Modelling Exponents

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Abstract

This paper discusses the mapping from *exponenda*—bundles of morphosyntactic information about *distribution* and *function/meaning*—to *exponents* in the recently established L_RFG framework. We focus on the phonological, prosodic, and morphosyntactic constraints modelled in *v(ocabulary)-structures*, the L_RFG representations of exponents. A v-structure is the output of the ν-mapping from an exponendum. Such mappings are listed in the Vocabulary as vocabulary items (VIs). Thus, the Vocabulary is a list of mappings from exponenda to exponents. From our v-structure representations of exponents, we derive a factorial typology of phonological dependence in formal terms. We also give a fully worked-out analysis of the English deadjectivizing verbalizer affix *-en*.

1 Introduction

We have been working on L_RFG since 2016 and have been publishing it in this venue since 2020 (Melchin et al. 2020; Everdell et al. 2021; Asudeh & Siddiqi 2022). In this paper, we turn our attention to the L_RFG theory of morphological *exponence*.[1] The theory of exponence is ultimately a theory of *exponents*. An exponent is a morphological representation that serves as the interface between an *exponendum* and a (*phonological*) *realization*. In L_RFG, an exponent is represented as a *vocabulary structure*, or *v-structure* for short. We have had a strong idea of vocabulary structure since the beginning, but we are now putting some meat on the bones. The *Vocabulary* in L_RFG is the mapping from the set of exponenda, the set of left-hand sides of *vocabulary items*, to the set of exponents, the set of right-hand sides of vocabulary items, i.e. the set of v-structures. The Vocabulary is thus nothing more or less than a set of vocabulary items, i.e. a set of pairs of exponenda and exponents, or the ν function characterized as a set.

A vocabulary item is represented as in (1) below, based on work in progress (Asudeh & Siddiqi Forthcoming).[2] The tuple in (1) is the representation of an exponendum. It is mapped by ν, the exponence function from exponenda to exponents, to its exponent, represented as a vocabulary structure. Note that although the exponence function ν expects a pair of a list and a set as its argument, as in $\nu(\langle[\alpha], \{\_\_\}\rangle) = \beta$, we often abbreviate this as $\nu(\alpha) = \beta$, since using the category is often sufficient for expository purposes.

(1) $$\Big\langle \underbrace{[\mathrm{C}_1,\ldots,\mathrm{C}_n]}_{\textit{distribution}} \;,\; \underbrace{\mathrm{F} \cup \mathrm{G} \cup \mathrm{I}}_{\textit{function/meaning}} \Big\rangle \xrightarrow{\nu} \Big[\quad\Big]_{\textit{v-structure}}$$

[1]Our thanks to the audience and reviewers for LFG23 for their helpful comments and questions. Many thanks to all of the participants in the weekly joint Carleton/Rochester L_RFG lab. Any remaining errors are our own.

[2]Readers with some familiarity of L_RFG may notice that the left-hand side of this vocabulary item is now a pair, unlike in Asudeh & Siddiqi (2022, 2023), where it was a triple. Similarly, there is no longer a 'Big Phi', Φ, in the left-hand side of vocabulary items. This is a consequence of certain refinements to the L_RFG architecture that we are not presenting here (Asudeh & Siddiqi Forthcoming).

The first member of an exponendum pair is a list of categories, which represents some part of the terminal yield of an L_RFG c-structure. Thus, the first member of the pair encodes the vocabulary item's syntactic *distribution*.

L_RFG assumes the morphosyntactic operation of *spanning* (Ramchand 2008; Svenonius 2016; Merchant 2015; Haugen & Siddiqi 2016). *Spans* are lists of c-structure categories which are involved in many-to-one cases of exponence in which a single v-structure expones multiple c-structure nodes. This is why the *distribution* coordinate in vocabulary items is a list rather than a single category. There are two kinds of spanning in L_RFG:

1. *Vocabulary Spanning*: the case where the category list in the first coordinate of an exponendum has length greater than one; i.e. vocabulary spanning is a matter of listing in the Vocabulary.

2. *Pac-Man Spanning*: the case where some category would be left unexponed and is instead mapped to a neighbouring exponent. In other words, Pac-Man spanning is a matter of the ν-mapping being a total function from the domain of c-structure nodes to the co-domain of v-structures; see §6 below for an example.

The second member of the pair on the left-hand side of the abstract vocabulary item in (1) is the union of a set of descriptions of f-structures, F, a set of descriptions of s-structures and Glue meaning constructors, G, and a set of descriptions of i-structures, I. Any of these sets may be empty. This union represents the *function/meaning* of the vocabulary item. In order to make it easier to refer to this union, we call it a *fugui*.

Let's now turn to the output side of the ν-mapping in (1), a vocabulary structure. A v-structure is modelled as an attribute-value matrix, similarly to f-structure. Attributes are symbols, like DEPENDENCE. Values are symbols, strings, v-structures, or sets of symbols.[3] On analogy with f-structures and f-descriptions, v-structures are *described* by v-descriptions, a set of defining equations and constraints that picks out the minimal satisfying v-structure, if any, as its model. Figure 1 shows the general framework that we will motivate. This is just (1) with the output side specified in a similarly abstract way to the input side. The case we use for exemplification is the English deadjectivizing verbalizer *-en*.[4] The v-structure for *-en* will be discussed in detail in §6 below.

1.1 Goals and overview

This paper has three main goals:

[3]Sets can obviously be generalized to contain any of the other kinds of values.

[4]We adopt the convention of writing the value of a set-valued feature without set-brackets when it is a singleton set; e.g. [CLASS *weak*] instead of [CLASS {*weak*}]. Similarly, in descriptions we will drop the $\in$ feature in paths and write (v DEP) = LT instead of (v DEP $\in$) = LT or LT $\in$ (v DEP).

$$\langle\, [\mathrm{C}_1,\ldots,\mathrm{C}_n], \mathrm{F} \cup \mathrm{G} \cup \mathrm{I} \,\rangle \overset{\nu}{\rightarrow}$$

distribution *function/ meaning*

$$v\text{-}s\left[\begin{array}{ll}
\textsc{phon(ological)rep(resentation)} & \begin{array}{l}\textit{phon. realization \& conditions}\\ \textbf{string}\end{array}\\
\textsc{p(rosodic)frame} & \begin{array}{l}\textit{prosodic unit}\\ \textbf{string wrapped around}\\ \rho\textbf{-correspondent of this v-s}\end{array}\\
\textsc{p(rosodic)domain} & \begin{array}{l}\textit{prosodic unit}\\ \textbf{string wrapped around}\\ \textbf{this } \textsc{pframe} \textbf{ value}\end{array}\\
\textsc{dep(endence)} & \begin{array}{l}\left\{\textsc{lt}, \textsc{rt}\right\}\\ \textbf{set of symbols}\end{array}\\
\textsc{class} & \begin{array}{l}\left\{\textit{inflectional classes}\right\}\\ \textbf{set of symbols}\end{array}\\
\textsc{host} & v\text{-}s\left[\begin{array}{ll}\textsc{ident(ity)} & \begin{array}{l}+\\ \textbf{symbol}\end{array}\\ \textsc{phonrep} & \ldots\\ \textsc{pframe} & \ldots\\ \textsc{dep} & \ldots\\ \textsc{class} & \ldots\end{array}\right]
\end{array}\right]$$

Figure 1: Exponence in $\mathrm{L_RFG}$

1. To develop a model of what is on the right-hand side of the exponence function, ν, i.e. a model of the properties of v-structure representations of exponents
2. To describe a factorial typology of prosodic and phonological dependence in formal terms
3. To provide an analysis of the English deadjectivizing verbalizer affix *-en*

The paper is structured as follows. The following section, §2, goes through the phonological features in Figure 1, describing, exemplifying and motivating them. Then §3 similarly goes through the morphosyntactic features. §4 briefly discusses the competition constraint on v-structures, **MostSpecific**. §5 goes through feature combinations in v-structures that create a useful subsumption ordering for classifying exponents as affixes, clitics, or free forms. §6 goes through an analysis of English *-en* in some detail. §6.1 presents a formal analysis. §6.2 provides details of the ρ-mapping from v-structure to p-structure, i.e. prosody, and also touches on the o-mapping from prosody to phonology. This section concludes with an *Everything Everywhere All At Once* diagram for English *blacken*. The diagram simultaneously represents the c-structure, v-structures, f-structure, s-structure, p-structure, phonology, $\nu/\phi/\sigma/\rho/o$-mappings, and Glue meaning composition proof for *blacken*; see

Figure 4.

2 Phonological and prosodic features

The first lot of features concern the phonology and prosody of the exponent. The feature PHONREP (PHONOLOGICAL REPRESENTATION) encodes the exponent's underlying phonological representation and any conditions it places on its phonological context. The feature PFRAME (PROSODIC FRAME) specifies any conditions the exponent places on its prosodic context. The PDOMAIN (PROSODIC DOMAIN) encodes the prosodic level at which the exponent 'prosodifies,' i.e. is integrated into the surrounding prosodic environment. Lastly, the feature DEP(ENDENCE) encodes the direction of prosodic dependence of the exponent.

2.1 PHONOLOGICAL REPRESENTATION

PHONREP provides the underlying phonological representation of the exponent. It takes a string as a value.[5] We typically represent the phonological form as segments, but we assume that these segments are underlyingly feature bundles. This allows aspects of the phonology to be underspecified. For example, much of English inflection is probably underspecified for [$\pm$voice]. This is also how sub-segmental morphology, such as umlaut, is handled.

The string value can also encode the phonological context of the exponent. For example, this forms part of our approach to French liaison.[6] The value can also encode a memorized, conditioned list. For example, the English indefinite determiners (*a/an*) are listed, phonologically conditioned allomorphs.

2.2 PROSODIC FRAME

The PFRAME denotes the metrical environment where the exponent is licit. It contains anything that can be a prosodic unit, including segments, moras, syllables, and larger prosodic structures. PFRAME constrains the output prosodic environment of the exponent. PFRAME takes as its value a string wrapped around the prosodic correspondent of the v-structure; the prosodic correspondent is the value of $\rho(\bullet)$, where $\bullet$ is the v-structure in question. The value encodes any conditions that the exponent places on its mapping to prosody, i.e. on its prosodic context. For example, FUCK-insertion in English is sensitive to foot structure: *(ábso)fucking(lùtely)* but **(abfuck)(ingso)(lutely)*. Similarly, *-um-* infixation (Austronesian) is sensitive to syllable structure (Orgun & Sprouse 1999; Roark & Sproat 2007: 30, 39–41).

[5] A reviewer wonders if this is sufficient to model autosegmental phonology. It may not be, in which case we would need to model PHONREP values with a more complex structure. However, for now we assume the simpler, string value.

[6] For example, the coda in French *mes* ('my') is only pronounced when the following word begins with a vowel: *mes* in *mes chats* ('my cats') does not end in a consonant, but it does in *mes amis* ('my friends').

2.3 PROSODIC DOMAIN

PDOMAIN takes as a value a string wrapped around (● PFRAME), i.e. the v-structure's PFRAME value. The value specifies in which prosodic domain the v-structure's ρ-correspondent is integrated into prosody according to some definition of prosodic phrasing at p-structure (e.g., Bögel 2015, 2021). For example, using $\cdot$ to represent the ρ-correspondent of the v-structure in question (i.e., $\cdot = \rho(\bullet)$), English geminates can only appear at [PDOMAIN $(\cdot)_\iota$], i.e. above the level of the prosodic word.[7] Similarly, some Germanic prefixes are metrical, [PDOMAIN $(\cdot)_\omega$], while others are extrametrical, [PDOMAIN $(\cdot),(\ )_\omega$]. We use the comma to represent the unordered concatenation of two intonational units; the following equality therefore holds: [PDOMAIN $(\cdot),(\ )_\omega$] = { [PDOMAIN $(\cdot)(\ )_\omega$] | [PDOMAIN $(\ )_\omega(\cdot)$] }. The actual order of comma cases must be set by the DEPENDENCE feature.

A viable analysis of German prefixes is promised by the prosodic domain account of the different stress and phonotactic restrictions on affixation. Those prefixes whose domain is [PDOMAIN $(\cdot)_\omega$] are stressed:

(2) *uralten* ('very old') German prefix; *(úr)(alten)* not **(urálten)*

In contrast, German prefixes whose domain is [PDOMAIN $(\cdot)_\iota$] are unstressed (they are extrametrical):

(3) *gealtert* ('aged') German prefix; *ge(áltert)* not **(gé)(altert)*

2.4 DEPENDENCE

DEP(ENDENCE) takes a set of symbols as its value. The symbols encode the direction of the prosodic dependency: left (suffixes and left-leaning clitics), right (prefixes and right-leaning clitics), or both (infixes and mesoclitics).[8] The value {LT}, typically abbreviated without the set brackets, encodes that the exponent v-structure is dependent to its left; i.e. the exponent is a suffix or left-leaning clitic. The value {RT}, again typically abbreviated without the set brackets, encodes that the exponent v-structure is dependent to its right; i.e. the exponent is a prefix or right-leaning clitic. The value {LT,RT} encodes that the exponent v-structure is dependent to both its left and right; i.e. the exponent is an infix or a mesoclitic (Harris 2002; Luís & Spencer 2004; Bögel 2015).[9] In sum, the presence of this feature entails prosodic/phonological dependence.

[7] Note that ω indicates a prosodic word and ι indicates an intonational phrase. Thus, $(\ )_\iota$ indicates that the material inside ( ) constitutes an intonational phrase.

[8] We assume here that circumfixes can be handled as a prefix/suffix combination, as in finite-state approaches (see, e.g., Beesley & Karttunen 2003). However, Bill Foley (p.c.) has suggested to us that there may be 'true' circumfixes that cannot be handled this way. If so, we could supplement DEP values with values like LEDGE (left edge) and REDGE (right edge).

[9] Note that DEP features are necessary to capture the nature of the dependency but we do not claim that they are sufficient to model all aspects of the dependent affix. For example, infixation and mesoclisis can also arise from complex interactions between DEP and the prosodic features PFRAME and PDOMAIN.

3 Morphosyntactic features

The second type of features concerns the morphosyntax of the exponent. The feature CLASS encodes purely morphologically distinctions, such as inflectional classes. The feature HOST plays an important role in our theory of affix exponence and realization. This feature relates the v-structure of an affix directly to the v-structure of its host/stem. This direct relationship between affixes and hosts allows us to very locally encode effects that in other frameworks are modelled by derivational operations, such as *head movement* (Travis 1984) or *lowering* (Bobaljik 1994), which are understood in Distributed Morphology (DM; Halle & Marantz 1993) as operationalizations of *morphological merger* (Marantz 1984).[10]

3.1 CLASS

Any theory of morphology needs to have some way of capturing purely morphological restrictions on distribution, such as an affix appearing with only a certain class of stems. In L_RFG, this is the purview of the CLASS feature, which takes a set of symbols as a value. This set encodes inflectional class and other purely morphological selectional properties. For example, this is where we capture verb classes and noun classes, such as Latin conjugations and declensions. Furthermore, the CLASS feature allows L_RFG to make room for *morphomic effects* while maintaining, like other DM frameworks, that 'morphomes' do not entail the existence of a separate generative morphological component (Aronoff 1976, 1994).

3.2 HOST

Another thing that any theory of morphology needs to capture is that affixes are phonologically and morphosyntactically conditioned. In L_RFG, we conceive of this conditioning as the affix constraining the possible hosts with which it can co-occur. This is accomplished through the HOST feature in v-structure.

HOST encodes the relationship between an affix and its host non-derivationally, through (modified) equality: in other words, the value of the HOST of the v-structure exponent of an affix is itself another exponent v-structure. Most of the features in HOST are features that we have already encountered: PHONREP, PFRAME, DEP, and CLASS (any of which can be underspecified as usual). The HOST can also be specified for the IDENT(ITY) feature, which is either present with the value + or not present at all. Thus, IDENT is effectively privative. Note that the HOST feature cannot contain HOST. This is captured by the *Principle of Local* HOST *Identification* (LHI) in (9) below. The LHI uses the *restriction* operator (Kaplan & Wedekind 1993) to ensure that when a HOST is identified, it brings with it all of its features *except* HOST (if it has one). The LHI ensures that an exponent can include information about its HOST, but not its HOST's HOST, etc. Thus, even though HOST

[10]This is an earlier idea that DM has adopted.

takes a v-structure as its value, only a limited one-level embedding is possible in v-structures. The effects of morphological merger are controlled by a feature that can occur only in HOST, [IDENT $+$]. Other than this feature, a HOST can be specified by an affix to have any of the v-structure features except HOST itself.

We assume that the ρ-mapping from v-structure to p-structure is sensitive to the HOST feature. If a v-structure α has a HOST v-structure β, then β's realization in p-structure must be prosodified in the PDOMAIN of α's realization. This is captured by the *Principle of* HOST *Mapping*:

(4) HOST *Mapping*

For all v-structures v, v':

$(v\ \textsc{host}) = v' \ \Rightarrow \rho(v') \in \rho(v\ \textsc{pdomain})$

We will discuss the ρ-mapping and prosodification more in §6.2 below.

3.2.1 HOST: IDENTITY

The feature IDENT(ITY) takes a symbol as a value. Its value is constrained to be the symbol $+$. Thus, the feature is either present as [IDENT $+$] or not present at all. It is (effectively) a privative feature. The IDENT feature captures locality conditions on the c-structural and f-structural context of the host. If [IDENTITY $+$] is present in the HOST, then the exponent in question constrains the identity of its host as follows:[11]

(5) HOST *Identification (Intuition)*

Given β, a v-structure containing the feature [HOST [IDENT $+$]], and η, a c-structure terminal node that β expones, β's HOST is the v-structure that expones the *closest* c-structural terminal node to η that maps to the *same* f-structure as η.

Closest is defined as follows:[12]

(6) Y is the closest c-structure node to X iff

- X c-commands Y; and
- there is no Z such that X c-commands Z and Z c-commands Y.

[11] At an even higher level of abstraction, the intuition is that [HOST [IDENT $+$]] encodes prosodic dependency as conditioned by morphology. The IDENT feature identifies what is to be prosodically grouped with what. The DEP feature encodes how they are to be grouped linearly. This captures what head movement captures in Minimalist analyses which require suffixes to move to the right edge of their complements, skipping adjuncts (tricky).

[12] Note that L_RFG does allow non-binary branching (Everdell et al. 2021), although the structures in this paper happen to be binary branching. In a ternary structure, given the definition of *closest* here, there would no closest node to X. We currently do not have any data that is relevant to the question, but it would be straightforward to add a condition to the definition of closeness such that sisters both count as closest.

The representations in Figure 2 sketch two situations in which [IDENT $+$] is satisfied and two in which it is not. Note that in all cases, η is a c-structure node that corresponds to β, i.e. $\nu(\eta) = \beta$.

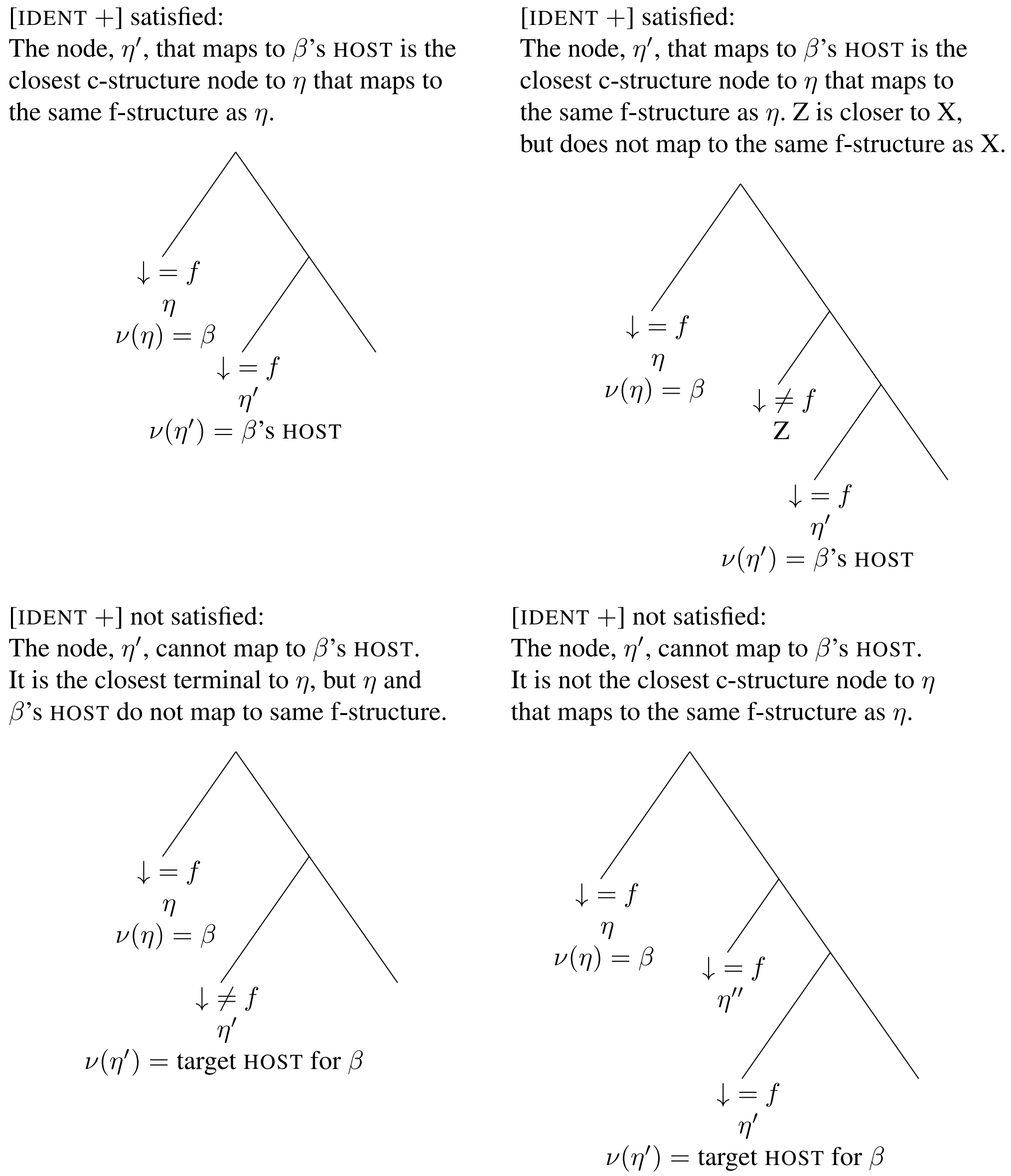


Figure 2: Two instances in which [IDENT $+$] are satisfied and two in which it is not

We can use the term *f-domain* for the set of c-structure nodes that map to the same f-structure as some c-structure node α. We define a function to yield a node's f-domain.

(7) For all c-structure nodes, n, in the set of c-structure nodes N for some c-

structure,

$\textbf{f-domain}(n) = \{n' \in N \mid \phi(n') = \phi(n)\}$

Note that **f-domain** ensures that a node is in its own f-domain, since equality is a reflexive relation. For example, **f-domain**(V), using the category label to stand in for the node, in a typical LFG analysis would include nodes labelled, V, V′, VP, I, I′, IP, C, C′, and CP. Since the function is reflexive, the minimal f-domain for any c-structure node that is ϕ-mapped is a singleton set containing that node itself. Only a c-structure node that is not mapped to f-structure can have an empty f-domain.

In (8) below, we also define a function, **closest**, to calculate the closest c-structure terminal to a node, based on the informal definition in (6) above and an assumed standard definition of *c-command*. Note that since c-command is typically defined in terms of dominance and dominance is often construed to be a reflexive relation (see, e.g., Bresnan et al. 2016: 136, fn. 11), we explicitly exclude the case where a node reflexively satisfies **closest**. A node should not count as the closest node to itself on both formal and theoretical grounds. The formal objection is that every node would always be the closest node to itself, so it would render the function pretty useless. The theoretical objection is that this in turn would allow v-structures to be their own HOSTs, which fails to capture the intuition behind the notion.[13]

(8) For all c-structure nodes, n, n', n'', in the set of c-structure terminal nodes T for some c-structure,

$$\textbf{closest}(n, n') \Leftrightarrow \textbf{c-command}(n, n') \wedge \neg[\textbf{c-command}(n, n'') \wedge \textbf{c-command}(n'', n')] \wedge n \neq n'$$

We can capture the [IDENT +] constraint with the following global constraint on the c-structure/v-structure interface:

(9) *Local* HOST *Identification (LHI)*
For all c-structure nodes, n, n', in the set of c-structure nodes N for some c-structure,

$$(\nu(n')\ \text{IDENT}) = + \Rightarrow \textbf{closest}(n, n') \wedge n' \in \textbf{f-domain}(n) \wedge (\nu(n)\ \text{HOST}) = \nu(n')\backslash\text{HOST}$$

The definition in (9) uses the restriction operator (Kaplan & Wedekind 1993) , $\backslash$, to state that $\nu(n)$'s HOST is the v-structure $\nu(n')$, *except* for any HOST information that $\nu(n')$ may contain. Note that this allows us to capture the notion of *bound stems*[14] as in:

(10) habl- Spanish
'talk'

[13]The c-command relation can be defined reflexively or non-reflexively. The last conjunct is only required if a reflexive c-command relation is assumed.

[14]Bound stems are common in languages that require all roots to be inflected, such as Romance languages. Unqualified bound stems are harder to find in languages like English.

Thus, a bound stem is a vocabulary item whose left-hand side contains a root and whose right-hand side is listed as [IDENT $+$]. That is, there are two ways for [IDENT $+$] to be marked on a v-structure:

1. By being specified as such on the right-hand side of a vocabulary item; i.e. by being listed in the Vocabulary
2. By the v-structure being the HOST for some other v-structure

As a consequence, *exponence* (the ν-mapping) can be sensitive to [IDENT $+$] as a matter of being listed in the Vocabulary; this is the case of bound stems. But [IDENT $+$] can also be marked on an exponent that is not listed as such, due to operations in the grammar, namely HOST Mapping and Local HOST Identification.

4 MostSpecific

L$_{\text{R}}$FG posits a constraint on the expression of phonological information, i.e. *morphophonology*, which we have called **MostSpecific** (Asudeh & Siddiqi 2023). **MostSpecific**(α, β) returns whichever exponent has the most restrictions on its phonological context.

The intuition behind **MostSpecific** is to prefer affixes over (otherwise compatible) clitics or free forms and to prefer clitics over (otherwise compatible) free forms. In other words, we get the following preference order:

(11) affix $\gg$ clitic $\gg$ free form

In terms of information encoded in vocabulary items, choose the VI whose output v-structure contains more information, i.e. more features. For example, if English comparative *-er*, an affix, and *more*, a free form, are in competition, then **MostSpecific** will select *-er*. Similarly, if English verbal inflection *-s* and *does* are in competition, then **MostSpecific** will select *-s*.

The proper subsumption relation on v-structures is used to formally capture the intuition behind **MostSpecific**: choose the exponent that contains the most information.[15]

(12) Given two exponents (v-structures), α and β,

$$\textbf{MostSpecific}(\alpha, \beta) = \begin{cases} \alpha \textbf{ if } \beta \backslash \text{PHONREP} \sqsubset \alpha \backslash \text{PHONREP} \\ \beta \textbf{ if } \alpha \backslash \text{PHONREP} \sqsubset \beta \backslash \text{PHONREP} \\ \bot \textbf{ otherwise} \end{cases}$$

The **MostSpecific** constraint is formalized as a function that takes two exponents, i.e. two v-structures, as arguments and returns whichever exponent contains the most information, using restriction to set aside PHONREP. If neither candidate contains more information than the other (i.e., the two candidates are tied, but possibly

[15]In the next section we will explain how v-structure specificity captures (11).

have different PHONREPs) or they contain information that is incompatible with each other, the constraint returns $\perp$, meaning that neither candidate is better than the other with respect to the constraint.

5 Classifying forms: DEPENDENCE & IDENT

In this section we show how v-structure features can be used to define various types of exponents. We seek to demonstrate how the particular features DEP and [IDENT +] can be used to form a factorial typology over types of exponents. The kinds of exponents that are of key interest for the typology are those for free forms, simple clitics, and affixes. In L_RFG, *free forms* are exponents that have the features in (13), with any value. Thus, free forms only specify their basic phonological and prosodic features, in particular their underlying phonological form (PHONREP) and any constraints on their prosodic context (PFRAME). Adding features to this further constrains the exponent.

(13) $\begin{bmatrix} \text{PHONREP} & \ldots \\ \text{PFRAME} & \ldots \end{bmatrix}$

The first added feature is DEP(ENDENCE), whose addition yields *simple clitics* or *leaners*. We arbitrarily call these *clitic$_a$*. These clitics have the features in (14), with any value. For example, the English possessive *'s* and auxiliary *'ll* are specified as [DEP LT] because they lean on the preceding element. We assume on general grounds that *'s* is the exponent of the category D and that *'ll* is the exponent of the category T.

(14) $\begin{bmatrix} \text{PHONREP} & \ldots \\ \text{PFRAME} & \ldots \\ \text{DEP} & \ldots \end{bmatrix}$

(15) English possessive *'s*

a. The car's fender
b. The car you are in's fender
c. The car you are exiting's fender

(16) English 'contractions'

a. The person who arrives first'll leave last
b. The person who passes out'll leave last
c. The person who hides'll leave last
d. The person who finds them'll leave last

As the reader can see in (15) and (16), leaners are not fussy about the category of the element that they attach to. For example, in (15a), the leaner attaches to a noun, as is expected of a genitive marker, but in (15b) it attaches to a preposition, and in (15c) to a verb. Note that *'s* always happens to lean on a DP, but this is because there is always a DP in its specifier (Abney 1987).

In contrast, *'ll* is not always preceded by a DP. For example, it can be preceded by a VP, provided the VP is the subject of the sentence:

(17) To arrive on time'll always bring you happiness.

The key thing to note is that the particular element at the right edge varies, and it's this element that is what the clitic's phonological form depends on; for example, it determines voicing assimilation: *the cat's meow* (voiceless) vs. *the car you are in's fender* (voiced).

Since the word 'clitic' is ambiguous in the literature, we want to distinguish these simple clitics from two other kinds, which we call respectively *phonological clitics* and *syntactic clitics*. Turning first to phonological clitics, these are a kind of clitic whose dependence properties are not determined by v-structure, but rather just by their phonology. We arbitrarily assign the term $clitic_b$ to these *phonological clitics*. For example, in the Frans Plank example, *drink a pint of milk*, the prosodic constituency is (*drinka*) (*pinta*) (*milk*) (Lahiri & Plank 2009). The phonological dependence of these examples is entirely a product of prosodic structure i) footing together *drink* and the reduced form of the indefinite determiner *a* and ii) footing together *pint* and the reduced form of the preposition *of*. In other words, this kind of prosodic phrasing is captured in p-structure (Bögel 2015, 2021), and simply arises from the fact that the relevant functional words (in this case, *a* and *of*) have /ə/ allomorphs. Therefore, the clitic_b variety in fact does not have a DEP feature in v-structure at all, because its surface dependence is no more lexically conditioned than the surface dependence of *drink* or *pint*. Thus, the v-structure template for clitic_b is identical to the one for free forms in (13) above.

Next we turn to syntactic clitics, which we arbitrarily call $clitic_c$. Here we do not make reference to 'special clitics.' We avoid this term simply because it tends to mean somewhat different things in different circles, although definitions overlap (see, for example, Spencer & Luis 2012). Note that it is not our intent to treat *syntactic clitic* and *special clitic* as equivalent terms. We expect a full theory of special clitics to deploy many of our morphosyntactic categories, including affixes and free forms. We define syntactic clitics as those elements that are associated with some clitic-specific syntactic category, e.g. Cl, in the c-structure (Bresnan et al. 2016: 144–145, Arregi & Nevins 2018). Syntactic clitics are not part of L_RFG theory proper, but are rather a c-structure notion. In other words, 'syntactic clitic' and 'clitic_c' are just terms for one of the things that authors mean when they use the term "clitic." Thus syntactic clitics are differentiated from simple clitics (clitic_a) above.[16] Indeed, elements of category Cl can be free-standing, affixal, or simple clitics/leaners, depending on their v-structure properties. For example, this is how we would treat Romance object clitics (à la Arregi & Nevins 2018):[17,18]

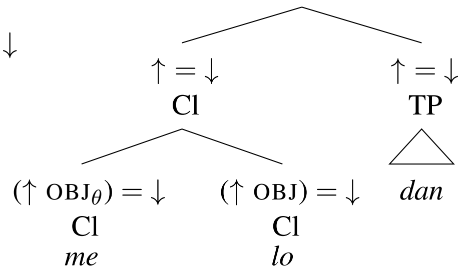
(18) me lo d-a-n. Spanish
1.SG 3.SG.MASC give-TV-PL
'They give it to me.'

[16]We thank a reviewer for suggesting these clarifications.

[17]Example (18) is declarative. In the imperative, *den=me=lo*, the clitics appear on the right side of the verb, rather than on the left as in (18), but the clitic constituent retains its order.

[18]The gloss TV stands for "theme vowel."

(19) Cl $\rightarrow$ Cl Cl
$(\uparrow \text{GF}) = \downarrow$ $(\uparrow \text{GF}) = \downarrow$



This is also how we have treated certain Ojibwe agreement clitics (Melchin et al. 2020).

Recall that leaners (clitic_{a}) arise from adding the feature DEP. Further specifying the v-structure by adding the feature [HOST [IDENT +]] yields the representation for an *affix*. Affixes arise from the combination of some DEP value and [IDENT +]. These exponents have the features in (20), but note that the only possible value for IDENT is +. In sum, leaners (clitic_{a}) add the feature DEP to the features for free forms and affixes add the feature [HOST [IDENT +]] to the features for leaners, yielding a strict subsumption ordering: free forms $\sqsubset$ leaners $\sqsubset$ affixes.

(20)
$$\begin{bmatrix} \text{PHONREP} & \ldots \\ \text{PFRAME} & \ldots \\ \text{DEP} & \ldots \\ \text{HOST} & \begin{bmatrix} \text{IDENT} & + \end{bmatrix} \end{bmatrix}$$

The use of DEP and [IDENT +] in classifying forms yields a factorial typology of major morphological kinds, as shown in Table 1. Note that (• FEAT) and ¬(• FEAT) are standard LFG notation for indicating respectively the obligatory presence or absence of feature FEAT in the structure designated by •. Notice that in this factorial typology there is a possible combination of features that we have not considered above. The combination in question — which is the presence of [IDENT +] in the absence of DEP—is shown in the bottom left cell of Table 1. The occupants of this cell would be elements that care about their HOST, and locality with respect to their host, but are not phonologically dependent. The details of what it means to be hosted without being phonologically dependent we leave for future work, but we anticipate that certain particles and prepositions might yield to this sort of analysis.

6 An example: *-en*

We now turn to a fully worked out example, an analysis of the English deadjectivizing verbalizer affix *-en*, shown in (21) with the logical types fully indicated on the meaning constructor that is the sole member of its fugui. This *-en* suffix occurs in words such as *blacken*, *quicken*, and *soften*. The suffix is simultaneously both very productive and quite restricted. It has many prosodic, phonological, and morphosyntactic restrictions on its host. It also places morphosemantic restrictions

	[• IDENT +]	¬[• IDENT +]
[• DEP]	*affix*	*clitic$_a$* *(leaner/simple clitic)*
¬[• DEP]	*some particles* *some prepositions*	*free form* *clitic$_b$* *(phonological clitic)* *clitic$_c$* *(syntactic clitic)*

Table 1: A factorial typology of major morphological kinds

on the result of combination with its host, such that the host must be a property of events or entities.[19] However, if the full set of constraints is satisfied, the affix arises productively. We base the morphophonological and morphosyntactic constraints represented in the v-structure on the analysis of Halle (1973), which requires the host to be monosyllabic and to end in an obstruent (optionally preceded by a sonorant). According to Halle, this is a well-formedness condition on the output, which is why *soften* and *hasten* are allowed (the /t/ is deleted in these contexts).

(21) $\langle\, [v_{\text{a}}],\ \{\ \lambda P_{et}\lambda v.\mathbf{become}_{et,vt}(P)(v) : ((\uparrow_\sigma \text{E}) \multimap \uparrow_\sigma)_{\varepsilon t} \multimap ((\uparrow_\sigma \text{E}) \multimap \uparrow_\sigma)_{\varepsilon t}\ \}\,\rangle \xrightarrow{\nu}$

$$v\begin{bmatrix} \text{PHONREP} & /\text{ən}/ \\ \text{PFRAME} & ((\quad)(\,\cdot\,)_\sigma)_{ft} \\ \text{PDOMAIN} & (\,(v\ \text{PFRAME})\,)_\omega \\ \text{DEP} & \text{LT} \\ \text{CLASS} & \text{WEAK} \\ \text{HOST} & \begin{bmatrix} \text{IDENT} & + \\ \text{PHONREP} & /\ldots([\mathbf{son}])[\mathbf{obs}]/ \\ \text{PFRAME} & (\,\rho(v\ \text{HOST})\,)_\sigma \end{bmatrix} \end{bmatrix}$$

We now go through each of the affix's properties and how we capture them:

1. With respect to its prosody and morphophonology, this affix is consistently pronounced as a syllable with a reduced vowel and an alveolar nasal coda. Therefore, its PHONREP value is /ən/. The affix is a syllable that is the last in its foot. Therefore its PFRAME value is $((\quad)(\,\cdot\,)_\sigma)_{ft}$ The affix's form is subject to local word-level phonotactics. Therefore, its PDOMAIN value is $(((\quad)(\,\cdot\,)_\sigma)_{ft})_\omega$.

[19]This is captured through standard semantic typing; see Figure 4 below for details.

2. With respect to dependency, the affix is a suffix, which means it is is dependent to its left. Therefore, its DEP value is LT (short for {LT}).

3. We have also included the feature CLASS in the v-structure, even though it is probably not the case that CLASS is relevant to this affix. Contemporary English probably does not synchronically have CLASS features; rather, it simply has regular verbs and irregular verbs. However, for illustrative purposes, we can use CLASS, as might have been the case in the history of English, to capture the strong/weak distinction in verbs. In this case, the resulting verb is a weak verb (in the Germanic sense); e.g. it is inflected with *-ed* in the past participle, unlike strong verbs like *take*, which is inflected in the past participle with the affix *-en*. Again, just for the purpose of illustration, we identify two classes in English, *weak* and *strong*. Therefore, the value of CLASS is WEAK.

4. Conditions on the host:

   (a) The affix 'lowers' to the head of the complement of the affix. Therefore, it contains the feature [HOST [IDENT +]]. As discussed above, this affix is subject to some kind of *morphological merger* operation in standard DM, such as head movement or lowering, because it is syntactically generated on the left of its host (given headedness in English), but appears on its right. We capture this directly, rather than derivationally, through the combination of [HOST [IDENT +]], which requires the affix to attach to its host, and [DEP LT], which requires it to appear to the right of its host (i.e., the host must be on its left).

   (b) The output form of the host must be no longer than one syllable. Therefore, the value of HOST PFRAME is $(\ldots)_\sigma$.

   (c) The host must also end in an obstruent, optionally preceded by a sonorant (per Halle 1973).[20] For example, *soften* is legal despite a seemingly illegal base, because the final /t/ in the base is not present in the output [sɑfn̩]. Furthermore, this restriction is a morphophonological constraint on the host and not a general phonological rule in English, because unaffixed forms with similar phonology are legal (e.g., **dryen* but *lion*, **dimmen* but *women*). Therefore, the value of HOST PHONREP is /. . . ([**son**])[**obs**]/.

5. The affix is a deadjectivizing verbalizer. As is common in Distributed Morphology, we assume multiple subvarieties of categories, such as subvarieties of little v (for example, this is how we would capture theme vowel selection in Spanish). The fact that *-en* is deadjectivizing is a consequence of c-structural head adjunction of little a to the particular little v that *-en* is

[20]We are presenting an unadulterated version of Halle's (1973) theory, but we are aware of complications, such as the well-formedness of *crispen*, which we set aside here.

the exponent of. The use of adjunction allows the selectional history to be transmitted through the c-structure:[21]

(22) $\mathrm{v_a} \quad \rightarrow \quad \underset{\uparrow = \downarrow}{\mathrm{v_a}} \quad \underset{\uparrow = \downarrow}{\mathrm{a}}$

6.1 Formal analysis

As is standard in LFG frameworks, $\mathrm{L_RFG}$ assumes that the ν-correspondence is defined and constrained by a description, which we can call a v-description. Thus, the exponent v-structure for *-en* can be described as follows, using • to represent "this v-structure" and · to represent "the p-structure correspondent of this v-structure," i.e. $\rho(\bullet)$:

(23)
$(\bullet\ \textsc{phonrep}) = /\text{ən}/$ $\quad$ $(\bullet\ \textsc{host ident}) = +$
$(\bullet\ \textsc{pframe}) = ((\quad)(\ \cdot\ )_\sigma)_{\mathit{ft}}$ $\quad$ $(\bullet\ \textsc{host phonrep}) =_c /\ldots([\textbf{son}])[\textbf{obs}]/$
$(\bullet\ \textsc{pdomain}) = (\ \rho(\bullet\ \textsc{pframe})\ )_\omega$ $\quad$ $(\bullet\ \textsc{host pframe}) =_c (\ \rho(\bullet\ \textsc{host})\ )_\sigma$
$(\bullet\ \textsc{dependence}) = \textsc{lt}$
$(\bullet\ \textsc{class}) = \textsc{weak}$

We can capture the general capacity to specify HOST content through this template:[22]

(24) $\textsc{host(i,pr,pf,d,c)} :=$
$\textsc{i} = + \Rightarrow (\bullet\ \textsc{host identity}) = +$
$\textsc{pr} \neq \textbf{Id} \Rightarrow (\bullet\ \textsc{host phonrep}) =_c \textsc{pr}$
$\textsc{pf} \neq \textbf{Id} \Rightarrow (\bullet\ \textsc{host pframe}) =_c \textsc{pf}$
$\textsc{d} \neq \textbf{Id} \Rightarrow (\bullet\ \textsc{host dep}) =_c \textsc{d}$
$\textsc{c} \neq \textbf{Id} \Rightarrow (\bullet\ \textsc{host class}) =_c \textsc{c}$

With (24) in hand, we can rewrite (23) as:

(25)
$(\bullet\ \textsc{phonrep}) = /\text{ən}/$ $\quad$ $(\bullet\ \textsc{dependence}) = \textsc{lt}$
$(\bullet\ \textsc{pframe}) = ((\quad)(\ \cdot\ )_\sigma)_{\mathit{ft}}$ $\quad$ $(\bullet\ \textsc{class}) = \textsc{weak}$
$(\bullet\ \textsc{pdomain}) = (\ \rho(\bullet\ \textsc{pframe})\ )_\omega$
$@\textsc{host}(+, /\ldots([\textbf{son}])[\textbf{obs}]/, (\quad)_\sigma, \_\_, \_\_)$

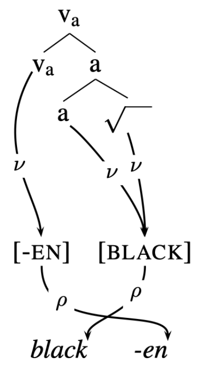
Any underspecified argument to a template is understood as an instance of the appropriate **Id** identity element (see footnote 22).

[21] This phrase-structural approach replaces the feature TYPE in the previous brief presentation of v-structure in Asudeh & Siddiqi (2023). This allows us to capture an attested transitive property of this kind of selection that TYPE failed to capture (Oleg Belyaev, p.c.; Belyaev 2023).

[22] Note that we take the element **Id** to be whatever the appropriate *identity* element is for the argument in question. That is, an underspecified argument to a template returns whatever element is appropriate to combine with the value type in question to yield no change to the value. In the case of v-structure values, **Id** is the empty v-structure, since this can be thought of as unifying with any v-structure α to yield α. In the case of string values, such as the values of PHONREP and PFRAME, **Id** is the empty string, since this concatenates with any string α to yield α. In the case of set values, e.g. the values of DEP and CLASS, **Id** is the empty set, since this unions with any set A to return A.

Note that the re-ordering of the affix and host happens at p(rosodic)-structure, via the ρ correspondence function. The L_RFG c-structure with additional ρ-mapping indicated is sketched in (26). The less marked alternative is a zero-marked form. L_RFG does not employ zero affixes. Zero-marking in L_RFG is a result of the fact that Pac-Man spanning is always available when overt exeponence otherwise fails; see §4 above. Some examples are shown in (27) and (28).[23]

(26)



(27)

Pac-Man spanning	*-en* affixation
to orange	**to redden**
to yellow	**to blacken**
to brown	* to brownen
* to red	* to orangen
* to black	* to yellowen

(28) a. The maple leaves **yellowed**, **reddened**, and finally **browned** in the sun.

b. Alex **reddened** the mushrooms with food dye and then **browned** them in a skillet.

Pac-Man spanning results in portmanteaus, whenever the HOST requirements of *-en* are not satisfied.

6.2 Mapping to Prosody

The essence of our morphological analysis of *blacken* is captured by (21) and (26) above. However, now it is time to say more about the ρ-mapping, which we base on, e.g. Bögel (2015, 2021). That is, given (21), how is the actual output of the ρ-mapping, the p-structure, to be represented? Similarly, how is the p-structure of the HOST, *black*, to be represented?

The answer to both these questions is shown in (29), but first, recall our principle (4), repeated here:

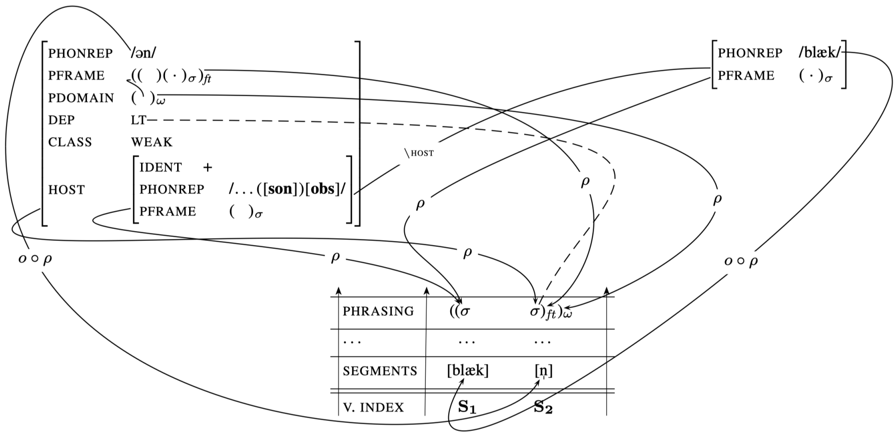
(4) HOST *Mapping*

For all v-structures v, v':
$(v \text{ HOST}) = v' \Rightarrow \rho(v') \in \rho(v \text{ PDOMAIN})$

Given (4), the ρ-mapping must be as in (29), where the p-structure is represented as a *p-diagram* (see Bögel 2015, 2021).

[23]We assume that the basic change-of-state predicate is what [$_{v_a}$ [$_a$ [$_{\sqrt{}}$ black]] en] denotes; i.e. *blacken* means to become black. Thus, (27) demonstrates the basic, inchoative use, whereas the agent/cause is encoded higher in the c-structure, as for examples like (28b).

(29)



Note that the SEGMENTS in the p-diagram represent the output *p(honological)-string* in our correspondence architecture; see Figure 3. These are o-mapped from p-structure, which is itself ρ-mapped from v-structure, so aspects of the phonological string can be mapped from v-structure using the composition of these mapping function, $o \circ \rho$. This is why the mapping arrow from PHONREP in each v-structure is annotated $o \circ \rho$.

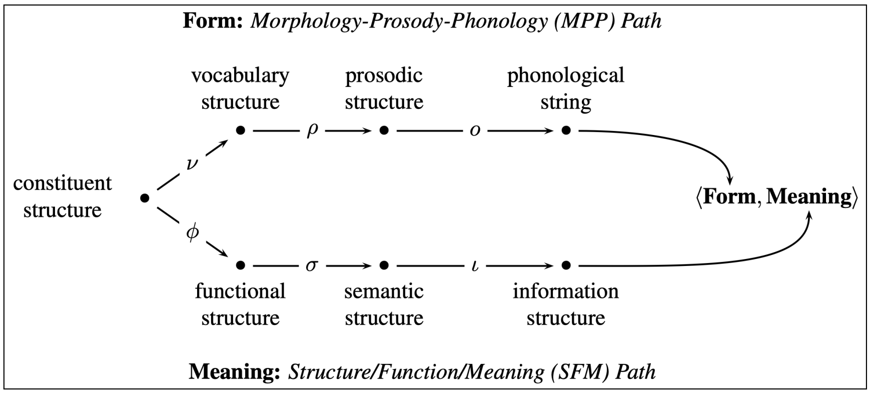


Figure 3: Revised L_RFG Correspondence Architecture

Figure 4 (page 21) shows what we call an *Everything Everywhere All At Once* (*EEAAO*) diagram for *blacken*; note that EEAAO is probably most easily pronounced as ‘dubE-dubA-O.’ A EEAAO diagram simultaneously represents the c-structure, v-structure(s), p-structure, f-structure, s-structure, mappings, and Glue proof(s) for an expression. It is a strength of the fully constraint-based ethos of L_RFG that one can simultaneously represent multiple kinds of grammatical information and how the different kinds of information relate to each other.

7 Conclusion

In this paper, we have developed a theory of the structure and form of an exponent. The theory also captures the constraining conditions on an exponent's environment and the principles mapping the exponent to prosody and phonology. We have shown how, in $\mathrm{L_RFG}$, an *exponent* is a vocabulary structure that is ν-mapped from an *exponendum*. The exponendum is the left-hand side and the exponent is the right-hand side of a *vocabulary item*, a listed mapping in the Vocabulary.

The overall mapping thus looks like this:

(30) $\textit{exponendum} \xrightarrow{\nu} \textit{exponent} \xrightarrow{o \circ \rho} \textit{realization}$

Importantly, this demonstrates that *exponence* and *realization* are not conflated in $\mathrm{L_RFG}$. Exponence is about the mapping from c-structure to v-structure, as conditioned by the Vocabulary. Realization is about the mapping from v-structure to prosody and phonology. In other words, exponence concerns part of the morphology-prosody-phonology path in the architecture, namely the morphological interface between syntax and form that is represented by v-structure, whereas realization concerns the rest of the MPP path, the ρ-interfaces between morphology and prosody and the o-interface between prosody and phonology.

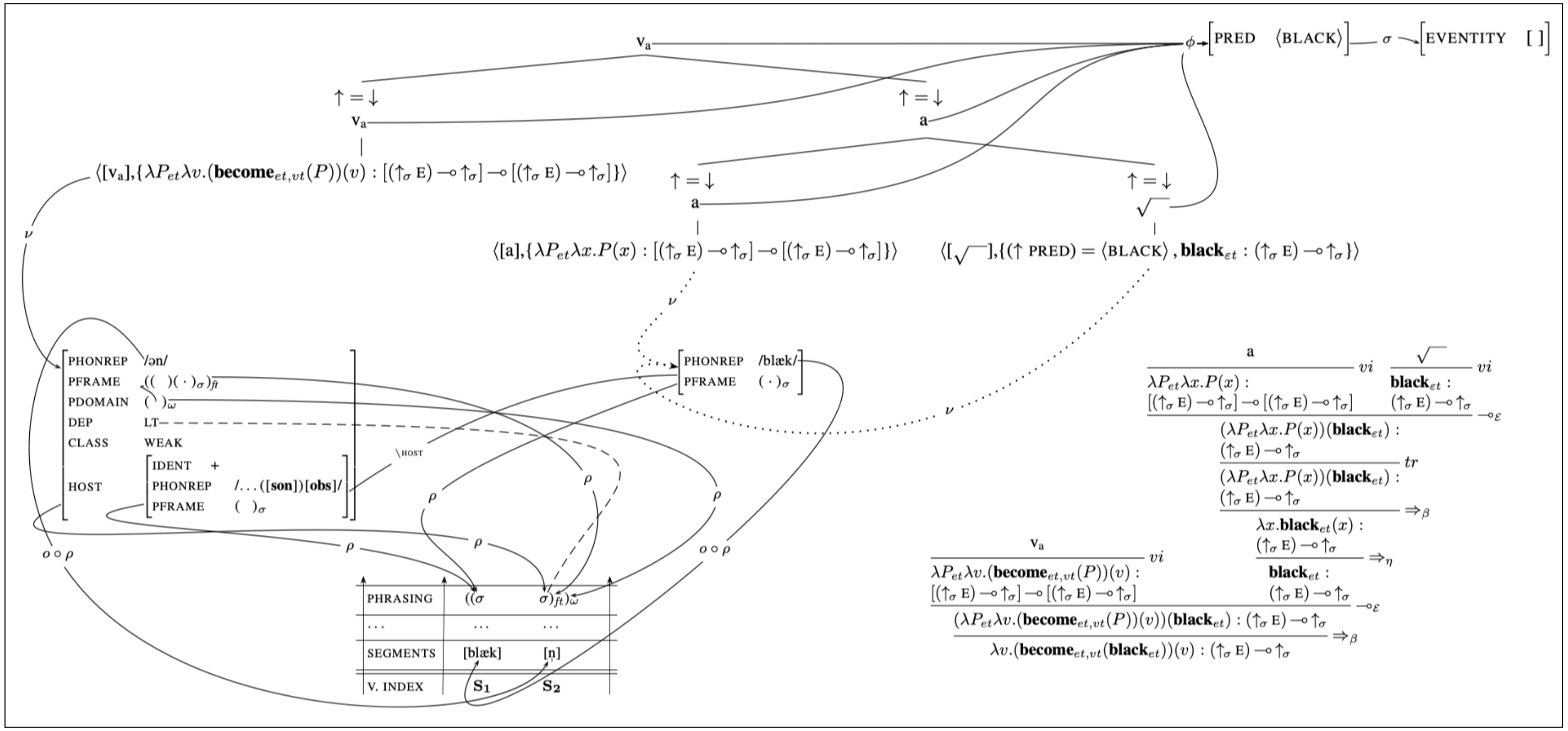


Figure 4: *Everything Everywhere All At Once* (EEAAO) diagram for *blacken*. Key: solid line without arrow indicates equality unless otherwise indicated; solid line with arrow indicate mapping as indicated; dotted line indicates Pac-Man spanning; dashed line indicates a feature's effect according to a general principle; $\multimap_{\mathcal{E}}$ indicates *implication elimination*; $\Rightarrow_{\alpha}$ indicates *alpha conversion*; $\Rightarrow_{\beta}$ indicates *beta conversion*; vi indicates a vocabulary item's contribution; tr indicates resolution of the disjunctive type ε for *eventities* ($\varepsilon = e \vee v$), to one of its disjoint subtypes (e or v, $e \neq v$), as type-appropriate.

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