# Realizational Morphosemantics*

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## 1 Our project

- We have been developing 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).
- The resulting framework, which we call *Lexical-Realizational Functional Grammar* ($L_R$FG; Melchin et al. 2020, Asudeh et al. 2021), is particularly well-suited to model North American Indigenous languages, which are characterized by *polysynthesis* and *nonconfigurationality*.
- In this talk, I present some initial attempts at an $L_R$FG theory and formalization of *morphosemantics*, i.e. the morphology–semantics interface.
- The talk will proceed as follows:
  - Section 2 looks at some problems at the morphology-semantics interface, in general terms.
  - Section 3 motivates and outlines the $L_R$FG framework, briefly comparing and contrasting it to standard LFG and standard DM. Further details are provided in the appendix.
  - Section 4 provides details on $L_R$FG's exponence function, $\nu$.
  - Section 5 looks at the general shape of $L_R$FG's solutions to these problems and offers a partial analysis of a case study (*brothers/brethren*).
  - Section 6 offers some conclusions and prospects.

*This work is part of an ongoing project led by Ash Asudeh and Dan Siddiqi. 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), and Will Oxford (University of Manitoba). I am grateful to all the project members for their participation and discussion, but especially to Mike and Paul, who have thus far been our main collaborators. Any errors in this talk are my own. Part of the research presented here was funded by SSHRC Insight Development Grant 430-2018-00957 (Siddiqi).

## 2 Motivation: Morphosemantic problems

- How is morphosemantics distinct from general lexical semantics?
  - We consider morphosemantics as encompassing all and only aspects of meaning that affect the mapping from a semantic representation to a phonological representation.
    - In L$_{\mathrm{R}}$FG terms, this is those meanings that condition the mapping to v-structure.
    - The principle that governs this mapping, formalized in (15) below, is **MostInformative**$_s$.
- Phenomena that L$_{\mathrm{R}}$FG attributes to the morphology-semantics interface:

1. Semantically conditioned morphology
   (a) Prefix *re-*
   (b) Suffix *-er*
2. Polysemy
   (a) *keep*
   (b) *clutch*
3. Lexicalization
   (a) *antsy*
   (b) *lousy*
   (c) *transmission*$_a$
   (d) *transmission*$_b$
4. Regulars/irregulars
   (a) *brothers/brethren*
   (b) *older/elder*
   (c) *perceivable/perceptible*
   (d) *uncombed/unkempt*
   (e) *compárable/cómparable*
   (f) *-ity/-ness* pairs
      i. *divineness/divinity*
      ii. *curiousness/curiosity*
      iii. *productiveness/productivity*

## 3 The L$_{\mathrm{R}}$FG framework

### 3.1 Motivation

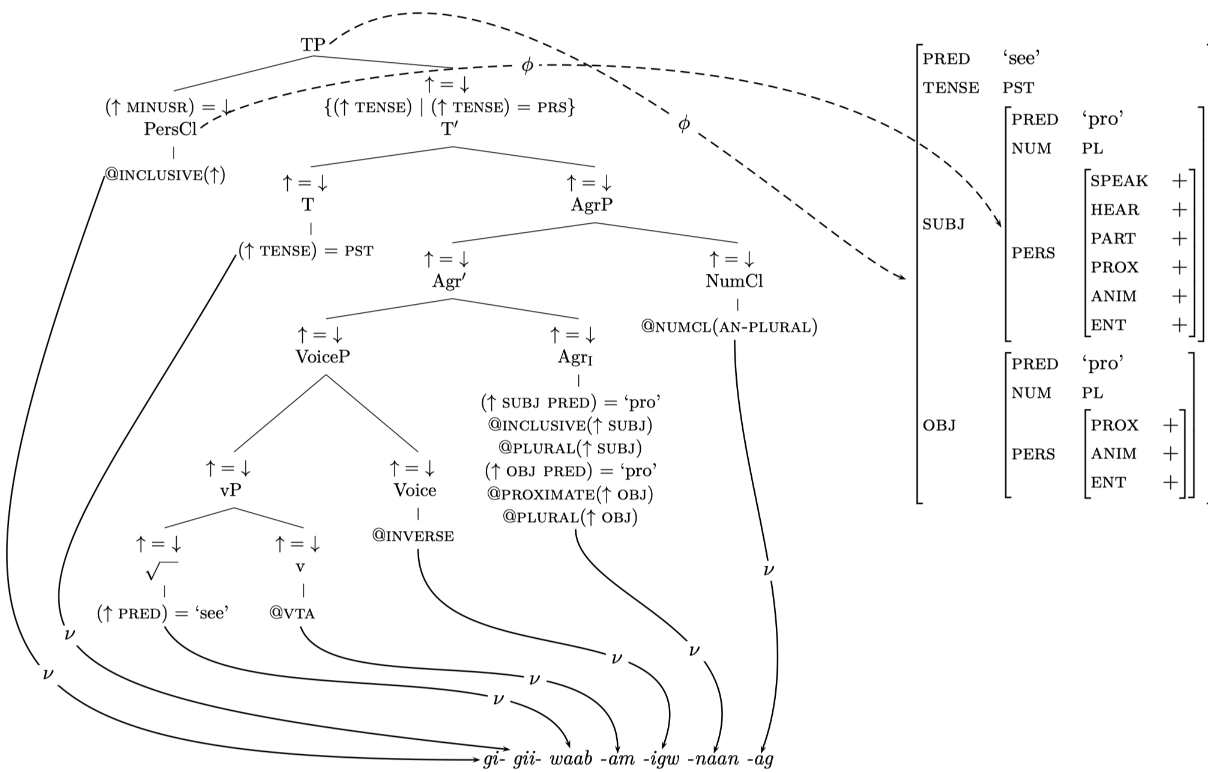
- L$_{\mathrm{R}}$FG is the offspring of an unlikely marriage between Distributed Morphology as a theory of morphological realization and Lexical-Functional Grammar as a theory of syntax and grammatical architecture.
- L$_{\mathrm{R}}$FG combines the strengths of the two frameworks:
  1. Like LFG, it 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).

### 3.2 Architecture and example

- $L_R$FG 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, $\nu$.
- 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 $L_R$FG analysis.

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

(2)



- V-structure precedes the phonological string in the Correspondence Architecture (see, e.g., Asudeh 2012: 53), resulting in the revised architecture in Figure 1.
- 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 (fed by constituent structure, as in LFG) and the meaning incorporates information structure (fed by semantic structure, as in LFG).[1]

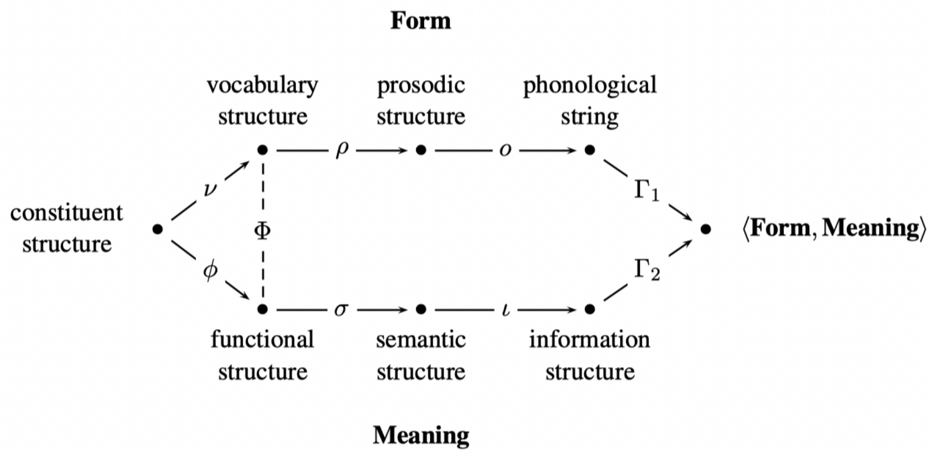



Figure 1: Correspondence Architecture

- 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.
- In today's talk, I want to focus on the morphology-semantics interface, i.e. *morphosemantics*, in $\text{L}_\text{R}$FG, although we won't have anything to say about the $\iota$-mapping to information structure.:

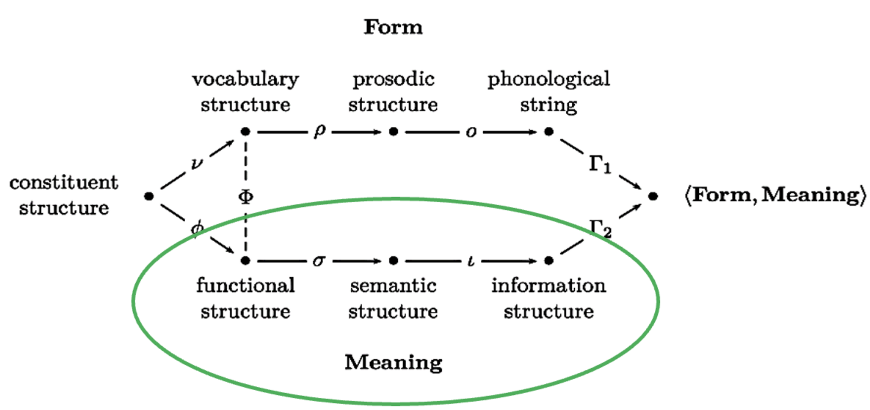



Figure 2: Morphosemantics in $\text{L}_\text{R}$FG

[1] 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.

### 3.3 Comparison with $L_R$FG's parent frameworks, DM and LFG: Highlights

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

(3) *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:

(4) *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. $L_R$FG *upholds* the part that states that "each leaf corresponds to one and only one c-structure node".
  2. $L_R$FG *rejects* the part that states that "morphologically complete words are leaves of the c-structure tree".
     - Clearly, the c-structure leaves/terminals in $L_R$FG 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 (29).

- 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).[2] 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 $L_R$FG 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, $L_R$FG 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), $L_R$FG is a *non-derivational*, *constraint-based* model of grammar.

- The constraints in $L_R$FG are an inherent part of the formal theory.

- See the appendix for more details on $L_R$FG in comparison to DM and LFG.

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

## 4 L$_R$FG's exponence function: $\nu$

- In our previous work (Melchin et al. 2020, Asudeh et al. 2021, Everdell et al. 2021), the exponence function $\nu$ mapped from a pair of arguments to a Vocabulary Item (VI), the exponent.
- However, since we are now turning our attention to semantics as well, we now add a third argument to $\nu$
  - 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, $\Phi$, 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.[3]
  - The third argument is a set of *meaning constructors* from Glue Semantics (Glue; Dalrymple 1999, 2001, Dalrymple et al. 2019, Asudeh 2012, 2022).
- Meaning constructors are pairs of terms from two logics (the colon is an uninterpreted pairing symbol):

(5) $\mathcal{M} : G$

  - $\mathcal{M}$ is an expression of the *meaning language* — anything that supports the lambda calculus.
  - $G$ is an expression of *linear logic* (Girard 1987), which specifies semantic composition based on a syntactic parse that instantiates the general terms in $G$ to a specific syntactic structure.
  - The meaning constructors serve as premises in a linear logic proof of the *compositional semantics*.

(6) Alex likes Blake.

(7) Meaning constructors: **alex** : $a$
**blake** : $b$
$\lambda y.\lambda x.\mathbf{like}(y)(x) : b \multimap a \multimap l$

(8) Note that $\lambda y.\lambda x.\mathbf{like}(y)(x)$ is $\eta$-equivalent to just **like**, but it is useful to use the expanded form to make the structure of the following proof more obvious.

(9)
$$\dfrac{\mathbf{alex} : a \qquad \dfrac{\lambda y.\lambda x.\mathbf{like}(y)(x) : b \multimap a \multimap l \qquad \mathbf{blake} : b}{\lambda x.\mathbf{like}(\mathbf{blake})(x) : a \multimap l}\multimap_{\mathcal{E}}, \Rightarrow_\beta}{\mathbf{like}(\mathbf{blake})(\mathbf{alex}) : l}\multimap_{\mathcal{E}}, \Rightarrow_\beta$$

  - The colours in the proof are not part of the representation, but highlight the meaning constructors as opposed to compositionally derived meanings, which are in black.
  - For a recent high-level introduction to Glue Semantics, see Asudeh (2022).

- Here are two sample VIs, the first for the Ojibwe root *waab* in (1) above and the second for the English equivalent *see*.[4] Note that we now use the $\eta$-equivalent form of the **see** function to reduce clutter.

Ojibwe (10) $\langle\, [\sqrt{\phantom{x}}],\ \Phi\{(\uparrow \text{PRED}) = \text{`see'}\},\ \{\mathbf{see} : (\uparrow \text{OBJ})_\sigma \multimap (\uparrow \text{SUBJ})_\sigma \multimap {\uparrow_\sigma}\}\,\rangle \xrightarrow{\nu}$ *waab*

English (11) $\langle\, [\sqrt{\phantom{x}}],\ \Phi\{(\uparrow \text{PRED}) = \text{`see'}\},\ \{\mathbf{see} : (\uparrow \text{OBJ})_\sigma \multimap (\uparrow \text{SUBJ})_\sigma \multimap {\uparrow_\sigma}\}\,\rangle \xrightarrow{\nu}$ *see*

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

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[3] We thank Ron Kaplan (p.c.) for discussion of this point. Any remaining errors are our own.

[4] The colours in (10) are not part of the representation. They are just there to help you parse out the parts better.

(12)

$$\sqrt{\phantom{x}}$$

$$(\uparrow \text{PRED}) = \text{`see'}$$

$$\textbf{see} : (\uparrow \text{OBJ})_\sigma \multimap (\uparrow \text{SUBJ})_\sigma \multimap \uparrow_\sigma$$

- The list of c-structure categories in the VI is the ordered set of categories in the tree that corresponds to the VI.
- The f-description is written below the c-structure node, as in standard LFG.
- The Glue meaning constructor(s) is/are written below the f-description, again as in standard LFG+Glue.

### 4.1 Conditions on exponence

- Let $V$ be the range of the exponence function $\nu$, the set of VIs (structured expressions); then the following conditions on exponence hold.
- **MostInformative**$_f(\alpha, \beta)$ returns whichever of $\alpha$,$\beta$ has the most specific f-structure in the set of f-structures returned by $\Phi$ applied to the unions of $\alpha/\beta$'s collected f-descriptions.
*Intuition.* Choose the VI that realizes an f-description 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.

(13) Given two Vocabulary Items, $\alpha$ and $\beta$

$$\textbf{MostInformative}_f(\alpha, \beta) = \begin{cases} \alpha \textbf{ if } \exists f \forall g . f \in \pi_2(\nu^{-1}(\alpha)) \wedge g \in \pi_2(\nu^{-1}(\beta)) \wedge g \sqsubset f \\ \beta \textbf{ if } \exists f \forall g . f \in \pi_2(\nu^{-1}(\beta)) \wedge g \in \pi_2(\nu^{-1}(\alpha)) \wedge g \sqsubset f \\ \bot \textbf{ otherwise} \end{cases}$$

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

(14) Given two Vocabulary Items, $\alpha$ and $\beta$,

$$\textbf{MostInformative}_c(\alpha, \beta) = \begin{cases} \alpha \textbf{ if } f = \pi_1(\nu^{-1}(\alpha)) \wedge g = \pi_1(\nu^{-1}(\beta)) \wedge g \subset f \\ \beta \textbf{ if } f = \pi_1(\nu^{-1}(\beta)) \wedge g = \pi_1(\nu^{-1}(\alpha)) \wedge f \subset g \\ \bot \textbf{ otherwise} \end{cases}$$

- **MostInformative**$_s(\alpha, \beta)$ returns whichever Vocabulary Item has the more specific meaning.
*Intuition.* Choose the VI whose denotation is more semantically contentful.
*Formalization.* The proper subset relation on set-denoting expressions is used to capture the intuition.

(15) Given two Vocabulary Items, $\alpha$ and $\beta$, of the same semantic type $T$, where $T$ is any type ending in $t$,

$$\textbf{MostInformative}_s(\alpha, \beta) = \begin{cases} \alpha \textbf{ if } [\![\alpha]\!] \subset [\![\beta]\!] \\ \beta \textbf{ if } [\![\beta]\!] \subset [\![\alpha]\!] \\ \bot \textbf{ otherwise} \end{cases}$$

[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.

- Notes:
  1. **MostInformative**$_c$ and **MostInformative**$_f$ are *morphosyntactic* constraints, whereas **MostInformative**$_s$ is a *morphosemantic* constraint.
  2. Each version of **MostInformative** can result in a tie, represented by $\bot$.
  3. There are regularities in the mappings/interfaces between structures, so it would be unlikely for all three **MostInformative** constraints to yield $\bot$. We are not currently aware of any empirical case that would merit such an analysis.

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

- **MostSpecific**$(\alpha, \beta)$ returns whichever Vocabulary Item has the most restrictions on its phonology.
*Intuition.* Choose the VI which is more phonologically restricted, i.e. the one that is subject to more phonological constraints.
*Formalization.* The cardinality of sets of phonological constraints is used to capture the intuition.

(16) Given two Vocabulary Items, $\alpha$ and $\beta$, a set of phonological constraints $P$, and a function **phon** that maps a Vocabulary Item to a subset of $P$,

$$\textbf{MostSpecific}(\alpha, \beta) = \begin{cases} \alpha \textbf{ if } |\textbf{phon}(\alpha)| > |\textbf{phon}(\beta)| \\ \beta \textbf{ if } |\textbf{phon}(\beta)| > |\textbf{phon}(\alpha)| \\ \bot \ \mathbf{otherwise} \end{cases}$$

- Consider the classic example of the English deadjectivizer *-en* to illustrate **MostSpecific**.
  - English has two key ways to derive a verb from an adjective to have the meaning *to cause X to gain* ADJ *property*.
  - The more marked version is the affix *-en*, which is perfectly productive assuming certain phonological restrictions.
  - The less marked version is a zero-marked form, which in $\text{L}_\text{R}$FG is a result of the fact that *Pac-man Spanning* is always competing with overt exponence, since $\text{L}_\text{R}$FG does not employ zero affixation.

(17)

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

# 5 The shape of $\mathrm{L_R}$FG solutions to problems of morphosemantics

- Let's consider the case of *brothers*/*brethren*.
- This pair exemplifies a familiar hyponymy relationship triggered by the coexistence of regular and irregular forms.
- *Brethren* takes the exceptional plural *-en*, but unlike the case with *child*/*children* or *ox*/*oxen*, *brethren* is not the only plural of *brother* and has a distinct, more specific meaning than the regular plural, *brothers*.
- Following Partee and Borschev (2003), we assume that a relational noun like $\sqrt{\text{BROTHER}}$ involves a relation between the nominal entity and some other entity, such as a possessor.
- The meaning term for $\sqrt{\text{BROTHER}}$ can be represented as follows:

  (18) $\lambda y \lambda x \lambda R.\textbf{male}(x) \wedge R(x, y)$

- Notice that, if left unresolved, the relational variable, $R$, must be filled from context.
- This is the meaning term for the obligatory meaning constructor for $\sqrt{\text{BROTHER}}$.
- Of course, the relation typically defaults to sibling, so we assume that there is a second, optional meaning constructor for $\sqrt{\text{BROTHER}}$ whose meaning term modifies the term above as follows:

  (19) $\lambda R.R(\textbf{sibling})$

  Thus, the *default* interpretation for *brother* is male sibling.

- However, as the term in (19) is optional, $R$ in (18) can instead be instantiated contextually/pragmatically, for example as **close.friend** (where culturally appropriate, which is evidence of its pragmatic nature).
- 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:

  (20) My brother spoke out of turn.

- We assume that the regular plural morpheme *-s* just expresses a plural meaning, following Link (1983):

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

- Thus, the *default* interpretation of *brothers* is male siblings.
- In contrast, *brethren* obligatorily expresses the following relational meaning constructor in addition to the general meanings in (18) and (21):

  (22) $\lambda R.R(\textbf{member.of.same.order})$

- 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.
- Given the default interpretation of male siblings for $\sqrt{\text{BROTHER}}+\text{PL}$, there are no grounds for $\textbf{MostInformative}_s$ to choose either one of *brothers*/*brethren* over the other (i.e., it returns $\perp$, which means the constraint is not decisive).

- This is because the set of members of an all-male order is not a subset of the set of male siblings or vice versa.
- However, if the relation $R$ in $\sqrt{\text{BROTHER}}{+}\text{PL}$ is left unspecified, then the set of members of an all-male group *is* a subset of the set of males that bear some relation to something, so **MostInformative**$_s$ would choose *brethren* over underspecified *brothers*, i.e., the result of applying the regular plural meaning to the meaning in (18).
- The upshot, then, is that in a context where *brethren* can be used, *brothers* can only be used a) with the same meaning as *brethren*, but due to a contextually specified $R$ — in that case **MostInformative**$_s$ would again return $\perp$, since the constraint is based on proper subsets and the two sets are equal in this case; or b) *brothers* must have some contextually available meaning that is not a proper superset of the meaning of *brethren*.
- In other words, 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 (23) or (24).

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

    (24) 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.

## 6 Conclusion

- Our goal in the morphosemantic component of the L$_{\text{R}}$FG 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 $\alpha$ or $\beta$ on its own.
- It is important to separate *theory* from *formalism*. The L$_{\text{R}}$FG *theory* consists of a grammatical architecture (repeated in Figure 3 below) and four principles, which I reiterate here with their intuitions:
  1. **MostInformative**$_f$: Choose the Vocabulary Item that realizes an f-description that defines an f-structure that contains the greater set of features.
  2. **MostInformative**$_c$: Choose the Vocabulary Item that realizes the greater set of categories.
  3. **MostInformative**$_s$: Choose the Vocabulary Item whose denotation is more semantically contentful.
  4. **MostSpecific**: Choose the Vocabulary Item which is more phonologically restricted, i.e. the one that is subject to more phonological constraints.

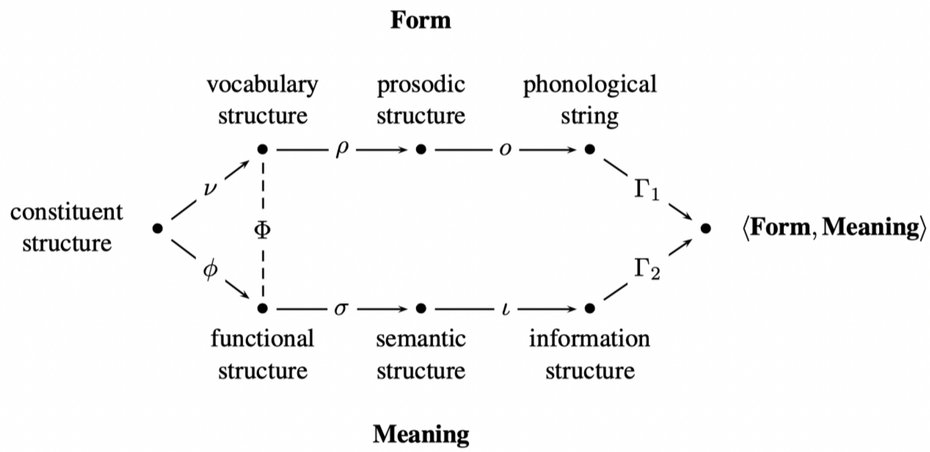


Figure 3: Correspondence Architecture

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# Appendix

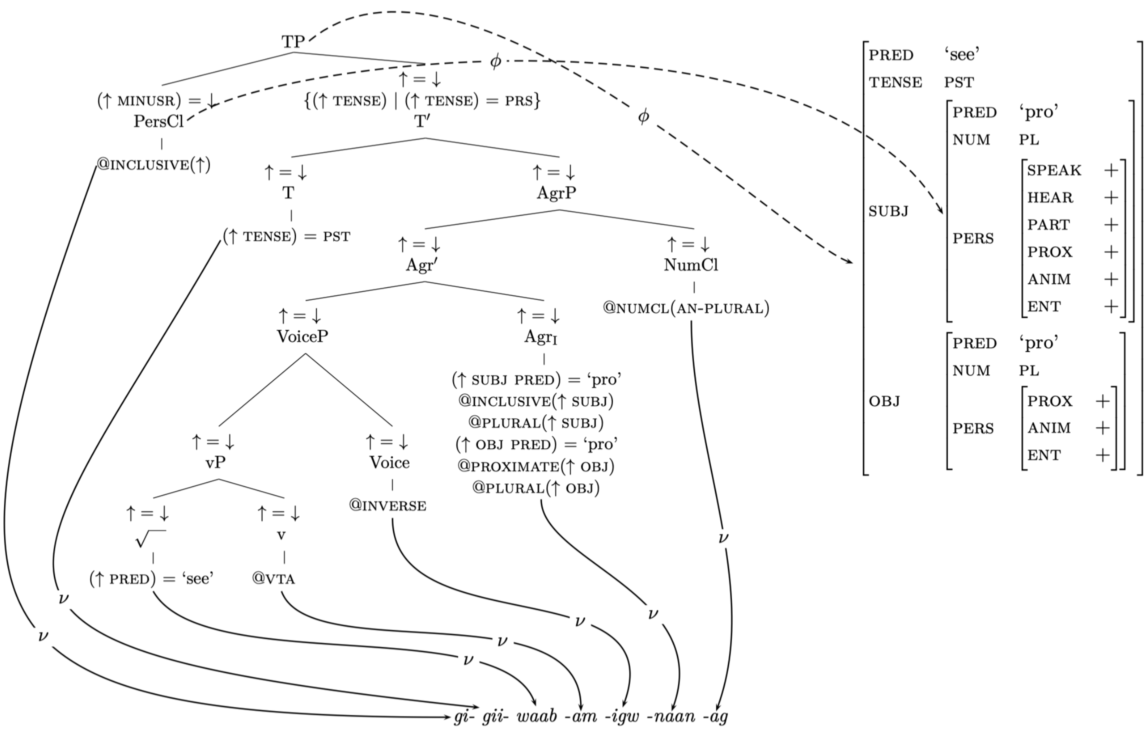
## A Comparison with standard LFG

- $L_R$FG 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, $\nu$.
- Formally, v-structure is a list, each member of which 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).[6]
- In this talk, only the strings themselves are relevant, so we make some simplifying assumptions:
  1. We represent the output of the exponence function, $\nu$, 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 4 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.
- Here is an example from Ojibwe (*Anishinaabemowin*, Algonquian) to demonstrate the basics of an $L_R$FG analysis.

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

[6] We would like to thank Tina Bögel for her insightful comments on this point at the LFG20 conference, and in extensive discussion afterwards. The details of the interaction between v-structure and the phonological string, in particular the effects of the metrical properties of VIs on mismatches in ordering between c-structure and the p-string, are currently being worked out and will be presented in future work in the $L_R$FG framework.

(26)




- 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 $\rho$ mapping as a mapping from vocabulary items to prosodic structures.

- In other words, the output of $\rho$ 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, $P$:

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

- The $o$ correspondence function takes the output of this $\rho$ 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 4.

- 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).[7]

- 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.

[7] 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.

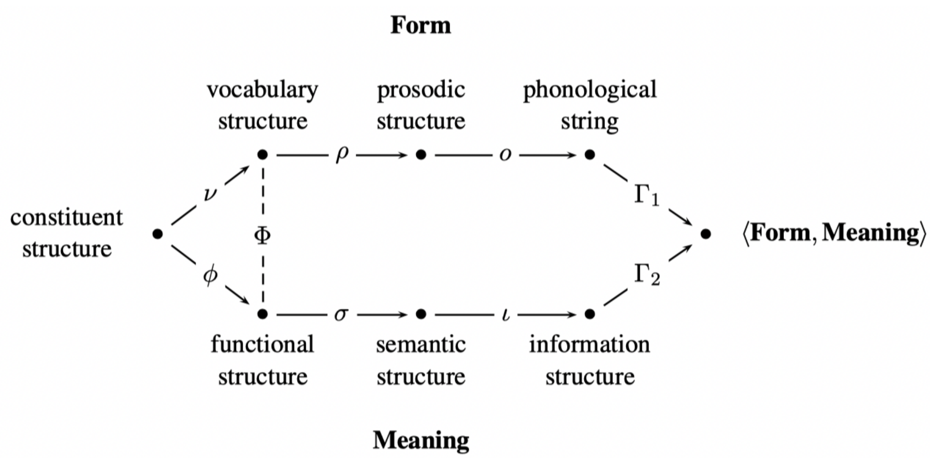



Figure 4: Correspondence Architecture

- 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.
- In today's talk, we want to focus on the morphology-semantics interface, i.e. *morphosemantics* in $L_R$FG, although we won't have anything to say about the $\iota$-mapping to information structure.

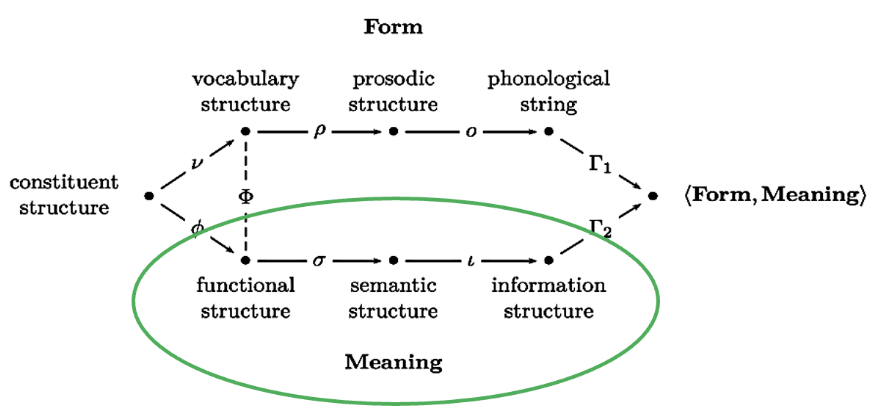



Figure 5: Morphosemantics in $L_R$FG

### A.1 $L_R$FG as a daughter framework of LFG

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

(28) *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:

(29) *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. $L_R$FG *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. $L_R$FG *rejects* the part that states that "morphologically complete words are leaves of the c-structure tree".
   - Clearly, the c-structure leaves/terminals in $L_R$FG 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 (29).
- 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).[8] 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.

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

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

[8] 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.

   (32) 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.

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

   (34) **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)

- L$_{\mathrm{R}}$FG thus 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.

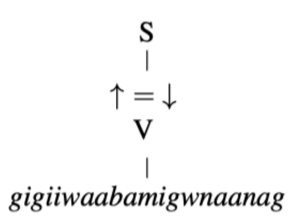
- With its focus on mismatches, L$_{\mathrm{R}}$FG is therefore strongly in the spirit of LFG.

  ○ 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 25 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 25 would instead look like the following (setting the f-description aside).

   (35)



# B Comparison of $L_R$FG with standard DM

- DM in $L_R$FG 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 (discussed below).
- How does this make $L_R$FG different from DMM?
  1. $L_R$FG 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 above, 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. $L_R$FG 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).
     - $L_R$FG 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 *hasten*, 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).

### B.1 $\mathrm{L_R}$FG as a daughter framework of DM

- $\mathrm{L_R}$FG is a variety of DM, despite the different syntax interface, so $\mathrm{L_R}$FG maintains all the key properties of DM.

  1. **Morpheme-based morphosyntax**
     - $\mathrm{L_R}$FG 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 $\mathrm{L_R}$FG, 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 standard in DM, it is definitely part of the DM literature.
     - Spanning is crucial to $\mathrm{L_R}$FG, rather than optional, but otherwise $\mathrm{L_R}$FG's view on morphemes and syntactic structure is virtually the same as in DM.
     - Indeed, $\mathrm{L_R}$FG c-structures are largely the same as syntactic trees found in DM outside of the featural content.
  2. **Realization**
     - Exponence in $\mathrm{L_R}$FG works almost identically to Vocabulary Insertion in DM.
     - The crucial difference is that a Vocabulary Item in $\mathrm{L_R}$FG is a more complicated representation than that of DMM as it also contains information relevant to prosodic structure constraints.
     - Exponence in $\mathrm{L_R}$FG 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 $\mathrm{L_R}$FG is also not a replacement algorithm that discharges features from a derivation.
       - In $\mathrm{L_R}$FG, 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 $\mathrm{L_R}$FG, v-structure is quintessentially non-generative.
     - While DMM has various operations that change the syntax along the PF branch, $\mathrm{L_R}$FG 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 $\mathrm{L_R}$FG: it is one of many representations described by a given co-description.
     - Additionally, like DM, $\mathrm{L_R}$FG rejects the part of the *Lexical Integrity Hypothesis* that mandates that complex words map to syntactic terminals.
  4. **Three lists**
     - $\mathrm{L_R}$FG maintains the tripartite division of wordhood that defines DM.
     - Indeed, $\mathrm{L_R}$FG adds a fourth "special domain" in the sense of Marantz (1997): $\mathrm{L_R}$FG distinguishes between morphological (vocabulary) atomicity and phonological (prosodic) atomicity.
     - In $\mathrm{L_R}$FG, 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**
   - $L_R$FG adopts this, though not directly through adopting the Subset Principle of DM.
   - In $L_R$FG, this falls out of two independently motivated elsewhere constraints, *MostInformative* and *MostSpecific*, where MostInformative is conditioned by meaning and MostSpecific is conditioned by form.
6. **Underspecification**: Yes.