Rethinking Cartography

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The “Cartographic Program” (Beletti 2004; Bennica and Munaro 2011; Brugé et al. 2012; Cinque 1999, 2002, 2006; Cinque and Rizzi 2010; Haegeman 2012; Rizzi 1997, 2004; Shlonsky 2015; Svenonius 2014; Tsai 2015, among many others) has investigated interesting, apparently stable, cross-linguistic linear orderings among a variety of sentence constituents, including left peripheral elements (1a), adverbs (1b) and attributive adjectives (1c).

(1) a. FORCE > TOPIC > FOCUS > TOPIC > FINITENESS > TENSE...
   b. HABITUAL > REPET > FREQ > VOL > CELERATIVE > ANT >...
   c. SIZE > LENGTH > HEIGHT > SPEED > DEPTH > WIDTH >...

In accounting for such orderings, the signature technical move of cartography is to postulate hierarchies of functional projections related by functional selection (2a-c):

(2) a. \([\text{FORCE} \ [\text{TOP} \ [\text{FOC} \ [\text{TOP} \ [\text{FIN} \ [\text{TENSE} \ ...]]]]]]\]
   b. \([\text{HABITUAL} \ [\text{REPETITIVE} \ [\text{FREQ} \ [\text{VOLITION} \ [\text{CELERATIVE} \ [\text{ANTERIOR} \ ...]]]]]]\]
   c. \([\text{SIZE} \ [\text{LENGTH} \ [\text{HEIGHT} \ [\text{SPEED} \ [\text{DEPTH} \ [\text{WIDTH} \ ...]]]]]]\]

Functional selection orders the phrases, which in turn orders the elements occurring within the phrases.

In this paper I review some basic assumptions of the cartographic program, noting three problems with functional hierarchies employed as a means to capture linear order. I label these the "problem of explanation," "the problem of plenitude" and the "problem of rigidity". I then compare linearity via functional hierarchies with linearity as observed in the familiar domain of integers. A key difference is that numerical linearity is the product of a single relation (<) ordering the entire domain whereas cartographic linearity results from many, potentially quite disparate selection relations applying pairwise. As I show, this difference frees numerical linearity from the problems attending functional hierarchies. I go on to consider recent work by Scontras et al 2017a arguing that a single "inequality relation" underlies the ordering of attributive adjectives in nominals, one that can be established independently of grammar. I demonstrate how this result might be incorporated into a feature-driven theory of syntactic projection that generates the cross-linguistic linear orderings investigated by cartography without appeal to functional selection or functional hierarchies. Finally, I extend this idea from adjectives to the general case, illustrating briefly with left-peripheral elements, as discussed by Rizzi (1997).

1.0 Functional Hierarchies and Functional Selection

As noted above, cartography derives linear orderings by appeal to functional selection and functional projections. In brief, the approach postulates a series of functional heads α, β, γ, δ, etc. in a series of concentric projections αP, βP, γP, δP, etc. where
each head stands in its own specific functional selection relation ($\Sigma_\alpha$, $\Sigma_\beta$, $\Sigma_\gamma$, ...) to the projection beneath it (3):

(3) 

Relevant linguistic items occupy head or Spec positions within these projections. The sequence of functional selection relations thus determines the sequence of projections, which in turn determines the order of linguistic items within those projections.

A key feature of this picture is that each head ($\alpha$, $\beta$, $\gamma$, $\delta$, etc) functionally selects a single complement of unique category. This property is definitional for Abney (1987) in distinguishing functional selection from the usual thematic selection operating in the argument structure of verbs. Thus whereas a verb like behave, which thematically selects a manner complement, will accept a range of categories (AdvP, NP, PP) in this function (4a), a functional head (e.g., Force) should select only a single category of complement (TopP) and no other (FocP).

(4)  
a. Alice $[\text{VP behaved [AdvP carefully]/[NP that way]/[PP in a tactical fashion]]}$.


The architecture of cartography, as an approach to linear ordering in grammar, raises a number of interesting, fundamental problems.

1.1 The Problem of Explanation

Having the technical means to express linear ordering in a theory is not the same thing as having an explanation for where those orderings come from. In cartography, the linear orderings we observe reflect the functional hierarchies that we posit. And those functional hierarchies reflect the functional selection relations that generate them. Hence explanation in cartography must pursue these functional selection relations. In relation to the hierarchy in (1c)/(2c), for example, we are led to ask a series of questions like:

- What is it about a SIZE head that makes it functionally select LENGTHP?
- What is it about a LENGTH head that makes it functionally select HEIGHTP?
- What is it about a HEIGHT head that makes it functionally select SPEEDP?

Etc.
Since the functional selection relations ($\Sigma_{\text{SIZE}}$, $\Sigma_{\text{LENGTH}}$, $\Sigma_{\text{HEIGHT}}$, ...) are all different, unique to each head type, the answers to these questions are all plausibly different as well.

To the best of my knowledge, current work in cartography has offered no answers to such question sets. When discussed at all, the sequence of functional selection relations appears to be left either as a bare fact about Universal Grammar or else treated as one whose ultimate explanation lies the domain of semantics. The first view is exemplified by statements like the following:

“UG expresses the possible items of the functional lexicon and the way in which they are organized into hierarchies” Cinque & Rizzi (2008: 53)

“Comparison of many different languages may provide evidence for determining the precise relative order of the different functional projections by combining the partial orders overtly manifested by different languages into what, in principle, should be a unique consistent order/hierarchy, imposed by UG”

“Conjectures as to the psycholinguistic motivation for [adjective order restrictions] need not be posed: [adjective order restrictions] fall out as a direct consequence of UG.” (Scott 2002: 97)

Although available in principle, this hypothesis clearly amounts to little more than stipulation, and one, furthermore, that emerging psycholinguistic data suggest is not correct. Recent experimental results by Leivada and Westergaard (2018) demonstrate that violations of cartographic orderings are not judged by native speakers to have the character of hard-wired constraint violations, but rather violations of (weak) preference orderings.

What about the second view, then: the idea that functional selection sequences might somehow be deducible from semantics? In modern formal semantics, selection is standardly given in terms of logical or semantic type. An expression of type $<\alpha,\beta>$ selects a phrase of type $\alpha$ to yield a phrase of type $\beta$. This view can be employed to explain the selection between, for example, a functional head like D and its accompanying lexical NP. The two are of appropriate types for combination in the observed way (5a). But this view does not appear adequate to explain, for example, the orderings of left peripheral elements (5b) or the orderings between modifier heads and phrases (5c). In the left periphery, heads select phrases of the type of propositions ($<s,t>$) and they project phrases of the same type ($<s,t>$). In the nominal domain, the heads select phrases of the type of predicates ($<e,t>$) and project phrases of the same type ($<e,t>$). The complements are thus all semantically nondistinct in the formal sense. No orderings are predicted by semantic type.

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1 The first two quotes are drawn from Leivada and Westergaard (2018); the third quote is drawn from Mišmaš, Marušič and Žaucer (2018).
Unless semantic type in the relevant domains comes to be articulated at a much finer level of granularity than is currently entertained, formal semantics seems to offer little hope of explaining cartographic hierarchies.

Informal semantic accounts appear no more promising. Williams (2009) notes the suggestion that functional hierarchies might correspond to ontological mereologies of "eventualities" - for example, speech acts, facts and events, with part-whole relations between them, so that events are part of facts, which are part of speech acts, etc. Given this, one might attempt to explain the acceptable ordering of the adverbs in (6a) versus the unacceptable orderings in (6b-d) via the containment relations in the projections in which the adverbs occur, itself a reflection of ontological part-whole relations (⊆). (6-d = 2a-d in Williams 2009).

As Williams notes however, such an account cannot be maintained in any simple form given examples like (7) (= 2e in Williams 2009), which would exhibit a speech act inside a fact on this account:

Evidently, the ontology applies to ordering within a single clause only, a result which would appear to make the account dependent on grammar and projection, and hence not an independent explanation for it.²

² These results do not foreclose "explanatory" projects with more limited goals. For example, Rizzi (2017)
1.2 The Problem of Plenitude

Capturing linear order via local functional selection relations entails that whenever we have two ordered linguistic elements X, Y (say large and broad) in different projections in a functional hierarchy, we must have all projections between them (8a). "Truncated" projections like (8b) are unavailable:

(8)  a. \([\text{sizeP large [LENGTHP [HEIGHTP [SPEEDP [DEPTHP [WIDTHP wide [NP board]]]]]]}]\) ✓
    b. \([\text{sizeP large [WIDTHP wide [NP board]]}]\) X!!

This is because functional selection is not transitive. If head α functionally selects βP and β functionally selects γP it does not follow that α functionally selects γP. Ordering between X, Y thus can be achieved only through the presence of entire intermediate sequence of heads and projections.³

This point entails that if the highest projection in a hierarchy is selected by a functional element and the lowest head in the functional projection selects some lexical phrase, the entire hierarchy must be present between them, even when no hierarchy elements are overtly realized (7). Broadly put, sentences and phrases must project complete functional hierarchies.

(7) \([\text{DP the [sizeP [LENGTHP [HEIGHTP [SPEEDP [DEPTHP [WIDTHP [NP board]]]]]]]}]\)

As many have noted (see Craenenbroeck 2012 and the references therein), this yields a dramatic proliferation of structure, with a single clause obliged to contain up to 150-200 phrasal projections by some estimates, the vast bulk of which are phonologically unrealized. The worry here is not a vague concern about "too much abstract structure", but rather that this structure is LF uninterpreted or "expletive". This outcome would appear to clash directly with the natural and highly attractive proposal of Chomsky (1995) that syntactic outputs be "fully interpreted" and that the structures presented to LF be "minimal" in the sense of containing only elements that are legible to, and "meaningful"

observes that a left peripheral focus can follow an interrogative head but cannot precede it (ia,b).

(i)  a. Mi domando se PROPRIO QUESTO, volessero dire.  INT > FOC
    'I wonder if EXACTLY THIS they wanted to say.'
    b. "Mi domando PROPRIO QUESTO, se volessero dire.  "FOC > INT
       'I wonder EXACTLY THIS if they wanted to say.'

Rizzi (2017) suggests this contrast is the product of additional relations obtaining within the functional hierarchy; specifically, an agree relation between a FORCE head and INT, with which FOCUS interferes, and a binding relation between FOCUS and its trace, with which INT interferes (iii).

(iii) *Mi domando FORCE PROPRIO QUESTO, se volessero dire __.

  FORCE ---- FOCUS ==> INT -----------------> __

Whether or not this view of INT-FOC ordering relations is correct, it should be clear that it does not extend to adjective and adverbial positioning, where the relevant agree, movement and binding relations do not obtain. Hence Rizzi (2017) does not foreshadow a general explanatory program for cartography.

³ These points do not exclude "truncated projections" altogether. For example, truncation might be possible consisting of a continuous functional sequence from a certain category down. Haegeman (refs) has investigated this possibility in adverbial clauses
at, the LF interface.

1.3 The Problem of Rigidity

Functional selection is not a gradable notion: a head $\alpha$ either does or does not functionally select a phrase $\beta P$. If it does, then the specifier and head of $\alpha P$ must precede all elements of $\beta P$ (modulo displacement). Applied recursively, this point entails that functional selection yields rigid orders.\footnote{Related ordering problems for cartography have been noted in the literature, including "transitivity failures" ($\alpha < \beta$ & $\beta < \gamma \nRightarrow \alpha < \gamma$) and apparent "ordering paradoxes". See Bobaljik (1999), Craenenbroeck (2006) and Nilsen (2003) for discussion.}

In some cases, the hierarchies that have been proposed by cartographers do correspond to rigid ordering judgments by speakers. For example, the functional hierarchy for adjectival modifier heads that yields the ordering $\text{SIZE} > \text{COLOR}$ corresponds to largely categorical judgments like (8a), with the one order good and the other strongly unacceptable. In other cases, however, the proposed orderings correspond to judgments either of weak preference (8b) or virtual fluidity (8c) (Truswell 2009).

(8) a. big red barn $\sim$ *red big barn
b. beautiful big house $\sim$ ?big beautiful house
c. circular red patch $\sim$ red circular patch

Functional hierarchies do not readily accommodate variability or gradability in speaker judgments about acceptable orderings, which occurs in many cases. Again, to the best of my knowledge, cartographers have offered no means to address this fact.

2.0 Linear Orders in Mathematics

Numbers, the canonical case of linear order in mathematics, compare interestingly on the issues discussed above. The integers ($\mathbb{Z}$) exhibit a linear order, which is displayed in hierarchical fashion via the familiar number line (9).

(9) \ldots \quad -5 \quad -4 \quad -3 \quad -2 \quad -1 \quad 0 \quad 1 \quad 2 \quad 3 \quad 4 \quad 5 \quad \ldots

Crucial properties of this domain include the following: each number is related locally to each adjacent number by a relation $\mathcal{R}$. But the relation $\mathcal{R}$ itself is not "local" in the sense that it holds (or fails to hold) pairwise between all numbers on the line and is the same in all cases (i.e., $<$). Furthermore, the relation $\mathcal{R}$ can be independently defined. Assuming a prior characterization of the positive integers $\mathbb{Z}^+$ and a subtraction operation, $\beta \mathcal{R} \alpha$ iff $\alpha - \beta \in \mathbb{Z}^+$.\footnote{See Beckenbach & Bellman (1961) for an accessible account of inequalities.}

Note that in this account, linear ordering among integers is not stated or explained via...
the number line (the "numerical hierarchy"). Rather linear ordering is defined by a single underlying relation $<$ on the domain $\mathbb{Z}$. This has important consequences with respect to the three problems we noted earlier with cartographic linearity. First, in the case of number we know what explains their linear order: it is the relation $<$, which humans cognize and which we can characterize independently of specific number pairs. The "numerical hierarchy" - the number line - is entirely derivative on $<$. Second, since $<$ holds (or fails to hold) pairwise between all integers, we don't appeal to "intermediaries" to explain relations between numbers - we don't say $2 < 5$ in virtue of $2 < 3 < 4 < 5$. Rather $2 < 5$ because $5 - 2 \in \mathbb{Z}^+$. No comparable issue of plenitude arises with numbers. Finally, the ordering of integers is rigid - $\alpha < \beta$ or $\beta < \alpha$ or $\alpha = \beta$ - precisely because one of the following holds: $\alpha - \beta \in \mathbb{Z}^+$ or $\beta - \alpha \in \mathbb{Z}^+$ or $\alpha - \beta = \beta - \alpha = 0$. Rigidity is thus a byproduct of the specific relation $<$ and how it's defined, which implies that other domains organized by other relations need not be expected to show rigidity.

### 3.0 Subjectivity and Adjectival Order

Scontras et al. (2017a) report interesting results from an experimental investigation of adjectival ordering suggesting something like the "mathematical picture" in the adjective domain. In brief, 26 relatively frequent, imageable adjectives from 7 classes (age, color, dimension, material, physical, shape, value) were examined. See Fig-1, reproduced from Scontras et al 2017a.

<table>
<thead>
<tr>
<th>Adjective</th>
<th>Class</th>
<th>Adjective</th>
<th>Class</th>
<th>Noun</th>
<th>Class</th>
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<tr>
<td>old</td>
<td>age</td>
<td>good</td>
<td>value</td>
<td>apple</td>
<td>food</td>
</tr>
<tr>
<td>new</td>
<td>age</td>
<td>bad</td>
<td>value</td>
<td>banana</td>
<td>food</td>
</tr>
<tr>
<td>rotten</td>
<td>age</td>
<td>round</td>
<td>shape</td>
<td>carrot</td>
<td>food</td>
</tr>
<tr>
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<td>age</td>
<td>square</td>
<td>shape</td>
<td>cheese</td>
<td>food</td>
</tr>
<tr>
<td>red</td>
<td>color</td>
<td>big</td>
<td>dimension</td>
<td>tomato</td>
<td>food</td>
</tr>
<tr>
<td>yellow</td>
<td>color</td>
<td>small</td>
<td>dimension</td>
<td>chair</td>
<td>furniture</td>
</tr>
<tr>
<td>green</td>
<td>color</td>
<td>huge</td>
<td>dimension</td>
<td>couch</td>
<td>furniture</td>
</tr>
<tr>
<td>blue</td>
<td>color</td>
<td>tiny</td>
<td>dimension</td>
<td>fan</td>
<td>furniture</td>
</tr>
<tr>
<td>purple</td>
<td>color</td>
<td>short</td>
<td>dimension</td>
<td>TV</td>
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<tr>
<td>brown</td>
<td>color</td>
<td>long</td>
<td>dimension</td>
<td>desk</td>
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<td>wooden</td>
<td>material</td>
<td>smooth</td>
<td>physical</td>
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<td>plastic</td>
<td>material</td>
<td>hard</td>
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<td>metal</td>
<td>material</td>
<td>soft</td>
<td>physical</td>
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<td></td>
</tr>
</tbody>
</table>

Experimenters elicited preference judgments on A-A-N object descriptions from 50 participants. These judgments involved manipulating a slider bar, as shown in (11), reproduced from Scontras et al 2017a:
Simultaneously, Scontras et al. performed a corpus study of attributive A-A pairings using the Switchboard Corpus and the British National Corpus. The preference study and the corpus study were highly correlated (83%), as shown in Fig-3, reproduced from Scontras et al. 2017a.

Scontras et al. (2017a) then performed 2 follow-up experiments intended to probe the perceived subjectivity of a given adjectival concept. The first task simply asked participants to assess subjectivity of an adjective by means of a slider bar (13):

The second task, called "faultless disagreement," asked participants to assess disagreements between two speakers with respect to an adjectival predication, rating whether both speakers could be right or whether one of them had to be wrong. Example disagreements are given in (14):
(14) a. Mary says: “That apple is old.”
Bob says: “That apple is not old”.
b. Mary says: “This desk is metal”
Bob says: “This desk is not metal”.

Presumably the more subjective the adjective, i.e., the more relative to speaker point of view, the more raters would be inclined to accept disagreement without judging one of the parties to be wrong. As indicated in (12) (see subjectivity and faultless), the results for the subjectivity and faultless disagreement tasks were highly correlated, strongly implying that they measure a common factor.

Scontras et al. (2017a) found that ordering naturalness was highly correlated with subjectivity as determined by scores on the subjectivity judgment and faultless disagreement tasks. (15a) plots individual adjectives, where the value on the naturalness scale indicates whether a given adjective prefers the first (value 1) or second (value 0) position in a A-A-N combination. As can be seen, the lower the subjectivity score, the greater the preference of an adjective for second position, closer to N. Subjectivity explained 85% of the variance and faultless disagreement explained 88% of the variance.

Scontras et al also computed results for pairs of adjective classes (e.g., age-color, value-dimension, etc.) to probe for A-A configuration effects. (15b) plots results for the pairings, where the subjectivity score reflects the difference in mean subjectivity score for the classes. Again the subjectivity and naturalness scores are highly correlated (80%). Scontras et al (2017a) also note that "... as the difference in subjectivity approaches zero, the naturalness ratings approach 0.5 (i.e., chance): ordering preferences weaken for adjectives of similar subjectivity (e.g., “yellow square” or “fresh soft”)" (p.58).

(15) a. b.
Scontras et al (2017a) expanded their experiment to a larger class of adjectives (78) and a larger subject pool to rate naturalness (495). They also recruited a larger pool of subjects (198) to rate subjectivity and faultless disagreement. The results were essentially the same. Scontras et al. (2017b) report adjectival ordering results based on some alternatives to subjectivity, for example, adjective inherentness (how essential an A's meaning is to N it modifies), intersective vs. subjective modification (the mode by which A composes with the N it modifies), and concept formability (whether A composes with N to form a complex, idiomatic concept). In all cases, they found subjectivity to be a better predictor of adjectival order.

The results of Scontras et al (2017a,b) on linearity in the adjectival domain are strongly reminiscent of what we observed with linearity in the numerical domain. Thus there appears to be a single "inequality" relation that speakers can judge between APs: \( \leq_{\text{SUBJ}} \). This relation induces an order on the whole domain of AP property classes (size, length, etc.). Speakers appear to make use of \( \leq_{\text{SUBJ}} \) in syntactic projection in the sense that their ordering preferences seem to reflect \( \leq_{\text{SUBJ}} \).

This in turn suggests an account of adjectival ordering that would avoid the three problems facing the cartographic account. Specifically, we would have some handle on what explains AP order, namely, the relation \( \leq_{\text{SUBJ}} \), which humans cognize and which we can characterize independently of specific As. The hierarchy of projections would be derivative on \( \leq_{\text{SUBJ}} \). Furthermore, since \( \leq_{\text{SUBJ}} \) holds pairwise between AP classes, we needn't appeal to "intermediaries" to explain order - we don't say large precedes wide because Size precedes Length precedes Height precedes Speed precedes Depth precedes Width. Rather large precedes wide because Size \( \leq_{\text{SUBJ}} \) Width. There is no issue of plenitude. Finally, and very importantly, adjectival ordering is predicted to be only as rigid as \( \leq_{\text{SUBJ}} \) determines. For adjectives A1, A2 whose subjectivity is judged equivalent (A1 \( \approx_{\text{SUBJ}} \) A2), we predict fluidity. Hence we obtain some grasp on gradability in ordering judgments.

It is unclear how one could incorporate these results into cartography and cartographic hierarchies as currently formulated. Consider a principle P of selection like the following:

\[
16) \quad P: \; X \text{ selects } YP \text{ if } Y \text{ is lower wrt } \leq_{\text{SUBJ}}.
\]

Observe that the notion of selection here cannot be functional selection since it is not category specific. In fact P just seems to restate the subjectivity ordering facts, attempting to import them into the selection concept. Can we implement something more like the "mathematical view" of linearity in a different more theoretically natural way?
4.0 Projection from Ordered Feature-Sets

Cartography "explodes" traditional heads like CP and AP (17a,b) in a two-step move. First, it identifies a set of features representing (essentially) subcategories of the relevant domain. Then it analyzes each feature as constituting a separate head of its own projection, organizing projections into a cartographic hierarchy.

\[
\begin{align*}
\text{(17) a. C} & \quad \downarrow \downarrow \downarrow \downarrow \downarrow \downarrow \downarrow \\
& \quad \{\text{FORCE}, \text{TOP}, \text{FOC}, \text{TENSE}, \ldots\} \\
\text{AP} & \quad \downarrow \downarrow \downarrow \downarrow \downarrow \downarrow \downarrow \\
& \quad \{\text{SIZE}, \text{LENGTH}, \text{HEIGHT}, \text{SPEED}, \text{DEPTH}, \text{WIDTH}, \ldots\} \\
\end{align*}
\]

However by separating the features into independent heads this way, the theory yields no way of ordering them via a single relation.

4.1 The Basic Proposal

I wish to suggest an alternative way of conceptualizing cartographic projection. I propose to retain the set of features identified by cartographers, but instead of projecting them as independent heads, organize them as feature sets born by unexploded heads H, where these sets are ordered by a relation $\leq_R$ (18):

\[
\begin{align*}
\text{(18)} & \quad \begin{align*}
\text{H} & \quad \downarrow \downarrow \\
& \quad \{\text{F1}, \text{F2}, \text{F3}, \ldots\} \\
& \quad \{\{\text{F1}, \text{F2}, \text{F3}, \ldots\}\} \\
\end{align*} \\
& \quad \{\text{F1} \leq_R \text{F2} \leq_R \text{F3}\}
\end{align*}
\]

I propose that we then align projection order of phrases with feature order via agreement as shown in (19):

\[
\begin{align*}
\text{(19) a. HP} & \quad \text{ALIGNMENT: Agree features in order from lowest ranked to highest ranked} \\
\text{b. HP} & \quad \\
\text{c. HP} & \quad \\
\end{align*}
\]

To give a potential example that I will later modify, suppose one viewed adjectival features as specifying potential attributes of nouns, so that Ns are their appropriate bearers. Then we might view projection of attributive As as shown in (20a-d):
(20) a. 

\[
\text{NP} \quad \text{gray mouse} \\
\quad \{[\text{COLOR}]/[\text{MAT}],[\text{SIZE}]\}
\]

b. 

\[
\text{NP} \quad \text{furry mouse} \\
\quad \{[\text{COLOR}]/[\text{MAT}],[\text{SIZE}]\}
\]

c. 

\[
\text{NP} \quad \text{small furry mouse} \\
\quad \{[\text{COLOR}]/[\text{MAT}],[\text{SIZE}]\}
\]

d. 

\[
\text{NP} \quad \text{small furry mouse} \\
\quad \{[\text{COLOR}]/[\text{MAT}],[\text{SIZE}]\}
\]

ORDERING: 

\([\text{COLOR}] \approx \text{SUBJ} \quad [\text{MATERIAL}] < \text{SUBJ} \quad [\text{SIZE}]\)

Note the crucial role played by the feature set: the ordering in the set resident on N organizes projection order of the attributive adjectives in NP. Note further that if two adjective classes are of equal subjectivity, so that their features are mutually unordered (for example, \([\text{MATERIAL}]/[\text{COLOR}]\)), we would expect projection to reflect this insofar as either order would become available (20c,d). Rigidity (or lack thereof) in the feature ordering would reflect itself in rigidity (or lack thereof) in the projection order.

4.2 A Revision

Although attractive in broad respects, there is a technical problem in the picture just sketched. Observe that in (19b) \([F\text{2}]\) agrees with \(H\) across a closer \([F\text{1}]\) of the same featural type as \([F\text{2}]\); similarly for \([F\text{3}]\) in (19c). Plausibly this situation represents a violation of Relativized Minimality as articulated by Rizzi (1990), which prohibits a more distant syntactic relation between an element \(X\) and an element \(Z\) in the presence of closer potential relation between \(X\) and an element \(Y\) (21).

(21) 
\[
[X \ldots [\ldots Y \ldots [\ldots Z \ldots ]]]
\]

One way of resolving the Relativized Minimality problem is by interpolating "light heads" in the derivation, so that in place of (19a-c) we have (22a-d). Observe crucially that in step (22b) we merge a light head \(h\) of the same phrase type as \(H\). \(h\) then attracts \(H\) (22c), which in turn allows \(\beta\) to agree with \(H\) without intervention by \(\gamma\) (22d).
Merger of the remaining \( \alpha \) would involve the same sequence of light head merger, followed by raising of \([h, H h]\), followed by agreement on \([F3]\).

As it turns out, this proposal has a near-perfect execution within the feature theory of Pesetsky and Torrego (2007), which postulates a three-way division in feature instances:

(21) a. \( \text{interpretable} \) F, associated with a “meaning”
    b. \( \text{valued} \) F, associated with visible marking/pronunciation
    c. \( \text{uninterpretable-unvalued} \) F, concordial

Assume the relevant features are interpretable on "arguments" of H (\( \alpha \), \( \beta \), \( \gamma \)), are valued on H and h (\(@\) one valuation per head), and are uninterpretable-unvalued otherwise. Assume also that all interface-legible features must include a valued and an interpretable instance. Finally, assume that it is unvalued features that initiate agreement under c-command.

Under these assumptions, (22a-d) can be recast as (23a-d), where we have now inserted appropriate feature instances, and where each instance of agreement is initiated by a c-commanding unvalued feature.
This sequence of operations would be repeated for \( \alpha \).

### 4.3 Projecting Adjectival Modifiers Again

This revised view of projection has the interesting consequence of excluding an analysis like (20a-d) where adjectival features are resident on a lexical N. Because the derivation in (23a-d) requires successive head raising, such an analysis would yield incorrect surface word order for nouns and attributive adjectives in which all but the initial adjective in a sequence would appear postnominally (24).

(24) A N A A
small mouse furry mouse grey mouse.

An alternative discussed by Larson (2014) and Larson and LaTerza (2017), and ultimately going back to Smith (1968), is to take D/d as the syntactic head bearing modifier features. Developing ideas from Generalized Quantifier Theory (Barwise and Cooper 1981 Keenan and Stavi 1986), Larson (2014) proposes that quantifiers in general bear two selection features \([\text{RES}]\) for "restriction" and \([\text{SC}]\) for "scope", where the latter is ordered below the former. Suppose that adjectival features are ordered by the subjectivity relation and arranged between \([\text{RES}]\) and \([\text{SC}]\). Then we can recast the initial sets of (20) as in (25).

(25) a. Merge D-NP

b. Merge d[COLv]

c. Raise D
Repeating this sequence of operations for the adjective *small* and for the *Pro* subject of *dP* (discussed in Larson 2014) we arrive at the result in (26a). The latter exhibits broad congruence to a more standard cartographic tree (26b). However there are crucial differences of detail.

(26) a. 

First, in (26b) the adjectival features \([\text{DIMENSION}]\) and \([\text{COLOR}]\) constitute separate functional heads standing in separate functional selection relations to their complements. In (26a), by contrast, the corresponding heads are all d’s and only a single functional selection relation is involved: d f-selects dP/DP.

Second, in (26b) ordering of projections must be stated through the distinct functional selection relations, as we have noted. In (26a), projection ordering is through the feature-set resident on D and by the constraint on agreement.

Third and finally, note that in (26b) DimensionP and ColorP must be situated within the entire functional heirarchy of adjectival projections (represented by the triangles). By contrast in (26a), the D head bears a subset of the adjectival feature set, and only those
features appearing in the subset are projected. No other adjectival projections are present, even covertly. (26a), but not (26b), thus has the "minimalism" discussed earlier in connection with the LF interface.

4.4 Projecting the Left-Periphery

The strategy pursued above for recasting cartographic adjectival projection can be extended to the full range of cartographic domains. The three basic technical moves are the same in all cases:

- Recast the relevant f-hierarchy as a feature set $F = \{[F_1], [F_2], [F_3], \ldots\}$,
- Replace cartographic f-heads with a single head $h/H$ relevant to the domain and bearing subsets of $F$,
- Establish an independent ordering relation $\mathcal{R}$ on $F$: $[F_1] \preceq \mathcal{R} [F_2] \preceq \mathcal{R} [F_3] \preceq \mathcal{R} \ldots$, generalizing the results of Scontras et. al.

I will briefly illustrate this general strategy for the cartography of left-peripheral projections, an area of inquiry initiated by Rizzi (1997), who offered the structure in (27).

\[(27)\]

Here the topmost projection (ForceP) is understood to be the locus of the illocutionary force features selected by higher predicates: declarative, interrogative, exclamative, etc. Beneath ForceP are projections for Topic and Focus, where TopP must apparently be available both above and beneath FocP, given Italian example pairs like (28a,b) where they appear in either order.\(^6\)

\[(28)\] a. Credo che a Gianni, QUESTO, gli dovremmo dire domani.

'I believe that to Gianni, THIS, we should say tomorrow.'

\(^6\) Rizzi (1997) proposes that the Top projections in (27) are recursive, allowing (in principle) any number of topics above or below FocP. However Beninca and Puleo (2004) argue forcefully against this view, and for a yet more finely articulated picture of the relevant domains.
b. Credo che **QUESTO, a Gianni**, gli dovremmo dire domani.

Finally, FinP is the locus of features associated with finiteness, nonfiniteness and subjunctivity.

In line with the above discussion, we may rework this picture as follows:

- Recast Rizzi's cartographic f-hierarchy for the left-periphery as the feature set \( \mathbb{L} = \{[\text{FIN}], [\text{TOP}_2], [\text{FOC}], [\text{TOP}_1], [\text{FOR}]\} \).
- Replace Rizzi's cartographic f-heads with a single head. Here I adopt the proposal of Banfield (1973) that the left periphery is the domain of the category E/e (for "expression").
- Assume a single ordering relation \( \mathcal{R} \) on \( \mathbb{L} \) yielding
  \[
  [\text{FIN}] \leq_{\mathcal{R}} [\text{TOP}_2] \leq_{\mathcal{R}} [\text{FOC}] \leq_{\mathcal{R}} [\text{TOP}_1] \leq_{\mathcal{R}} [\text{FOR}]
  \]

On the revised view, the left periphery will be generated by E heads bearing subsets of \( \mathbb{L} \), projected along the same lines as in (25) above.

To give an example, Rizzi (1991) proposes that interrogative *why* is generated directly in its left peripheral position as a specifier of ForceP whereas other *wh*’s are moved there from within the clause. To derive examples like *why Max left* and *who left* we will assume an E head bearing \{[FIN],[FOR]\}. We will also assume (plausibly) that [FIN] is interpretable on the T head of TP and that [FOR] is interpretable on *wh*-phrases.

In the case of *why Max left* (29a) the derivation goes as in (29b-d). The finite TP is built up with a T head bearing \([\text{FIN}]\). E bearing \{[FIN],[FOR]\} then merges first with TP since \([\text{FIN}] \leq_{\mathcal{R}} [\text{FOR}]\) (29b). To value [FOR] the little e head \( e_{[\text{FOR}]} \) is merged. \( e_{[\text{FOR}]} \) raises the E head and agrees with it on [FOR] (29c). Finally, wh- *why* is externally merged, agreeing on [FOR] (29d). Notice that both \([\text{FIN}]\) and [FOR] now have interpretable and valued instances linked by agreement, hence the structure if LF legible.

(29) a. \( e_P \text{ why Max left} \]

\[
\begin{array}{c}
\text{E} \\
\{[\text{FIN}],[\text{FOR}]\} \\
\text{TP} \\
\text{Max T leave} \\
\text{[FIN]} \\
\end{array}
\]

\[
\text{Merge E & TP Agree [FIN]}
\]
The derivation for *who left* (30a) is virtually the same except that who bearing interpretable [FOR] is merged in TP. When E merges with TP it can thus agree both features with the corresponding TP-internal elements. To value [FOR] e_{FORv} is again merged, raising the E head and agrees with it on [FOR]. Now e_{FORv} agrees with E which agrees with who. By transitivity, e_{FORv} agrees with who. The light head may then activate its edge feature, raising who to its specifier where it agrees on [FIN] (30b). Note again that both [FIN] and [FOR] have interpretable and valued instances linked by agreement, hence the structure if LF legible.

(30) a.  [eP who who left]

b.  [who [iFOR]
    eP e'

    e E
    [FORv] ([FIN],[FOR])

    E
    ([FIN],[FOR])

    TP

    Max T leave

    [iFIN]

As in the case of attributive modifiers, the central organizing element in these derivational scenarios is the feature set, whose respective ordering fixes the order in which phrases are merged in structure.
5.0 Conclusion

Proceeding in the way urged above would analogize the cartographic project in syntax to the most successful cartographic project yet executed in linguistics, namely, universal phonetics. The familiar "cartography of human vowels" is a vowel space known to be determined by extra-linguistic anatomical, perceptual, gestural and acoustical factors. The linguistic system digitizes this space with features, identifying perceptually salient, acoustically stable, gesturally replicable feature-bundles as segments. Feature relations (front/central/back) reflect the extra-linguistic organization.

The results of Scontras et. al. suggest a comparable extralinguistic, cognitive space of attributes associated with entities organized according to whether they pick out objective, factual properties of things vs. subjective properties, plausibly an important attention space for creatures concerned with reality. The linguistic system digitizes this attribute space with features, identifying stable bundles of these features as modifier concepts. The relations between these features - their ordering - reflects extra-linguistic organization, here the subjectivity relation. Under the broader project these results suggest, a key aim for "cartography" becomes identification of the key cognitive relations underlying the features and feature orderings found in the major projections. Doing so would hold out the prospect of a genuinely explanatory cartographic project, one that current approaches, by their reliance on notions like functional selection, appear unlikely to achieve.

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