Morphological Variation, Symmetry Breaking and Reduction of Complexity

4th Lecture

Anna Maria Di Sciullo
UQAM

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Outline

1. Diachrony and morpho-syntactic complexity
2. Models of language development and change
3. Symmetry breaking and the development of P
4. Complexity reduction in phylogeny
1. **Diachrony and morpho-syntactic complexity**

The language faculty is stable. Languages vary because of contact with the environment. The variation is the consequence of a change in the properties of features.

Diachronic variation is gradual and it may bring about morphological complexity giving rise to differences in the form and in the distribution of morphological elements (prepositions, postpositions, adpositions, circumpositions).

We will discuss diachronic evidence from Indo-European languages showing that symmetry breaking reduces the complexity that arises in the development of functional elements. See Di Sciullo (2014) for further discussion.

(1) \[Quniv \ldots [Dem \ldots [Numord \ldots [RC \ldots [Numcard \ldots [Cl \ldots [A \ldots NP]]]]]]\]  
\quad (Cinque 2005)

(2) CPlace - DegPlace - Place - Ploc - DP  
\quad (den Dikken, to appear, Koopman 2000)

(3) \(p\) - Deg - Deix - Loc - AxPart - K – DP  
\quad between -near- - besides -  
\quad (Svenonius 2013)
Three cases

- multi-functional -esimo
- supplementary a-
- unstable cum/co
1.1 -esimo

The multi functional –esimo diachronic development.

From Latin –esimus (masc.) gave rise to the –esimo (It) –ième (Fr) in ordinals, e.g. ventesimo (It), vingtième (Fr)

In Vulgar Latin *metipsimus* is formed of met (ego), ipse (self focus) and -issimus (superlative). *The* Roman-Latin *medisime* gave rise to medesimo in Italian, meïsme and mesme in Old French, to mismo in Spanish and to mesmo in Portuguese.

(4)

```
         Numord  Adj  N
-esimus  -issimus  -esimo
         -esimo  SM
```

From Latin –esimo (identical form in masc. and fem.) derived complex N from N: protestante, protestantesimo
-esimo in ordinal numbers

Language variation

-Cardinals
  Lexical numbers and complex numerals

  ![Diagram of complex numeral structure]

-Ordinals
  Based lexical / complex numerals
  Based on complex numerals

<table>
<thead>
<tr>
<th>Ordinal</th>
<th>Italian</th>
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<tr>
<td>first</td>
<td>primo</td>
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<td>second</td>
<td>secondo</td>
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<td>third</td>
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<td>eighth</td>
<td>ottavo</td>
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<tr>
<td>ninth</td>
<td>nono</td>
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<tr>
<td>tenth</td>
<td>decimo</td>
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<tr>
<td>eleventh</td>
<td>undicesimo</td>
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<tr>
<td>twelfth</td>
<td>dodicesimo</td>
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<td>thirteenth</td>
<td>tredicesimo</td>
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</tbody>
</table>
In Italian, the merger of -esimo with a complex cardinal yields an ordinal number.

undic-esimo, …vent-esimo, … mill-esimo, … million-esimo, …

Si tratta dell'ennesimo dramma di una lunga serie.

‘It is the umpteenth drama in a long series.’
-esimo in adjectives

The merger of esimo with med yields an emphatic identity adjective, as the examples in (5)-(8) illustrate.

(5) medesimo, medesima, medesimi
   ‘same sg’, ‘same fem sing’, same pl’

(6) Mi ha detto le medesime cose.
   ‘He told me the same things.’

(7) Il presidente medesimo era presente
   ‘The president EMPHATIC was present.’

(8) Il presidente era il medesimo.
   ‘The president was the same one.’
Ordinal numbers and adjectives in Italian

The ordinal number, the adjective and the pronoun have a binary branching structure and include a multifunctional affix structure

Complexity reduction: Minimize externalization (SM)

- *esimus*     - *issimus*     - *esimo*

- *esimo*
1.2 Supplementary a in Italian

There is variation in the pronunciation of the preposition a ‘at’ in functional words denoting locations and directions in Italian dialects, including Fallese, a dialect spoken in Abruzzi (Catinella, 1998) and Piemontese.

The supplementary a in Fallese is a morphological remnant of Latin ad/ab PP structures. Not present in Italian.

(9) a. addo (Fa)  (10) a. *achi (Fa)
    b. dove (It)         ‘who’
   ‘where’
    b. *ache
    ‘what’
    c. *aquale
    ‘which’
    d. *aquand
    ‘when’
    e. *aquant
    ‘how much’
    f. *apeche
    ‘why’
Locative prepositions

In Latin, when a complement expresses not the place itself but the proximity of a place or a person, it is preceded by a preposition, *ab, ad, or apud* ‘to, toward, near’.

In Fallese the prefix *a-* is part of complex prepositions, whereas this is not the case for their Italian (It) counterparts, (11)-(12). This suggests that supplementary *a-* in Fallese could be the remnant of the Latin locational preposition *ad*.

(11) a. ammonde (Fa)  
    b. ad montem (Lat)  
        at hill ‘upward’  
    c. in salita (It)

(12) a. abballe (Fa)  
    b. ad vallem (Lat)  
        at valley ‘downward’  
    c. in basso (It)
Other functional categories

Supplementary \( a \)- in functional categories other than prepositions, wh-words, deictic determiners, adverbs:

(13) WH-P
   a. addo (Fa)   b. ad ubi (Lat)   c. dove (It)
   at where ‘where’
   b. aqquande (Ar)   b. ad quando (Lat)   c. quando (It)
   at when ‘when’

(14) DEM
   a. aecche (Fa)   b. ad ecce (Lat)   c. qui (It)
   at here ‘here’
   b. aell   b. ad illic   c. li (It)
   at there ‘there’

(15) ADV
   a. accusci (Fa)   b. eccu sic (Lat)   c. cosi (It)
   it is so ‘thus’
   b. allore   b. ad hora(m)   c. allora (It)
   at this ‘then’
Other dialects

Supplementary a- is expected to be found in other dialects in similar structures. This is the case in Piemontese (Brero 1975, Gribaud 1983)

(16) Wh-P
    ando (Pie)      dove (It)      ou (Fr)
    ‘where’

(17) PP
    abass (Pie)    in basso (It)  abbasso (Fa)  en bas (Fr)
    ‘down’

(18) Adv
    ancheuj (Pie)  oggi (It)      aujourd’hui (Fr)
    ‘today’

Complexity reduction: Minimize externalization (SM)
    pronounce the minimum
1.3 Comitative co-pronominal complement

Latin is prepositional, Old Italian is also postpositional and circumpositional. Modern Italian is prepositional: *cum me, me cum, meco, con meco, con esso meco, con me*, as evidenced in Di Sciullo, Nicolis & Somesfalean (2014).

We proposed an account of the diachonic change in terms of the interaction of the computational procedure of the language faculty with principles reducing complexity:

*Directional Asymmetry Principle (DAP).*
Language development is symmetry breaking. (Di Sciullo 2011)
The P shell

We proposed an account for this variation in terms of a P-Shell structure, which we take to be the minimal structure for functional categories, as in Di Sciullo (2000, 2005). The lower and the higher heads of the P-Shell host formal features, valued features as well as unvalued features, including Case features. The pronominal complement may occupy different position in the P-Shell, linked to the sister of the lower P head.

\[
\text{cum me, me cum, meco, con meco, con esso meco, con me}
\]

Latin__________ Old Italian ____________ Modern Italian
Explaining the phenomenon

Diachronic changes can be explained in terms of the interaction of the grammar internal pressure imposed by the initial position of the P head, on the one hand, and, on the other hand, by principles of efficient computation.

Complexity may arise from experience (language acquisition, language contact, pragmatic factors, etc.) giving rise to choice points (symmetry) in functional feature structure, with the consequences of enlarging the set of possible derivations. Principles of parsimony, falling into the third factor, will eliminate the complexity by breaking the symmetry brought about by experience.

Principles of efficiency are deep rooted in the human cognitive system and act as soon as possible in language acquisition. Their effects are however gradual in language diachronic development, as environmental dynamics is not deterministically driven by genetic determinism.
Directional Asymmetry Principle

Evolutionary developmental universals emerge in language historical development in terms of the Directional Asymmetry Principle (DAP). According to the DAP, Language development is symmetry breaking. (Di Sciullo 2011)

The DAP targets properties of relations, (33), between features, (34), and structures, (35).

(33) \( R(a,b) \land R(b,a) \rightarrow R(a,b) \)

(34) \textit{Valued/Unvalued Feature Constraint (V/UFC)}
In a functional feature structure \( F \), \([F[F][uF]]\), where \([F]\) and \([uF]\) are symmetrical with respect to \( F \), the symmetry will tend to be broken in language development.

(35) \textit{Head Initial/Final Constraint (HI/FC)}
In a configuration \([X X YP]\), where \( X \) is a head and \( YP \) is its complement, if both \(<X, YP>\) and \(<YP, X>\) are possible SM linearizations, only one linearization will tend to survive in language development.

The DAP is not a global principle on the development of languages. It is a local principle applying to micro feature structures within languages, for example the fluctuation in the position of the pronominal complement with respect to its comitative prepositional head. Once the asymmetrical stage it attained in a given micro structure, symmetry may reappear within that micro structure. The DAP predicts that the symmetry will gradually be eliminated.

The DAP and the Models of language variation

Macro parameters
Minimalism and micro parameters

Phylogenetic stable states
Phylogenetic dynamic states
Macro parameters

Principles and Parameters Model
Parameter : option left open in the principles of UG
Macro parameters
  - Head directionality parameter
  - Pro-drop parameter
  - Bounding nodes
  - Polysynthesis parameter
Micro parameters

Open questions
- Are there restrictions on possible parameters? (limited set?)
- Are all parameters binary? How many are there?
- Which parameter setting algorithm is correct?
- Are there any biological correlates?
Micro parameters

Minimalist program (Merge and the computational procedure of feature valuing)
Parameters reduce to abstract properties (features) of functional elements
Unified approach to variation between languages and dialects

Demonstratives (Dem) are universally generated in a ‘low area’
of the DP (D Gen1 Adjs Dem Gen2 NP) and different movements
(parameter 1- 4) derive the different positions of Dem cross-linguistically
(Longobardi and Guardiano 2009)

Par 1: - Strong deixis (Dem moves to Spec DP to check deixis)
Par 2: - Strong locality (Dem moves to Spec DP to check deixis and locality)
Par 3: - DP over Dem (Dem moves to the Spec DP, DP moves to its left periphery)
Par 4: - D(person)-licensing Dem (Dem and the article never co-occur in Spec DP)
### Table A

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<th>Fr</th>
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<td>+</td>
<td>+</td>
<td>+</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<td>-</td>
<td>-</td>
<td>-</td>
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<td>-</td>
</tr>
</tbody>
</table>

**Micro parameters**
**Phylogenetics**

**Based on lexical properties**  
(Gray and Atkinson 2003; Pagel, Atkinson, and Meade 2007)  
Language taxonomy based on word cognates.

**Based on abstract syntactic properties**  
(Longobardi and Guardiano 2009)

Parametric syntax serves phylogenetic purposes better than lexical methods.

Languages and dialects are more closely related than what it might appear from the classifications based on lexical items.
**Phylogenetics stable /dynamic states**

**Based on stable states**
Languages with dominant VSO order are always prepositional. With overwhelmingly greater than chance frequency, languages with normal SOV order are postpositional. (Greenberg’s Universals)

**Based on dynamic states**

(A)symmetry based syntax serves phylogenetics purposes from a dynamic viewpoint.

Symmetry-breaking comparison method displays the advantages of phase transition dynamics.

Languages and dialects are more closely related than what it might appear from the classifications based on stable states.
Symmetry, antisymmetry, asymmetry

Properties of relations, including symmetry and asymmetry are used in biology, physics and linguistics to describe the properties and the dynamics of natural systems.

- In linguistics, properties of relations have been shown to contribute to our understanding of linguistic phenomena.

  Kayne 1994, *The Antisymmetry of syntax* (a)
  (LCA: c-command and linearization)
  Moro 2000, *Dynamic Antisymmetry* (b)
  (symmetry breaking and displacement)
  Di Sciullo 2005, *The Asymmetry of Morphology* (c)
  (asymmetry and preservation)
Symmetry breaking, which may occur at multiple levels, is a prevalent process in biology, because organismal survival depends critically on well-defined structures and patterns at both microscopic and macroscopic scales.

Symmetry breaking at the sub-cellular level can lead to the establishment of a persistent for such processes as cell division, cell fusion, and axon specification.

Symmetry breaking is a result of the interplay between the system dynamics and the internal or external cues that initiate and/or orient the eventual outcome. (Thompson 1942).
In evolutionary developmental biology, symmetry-breaking is a core aspect of evolution and change in different species (Graham, Freeman & Emlen 1999; Palmer 1996, 2004; Palmer & Lowentin 2004).

Phylogenetic patterns of variance in the evolution of bilateral asymmetric species:
Symmetry > fluctuating asymmetry > directional asymmetry (Palmer)

Development & evolution of claw asymmetry in fiddler crabs (Uca)
Phenotype-leads mode of evolution (genetic assimilation)
Palmer (Science 2004, Current Biology 2009)
Summary of Part 2

- Computational procedure of the LFN + experience + Factors reducing complexity
- Open questions in our understanding of language variation
- The DAP and dynamic models of phylogeny
3. Predictions

*DAP and the development of P*

Two predictions of the DAP developmental constraint:

A: Stable state / Directional asymmetry should be synchronically widespread.

B: Oscillation / Fluctuating asymmetry should characterize older diachronic stages.

Both predictions are borne out for the development of P and its DP complement.

(Di Sciullo 2012, 2013; Di Sciullo and Nicolis 2012)
Prediction A for P
Stable state / Directional asymmetry should be synchronically widespread
(De Sciullo & Nicolis 2012)

<table>
<thead>
<tr>
<th>Study</th>
<th># lgs</th>
<th>Pr</th>
<th>Po</th>
<th>Pr / Po</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greenberg (1963)</td>
<td>30</td>
<td>16</td>
<td>14</td>
<td>0</td>
</tr>
<tr>
<td>Greenberg (1963) appendix II</td>
<td>142</td>
<td>63</td>
<td>79</td>
<td>0</td>
</tr>
<tr>
<td>Hawkins (1983)</td>
<td>336</td>
<td>148</td>
<td>188</td>
<td>0</td>
</tr>
<tr>
<td>WALS (queried 2011)</td>
<td>1185</td>
<td>512</td>
<td>577</td>
<td>58</td>
</tr>
<tr>
<td>SSWL (queried 2011)*</td>
<td>97</td>
<td>70</td>
<td>31</td>
<td>13</td>
</tr>
</tbody>
</table>

Order of Adposition and Noun Phrase (WALS)
- Postpositions: 577 languages
- Prepositions: 512 languages
- Inpositions: 8 languages
- No dominant order: 58 languages
- No adpositions: 30 languages
- 1185 languages
The predictions A and B are validated on a number of languages closely related to Proto-Indo-European.
**Prediction B for P:**

*Fluctuation should characterize older diachronic stages*

*(Di Sciullo & Nicolis 2012)*

<table>
<thead>
<tr>
<th>Language/time</th>
<th>Dominant</th>
<th>Fluctuat. asym.</th>
<th>Direct. asym. in later stages/derived lgs</th>
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</thead>
<tbody>
<tr>
<td>Old 17th-16th c. BC Hittite</td>
<td>Po</td>
<td>Yes</td>
<td>Yes: New Hittite (14th-13th c. BC): PostP only</td>
</tr>
<tr>
<td>Techarian A (3.2)</td>
<td>Po</td>
<td>Yes</td>
<td>? No languages derived from Tocharian</td>
</tr>
<tr>
<td>Techarian B (3.2) 5th-8th c. AD</td>
<td>Po</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Old Armenian (3.3) 5th–9th c. AD</td>
<td>Po</td>
<td>Yes</td>
<td>Yes: Modern Armenian (Po, few relics of prepositions)</td>
</tr>
<tr>
<td>Homeric Greek 1000-800 BC</td>
<td>Pr</td>
<td>Yes</td>
<td>Yes: Modern Greek (fully Pr);</td>
</tr>
<tr>
<td>Albanian</td>
<td>Pr</td>
<td>No (Pr only)</td>
<td>Yes: Modern Albanian (Pr)</td>
</tr>
<tr>
<td>Old Persian from 2nd millen. BC</td>
<td>Po: Cuneiform Persian: Younger Persian Pr: Coptic Pr: Younger Avestan</td>
<td>Yes</td>
<td>Yes: Persian (PreP only) No: Pasho (still mixed, both PreP and PostP attested)</td>
</tr>
<tr>
<td>Indo-Aryan Vedic Sanskrit 1200BC</td>
<td>Po</td>
<td>Yes</td>
<td>Yes: Hindi (fully PostP)</td>
</tr>
<tr>
<td>Old Slavic</td>
<td>Pr</td>
<td>Yes</td>
<td>Yes: Czech, Serbian, Bulgarian No: Russian</td>
</tr>
<tr>
<td>Old Germanic</td>
<td>Pr</td>
<td>Yes?</td>
<td>Yes: Germanic (Pr only)</td>
</tr>
<tr>
<td>Latin</td>
<td>Pr (very strongly)</td>
<td>Yes?</td>
<td>Yes: Romance (Pr only)</td>
</tr>
<tr>
<td>Celtic</td>
<td>Pr</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Summary

The predictions A and B for our hypothesis for the development of P are validated on a number of languages closely related to Proto-Indo-European.

The diachronic development of languages displays a phase of fluctuation where a complement may precede or follow its P head; this is true even for languages which display a clear preponderance of prepositions or postpositions. (Hewson and Bubenik 2006; Friedrich 1975).

As evidenced in Di Sciullo & Nicolis (2012), there is a clear diachronic tendency towards the gradual elimination of a fluctuating state and the development of a stable state, in the Indo-European diachrony:

- Homeric Greek > Classical Greek > Modern Greek
- Latin > Umbrian > Old Italian > Modern Italian
- Old English > Early Modern English > Modern English
4. Complexity reduction in phylogeny

Why would there be a bias favoring prepositions instead of postpositions in the diachronic development of P in the languages under consideration?
Pre-positions and postpositions

The fluctuation between pre- and post- nominal positions wrt a functional head may follow from the availability of both a valued and an unvalued [D] feature for the functional heads F and P dominating D. Only the [uD] feature of F is checked in the case of prepositions, whereas the [uD] feature of P would also be checked in the case of post-positions.
Factors reducing complexity

Principles external to the Language Faculty
Part of other cognitive systems of the brain / natural world

Derivational:
- Reducing the computational load
  - Shortest derivation (Kolmogorov 1965)
  - Fodor, Bever & Garrett (1974)
- Limiting the search space
  - Derivation by phases, Minimal search, etc.
  - (Chomsky 2000, 2005, 2008)

Representational:
- Reducing the computational load of the interfaces
  - Pronounce the minimum (SM) (Chomsky 2011)
  - Syntax-semantic transparency thesis (CI) (Chierchia 1985)
- Limiting the set of possible acquirable grammars and language variation
  - (Yang 2002, Niyogi 2006, Niyogi and Berwick 2009)

Dynamics of complex systems:
- Symmetry breaking in phylogeny (DAP) (Di Sciullo 2011-2013)
Summary

We proposed a developmental universal relying on symmetry-breaking and tested its empirical predictions. As predicted a fluctuating symmetry (choice point) can be observed in the diachrony of the languages in consideration and tends to be gradually reduced. Generally, the surviving derivations are shorter than the ones that were eliminated. This brings further justification to the hypothesis that symmetry breaking is part of the factors reducing complexity.
Further questions

Most languages go through a stage of fluctuation. Most predominantly prepositional languages remained prepositional after the fluctuation (Greek, Latin, Germanic).

Some predominantly postpositional became prepositional after fluctuation (Persian)

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A) Why is it the case that the fluctuation is still ongoing in some languages?
   (Russian, Chinese, Pashto)

B) Why are there languages with postpositions at all?
   (Hittite, Hindi)
Questions A and B

A) Why is it the case that the fluctuation is still ongoing in some languages ((Russian, Chinese, Pashto) ?
Notice that this does not goes against our theory, which does not treat fluctuating asymmetry as banned by grammar, but rather considers it computationally more costly than directional asymmetry. What we predict is that a switch from fluctuating to directional asymmetry is complexity reducing and thus likely to happen.

To exemplify, consider the possibility of expressing the notion of movement along a path by means of either a postposition ta “for” or a preposition pə “by”.

a. …melma to guests for
   b. pə lār (Pashto) by road

“[they are preserving X] for the guests” “by the road”

B) Why are there languages with postpositions at all?
Some predominantly postpositional languages remained postpositional after fluctuation (Hindi). Why is this the case ?

Greenberg’s Universal no 4: languages with normal SOV order are postpositional.(e.g. Hindi, Turkish, Finnish, Hindi, Korean, Hungarian), and VSO languages are always prepositional (Welsh, Classical Arabic, Tagalog).

Middle-Late-New Hittite (14th-13th c BC) Middle and Late Hittite are consistently post-positional. For example, while andan (‘inside’) can be used both pre- or post-positionally in Old Hittite, it becomes exclusively post-positional in New Hittite, (18), (H&B p.96).

[7D-i anda ]lāhuwai River-dat/loc into pour-3sg
“she pours into the river”

In SOV language, Object Shift in PP (Bošković 2004) would not be costly because it is required independently.
Selected references


Selected references


Morphology and Computation
Recapitulation of the Lectures

Minimalism and I-morphology
  composition & recursion
  based on asymmetrical relations, structure and features
derivation, exocentric compounds, complex numerals

Exploring asymmetry effects in I-morphology
  Processing asymmetric relations
  argument/adjunct asymmetry in deverbal compounds
  internal/external aspect asymmetry in prefixed verbs

Two approaches to morphological complexity
  I-complexity ≠ E-complexity
  behavioral and computational linguistic results
derivational morphology, compounds

Morphological variation, symmetry breaking and reduction of complexity
  language diachronic morpho-syntactic complexity
  the DAP and the development of prepositions in phylogeny
Principles reducing complexity:
  Minimize symmetry
  Minimize externalization