Realizational Morphosemantics in $\mathrm{L_RFG}$*

Ash Asudeh†‡ & Dan Siddiqi‡
†University of Rochester & ‡Carleton University

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1 Our project

- *Lexical-Realizational Functional Grammar* ($\mathrm{L_RFG}$; Melchin et al. 2020a, Asudeh et al. 2021, Asudeh and Siddiqi forthcoming) is a theoretical framework that couples Lexical-Functional Grammar (LFG; Bresnan et al. 2016) with the realizational, morpheme-based approach to word-formation of Distributed Morphology (DM; Halle and Marantz 1993).
- According to the classification of morphological theories offered by Stump (2001), $\mathrm{L_RFG}$ is
  - *Lexical:* The lexicon is an inert list of mappings from formal properties to phonological representations (a.k.a. morphemes); and
  - *Realizational:* Morphology expresses syntactic categories and features and, possibly, semantics.
- In this talk, we present some initial attempts at an $\mathrm{L_RFG}$ theory and formalization of *morphosemantics*, i.e. the morphology–semantics interface.
- The talk proceeds as follows:
  - Section 2 looks at some problems at the morphology-semantics interface, in general terms.
  - Section 3 provides details on $\mathrm{L_RFG}$'s exponence function, ν.
  - Section 4 looks at the general shape of $\mathrm{L_RFG}$'s solutions to these problems and offers a partial analysis of four case studies:

    1. *divineness/divinity*
    2. *uncombed/unkempt*
    3. *people/persons*
    4. *brothers/brethren*

  - Section 5 offers some conclusions and prospects.

*This work is part of an ongoing project led by Ash Asudeh and Dan Siddiqi; see lrfg.online. The project also involves Oleg Belyaev (Moscow State University), Bronwyn Bjorkman (Queen's University), Tina Bögel (University of Konstanz), Michael Everdell (University of Texas, Austin), Paul Melchin (Carleton University), Will Oxford (University of Manitoba) and our students, Veronica Burrage (Rochester) and Sam Turnbull (Carleton). We are grateful to all the project members for their participation and discussion, but especially to Mike, Paul, and Tina, who have thus far been our main collaborators. Any errors in this talk are our own. Part of the research presented here was funded by SSHRC Insight Development Grant 430-2018-00957 (Siddiqi).

2 Background

2.1 Motivation: Morphosemantic problems

- How is morphosemantics distinct from general lexical semantics?
  - We regard morphosemantics as encompassing all and only aspects of meaning that affect the mapping from a semantic representation to a phonological representation.
    - In L_RFG terms, this is those meanings that condition the mapping to v-structure.
    - The principle that governs this mapping, formalized in (6) below, is **MostInformative**$_s$.
- Phenomena that L_RFG attributes to the morphology-semantics interface:

1. Semantically conditioned morphology — morphemes which have semantic wellformedness conditions on their base
   - *re-establish*
2. Polysemy — morphemes which can appear in a wide variety of semantic and functional environments
   - *keep*
3. Lexicalization — complex morphological forms, consisting of seemingly productive morphology, that do not necessarily have the compositionally predicted meanings
   - *antsy*
   - *lousy*
4. Regulars/irregulars — extant pairs of regular and irregular forms where one form contains more specialized meaning
   - *brothers/brethren*
   - *uncombed/unkempt*
   - *divineness/divinity*
   - *compárable/cómparable*

- In this talk, we consider putative varieties of 4.

2.2 Theoretical framework

- The L_RFG framework has been described in a number of papers (Melchin et al. 2020a,b, Asudeh et al. 2021, Everdell et al. 2021, Everdell and Melchin 2021) and a book-length treatment is also underway (Asudeh and Siddiqi forthcoming).
- The appendix of this handout also contains a brief summary of the L_RFG framework and its relationship to its parent frameworks, LFG and DM.
- In today's talk, we want to focus on the morphology-semantics interface, i.e. *morphosemantics*, in L_RFG, although we won't have anything to say about the ι-mapping to information structure. This is schematized in Figure 1.

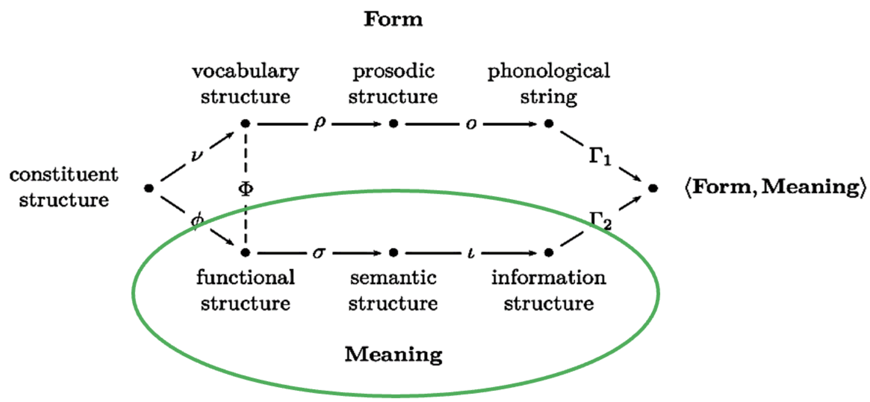


Figure 1: Morphosemantics in L$_\text{R}$FG's Correspondence Architecture

3 L$_\text{R}$FG's exponence function: ν

- In our previous work (Melchin et al. 2020a, Asudeh et al. 2021, Everdell et al. 2021), the exponence function ν mapped from a pair of arguments to a v(ocabulary)-structure, the exponent.

- However, since we are now turning our attention to semantics as well, we now add a third argument to ν:

  - The first argument is a list of pre-terminal categories, typically of length 1, which are taken in the linear order they appear in the tree.
  - The second argument is itself a function, Φ, which maps an f-description to the set of f-structures that satisfy the description; i.e. $\Phi(d \in D) = \{f \in F \mid f \models d\}$, where D is the set of valid f-descriptions and F is the set of f-structures.[1]
  - The third argument is a set of *meaning constructors* from Glue Semantics (Glue; Dalrymple 1999, 2001, Dalrymple et al. 2019, Asudeh 2012, 2022).[2]

- Here are two sample VIs, the first for the Ojibwe root *waab* in (42) above and the second for the English equivalent *see*.[3] Note that we use the η-equivalent form of the **see** function to reduce clutter.

(1) $\langle\, [\sqrt{}], \Phi\{(\uparrow \text{PRED}) = \text{‘see’}\}, \{\textbf{see} : (\uparrow \text{OBJ})_\sigma \multimap (\uparrow \text{SUBJ})_\sigma \multimap {\uparrow_\sigma}\}\,\rangle \xrightarrow{\nu}$ *waab* Ojibwe

(2) $\langle\, [\sqrt{}], \Phi\{(\uparrow \text{PRED}) = \text{‘see’}\}, \{\textbf{see} : (\uparrow \text{OBJ})_\sigma \multimap (\uparrow \text{SUBJ})_\sigma \multimap {\uparrow_\sigma}\}\,\rangle \xrightarrow{\nu}$ *see* English

- In a c-structure tree, this is represented as follows:

(3)
$$\sqrt{}$$
$$(\uparrow \text{PRED}) = \text{‘see’}$$
$$\textbf{see} : (\uparrow \text{OBJ})_\sigma \multimap (\uparrow \text{SUBJ})_\sigma \multimap {\uparrow_\sigma}$$

- Henceforth, we will show only the meaning language side of the Glue meaning constructors.

[1] We thank Ron Kaplan (p.c.) for discussion of this point. Any remaining errors are our own.
[2] For a recent high-level introduction to Glue Semantics, see Asudeh (2022).
[3] The colours in (1) are not part of the representation. They are just there to help you parse out the parts better.

3.1 Conditions on exponence

- Let V^i be the domain of the exponence function ν in some language L, i.e. the set of inputs to Vocabulary Items in L.
  - We write $V^i(\alpha)$ to indicate the domain of some particular Vocabulary Item, α. We write $\pi_n(V^i(\alpha))$ to indicate the n^{th} projection of $V^i(\alpha)$. For example, $\pi_1(V^i(\alpha))$ returns the c-structure list in the first projection of the input to Vocabulary Item α.
    - **Caution:** This π is just standard notation for retrieving arguments to functions and should not be mistaken for a correspondence function π.
- The following conditions on exponence hold.

1. **MostInformative**$_c(\alpha, \beta)$ returns whichever of α,β has the longest list of c-structure categories.

   Intuition. Whenever possible, prefer portmanteau forms.[4] In terms of lists of categories in Vocabulary Items, choose the VI that realizes the greater set of categories.

   Formalization. The proper subset relation on lists-as-sets is used to capture the intuition.[5]

   (4) Given two Vocabulary Items, α and β,

   $$\textbf{MostInformative}_c(\alpha, \beta) = \begin{cases} \alpha \textbf{ if } f = \pi_1(V^i(\alpha)) \wedge g = \pi_1(V^i(\beta)) \wedge g \subset f \\ \beta \textbf{ if } f = \pi_1(V^i(\alpha)) \wedge g = \pi_1(V^i(\beta)) \wedge f \subset g \\ \bot \textbf{ otherwise} \end{cases}$$

2. **MostInformative**$_f(\alpha, \beta)$ returns whichever of α,β has the most specific f-structure in the set of f-structures returned by Φ applied to α/β's collected f-description.

   Intuition. Whenever possible, prefer portmanteau forms. In terms of f-descriptions in Vocabulary Items, choose the VI that defines an f-structure that contains the greater set of features.

   Formalization. The proper subsumption relation on f-structures (Bresnan et al. 2016: chap. 5) is used to capture the intuition.

   (5) Given two Vocabulary Items, α and β,

   $$\textbf{MostInformative}_f(\alpha, \beta) = \begin{cases} \alpha \textbf{ if } \exists f \forall g. f \in \pi_2(V^i(\alpha)) \wedge g \in \pi_2(V^i(\beta)) \wedge g \sqsubset f \\ \beta \textbf{ if } \exists f \forall g. f \in \pi_2(V^i(\beta)) \wedge g \in \pi_2(V^i(\alpha)) \wedge g \sqsubset f \\ \bot \textbf{ otherwise} \end{cases}$$

[4] We use the term *portmanteau* as any Vocabulary Item that has size greater than one for any of its three input coordinates in V^i, i.e. its list of categories, set of f-descriptions, or set of Glue meaning constructors.

[5] We can think of a list as a set of pairs, where the first member of each pair is an integer indexing the second member's position in the list.

3. **MostInformative**$_s(\alpha, \beta)$ returns whichever Vocabulary Item has the more specific meaning.

   Intuition. Whenever possible, prefer portmanteau forms. In terms of meanings encoded in Vocabulary Items, choose the VI whose denotation is more semantically contentful.

   Formalization. The proper subset relation on set-denoting expressions is used to capture the intuition.

   (6) Given two Vocabulary Items, α and β, and given a function Σ that returns the set of valid canonical proof conclusions that are computable from a set of Glue meaning constructors,

$$\textbf{MostInformative}_s(\alpha, \beta) = \begin{cases} \alpha \textbf{ if } f = \pi_3(V^i(\alpha)) \wedge g = \pi_3(V^i(\beta)) \wedge \Sigma(g) \subset \Sigma(f) \\ \beta \textbf{ if } f = \pi_3(V^i(\alpha)) \wedge g = \pi_3(V^i(\beta)) \wedge \Sigma(f) \subset \Sigma(g) \\ \perp \textbf{ otherwise} \end{cases}$$

- Notes:
  i. **MostInformative**$_c$ and **MostInformative**$_f$ are *morphosyntactic* constraints, whereas **MostInformative**$_s$ is a *morphosemantic* constraint.
  ii. Each version of **MostInformative** can result in a tie, represented by $\perp$.

- In addition to these three constraints on the expression of syntactic and semantic information, L$_{\text{R}}$FG posits a constraint on the expression of phonological information, i.e. *morphophonology*, which we have called **MostSpecific**.

  - Let V^o be the co-domain of the exponence function ν in some language L, i.e. the set of outputs of Vocabulary Items in L.
    - We write $V^o(\alpha)$ to indicate the co-domain of some particular Vocabulary Item, α — i.e., the output vocabulary structure.

4. **MostSpecific**(α, β) returns whichever Vocabulary Item has the most restrictions on its host, i.e. its phonological context.

   Intuition. Whenever possible, prefer affixes. In terms of information encoded in Vocabulary Items, choose the VI whose output v-structure has more specific content in the HOST feature.

   Formalization. The proper subsumption relation on feature structures — i.e., v-structures — is used to capture the intuition.

   (7) Given two Vocabulary Items, α and β,

$$\textbf{MostSpecific}(\alpha, \beta) = \begin{cases} \alpha \textbf{ if } (V^o(\beta) \text{ HOST}) \sqsubset (V^o(\alpha) \text{ HOST}) \\ \beta \textbf{ if } (V^o(\alpha) \text{ HOST}) \sqsubset (V^o(\beta) \text{ HOST}) \\ \perp \textbf{ otherwise} \end{cases}$$

3.2 An example of exponence[6]

- Consider the classic example of the English deadjectivizing verbalizer *-en*.
- English has two key ways to derive a verb from an adjective to have the meaning *to cause X to gain* ADJ *property*.

1. The more marked version is the affix *-en*, which is perfectly productive assuming certain phonological well-formedness conditions. In particular, the output form of the base must be no longer than one syllable and end in an obstruent, optionally preceded by a sonorant (Halle 1973).[7]
   - Here is the VI for *-en*. It maps a triple consisting of information about c-structure, f-structure (here empty), and compositional meaning to a vocabulary structure. We represent the v-structure as a feature structure in (8), but the right-hand side of $\xrightarrow{\nu}$ is really a *description* of a v-structure, as in (9).

(8) $\langle\ [\text{v}], \Phi\{\ \}, \lambda P.\textsc{cause}(\textsc{become}(P))\ \rangle \quad \xrightarrow{\nu} \quad \begin{bmatrix} \textsc{phon.rep} & /\text{ən}/ \\ \textsc{pframe} & (\ )_{foot} \\ \textsc{type} & \textsc{verbal} \\ \textsc{dep} & \begin{bmatrix} \textsc{align} & \textsc{right} \\ \textsc{identity} & \textsc{niece} \end{bmatrix} \\ \textsc{host} & \begin{bmatrix} \textsc{type} & \textsc{adjectival} \\ \textsc{pframe} & \Big(/\ldots([\textbf{son}])[\textbf{obs}]/\Big)_{\sigma} \end{bmatrix} \end{bmatrix}$

   - Equivalent description, where • is defined as the current v-structure:[8]

(9)
(• PHONEMIC.REPRESENTATION) = /ən/
(• PFRAME) = $(\ )_{foot}$
(• TYPE) = VERBAL
(• DEPENDENCE ALIGN) = RIGHT
(• DEPENDENCE IDENTITY) = NIECE
(• HOST TYPE) = ADJECTIVAL
(• HOST PFRAME) = $(/\ldots([\textbf{son}])[\textbf{obs}]/)_{\sigma}$

   - **MostSpecific** will require *-en* to appear whenever the adjectival base satisfies the HOST requirements of *-en*.

2. The less marked version is a zero-marked form, which in L_RFG is a result of the fact that *Pac-man Spanning* (Haugen and Siddiqi 2016, Melchin et al. 2020a) is always competing with overt exponence, since L_RFG does not employ zero affixation.
   - Pac-man Spanning is the result of the three **MostInformative** constraints preferring portmanteaus, whenever the HOST requirements of *-en* are not satisfied.

(10)

Pac-man Spanning	*-en* Affixation
to orange	to redden
to yellow	to blacken
* to red	* to orangen
* to black	* to yellowen

[6] This example of exponence was developed with Tina Bögel as part of her contribution to the forthcoming L_RFG book (Asudeh and Siddiqi forthcoming).

[7] For example, *moisten* is legal despite a seemingly illegal base, because the final /t/ in the base is not present in the output [mɔɪsn̩].

[8] NIECE is a c-structure node. We have worked out a formal definition, but here we just give the intuition: A niece is the head daughter of a phrasal sister of the c-structure head that maps to the v-structure in question (i.e., the one that specifies [DEPENDENCE [IDENTITY NIECE]]).

4 The shape of L_RFG solutions to problems of morphosemantics

- Recall that the three cases we are looking at today all concern a specific kind of stem allomorphy. Namely, they are all putative cases of regular and irregular forms in competition, where both the regular and the irregular are grammatical.
- In these cases, a common view is that the irregular contains more specialized meaning than the regular, as a function of portmanteaus in the grammar (see, e.g., Aronoff 1976 et seq.) and whole word storage in processing (see, e.g., Baayen 1992 et seq.).

4.1 *Divinity/divineness*

- The regular/productive form *divineness* is a word that expresses a (positive) quality.

(11) This chocolate is divine but is affordable despite its divineness.

- The irregular form *divinity*, at least for most native speakers, also involves some notion like “holiness”.

(12) ! This chocolate is divine but is affordable despite its divinity.

(13) This communion wafer is divine but is bland despite its divinity.

- (12) is odd, because it attributes the quality of holiness to chocolate, which does not accord with common world knowledge. On the other hand, (13) accords with our world knowledge, since (in the requisite theology) communion wafers are indeed holy.
- The relevant meanings can be represented something like this:

(14) $[\![\textit{divineness}]\!] = \lambda x.\textbf{good}(x)$

(15) $[\![\textit{divinity}]\!] = \lambda x.\textbf{good}(x) \wedge \textbf{holy}(x)$

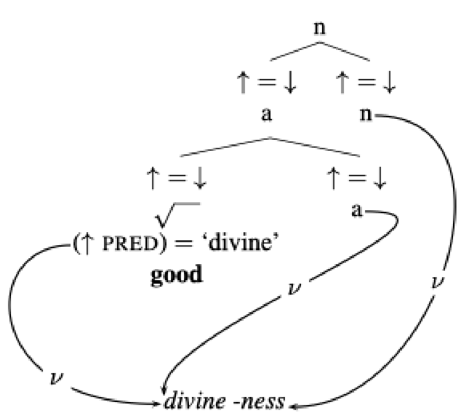
- In a c-structure, where the Glue meaning constructor forms part of the input to exponence, if the relevant meaning constructor is $\lambda x.\textbf{good}(x) \wedge \textbf{holy}(x)$, this can only be realized as *divinity*.[9]

(16) $\langle\ [\sqrt{\ },\text{a}],\ \Phi\{(\uparrow \text{PRED}) = \text{‘divine’}\},\ \{\textbf{good}\}\ \rangle \overset{\nu}{\to}$ *divine*

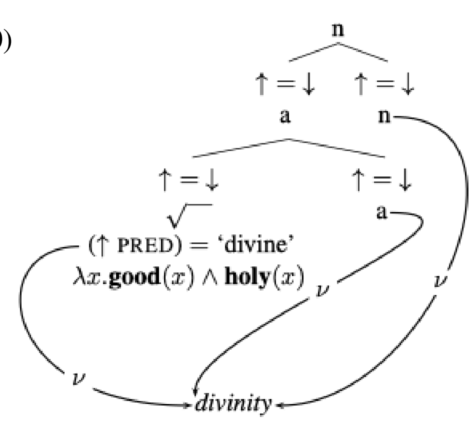
(17) $\langle\ [\text{n}],\ \Phi\{\ \},\ \{\ \}\ \rangle \overset{\nu}{\to}$ *-ness*

(18) $\langle\ [\sqrt{\ },\text{a,n}],\ \Phi\{(\uparrow \text{PRED}) = \text{‘divine’}\},\ \{\lambda x.\textbf{good}(x) \wedge \textbf{holy}(x)\}\ \rangle \overset{\nu}{\to}$ *divinity*

(19)



(20)



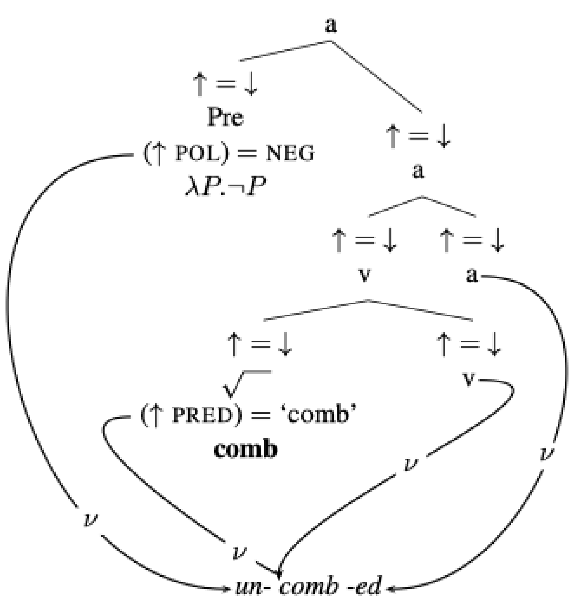
[9] Henceforth, we use italicized words as stand-ins for v-structures.

- Here we see that the presence in (20) of *divinity* (rather than *divineness*) is mandated by two conditions on exponence:
  1. **MostInformative**$_c$ selects *divinity* because it is a portmanteau over the category n.
  2. **MostInformative**$_s$ selects for *divinity* because it is a portmanteau over the Glue meaning term **holy**.
- In (19), on the other hand, while the first member of *divinity*'s V^i triple is satisfied (all three categories are present) — as are all the requirements of the second member of V^i — the absence of **holy** in the third member of the triple fails to license the presence of *divinity*. Thus, the more complex candidate *divineness* is licensed.

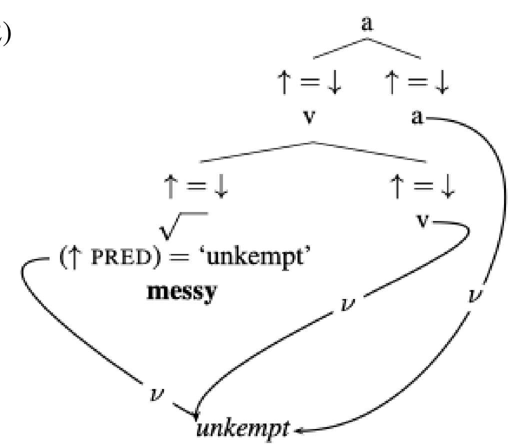
4.2 *Uncombed/unkempt*

- At first glance, the case of *uncombed* vs. *unkempt* seems parallel to *divine/divinity*. Indeed, this might be true for some dialects (such as Dan's!), for whom the meaning of *unkempt* entails the meaning of *uncombed*. These folks seem to be aware of the historical connection between the two forms.
- However, for most speakers of English, *unkempt* has a distinct root from *comb* (meaning its PRED feature is not [PRED 'comb']).
  - Indeed, for these speakers, despite surface morphology, *unkempt* is not even negative!
  - In this case, what we see here are two completely different c-structures: one which licenses the complex form *un-comb-ed* (21) and another that licenses the simplex form *unkempt* (22).

(21)



(22)



4.3 *People/persons*

- Again at first blush, *people/persons* appears to be similar to *divineness/divinity*. While it is often argued that *people* is not actually a suppletive plural for *person* (see discussion in Siddiqi 2021), we set that debate aside and assume that *people* in fact does express [PRED 'person'].

- This case is particularly interesting: For some speakers for whom *people* is the unambiguous plural of *person*, it is actually *persons* — the seeming regular — which has specialized meaning! It appears only in highly formal contexts/registers.

  (23) In cases of missing persons, the police search for missing people.

  (24) Indigenous people should contact the Indigenous Persons Bureau.

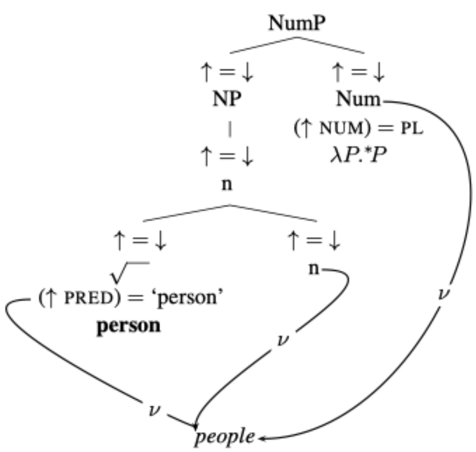
  (25) This room's capacity is 25 people, which is why there is a sign that says "Max 25 Persons".

- This highly specialized meaning is evidence for the claim that *persons*, despite its seemingly regular morphology, is indeed a portmanteau (see Haugen and Siddiqi 2016).

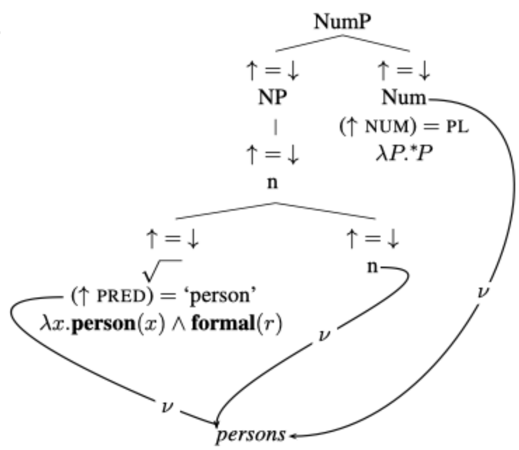
- Further evidence for this claim is the fact that *persons* is legal in compounds (e.g., Missing Persons Department; see Siddiqi 2009 for discussion).

- Therefore, *persons* and *people* are in fact *both* portmanteau forms realizing the same c-structural and f-structural spans, as seen here in (26) and (27).

(26)



(27)



- Thus, it is only **MostInformative**$_s$ that selects *persons* over *people*, and only in formal registers.

- We do not show the Vocabulary Items here, but they can be inferred from the c-structures in (26) and (27).

- We assume a mereological plural meaning, following Link (1983):

  (28) $\lambda P.{}^{*}P$

4.4 *Brothers/brethren*

- Let's consider the case of *brothers/brethren*.

- Again at first blush, we expect another *divineness/divinity* analysis. Instead we see that this requires a much more nuanced semantic account.

- Following Partee and Borschev (2003), we assume that a relational noun like *brother* involves a relation between the nominal entity and some other entity, such as a possessor.

- The meaning term for *brother* can be represented as follows:

  (29) $\lambda y \lambda x \lambda R.\mathbf{male}(x) \wedge R(x, y)$

  - Notice that, in an utterance where this is unresolved, the relational variable, R, is filled from context.
  - In sum, (29) is the meaning term from the one *obligatory* meaning constructor for *brother*.

- Of course, the relation **sibling** is always available in the null context.

  - So we assume that there is a second, optional meaning constructor for *brother* whose meaning term modifies the term in (29) as follows:

    (30) $\lambda R.R(\mathbf{sibling})$
  - Thus, the interpretation of male sibling is available without context, but other interpretations are available if context and pragmatic knowledge supports them.

- In other words, as the term in (30) is optional, R in (29) can instead be instantiated contextually/pragmatically, for example as **close.friend** (where culturally appropriate, which is evidence of its pragmatic nature).

  - Here are the Glue terms from the VI for *brother*:

    (31) $\lambda y \lambda x \lambda R.\mathbf{male}(x) \wedge R(x, y)$
    ($\lambda R.R(\mathbf{sibling})$)
  - The optional meaning is thus available, and provides the interpretation in the null context. Alternatively, the pragmatic context fills in the R, such as in the case of **close.friend**.

- Indeed, *brother* can also be the singular of *brethren*, with the relevant meaning, as in the favoured reading, outside of other context, of a monk saying of another monk at the same monastery:

  (32) My brother spoke out of turn.

- In contrast, *brethren* obligatorily expresses the following relational meaning constructor in addition to the general meanings in (29) and (28):

  (33) $\lambda R.R(\mathbf{member.of.same.order})$

- So *brethren* denotes the members of an all-male order. For speakers for whom the group must be a religious order, the meaning can be suitably further restricted.

- We now have what we need to list the three VIs in this competition:

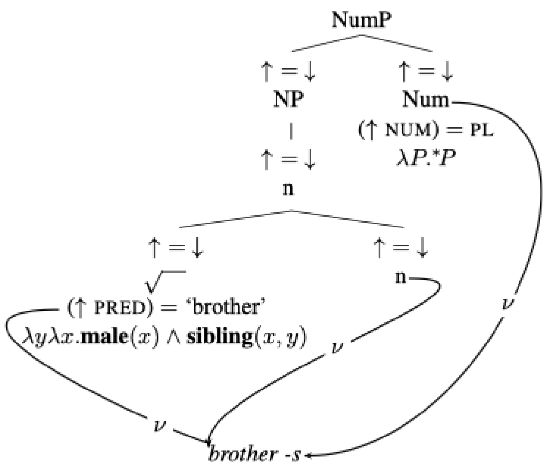
(34) ⟨ [$\sqrt{\ }$,n], Φ{(↑ PRED) = ‘brother’},
$\{\lambda y \lambda x \lambda R.\textbf{male}(x) \wedge R(x,y), (\lambda R.R(\textbf{sibling}))\}$ ⟩ $\xrightarrow{\nu}$ *brother*

(35) ⟨ [Num], Φ{(↑ NUM) = PL}, $\{\lambda P.^{*}P\}$ ⟩ $\xrightarrow{\nu}$ *-s*

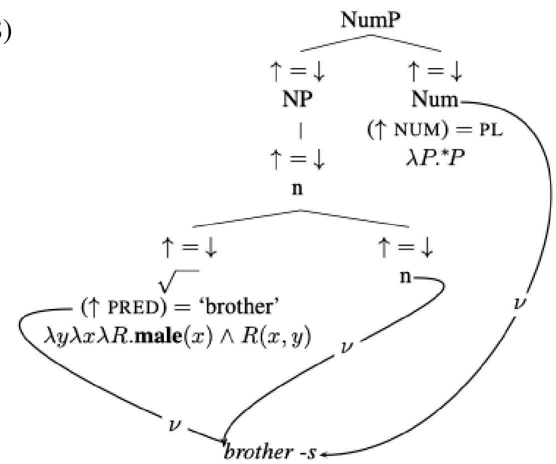
(36) ⟨ [$\sqrt{\ }$,n,Num], Φ{(↑ PRED) = ‘brother’},
$\{\lambda y \lambda x.\textbf{male}(x) \wedge \textbf{member.of.same.order}(x,y)\}$ ⟩ $\xrightarrow{\nu}$ *brethren*

- In sum, as you can see in (37) and (38), *brothers* is licensed because either the relationship is fully specified as male sibling or appears underspecified, allowing for contextual specification of R.
  - This underspecified R may resolve as male sibling due to pragmatic forces, but it need not; it could resolve to close friend, among other possibilities.

(37)

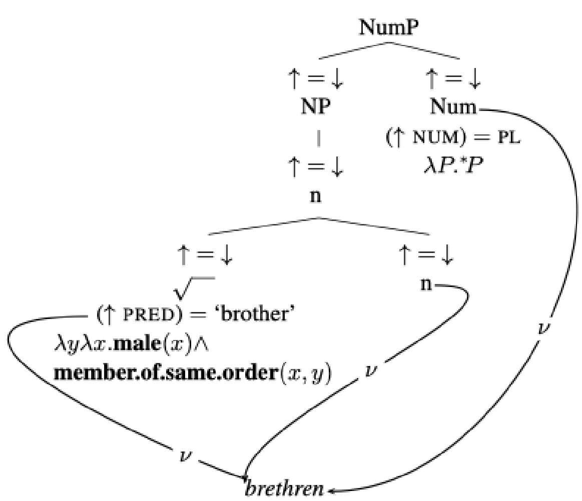


(38)



- *Brethren* is disallowed in both (37) and (38) because of the absence of **member.of.same.order**. Thus, licensing of *brethren* fails despite the fact that **MostInformative**$_c$ would prefer *brethren* over *brothers*, because *brethren* is a portmanteau over Num.
- On the other hand, in (39), **member.of.same.order** is specified in the c-structure, so **MostInformative**$_s$ and **MostInformative**$_c$ together select *brethren* over *brothers*.

(39)



- Since the $\sqrt{\ }$ node containing [PRED 'brother'] can come to have the meaning **member.of.same.order** through two means — overt specification and contextual specification — we make a correct prediction about morphosemantics here:
  - The word *brothers* can be used with the same meaning as *brethren* when the meaning is contextually available, as when a monk might equivalently say (40) or (41).

    (40) My brethren will make sure you are comfortable.

    (41) My brothers will make sure you are comfortable.
  - However, the latter utterance could instead have other contextual meanings.
  - Thus, if the monk wished to communicate specifically that the members of the order will ensure the addressee's comfort, *brethren* would be a better choice than *brothers*, because *brethren* has a more specific meaning.

5 Conclusion

- Our goal in the morphosemantic component of the L_RFG project is to use the actual compositional semantics to make morphological predictions.
- We use the meaning constructors from Glue Semantics to accomplish this.
  - *Locality*: A benefit of this is that meaning constructors are anchored to particular f-structures and thus only take scope over their f-structural anchor. We essentially get semantic locality for free: there simply is no question of being able to look "outside your domain" for a relevant feature, and therefore no need to place extra limits on processes for matching features and their probes.
- Our approach to capturing semantic specificity/information is akin to what may be familiar from event semantics: We leverage logical conjunction such that a term $\alpha \wedge \beta$ is necessarily at least as informative, and almost always more informative, than either α or β on its own.
- It is important to separate *theory* from *formalism*. The L_RFG *theory* consists of a grammatical architecture (repeated in Figure 2 below) and four principles, which we reiterate here with their intuitions:
  1. **MostInformative**$_f$: Whenever possible, prefer portmanteau forms. Choose the VI that defines an f-structure that contains the greater set of features.
  2. **MostInformative**$_c$: Whenever possible, prefer portmanteau forms. Choose the VI that realizes the greater set of categories.
  3. **MostInformative**$_s$: Whenever possible, prefer portmanteau forms. Choose the VI whose denotation is more semantically contentful.
  4. **MostSpecific**: Whenever possible, prefer affixes. Choose the VI whose output v-structure has more specific content in the HOST feature.

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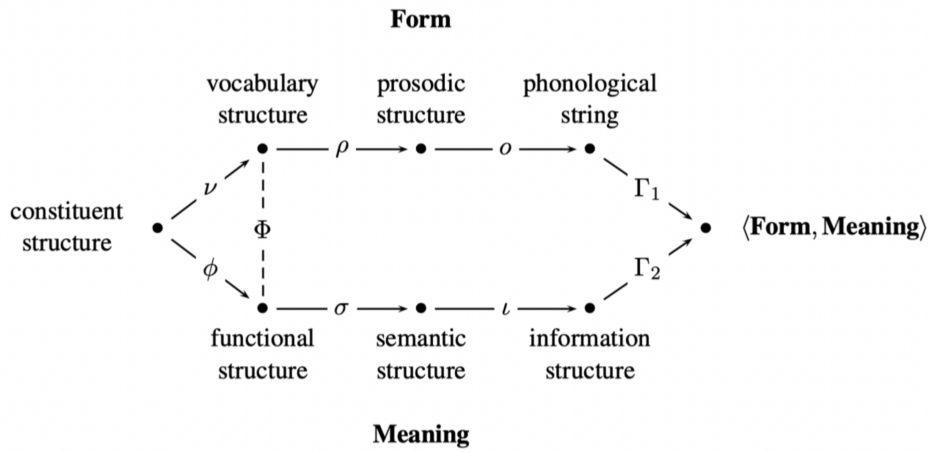

Figure 2: L$_R$FG Correspondence Architecture

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Appendix

A The L_RFG framework

A.1 Motivation

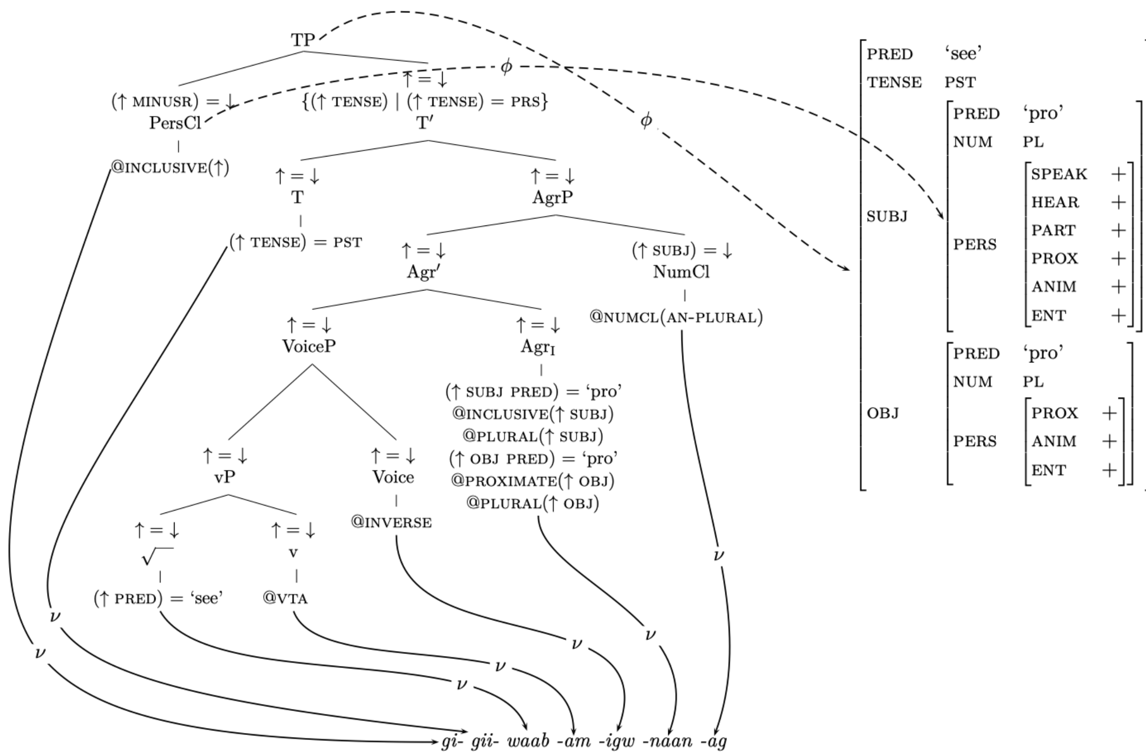
- L_RFG is the offspring of an unlikely marriage between Distributed Morphology as a theory of morphological realization and Lexical-Functional Grammar as a theory of syntax and grammatical architecture.
- L_RFG combines the strengths of the two frameworks:
  1. Like LFG, it is a declarative, representational and constraint-based theory (without the bottom-up, phase-based derivations of Minimalism) that is ideally suited to modelling nonconfigurationality.
  2. Like DM, it provides a realizational, morpheme-based view of word-formation and is good at modelling complex morphological structures including those found in polysynthetic languages, such as many North American Indigenous languages.
- Additionally, because the realizational module, v(ocabulary)-structure, has access to prosodic structure, LrFG has the potential to give non-transderivational (computationally simpler) prosodic explanations for morpheme alignment and surface form phenomena that are typically alternatively analyzed in transderivational harmonic approaches to the morphology-phonology interfaces such as Optimality Theory (Prince and Smolensky 1993, 2004).

A.2 Architecture and example

- L_RFG is syntactically similar to standard LFG, with changes to the c(onstituent)-structure tree and its relationship with morphosyntactic elements.
- The terminal nodes of c-structures *are not words*, but instead are *f-descriptions* (sets of f(unctional)-structure equations and constraints) and Glue Semantics *meaning constructors* (terms that are used in the computation of compositional semantics).
- The c-structure is mapped to a v(ocabulary)-structure, a linearized structure in which vocabulary items (VIs) *expone* (i.e., realize) the features in the terminal nodes, via a correspondence function, ν.
- Vocabulary structure is a morphophonological structure that maps to phonological form via prosodic structure.
- Here is an example from Ojibwe (*Anishinaabemowin*, Algonquian) to demonstrate the basics of an L_RFG analysis.

(42) gi- gii- waab -am -igw -naan -ag
2 PST see VTA INV 1PL 3PL
'They saw us(incl).'

(43)



- The output of the grammar for any particular set of input formatives, is a form–meaning pair where the form incorporates prosody (fed by constituent structure, as in LFG) and the meaning incorporates information structure (fed by semantic structure, as in LFG).[10]

- The relationship between terminal nodes and VIs is many-to-one, using the mechanism of *Spanning* (Haugen and Siddiqi 2016, Merchant 2015, Ramchand 2008, Svenonius 2016); i.e. one VI may realize features of multiple terminal nodes.

- The result is similar to the Lexical Sharing model proposed for LFG by Wescoat (2002, 2005, 2007), but maintains, like DM, that the complex internal structures of words are part of syntax.

[10]Note that the *set* of all grammatical form-meaning pairs may have a given form recurring in several pairs, if it is ambiguous, or a given meaning recurring in several pairs, if it is expressible in alternative ways.

A.3 Comparison with L_RFG's parent frameworks, DM and LFG: Highlights

- The obvious point of contrast between L_RFG and LFG concerns the Lexicalist Hypothesis (Chomsky 1970, Lapointe 1980):

  (44) *Lexicalist Hypothesis*
  No syntactic rule can refer to elements of morphological structure. (Lapointe 1980: 8)

- In LFG this is captured in the *Lexical Integrity Principle*, through formulations like the following:

  (45) *Lexical Integrity*
  Morphologically complete words are leaves of the c-structure tree, and each leaf corresponds to one and only one c-structure node. (Bresnan et al. 2016: 92)

- This statement has two parts:
  1. L_RFG *upholds* the part that states that "each leaf corresponds to one and only one c-structure node".
  2. L_RFG *rejects* the part that states that "morphologically complete words are leaves of the c-structure tree".
     - Clearly, the c-structure leaves/terminals in L_RFG are not "morphologically complete words". The c-structure leaves/terminals are feature bundles that *map* to form, but the form itself is not part of the terminal node.
- However, notice that the notion *morphologically complete word* is left unanalyzed in the definition in (48).
- In fact, it is far from clear that "morphologically complete word" is a coherent notion (see, for example, Anderson 1982).
  - The essential problem is that there are multiple relevant notions of wordhood, and they don't align on a single type of object that we can point to and unambiguously and confidently call a word (Di Sciullo and Williams 1987).[11] In fact, there can be mismatches between the phonological, syntactic, and semantic aspects of words (Marantz 1997).
- This brings us to the the tripartite division of wordhood that defines DM, which L_RFG inherits as three criteria on wordhood:
  1. A word as an unanalyzed phonological string (phonological criterion)
  2. A word as a syntactic atom (syntactic criterion)
  3. *A word as a lexicalized string with a non-compositional meaning* (semantic criterion)
- Like DM, L_RFG is a realizational, morphemic model of morphology that focuses on morphological interfaces.
- These interfaces are captured by the arrangment of discrete structures and correspondence functions between them, an idea inherited from LFG.
- However, unlike mainstream DM, which assumes a Minimalist syntax (for mostly socio-historical reasons, as far as I can tell), L_RFG is a *non-derivational*, *constraint-based* model of grammar.
- The constraints in L_RFG are an inherent part of the formal theory.

[11] This is a long and broad discussion that we cannot possibly do justice to here.

B Comparison with standard LFG

- L_RFG is similar to standard LFG, with changes to the c-structure and its relationship with morphosyntactic elements.
- The terminal nodes of c-structures *are not words*, but instead are f-descriptions (sets of f-structure equations and constraints)
- The c-structure is mapped to a v(ocabulary)-structure, a linearized structure in which vocabulary items (VIs) *expone* (i.e., realize) the features in the terminal nodes, via a correspondence function, ν.
- Formally, a v-structure is a feature structure defining morphophonological properties relevant to the linear placement and metrical properties of the item.
  - This includes the phonemes/segments, as well as the metrical frame which determines syllable structure, affix/clitic status, and so on.
  - Thus, the v-structure roughly corresponds to the p(honological)-form portion of a lexical entry in the metrical theory of Bögel (2015).[12]
- In this talk, the strings themselves are mainly relevant, so we can make some simplifying assumptions:
  1. We represent the output of the exponence function, ν, simply as a string, not a full VI structure.
  2. We show alignment informally using the standard notational convention of adding a dash to the left or right of the string.
  3. We do not show the $o \circ \rho$-mapping (see Figure 3 below), but instead let the phonological forms stand in for the VI strings (i.e., we conflate the two for simplicity/presentational purposes).
- In sum, vocabulary structure is a morphophonological structure that maps to phonological form via prosodic structure.
- We complete the v-structure mappings by introducing a new phonological correspondence function, o, which maps from prosodic structure to phonological strings, and treating the ρ mapping as a mapping from vocabulary items to prosodic structures.
- In other words, the output of ρ is the prosodic structure and the output of o is the final result of phonological processes, a set of strings that are based on the prosodic well-formedness conditions of VIs.
- The morphology is responsible for the input to phonology, but phonology does whatever phonology does to create the output, which is not part of morphology per se.
- Given the set of VIs, V, and a set of prosodic structures, P:

(46) $\rho : V \rightarrow P$

- The o correspondence function takes the output of this ρ correspondence function as its input and so maps to the phonological string (o's output) from the prosodic structure that corresponds to the vocabulary item.
- Thus, in this framework, v-structure precedes the phonological string in the Correspondence Architecture (see, e.g., Asudeh 2012: 53), resulting in the revised architecture in Figure 3.

[12] We would like to thank Tina Bögel for her insightful comments on this point at the LFG20 conference, and in extensive discussion afterwards.

- The output of the grammar, $\langle\Gamma_1, \Gamma_2\rangle$, for any particular set of input formatives, is a form–meaning pair where the form incorporates prosody (still fed by constituent structure) and the meaning incorporates information structure (still fed by semantic structure).[13]
- The relationship between terminal nodes and VIs is many-to-one, using the mechanism of *Spanning* (Haugen and Siddiqi 2016, Merchant 2015, Ramchand 2008, Svenonius 2016); i.e. one VI may realize features of multiple terminal nodes.
- The result is similar to the Lexical Sharing model proposed for LFG by Wescoat (2002, 2005, 2007), but maintains the complex internal structures of words as part of syntax.

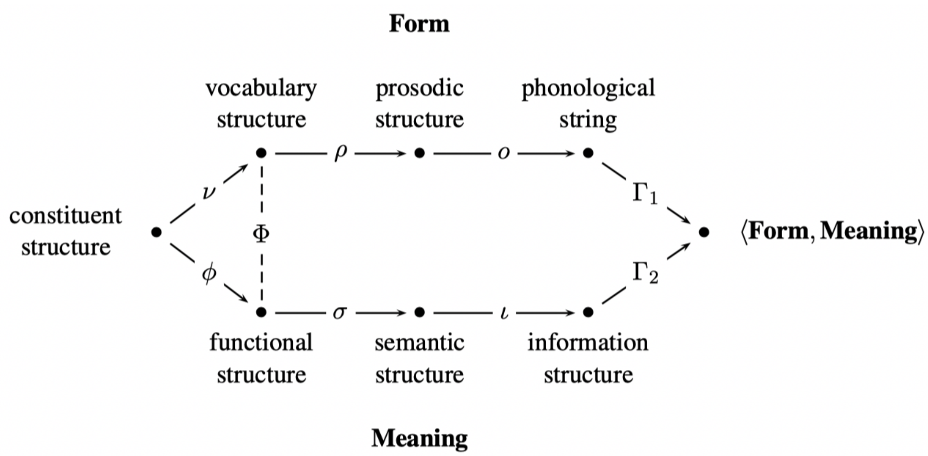


Figure 3: L_RFG Correspondence Architecture

[13]Note that the *set* of all grammatical form-meaning pairs may have a given form recurring in several pairs, if it is ambiguous, or a given meaning recurring in several pairs, if it is expressible in alternative ways.

B.1 L_RFG as a daughter framework of LFG

- The obvious point of contrast between L_RFG and LFG concerns the Lexicalist Hypothesis (Chomsky 1970, Lapointe 1980):

(47) *Lexicalist Hypothesis*
No syntactic rule can refer to elements of morphological structure. (Lapointe 1980: 8)

- In LFG this is captured in the *Lexical Integrity Principle*, through formulations like the following:

(48) *Lexical Integrity*
Morphologically complete words are leaves of the c-structure tree, and each leaf corresponds to one and only one c-structure node. (Bresnan et al. 2016: 92)

- This statement has two parts:

1. L_RFG *upholds* the part that states that "each leaf corresponds to one and only one c-structure node".
   - This may contrast with Lexical Sharing (Wescoat 2002, 2005, 2007), in which portmanteau forms like *du* ('of.DEF.MASC.SG') in French appear to correspond to more than one c-structure node. We need to look under the hood carefully, though, to see what the formal definition of Lexical Sharing is rather than simply going by its graphical representation, which may be misleading. We haven't done this work yet.
2. L_RFG *rejects* the part that states that "morphologically complete words are leaves of the c-structure tree".
   - Clearly, the c-structure leaves/terminals in L_RFG are not "morphologically complete words". The c-structure leaves/terminals are feature bundles that *map* to form, but the form itself is not part of the terminal node.

- However, notice that the notion *morphologically complete word* is left unanalyzed in the definition in (48).

- In fact, it is far from clear that "morphologically complete word" is a coherent notion (see, for example, Anderson 1982).

  - The essential problem is that there are multiple relevant notions of wordhood, and they don't align on a single type of object that we can point to and unambiguously and confidently call a word (Di Sciullo and Williams 1987).[14] In fact, there can be mismatches between the phonological, syntactic, and semantic aspects of words (Marantz 1997).

1. Portmanteau words are examples of things that are phonologically simple but semantically and syntactically complex.

(49) Tu bois **du** lait. French
you drink of.DEF.MASC.SG lait
'You drink/are drinking milk.'

(50) **Imma** go. English dialect
1SG.FUT.PROX go
'I'm about to go.'

[14] This is a long and broad discussion that we cannot possibly do justice to here.

2. Idiomatic expressions are phonologically and syntactically complex, but not necessarily semantically complex, and never in a way that maps entirely transparently to their phonology and syntax.

(51) I read **the shit out of** this book.
INTENSIFIER
'I thoroughly read this book.'

3. Units of syntax can be phonologically or semantically dependent on their contexts.

(52) Je **l'**ai vu. French clitic
I 3SG.saw
'I saw it.'

(53) **The cat**'s been let out of the bag.

- L$_\mathrm{R}$FG thus countenances three criteria for wordhood:

1. A word as an unanalyzed phonological string (phonological criterion)
2. A word as a lexicalized string with a non-compositional meaning (semantic criterion)
3. A word as a syntactic atom (syntactic criterion)

- In other words, L$_\mathrm{R}$FG assumes that there are three notions of wordhood that sometimes happen to align, but can diverge, i.e., there are mismatches between the three types of wordhood.

- With its focus on mismatches, L$_\mathrm{R}$FG is therefore strongly in the spirit of LFG.
  - L$_\mathrm{R}$FG uses the standard *co-description* mechanism of LFG (for recent exposition, see Dalrymple et al. 2019) to simultaneously state the phonological, syntactic and semantic aspects of formatives.

- Here are some possible points of comfort for an LFGer gazing on L$_\mathrm{R}$FG's familiar yet alien landscape:

1. L$_\mathrm{R}$FG could be considered to be offering a morphological theory for LFG that had previously been captured by somewhat ad hoc devices like phrase structure rules for word formation; see, e.g., the discussions of Japanese and West Greenlandic in Bresnan et al. (2016). In other words, LFG owes some kind of theory of word structure, which has generally been lacking until recently (see, e.g., Dalrymple 2015, Dalrymple et al. 2019), and L$_\mathrm{R}$FG seeks to pay that debt.
2. The Vocabulary Items of L$_\mathrm{R}$FG contain much the same information as LFG's lexical entries, but without the commitment that morphophonological form is bundled as part of the lexical entry. It should be easy to specify an algorithm for translating L$_\mathrm{R}$FG's VIs into LFG lexical entries.
3. Related to the first two points, if one were to want to maintain some version of the Lexicalist Hypothesis, one could view L$_\mathrm{R}$FG as offering a microscopic view of the structure of "words", in particular major categories like verb and noun. For example, the TP node in (43) in some sense *is* the verb, but the L$_\mathrm{R}$FG c-structure shows its internal structure. A standard LFG c-structure for example (43) would instead look like the following (setting the f-description aside).

(54)
S
|
$\uparrow = \downarrow$
V
|
gigiiwaabamigwnaanag

C Comparison with standard DM

- DM in L_RFG form is very similar to DM with a Minimalist syntax (DMM), with the key difference that it assumes an interface with LFG as a model of syntax.
- How does this make L_RFG different from DMM?

1. L_RFG is a non-derivational, constraint-based model of the grammar.
   - Distributed Morphology is a realizational model of morphology.
   - Conceptually, realizational morphology is akin to harmonic approaches to phonology (such as Optimality Theory; Prince and Smolensky 1993, 2004).
     - The task is to identify the surface representation that best realizes the featural content of a underlying form that has been constrained by certain well-formedness conditions.
     - Indeed, Vocabulary Items themselves, along with the Subset Principle, are the well-formedness conditions that must be satisfied in order to satisfy a legal surface representation.
     - In this way, realizational morphology is inherently non-derivational.
     - Its opposite, incremental morphology, can be derivational.
   - As a model of morphology, aside from the fact that insertion is cyclic in some varieties of DM, there is nothing derivational at all about DM.
   - Setting aside mechanisms such as *Readjustment* which are not discussed here, the six core principles of DM, as described in §C.1, describe a model of grammar that assesses the well-formedness of a surface representation (*Vocabulary Insertion*) against the final output of PF-branch operations (at least on a phase by phase basis).
   - Intuitively, a model that assesses the welformedness of representations is better suited to be interfaced to other models that assess the wellformedness of representations.

   ⇒ LFG is that. Minimalism is not.
2. L_RFG allows for exponence to be subject to dependencies on several different modules.
   - It is well-known that affixes (and other morphological processes) are not only subject to (morpho)syntactic conditions.
   - Affixation is conditioned by semantics (see, for example, the semantic restrictions *re-* requires of its base) and phonology (see, for example, the phonological restrictions the comparative *-er* and the deadjectivizer *-en* require of their bases).
   - L_RFG is able to capture all three of these types of conditioning on morphological processes precisely because the morphological representation (v(ocabulary)-structure) imposes constraints on the mappings (either directly or indirectly) to not only c-structure, but f-structure, s(emantic)-structure, and p(rosodic)-structure.
   - In contrast, PF in DMM is explicitly blind to LF in the Y model, so meaning directly affecting form (such as the difference between *brothers* and *brethren* or *older* and *elder*) is excluded in DMM.
     - Additionally, surface phonology is ordered after insertion is complete, so output-sensitive morphology (such as the legality of *moisten*; see Halle 1973 for discussion) is difficult or even impossible to obtain absent a DM-OT interface such as proposed by Bye and Svenonius (2012).

C.1 L_RFG as a daughter framework of DM

- L_RFG is a variety of DM, despite the different syntax interface, so L_RFG maintains all the key properties of DM.

1. **Morpheme-based morphosyntax**
   - L_RFG directly adopts the *monolistemicity* and *spanning* model of Vocabulary Items developed for DM in Haugen and Siddiqi (2016).
   - Haugen and Siddiqi's model of the vocabulary is neither purely morpheme-based nor word-based, but rather is listeme-based.
   - In L_RFG, the key property for determining what is a Vocabulary Item is not decomposability, as is true in standard DM, but rather listedness.
   - While *Spanning* is not universally adopted in DM, it is definitely part of the DM literature.
   - Spanning is crucial to L_RFG, rather than optional, but otherwise L_RFG's view on morphemes and syntactic structure is virtually the same as in DM.
   - Indeed, L_RFG c-structures are largely the same as syntactic trees found in DM outside of the featural content.
2. **Realization**
   - Exponence in L_RFG works almost identically to Vocabulary Insertion in DM.
   - The crucial difference is that a Vocabulary Item in L_RFG is a more complicated representation than that of DMM as it also contains information relevant to prosodic structure constraints.
   - Exponence in L_RFG is also sensitive to more information than in DMM: it is conditioned also by *meaning constructors* from Glue Semantics (Dalrymple 1999, 2001, Dalrymple et al. 2019, Asudeh 2012) and by f-structures.
   - Finally, exponence in L_RFG is also not a replacement algorithm that discharges features from a derivation.
     - In L_RFG, it is a set of pairwise correspondence functions between representations in v-structure, c-structure, f-structure, and p-structure.
3. **Morphology as an interface**
   - In L_RFG, v-structure is quintessentially non-generative.
   - While DMM has various operations that change the syntax along the PF branch, L_RFG has no such operations.
   - The form of v-structure is entirely determined by the satisfaction of constraints on the mappings with other representations.
   - Morphology is not an output of L_RFG: it is one of many representations described by a given co-description.
   - Additionally, like DM, L_RFG rejects the part of the *Lexical Integrity Hypothesis* that mandates that complex words map to syntactic terminals.
4. **Three lists**
   - L_RFG maintains the tripartite division of wordhood that defines DM.
   - Indeed, L_RFG adds a fourth "special domain" in the sense of Marantz (1997): L_RFG distinguishes between morphological (vocabulary) atomicity and phonological (prosodic) atomicity.
   - In L_RFG, morphological atomicity, phonological atomicity, semantic atomicity, and semantic atomicity do not necessarily align on the same object. Each corresponds to a different representation in the Correspondence Architecture, as described by co-description.

5. **Elsewhere Principle**
   - L$_{\text{R}}$FG adopts this, though not directly by adopting the Subset Principle of DM.
   - In L$_{\text{R}}$FG, this falls out of independently motivated elsewhere constraints, the **MostInformative** family of constraints (**MostInformative**$_c$, **MostInformative**$_f$, **MostInformative**$_s$) and **MostSpecific**, where **MostInformative** is conditioned by grammar/meaning and **MostSpecific** is conditioned by form.
6. **Underspecification**: Yes.