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Systemic Markedness in Sibilant Inventories

Edward Flemming (flemming@mit.edu)
Massachusetts Institute of Technology

Place contrasts among sibilant fricatives

- [s] dental/alveolar, [ɕ] alveolopalatal, [ʃ] palatoalveolar, [ʂ] retroflex

s	ɕ	ʃ	ʂ	attested?	examples
✓	✓			**yes***	Japanese, Forest Nenets, Cavineña, Irish
✓		✓		yes	English, French, German, Khasi, Malay, Aymara
✓			✓	yes	Mazatec, Papago, Serbo-Croatian dialects, Slovak
✓	✓		✓	yes	Mandarin, Polish, Telugu, Malayalam, Naxi
✓		✓	✓	yes	Burushaski, Hmong, Jacaltec, Tulu, Acoma
✓	✓	✓		**no**	-
✓	✓	✓	✓	yes	NW Caucasian

*Only where [ɕ] patterns as the palatalized counterpart of [s] in a broader set of palatalization contrasts (e.g. [p, pʲ], [t, tʲ])

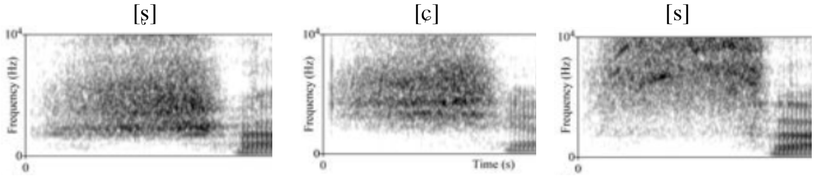
- These restrictions on sibilant place inventories cannot be accounted for in terms of fixed rankings of standard markedness constraints because different implicational universals hold in inventories with two vs. three sibilant places
  - ➢ They can be derived using constraints that penalize perceptually indistinct contrasts (Flemming 2004, 2017).
  - ➢ Maximizing the distinctiveness of contrasts leads to different preferences when two vs. three sibilants are involved.

- Survey builds on Padgett & Zygis (2007), Zygis & Padgett (2010), using the PHOIBLE database (Moran et al 2014)
- Descriptions must be interpreted carefully, preferably based on phonetic data.
- PHOIBLE contains three languages described as having [s, ɕ, ʃ] inventories:
  - Chuvash (Kruger 1961 via UPSID) – Other sources and analysis of recordings indicate inventory is [s, ɕ, ʂ].
  - Tehuelche (Gerzenstein 1968 via UPSID). Gerzenstein actually posits [s, ʃ, ʂ] or [s, ɕ, ʂ]. Other sources indicate that the inventory is [s, ʃ] (e.g. Fernández-Garay 2007) or [s, ʂ] (e.g. Viegas Barros 2009) with allophonic variation of /s/.
  - Bandjoun/Bamileke-Ghomálá – Nissim (1981) actually describes an [s, (t)ʃ] inventory, with [s] as a free variant of [tʃ] in some contexts.

Elements of the analysis

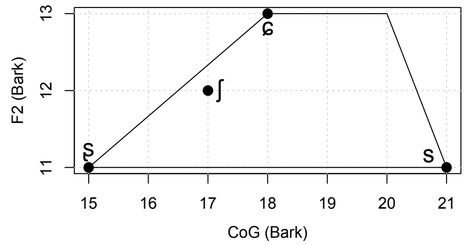
- Preference for perceptually distinct contrasts:
  - MINDIST = d : penalizes contrasting sounds that are separated by a perceptual distance less than d
- Effort constraints: *ɕ/ʂ >> *ʃ >> *s (cf. Padgett & Zygis 2007)
- MAXIMIZE CONTRASTS – favors larger inventories

Polish sibilants (Lee-Kim 2014)



Perceptual space of possible sibilants

- Primary dimensions (Zygis & Padgett 2010):
  - ➢ F2 transitions
  - ➢ Frequency of spectral peak (quantified by spectral Center of Gravity (CoG))



  - Ranges of dimensions based on studies of Japanese (Li et al 2009), Mandarin (Lee-Kim 2011), Polish (Nowak 2006, Zygis & Hamann 2003), Russian (Kochetov 2017) and English (Jongman et al 2000) sibilants, and on general articulatory considerations.
- Perceptual distinctiveness of a contrast is the weighted distance between contrasting sounds in this space:

$$d_{ij} = \sqrt{(1-w_{F2})(CoG_i - CoG_j)^2 + w_{F2}(F2_i - F2_j)^2}$$

  - $0 < w_{F2} < 1$ models language-specific allocation of attention between dimensions
  - More generally, $d_{ij} = \sqrt{\sum_k w_k \left(x_{ik} - x_{jk}\right)^2}$ where $\sum_k w_k = 1$ (Nosofsky 1986)
- Sibilants may be drawn from any point in the space.

All languages with 3 sibilant places include [ʂ]

- Suggests *ʃ, *ɕ >> *ʂ, but languages with two sibilant places can contain any of the non-anterior sibilants, implying no fixed ranking among *ʃ, *ɕ, *ʂ
- Initially consider only the CoG dimension ($w_{F2} = 0$)
- The maximally distinct inventory of 3 is [s, ɕ, ʂ] – d = 3 for [s-ɕ], [ɕ-ʂ]
- So maximum inventory size is determined by ranking of MAXIMIZE CONTRASTS and MINDIST = 4

	$w_{F2} = 0$	MINDIST = 2	MINDIST = 3	MAXIMIZE CONTRASTS	MINDIST = 4	MINDIST = 6
a.	s ʂ			2!		
b.	☞ s ɕ ʂ			3	**	**

- The attested 3-place inventories minimize violation of *ʂ/ɕ [s, ʃ, ʂ], or maximize distinctiveness [s, ɕ, ʂ]

	$w_{F2} = 0$	MINDIST = 2	MINDIST = 3	MAX CONTRASTS	*ʂ/ɕ	MINDIST = 4	MINDIST = 6	*ʃ
a.	☞ s ɕ ʂ			3	**	**	**	
b.	s ʃ ʂ		*!	3	*	*	**	*
c.	s ɕ ʃ	*!	*	3	*	**	***	*

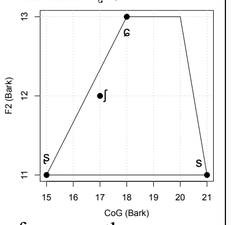
  - ➢ Unattested [s, ɕ, ʃ] is harmonically bounded by [s, ʃ, ʂ]
- 2-place inventories: [s, ʂ] is maximally distinct, [s, ʃ] minimizes effort, [s, ɕ] is harmonically bounded with $w_{F2} = 0$.

	$w_{F2} = 0$	MINDIST = 2	MINDIST = 3	MINDIST = 4	MINDIST = 6	*ʂ/ɕ	MAX CONTRASTS	*ʃ
a.	☞ s ʂ					*	2	
b.	s ʃ				*!		2	*
c.	s ɕ			*!	*	*	2	

[s, ɕ] only occurs where [ɕ] = /sʲ/

- The [s, ɕ] inventory can be derived with higher w_{F2} (> 0.87)
  - ➢ Implies the contrast is based primarily on F2 transitions – i.e. a palatalization contrast (cf. Padgett & Zygis 2007)
- Derivation of 2-place contrasts is as above for $w_{F2} < 0.87$
- For $w_{F2} > 0.87$, [s-ɕ] is the most distinct 2-way contrast, so possible winners are [s, ɕ] and [s, ʃ], depending on the ranking of MINDIST = 2 and *ʂ/ɕ

	$w_{F2} = 0.9$	MINDIST = 1.5	MINDIST = 2	*ʂ/ɕ	MAX CONTRASTS	*ʃ
a.	s ʂ		*!	*	2	
b.	s ʃ		*!		2	*
c.	☞ s ɕ			*	2	



- [s, ɕ, ʂ] is the best dispersed 3-way contrast for all values of w_{F2}, so the typology of 3-way contrasts is unchanged.

	$w_{F2} = 0.9$	MINDIST = 1.1	MINDIST = 1.5	MAX CONTRASTS	*ʂ/ɕ	MINDIST = 2	*ʃ
a.	☞ s ɕ ʂ			3	**	*	
b.	s ʃ ʂ		*!	3	*	*	*
c.	s ɕ ʃ	*!	*	3	*	*	*

- If a language puts high weight on F2 transitions then all palatalization contrasts are more distinct, so we expect such a language to include palatalization contrasts in general, not just [s, ɕ]
  - ➢ 2-place [s, ɕ] inventory implies other palatalization contrasts (e.g. [t-tʲ])
- True of the [s, ɕ] languages that I am aware of: Japanese (Ito & Mester 2003), Cavineña (Guillaume 2008), Forest Nenets (Salminen 2007), Irish (Ní Chasaide 1999)
- This generalization does not apply to [s, ɕ, ʂ] languages: e.g. Malayalam contrasts these places, but lacks other palatalization contrasts.
  - [s, ɕ, ʂ] can be derived with all values of w_{F2}.
- Difficult to derive these patterns with standard markedness constraints
  - The generalization that [s, ɕ] inventories imply other palatalization contrasts might suggest that *ɕ >> *tʲ (or some other *Cʲ constraint) universally, so [ɕ] implies [tʲ].
  - But this would incorrectly predict that [s, ɕ, ʂ] inventories should also be accompanied by other palatalization contrasts.

Extensions

- There is almost certainly variation within the broad categories of sibilant distinguished here.
  - Such variation could be derived by replacing *ɕ/ʂ >> *ʃ >> *s with a more elaborated scale of effort constraints.
- Extend the typology to include palatalized sibilants such as [sʲ]
- Distinguish varieties of [s], e.g. dental [s̪] vs. alveolar [s]
- All of these lines of inquiry require more phonetic data on more languages.

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