for SSM, because it is based on lexical entries that do not depend on coindexation.

Moreover, recall from the discussion in § 3 that in the SSM the affix functions as a head and thus has a central role in derivation. In contrast, since in RM affixes are not lexical items, they cannot be heads. This is in accord with Construction Morphology, where headedness is said to be represented as a constructional property (Masini & Audring 2019). As J&A note, in RM, what determines the category of a composite word is not the affix per se, but rather the schema containing the affix. This takes away from derivational affixes the important role of head of a structure that they have traditionally held in a variety of word formation approaches.

However, this is not the most important problem for RM and the constructional approach to morphology in general. As we just saw, in resultatives it makes sense for the construction to carry meaning because the meaning of the verb is not sufficient. However, in regular word formation, the meaning of an affix, combined with the meaning of the base, is enough to account for the meaning of the entire derivative. Thus, it is not necessary for the construction (the schema) to carry the meaning that the affix can provide. It is clear that J&A, Jackendoff & Audring (2019), and Construction Morphology in general, are extending into morphology a characteristic of syntactic constructions (such as that of the resultative), in order to be able to have a single formalism throughout the grammar. However, this leads to an additional inconsistency, that of unnecessarily ascribing meaning to a morphological construction when meaning is already accounted for by the components of the structure, in this case via a concatenative process.

This problem is compounded by the fact that in languages with regular derivation, lexical bases can take multiple affixes, each contributing a different meaning, as part of the same type of derivation (e.g. nominalization), that is, in the same type of construction. For example, the Spanish adjective *moderno* 'modern' forms nouns with both the suffix *-idad* (*modern+idad* 'modernity') and *-ismo* (*modern+ismo* 'modernism'), and the suffixes *-ería* and *-ero* attach to the same base, *joya* 'jewel', to produce the nouns *joy+ería* 'jewelry store' and *joy+ero* 'jeweler'; the English verb *attract* forms the adjectives *attract+ive* and *atract+able*; and Clahsen and Ikemoto (2012) cite the Japanese adjective *tuyo-i* 'strong', which forms the nouns *tuyo+sa* '(degree of) strength' and *tuyo+mi* 'virtue or talent', with the suffixes *-sa* and *-mi*, respectively. Notice that in all cases, while the output with a given base is of the same type (e.g. noun formation), the derived words have different meanings.

For the Japanese example, Clahsen & Ikemoto (2012) note that the suffixes *-sa* and *-mi* have parallel formal properties—that is, they both change the category of the base in the same way and are part of the same type of construction—but differ with respect to their semantic properties. Since both suffixes form the same type of construction with the same base, but the derived words have different meanings, what determines the difference in meaning? It cannot be the construction, because that is what they have in common. The difference in meaning of the derived forms, in the Japanese and the other examples, must be accounted for by the meaning contributed by each affix. Keeping in mind that this is a common phenomenon in languages with derivation, this is further evidence for the autonomy of affixes with respect to meaning

contribution, and against the constructional (schema-based) analysis of RM, where affixes are devoid of meaning.

Given this situation, the pre-RM lexical entries in the PA for affixes, such as (6), are more compatible with the PA itself because they avoid the inconsistencies of schemas due to the fact that their semantics is coindexed with both the syntax and phonology. These pre-RM lexical entries are of the same sort as SSM lexical entries.

It is also unclear in RM how changes in argument structure (e.g. loss or addition of arguments) occur in word formation. According to J&A and Jackendoff & Audring (2019), the morphosyntax-semantics interface is responsible for the effects of morphological combination on argument structure. For example, event or process nominals such as *abandonment* preserve the argument structure of the corresponding verb *abandon*, while agentive nominals like *baker* and result nominals like *inscription* denote one of the semantic arguments of the corresponding verb. However, Jackendoff & Audring (2019) do not show what exactly are the effects on argument structure (e.g. what arguments are inherited and which are lost). In contrast, this is accounted for in a fine-grained way in the SSM. As for J&A, while they discuss some examples, there are inconsistencies related to those that arise with respect to coindexation, as discussed in § 4, as well as with those discussed in § 3 regarding drawbacks of models based on coindexation. For instance, for an example with *baker* in J&A, the semantics is not linked to anything in the schema for the nominalizing suffix *-er*, and the Agent argument still appears in the lexical entry for the derived form *baker*, when it is actually disallowed syntactically (cf. **John baker of cakes*).

Another important contrast between the SSM (as incorporated into the PA) and RM is that, as noted above, in the former, morphology does not interface directly with phrasal syntax or semantics. It does so via the lexicon, as shown in (21). This is especially true of bound morphemes such as affixes, which according to some approaches (e.g. the Lexical Integrity Principle of Bresnan & Mchombo 1995), are visible to syntax and semantics only through the lexicon. This brings us to the lexicalist hypothesis or lexicalism, of which the Lexical Integrity Principle is a key part. Bruening (2018) makes a scathing critique of the lexicalist hypothesis, which says that the component of grammar that produces words is distinct and strictly separate from the component that produces phrases, arguing that it is both wrong and superfluous, for a variety of reasons. However, Müller (2018) provides an effective rebuttal, showing that several of Bruening's (2018) claims are wrong, and demonstrating that phrases that are inflected (e.g. *They Bonnie and Clyded us…*) can receive a treatment in morphological terms if they are considered stems.

The dual-route model accounts for inflected quotations in a similar way. For example, Pinker (1999) shows that speakers see a quotation as a rootless unit to which a default rule can apply. When a word or structure is rootless, it is disconnected from any inflected forms stored in memory (unlike, say, *sing*, which has its past *sang* stored with it). However, the rootless unit is not left without a past tense or plural when needed; the rule applies and turns it into a regular form by adding a suffix, as we can see in *She "Yes, dear"ed me all day long* and *I found three "rich man"s on p. 10* (not *three "rich men."*). The phrases and quotations are now units similar to words that can undergo affixation, not phrasal structures. Note as well the mentalist framework needed for the explanation. The key factor is that these utterances are represented in the mind as stretches of sound pressed into service as a word (Pinker 1999), regardless of what their function was before they were inflected. Their mental representation is

key to analyze them as morphological rather than syntactic units. Insofar as the SSM is lexicalist, it finds support in evidence such as this.

Finally, pragmatics seems to play a role in cases where syntax appears to be able to "see" inside morphological structures, in what seems to be a counterexample to Williams' (2007) observation that morphological derivations are encapsulated, hidden from the view of phrasal syntax. In a sentence such as *Reagan$_i$ ites admired his$_i$ sense of humor*, where a word-internal constituent serves as an antecedent for a pronoun, pragmatics seems to come into play to coindex the base of the derivative (*Reagan*) and the pronoun. It may have to do with the fact that we are talking about a person, in particular a famous person. Using the similar example *Reagan$_i$ ites no longer agree with him$_i$*, Montermini (2006) argues that the coreference in this type of sentences is pragmatically motivated, among other things because it is improved when the noun is a proper name, which is strongly referential and involves a salient object in the discourse. Fábregas (2011) presents grammatical tests that support Montermini's pragmatic analysis, as well as a similar one by Sproat (1988).

In addition, this is not a productive process, especially when the referents involved are objects, not people. Consider these ungrammatical sentences, where the pronouns and their potential antecedents cannot be coindexed: **Pian$_i$ ists admire its$_i$ /their$_i$ versatility. *After they were hospital$_i$ ized, it$_i$ was hard to find, so we couldn't visit them*. Pragmatics, which is mentioned by Bruening (2018) only once in a footnote, seems to be quite important to explain exceptional cases where lexicalism appears to be violated.

Processing considerations lend further support to this idea of the lexicon as an interface between morphology and the phrasal components. According to Jackendoff's (2013a) processing model, in the processing of a sentence, the first step after receiving linguistic input concerns the lexicon alone, without connecting with the phrasal components. Working memory, seeking potential lexical matches, sends a call to the lexicon. Only full words (taken from the lexicon) can be incorporated (Jackendoff uses the terms "bound" or "copied") into a phrasal structure as processing is taking place; affixes cannot be copied by themselves, alone. This means that word formation needs to take place before this lexical copying, so that fully-formed lexical items can participate in phrasal processing. Lexical items then separate into their respective phrasal components to participate at the interfaces (in working memory), which gives support to the representation in (21).

Note that the requirement for lexical items to be fully-formed before entering a structure is not incompatible with parallel processing. As seen in (21), it is the phrasal levels that undergo processing in parallel, with the lexicon supplying them material and serving as an interface to morphology. That an affix cannot participate by itself, without its base, in a phrase or sentence (only the full item can), is simply a requirement of the grammar.

All the characteristics and drawbacks of RM discussed above are shared by constructional schemas in Construction Morphology proper (Masini & Audring 2019, Booij & Audring 2015, Booij 2010, 2013). For example, in the schema of the suffix -*hood* in (37), the affix is not reflected in the meaning of the derivative; that is, the affix does not contribute semantically to the derivation, and only provides syntactic and phonological information (index *k* in 37). Again, it is the schema that provides the semantic information for the derivative, which, as noted above, leads to an

inconsistency due to the extension of principles from syntactic constructions applied to morphological structures.

(37)   Schema for a suffix in Construction Morphology

a. $[N_i \text{ Suff}_k]N_j \leftrightarrow [\text{Quality of SEM}_i]_j$

b. $[N_i \text{ } hood_k]N_j \leftrightarrow [\text{Quality of SEM}_i]_j$

[adapted from Booij and Audring (2015)]

It is also noteworthy that the lack of a link between form and meaning in RM is not restricted to affix schemas. There is a delinking of the semantics even in some simplex lexical entries. For example, while in the lexical entry for *pig* in (38) both phonology and syntax are linked to the semantics, in *devour* (39), only part of the semantics, the Patient, is linked to phonology and syntax. The core meaning, DEVOUR, is left unlinked.

(38)   Lexical entry for *pig*

Semantics: PIG_1

Syntax: N_1

Phonology: $/\text{pig}/_1$

[J&A]

(39)   Lexical entry for *devour*

Semantics: $[\text{DEVOUR (Agent: X, Patient: Y}_1)]_2$

Syntax: $[V_3 \text{ NP}_1]_2$

Phonology: $/\text{dəvawr}_{3....1}/_2$

[adapted from J&A]

For another example, in RM, for both regular and irregular verbs and nouns, semantic features that correspond to syntactic features such as Plural and Past are not linked to anything, and in irregulars, syntactic features are also unlinked and isolated. They are not linked to phonology and, more importantly, syntactic and semantic features are not linked to each other within the entry. For example, notice the lack of coindices in (40b) for PLUR (a semantic feature) and PL (a syntactic feature). Yet these are not schemas nor complex lexical items, but rather simplex items (see more examples in J&A: 14, 96, 144, 162).

(40)　　Lexical entries for base noun and irregular plural

　　　a.　　Semantics:　　$SHEEP_1$

　　　　　　Syntax:　　　N_1

　　　　　　Phonology:　　$/ship/_1$

　　　b.　　Semantics:　　$PLUR\ [(SHEEP_1)]_2$

　　　　　　Syntax:　　　$[_N\ N_1\ \ PL]_2$

　　　　　　Phonology:　　$/ship/_{1,2}$

　　　　　　　　　　　[adapted from J&A]

These are additional examples that illustrate the asymmetries and inconsistencies of the RM model, brought about by a representation based on schemas and coindexation. In contrast, these problems do not arise in SSM, as all lexical items are represented the same way, with no distinction between a schema and an actual lexical item.

Finally, the separation of phrasal syntax and semantics, on the one hand, from the lexicon below the word level (i.e. morphology) appears to receive support from the Bottleneck Hypothesis (Slabakova 2008, 2013), which states that (functional) morphology is processed differently from syntax and semantics. The rationale for the Bottleneck Hypothesis is as follows (Slabakova 2013): 1) Functional morphology reflects syntactic and semantic differences between languages; 2) Narrow syntactic operations and meaning calculation are universal; 3) In order to acquire syntax and meaning in a second language, the learner has to go through the functional morphology; 4) Hence, morphology is the bottleneck of acquisition. Learners tend to encounter enhanced difficulty in learning morphology, as compared to syntax and semantics. Notice the inherent separation between the phrasal and morphological levels expressed in this hypothesis. Learners have to deal with operations going on below the word level before they can fully master those that occur at the phrasal level.

Moreover, the notion of "conceptual complexity" (Brown 1973) seems to provide support for both the separation of phrasal syntax and semantics from morphology, and for the Bottleneck Hypothesis. Blom (2019) notes, for example, that the 3rd person sg. *-s* in English may be acquired late because 3rd person, singularity, and present tense are expressed simultaneously. In addition, the occurrence of *-s* in other contexts such as plural (*books*) or possessive (*Peter's book*) adds to the difficulties of mapping form to function, which increases the conceptual complexity load for the learner. This suggests that there is a stronger connection between morphology and lexical semantics than between syntax and lexical semantics, which makes morphology harder to acquire.
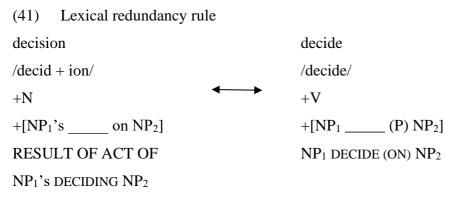
5. Lexical Redundancy Rules

This section compares lexical redundancy rules with their equivalents in other approaches. The upshot is that, just like its equivalents, lexical redundancy rules are relational and perform the same or very similar functions as relational schemas in RM, as rules in realizational approaches (such as word and paradigm theory), and as inheritance hierarchies (e.g. in HPSG). It is shown that, in their central function, the rules and hierarchies in the other approaches are variants of lexical redundancy rules. Everything those rules explain can be accounted for by lexical redundancy rules as well.

5.1. Lexical Redundancy Rules and RM
As noted in §§ 3, 4 according to the dual-route model, irregular, semiproductive, or unpredictable forms have to be memorized and are stored in a sort of analogical (associative, relational) network that is a part of the lexicon and implements lexical redundancy rules. Some schemas in RM are relational and perform the same function as lexical redundancy rules. Likewise, lexical entries in SSM can be relational, governed by lexical redundancy rules. Pinker (1999) notes that lexical redundancy rules, which capture patterns of similarity among words stored in memory, are an integral part of the dual-route model. In addition, Pinker & Ullman (2002) point out that many morphological phenomena are neither arbitrary lists nor fully systematic and productive, and lexical redundancy rules, by capturing patterns of redundance, allow for generalization by analogy (e.g. *drink-drank* generalizing to *spling-splang*). In fact, lexical redundancy rules were proposed long before the relational schemas of Construction Morphology. Jackendoff (1975) formalized lexical redundancy rules over a decade before Fillmore et al.'s (1988) classic paper on Construction Grammar, and Construction Morphology was formulated over two decades after that (cf. Booij 2010).

(41) illustrates a lexical redundancy rule, adapted from Jackendoff (1975). The rule designates as redundant that information in a lexical entry which is predictable by the existence of a related lexical item. The two-way arrow is read as the symmetric relation "is lexically related to." Thus, the lexical redundancy rule can be read as, "A lexical entry *x* having such-and-such properties is related to a lexical entry *y* having such-and-such properties." Notice the coindices in (41), which do the same work as those in relational schemas.

(41)   Lexical redundancy rule

decision		decide
/decid + ion/		/decide/
+N	$\longleftrightarrow$	+V
+[NP$_1$'s _____ on NP$_2$]		+[NP$_1$ _____ (P) NP$_2$]
RESULT OF ACT OF		NP$_1$ DECIDE (ON) NP$_2$
NP$_1$'s DECIDING NP$_2$		

[adapted from Jackendoff 1975]

Relational schemas are compared and even equated to lexical redundancy rules throughout J&A. For example, J&A point out that patterns that cannot be captured by productive rules require principles that some theories have called lexical redundancy rules, and that they call relational schemas, thus equating lexical redundancy rules to schemas. They add that schemas function in a relational role, more or less parallel to traditional lexical redundancy rules. That is, schemas do the work traditionally attributed to lexical redundancy rules. Relational links encode patterns of redundancy, and by capturing the redundance between lexical items, they fulfill the function of lexical redundancy rules. Note that in all of these descriptions, either lexical redundancy rules or redundancy are mentioned explicitly. J&A seem to recognize that relational schemas are a variant of lexical redundancy rules. It seems to be that, in essence, relational schemas are a modification and formalization of lexical redundancy rules.

In the relational schemas of RM, the relation between entries (represented in part by the two-way arrow in (41)) is determined by coindexation. Consider the example in (42), where, as J&A note, *assassin* and *assassinate* motivate each other, and there is no need to say which word is derived from which. This is precisely one of the functions of lexical redundancy rules as described by Jackendoff (1975), and what the rule in (41) is doing with *decide* and *decision*.

(42)   Lexical entries for *assassin* and *assassinate*

     a.   *assassin*

           Semantics: [PERSON [WHO MURDERS POLITICIAN]$_1$]$_2$

           Syntax: N$_2$

           Phonology: /əsæsən/$_2$

     b.   *assassinate*

           Semantics: [MURDER POLITICIAN]$_1$

           Syntax: [$_N$ N$_2$ aff$_3$]$_1$

           Phonology: /əsæsən$_2$ ejt$_3$/$_1$ [adapted from J&A]

Seeing the close similarity between relational schemas and lexical redundancy rules, and keeping in mind that in SSM lexical redundancy rules operate over lexical items rather than over schemas, a key difference between RM and SSM lies rather in unification, the process that takes care of regular formation. While in RM there is unification of schemas, in their generative role, in SSM there is unification of lexical entries. However, just like schemas, lexical items in SSM contain variables (e.g. for subcategorization and selection constraints in verbs and affixes), as seen in § 3 (see J&A), that are instantiated after unification. Crucially, in SSM, any morphological

structure that cannot be formed or accounted for by unification is taken care of by lexical redundancy rules.

Finally, it is important to point out two other problems with RM: excessive and confusing coindexation, and excessive creation of schemas. J&A illustrate more fully detailed schemas (e.g. for the *-en* suffix) that have a large number of coindices, with some pieces of the schema having up to two pre-subscripting coindices each, in addition to the usual post-subscripting coindices, totaling 24 coindices for a single schema. This is unwieldy, confusing and hard to interpret, and J&A in fact admit that this type of representation just happens to be impossible to use. Note that these more precise schemas with 20+ coindices are presumably closer in detail to how real schemas are supposed to be represented. Furthermore, there is a need to differentiate interface links (within a schema) from relational links (between schemas), of which there are four kinds, which according to J&A is not always perspicuous. Given this, the question arises as to whether this type of schema representations is plausible in terms of processing. In contrast, in a system with no schemas such as the dual-route model, while each stored item is related to many other items via lexical redundancy rules, there are no intermediary schemas that can cause confusion due to different types of coindices.

The problem of proliferation of schemas in RM is illustrated by the English past and present tenses, which are used to express not only past or present time, but a variety of other semantic functions (such as the present being used for a scheduled future, as in *We leave tomorrow*). In order to account for this polysemy, J&A posit 15 possible schemas for the Past tense and a similar number for the Present tense. They call this a clumsy solution, but then go on to say that it might be correct. By contrast, in SSM this is accounted for with polysemous lexical entries for affixes, and lexical redundancy rules for exceptional cases.

5.2. Lexical Redundancy Rules and Rules in Realizational Approaches

All realizational approaches have in common that they are word-based; that is, as with lexical redundancy rules (Jackendoff 1975), they relate a word to another word. Lexical redundancy rules such as the one illustrated in (41), repeated below as (43), have a very similar function to realizational rules in paradigm-based models such as the ones in (35), repeated below as (44). Both types of rule indicate what information two or more related lexical entries share and in what ways they differ. Thus, lexical redundancy rules already account for what realizational rules account for; realizational rules can be considered variants of lexical redundancy rules.

(43)   Lexical redundancy rule

decision		decide
/decid + ion/		/decide/
+N	$\longleftrightarrow$	+V
+[NP$_1$'s _____ on NP$_2$]		+[NP$_1$ _____ (P) NP$_2$]
RESULT OF ACT OF		NP$_1$ DECIDE (ON) NP$_2$
NP$_1$'s DECIDING NP$_2$		

[adapted from Jackendoff 1975]

(44)   a. Rule in a word-and-paradigm model (adapted from Anderson 1992 and Spencer 1991)

       [+past]

       /X/ $\rightarrow$ /X + ed/

       (walk $\rightarrow$ walked)

       b. Rule in Paradigm Function Morphology (adapted from Stump 2019)

       [finite past]: X $\rightarrow$ Xd (talk $\rightarrow$ talked)

As noted in § 3, lexical rules (a type of realizational rule) are once-only rules, in that once a word has been formed, it cannot be unformed, regardless of whether the word is new or unknown to most speakers. That is because they are entirely word-based, so both their input and output is a word that cannot be broken down into parts that can be stored or analyzed separately. This is precisely the type of words that lexical redundancy rules help organize. Lexical redundancy rules deal with the words that have to be memorized, while the SSM compositional rules deal with decomposable, regular words. As noted in § 5.1, in SSM, morphological structures that cannot be formed or accounted for by unification (the regular process) are taken care of by lexical redundancy rules.

Furthermore, realizational approaches can deal well with inflection, where no changes in argument structure are involved. However, in derivation, while the category change is reflected in the rule itself, as seen in (11), repeated below as (45), changes in argument structure have to be stated as part of the rule. They do not follow from other principles or structures, as in SSM. In that sense, they are ad hoc or arbitrary.

(45)   Aronoff's WFRs
       a. [read]V $\rightarrow$ [[read]V + able]A
           Condition: The base [X] is transitive
           Syntax: The object argument of [X] corresponds to the subject of
           [Xable]
           Semantics: 'capable of being read'
                             [adapted from Aronoff 1976]

Another important point connected to realizational rules is related to Aronoff's (2007) realizational approach, which sees morphological regularity/irregularity as gradient rather than discrete. He starts by saying that in traditional approaches, lexical roots are supposed to be the atomic meaningful units of language, and this runs into problems when two instances of the same root share little or no meaning, for example, as in *permit* and *remit*, which share the Latinate root *-mit*. There is a similar situation with Hebrew roots such as KBʃ in *keveʃ*, which can have a variety of unrelated meanings, including 'gangway,' 'step,' 'degree,' or 'pickled fruit.' Aronoff notes that it has been shown that words formed with these roots have robust morphological

properties that bear no relation to meaning and little to phonology, leaving room for these morphemes within a lexeme-based framework, but not as the basic meaningful atoms of language. According to Aronoff, traditional approaches simply deny the linguistic reality of roots entirely. He argues that, however, there is a middle ground, where words have morphological structure even when they are not compositionally derived, and where roots are morphologically important entities, though not particularly characterized by lexical meaning.

This is entirely compatible with SSM, the dual-route approach, and the PA, where not all morphemes have to be signs. As seen in § 3, there is evidence that words with bound roots, such as *ble* Spanish patrimonials, are not represented in the mind of speakers the same way as regular, compositional derived forms. Thus, they have to be stored and are subject to lexical redundancy rules. The same is the case for the Latin and Hebrew roots cited by Aronoff (2007) as evidence for the gradience of irregularity. In fact, within PA, Jackendoff (2002) proposed that items such as *yes*, *hello*, *ouch*, *abracadabra*, *cran-* in *cranberry*, and the *do* in *do*-support (*I didn't like him*) lack either syntactic or semantic information and thus are defective lexical items. They are also known as nonstereotypical or noncanonical lexical items or nonlexical bases (J&A). For example, *ouch*, which has phonology and semantics, can be used on its own as a meaningful utterance and cannot be combined with other words in a sentence. This is because it lacks syntactic information. And the *do* of *do*-support is present just to carry the Tense; it does not have semantic information.

Words in Spanish and other languages formed by bound roots (e.g. *per+ceive*, *em+pathy*, Sp. *pro+vocar* 'to provoke') can also be considered defective items that have morphological information but lack meaning. For example, *sume* in *consume*, *duce* in *reduce*, and *vocar* in Sp. *invocar* 'to invoke' do not have an identifiable meaning the way a free base such as *attach* does in *reattach*. Since the roots do not have a meaning, it would be hard to ascribe any meaning to the prefixes either; they also appear to lack meaning in these formations. For example, the *re* in *reduce* is meaningless as compared to the *re* in *reattach*. However, the words manifest some regularities, which may lead one to think that they have some degree of compositionality. For example, roots undergo what seems to be a systematic change when verbs are nominalized with the suffix *-ion* (e.g. *con**ceive** > con**cept**ion*, *per**ceive** > per**cept**ion*; *re**duce** > re**duct**ion*, *pro**duce** > pro**duct**ion*; Sp. *con**vocar*** 'convene' > *con**vocac**ión*, *in**vocar** > in**vocac**ión*) (cf. Bochner 1992). These are part of the robust morphological properties mentioned by Aronoff.

However, these apparent regularities are actually very similar to those shown by irregular forms that need to be memorized, are stored in an associative network, undergo analogy, and are subject to lexical redundancy rules; precisely those items that are accounted for by the dual-route model. First, they are unproductive; at least with Latin bound roots, it seems that no novel or nonce forms can be created (cf. **pro+ceive*, **in+ceive*, **de+sume*, **de+pel* vs. *compel*, *repel*). This is in contrast to Latinate bases which are independent words and can combine freely, in rule-like fashion, with several prefixes to form grammatical novel forms (e.g. *re+admit*, *pre+admit*; *re+submit*, *co+submit*; *over+protect*, *under+protect*).

Second, the systematicity of the root change in nominalization is reminiscent of the cluster effects or patterns found in irregular verbs. The changes in the root in *consume—consumption*, *resume—resumption*; *confer—conferral*, *refer—referral*; *permit—permission*, *transmit—transmission* roughly parallel those of (in no particular

order) *ring—rang, sing—sang*; *cling—clung, stick—stuck*; *blow—blew, grow—grew*; *bind—bound, find—found*. Aronoff (2007) completely ignores the dual-route approach, which provides a principled explanation to these phenomena without the need to claim that irregularity is gradient. Bound roots, seen as nonstereotypical lexical items in PA, are pieces of structure that are stored just like the prototypical lexical entries (that consist of a triplet of phonological, syntactic and semantic information), but lack one of these pieces of information. In fact, Jackendoff (2002) suggests that even pieces of phrase structure such as [ᵥₚ V NP] can be considered defective lexical items that lack phonology and semantics.

       Finally, we have lexical rules within HPSG, which have been mentioned in several parts of the present paper. (46) shows a lexical rule in simplified notation, adapted from Bonami and Crysmann (2016) and Riehemann (1998), and partly in the style of Abeillé & Borsley (2021). As with rules in other realizational approaches, the lexical rule relates two words (and thus is word-based); it indicates that the verb *read* is related to the adjective *readable*, and expresses the relationship between the two lexical entries by means of coindexation (numbers in squared brackets). For example, the undergoer in *read* is the subject of *readable*. Notice that the Actor is still a part of the representation of *readable*, but it is actually no longer a participant (**The book is readable by Peter*). This is one of the drawbacks of this type of rules, as compared to derivations in SSM, where slot structure and percolation account for suppression of arguments that should not appear in the output.

(46) Derivational lexical rule in HPSG

[*read*, V]   [*readable*, A]
[ARG-ST: NP[1], NP[2]]   →   [VALENCE: SUBJ[**2**]]
[SEM: *read-rel*; ACT[1], UND[2]]   [SEM: *possible-rel*; **ACT[1]**, UND[**2**]]

       Another type of lexical rule in HPSG is known as an inflectional unary branching construction, shown in (47). This type of rule originated in Sign-Based Construction Grammar (SBCG), which, according to Abeillé & Borsley (2021), is a version of HPSG (cf. Sag 2012). As in (46), the rule in (47) relates two words and expresses the relationship between the two lexical entries by means of coindexation. The only difference is that the base (*open*) is represented below the inflected word (*opened*) to indicate that the branching is unary. The key difference between the two entries is the feature *past* in the inflected word. In this example, because it is inflectional, the argument structure and semantics of the input and output remain the same.

(47) Inflectional unary branching construction in SBCG/HPSG

              MTR   [*open+ed*, V
                       [SYN: *finite*, ***past***]
                       [ARG-ST: NP[1]], NP[2]]
                       [SEM: *open-rel*; ACT[1], UND[2]]

DTR   [*open*, V
         [SYN: *finite*]
         [ARG-ST: NP[1]], NP[2]]
         [SEM: *open-rel*; ACT[1], UND[2]]

                                         [adapted from Michaelis 2013]

Meurers (2001) uses a representation of a lexical rule with IN and OUT features that correspond to the MTR (MOTHER)/DTR (DAUGHTER) features of SBCG seen in (47). Unary branching constructions are called unary lexical rules in Meurers (2001) and Davis and Koenig (2021). Thus, they are a notational variant of lexical rules. Because unary lexical rules and IN and OUT rules are just different types of lexical rules, they have the same disadvantages as traditional HPSG lexical rules as noted above and discussed in various sections.

5.3. Lexical Redundancy Rules and Inheritance Hierarchies
As noted in Davis & Koenig (2021), HPSG and LFG took their lead from Jackendoff's (1975) work on lexical redundancy rules. This means that Jackendoff (1975) is a precursor to HPSG, and lexical redundancy rules are the basis for HPSG's view of how the lexicon is organized. Likewise, Riehemann (1998) notes that her Type-Based Derivational Morphology (TBDM) model is similar enough to Jackendoff's (1975) lexical redundancy rules to think of it as an incorporation of those insights into an HPSG architecture. A comparison with Riehemann (1998) is particularly useful because, according to Bonami and Crysmann (2016), Riehemann's (1998) has become the standard approach for derivation within HPSG. In addition, Crysmann (2021) observes that Riehemann (1998) has had a significant impact on subsequent work on word formation, both within the framework of HPSG and beyond.

To capture generalizations about productive, semi-productive and fixed patterns of *-bar* formations, Riehemann (1998) proposed a type hierarchy as the one shown in Figure 1. As in the type hierarchy, lexical redundancy rules can capture the fact that *-able* adjectives have the possibility semantics in common (signaled with *poss-bar-adj*), and the exceptions and subregularities represented in the inheritance network (e.g. *prep-bar-adj*) can also be captured by lexical redundancy rules.
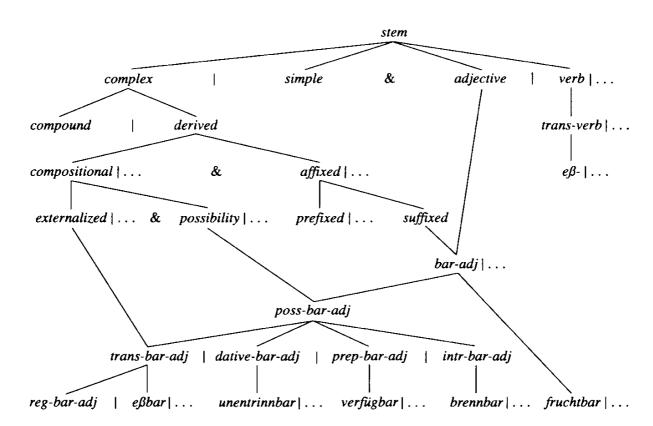
Figure 1: Type hierarchy for *-bar* 'able' derivation [Riehemann 1998]

Riehemann (1998) emphasizes that with this type hierarchy no generalizations are missed; for example, the fact that all *-bar* words are adjectives and have similar semantics. The same is true for lexical redundancy rules; they serve to make generalizations between lexical items. Given that lexical redundancy rules are the conceptual precursors of and do the job that inheritance hierarchies do, it can be argued that inheritance hierarchies and redundancy rules are roughly equivalent or notational variants.

According to Davis & Koenig (2021), there is a problem for rigid, monotonic inheritance hierarchies (such as Riehemann's (1998) type hierarchy above), where none of the information inherited by the supertypes to their subtypes can be overridden. This runs into difficulties when dealing with lexical entries that contain morphological irregularities. For example, how can productive regular forms such as **childs* be blocked, and only *children* allowed as a lexical entry? Although the plural of *child* inherits the information from the pertinent lexical entry and from the *plural-noun* type, which entails the phonology for **childs*, this regular plural form needs to be overridden to get the correct *children*. However, monotonic inheritance does not allow this overriding. Similar issues arise for word formation.

Due to this problem, several approaches to exceptions and irregularities have been proposed within HPSG, including default unification and type underspecification. (Davis & Koenig 2021 note that even with these devices, various complex issues arise in attempting to formulate a workable system of inheritance.) For morphological irregularities such as *children*, some of these devices could be used, with a type for the lexical entry of *child* that overrides the regular plural form. But this

is precisely what the associative network of the dual-route model does. Words such as *child*, *take*, and *strong* are stored along with their irregular forms, *children*, *took*, and *strength*, respectively, and these irregular forms are retrieved when needed. No overriding is necessary. Lexical redundancy rules, as formulated by Jackendoff (1975), relate words to other words without a commitment to inheritance via an HPSG-type hierarchy. They already account for what is a problem in HPSG inheritance hierarchies.

This problem arises because the inheritance hierarchy is used in an attempt to account for both regular and irregular forms (e.g. *books* and *children*). In contrast, the parallel competition between the default rule (unification) and memory search in the dual-route model accounts for both regular and irregular forms in a simple and clearcut way.

Finally, Davis and Koenig (2021) note that lexical rules are now simply unary-branching rules within the type hierarchy. As such they are not formally distinct from the rest of the hierarchy. Thus, based on the discussion above, their function can be replaced by lexical redundancy rules. Note as well that the drawbacks of inheritance hierarchies discussed above are shared by constructional approaches that also make use of inheritance hierarchies, including J&A and Construction Morphology (e.g. Booij 2010). For example, J&A note that both words and syntactic constructions inherit properties from more general constructions. That inheritance needs to be regulated, which may give rise to some of the problems raised by Davis & Koenig (2021) mentioned above.
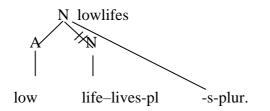
6. Further Issues

As mentioned in § 2, idioms (e.g. *down in the dumps*), constructional idioms (or lexical VPs, e.g. *take NP for granted*), and noncanonical utterance types (or "syntactic nuts") (e.g. *off with his head*) are stored as wholes in the lexicon. These structures are not the result of morphological processes that occur below the word level (see Jackendoff & Audring 2019, Culicover & Jackendoff 2005) and thus do not need to be accounted for by the SSM. For its part, compounding, which has traditionally been considered a morphological process, is distinct from ordinary morphology (see Jackendoff 2009, 2010b) as it operates under *sui generis* protogrammatical principles. However, compounds, which are a type of word, just like simplex or derived words have to be inserted fully-formed as a single unit into a structure undergoing processing (cf. *He is a frog man* vs. **He is a frog very tall man*). While the SSM does not have a developed account for compounding, as Pinker (1999) and Pinker & Ullman (2002) show, percolation is necessary in compounding at least to determine the head of the compound. In English, compound headedness is fully predictable because all endocentric compounds (e.g. *extension cord*) are right-headed, but in other languages there are both left-headed and right-headed compounds and percolation plays a role in determining headedness.

As for exocentric compounds, again, Pinker (1999) and Pinker & Ullman (2002) provide an explanation of both their semantics and the way they are inflected, making reference to percolation. For example, when the noun *life* combines with *low* to form the exocentric compound *lowlife*, the compound no longer has access to the information of its component words, including the plural from *life*. Due to pragmatics and context, a *lowlife* refers to a kind of person (who leads a low life), not to a kind of life. For it to have that meaning, the percolation channel is plugged up, as seen in (48).

With the pipeline to memory disabled, no information stored with *life* (e.g. its irregular plural, *lives*) can percolate to the branching node. With the irregular plural unavailable, the default, regular *-s* is attached and we get *lowlifes* (cf. *low-lives).

(48) Exocentric compound

All exocentric compounds work this way. For example, a *cutthroat* is not a kind of throat, a *lazybones* is not a kind of bones, and a *swansong* is not a kind of *song*. Likewise, in Spanish, a *puntapie* [tip + foot] 'kick' is not a kind of foot, a *lengualarga* (or *lengüilargo*) [tongue + long] 'person who tells on others' is neither a kind of tongue nor something long, and a *tocadiscos* [play + records] 'record player' is a device, not a kind of record. Notice the clear role played by pragmatics in the Spanish exocentric compound *lavaplatos* [wash + dishes], which can either mean 'washing machine' or refer to a person who washes dishes (a dishwasher), depending on the context. For either meaning, however, the clogging of the percolation pipeline has to occur, because *lavaplatos* is definitely not a kind of dish.

Lastly, it may well be that slot structure is a universal template for lexical organization. Regarding the acquisition of lexical items and morphological structures, it could be argued that a lexical entry is constructed from the input a learner hears, and that this does not necessarily entail a universal process. However, the information the learner gathers from the input, even if it is partial, has to go into a structure; it has to be stored in an organized way, and this may well be a universal template organized in the form of a slot structure.

7. Conclusions

Building on the SSM (Benavides 2003, 2009, 2010), we have shown how a well-worked out model of morphology that is compatible with the PA can serve to supplement this framework, thus enhancing its explanatory power. By integrating a well-developed morphological component into the PA that accounts for word formation processes below the word level, the present proposal contributes to linguistic research by helping to make the PA framework an even more comprehensive theoretical tool. It has been shown that neither realizational approaches to morphology—that see affixes as exponents or cues for lexical rules—nor an approach based on schemas (constructions), can adequately capture the full import of the contribution of affixes to derivations. In contrast, the SSM shows how, through the use of slot structure and the mechanism of percolation, the affix determines the structure and content of the derived word, including its meaning and argument structure. In addition, lexical redundancy rules account for the organization of irregular forms. This paper represents a contribution in that it can incentivize the further exploration into the

advantages and disadvantages of integrating either a concatenative or a relational morphological component into the PA.

Given the intimate relationship between processing and language acquisition, the PA is relevant to the study of both first and second language acquisition. Future research could explore the implications of the PA for second language acquisition theories, in particular with respect to the acquisition of morphological structures. A more in-depth analysis of how the Bottleneck Hypothesis may provide support for the separation of phrasal syntax and semantics, on the one hand, from the lexicon below the word level would be an example of such research projects.

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