How economical are phonological inventories?

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This poster is for you if you're interested in

- Feature economy and/or contrastive underspecification;
- Quantitative, database-driven, typological approaches to phonological inventories (PI).

Aim of the study

- To quantify and describe the extent of feature economy in PI;
- To understand how PI recruit specific articulatory dimensions depending on their size.

Background

With the *all-inclusive universal phonetic space*, Lindblom & Maddieson (1988) explain how PI vary their structural dimensions both in quantity and quality depending on their size.

PI are trade-offs between two opposite constraints, *ease of articulation* and *perceptual salience*:

- Smaller PI use few basic phonetic dimensions;
- Larger PI recruit more complex dimensions to preserve perceptual contrast.

The notion of feature economy:

Feature economy or maximal use of available features (Ohala, 1980) reflect the *ease of articulation*: PI tend to maximize the use of their phonetic dimensions in terms of segments.

- (Lindblom & Maddieson, 1988): when the size of a PI increases, so does the number of phonetically complex consonants in this system;
- (Marsico et al., 2003): 2 segments tend to differ from each other by at least 2 features;
- (Clements, 2003ab): the frequency of occurrence of a particular segment is significantly correlated to the number of other segments in the system bearing the same features.

Approach

- To define an alternative quantification of feature economy;
- To adopt a more parcimonious underspecified description of PI;
- To compare phonetic dimensions given their frequency of use in phonological contrasts.

Data and methods

Expanded version of the UPSID Database (Maddieson, 1984 ; Maddieson & Precoda, 1990): genetically & geographically balanced sample of 451 PI, described by 833 different segments and 100 articulartory IPA-compliant features.

Underspecification

A *contrastive* underspecification to address systemic redundancy: the minimal description, in terms of features, contrasting all the segments of a PI. For each system: calculate all the possible underspecifications.

Quantifying & describing feature economy

For each language and both full and underspecified descriptions:

- Extract the set of features (F) describing its segments (Nas: # of actual segments);
- Extract all the possible segments of UPSID that can be generated with F (Nps: # of potential segments);
- Compute the ratio Nas/Nps. This ratio is equal to 1 when the economy is maximal;
- For each feature or class of features (manner, height...), compute the frequency of use.

Results

- Measures averaged on all possible underspecifications for a PI.
- Results for individual PI averaged per system size (i.e. number of segments in the PI);
- High variability of most right tails of distributions: to be discarded, since large sizes may be represented by a single system

Quantification of feature economy

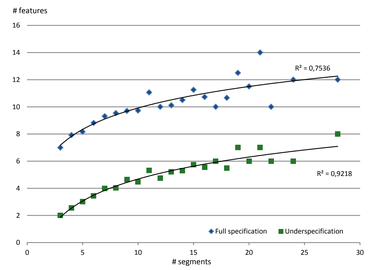

Figure 1: Average number of features of a system against its number of segments for full and underspecification. (vowels only).

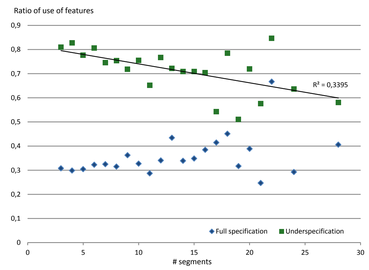

Figure 2: Average ratio of use of features plotted against the size of a system for full and underspecification. (vowels only).

Feature economy	Vowels		Consonants	
	FSpec.	USpec.	FSpec.	USpec.
Average	**0.33**	**0.76**	**0.28**	**0.49**
Std. deviation	**0.085**	**0.124**	**0.075**	**0.107**

Table 1: Feature economy calculated as the ratio of the number of actual segments of a system by the number of possible segments given its features.

- The more segments in a system, the more features needed to describe them (Fi.g 1);
- The underspecified set of features is on average half the fully specified one (Fig. 1);
- Similar trends for vowels and consonants (not shown);
- When considering full specification, systems are far from being economical (Table 1);
- When considering underspecification, systems are more economical (Table 1);
- Vowels systems are more economical than consonants (Table 1);
- Underspecification suggests that systems become less economical as they grow (Fig. 2).

Description of feature economy (in underspecified systems)

Focus on two primary phonetic dimensions (height for vowels, manner for consonants) and secondary features.

- The more vowels a system has, the more use of height distinctions (Fig. 3);

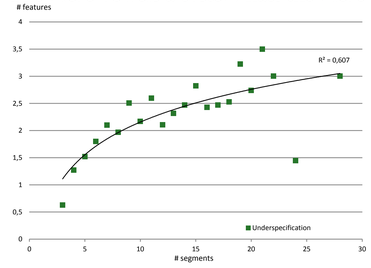

Figure 3: Average number of height features in underspecifications as a function of size. (vowels).

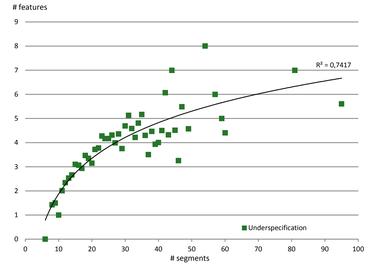

Figure 4: Average number of manner features in underspecifications as a function of size. (consonants).

- No such pattern is observed for rounding and backness (not shown);
- 98% of all underspecifications for a system include a height distinction, whereas this decreases to 91% for backness and drops down to 51% for rounding (not shown);
- The more consonants a system has, the more use of manner distinctions it makes (Fig. 4);
- This applies to place too, but not as obviously to laryngeal settings (not shown).

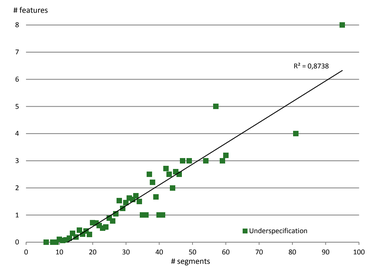

Figure 5: Average number of secondary features in underspecifications as a function of size. (consonants).

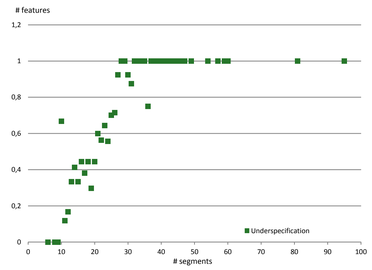

Figure 6: Average % of underspecifications containing a secondary feature as a function of size. (consonants).

- The more consonants in the system, the more secondary features are relied on to minimally describe the system. The correlation is linear (Fig. 5);
- The same linear correlation holds for vowels (not shown);
- The contrastive use of at least one secondary feature presents an S-type pattern (Fig. 6).

When we consider the 'need' for a specific dimension in underspecifications, all languages have at least one manner and one place distinction but need more than 30 segments for secondary features to systematically be part of underspecifications (Fig. 6).

Conclusion

- Economy is revealed when using a parsimonious 'contrastive' underspecification;
- Economy is not maximal and mostly active in vowel systems;
- Economy decreases with the size of the system (for vowels and consonants);
- Small inventories are organized around a few primary phonetic dimensions (height & backness for vowels, manner & place for consonants);
- Secondary dimensions appear in small systems, but only become indispensable - not at least partially redundant with primary features to contrast segments - in larger systems.

Interpretation:

- Vowels constitute a continuous phonetic space, contrary to consonants;
- The need for a sufficient perceptual contrast may explain partial economy.

References

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