CONSONANT CONFUSABILITY AND SIMILARITY AVOIDANCE PATTERNS

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Questions

Goals

1. Establish **confusion rates** between pairs of **Bengali consonants (Cs)** in quiet, noise, and babble
2. Explore if **confusability reflects similarity** as applied in **fixed segment (FS) reduplication**

Background: C inventory

Bilabial	Labio-dental	Dental	Alveolar	Post-alveolar	Velar	Glottal
p b b^fi		t̪ d̪ $t̪^h$ $d̪^fi$		t d t^h d^fi	k g k^h g^fi	
				tɕ dʑ $tɕ^h$ $dʑ^fi$		
m		n			ŋ	
	f	s	ʃ			h
			ɹ			
		l			Table taken from K10	

- **4-way [voi] & [asp] contrast**
- **3 MajPlaces**: [lab], [cor], [dor]
- **3 MinPlaces** within [cor]: dental, (post-)alveolar, alveolopalatal

Background: FS reduplication

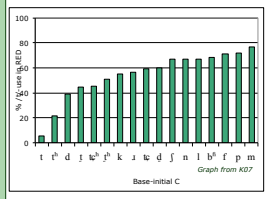
Fixed segment (FS) reduplication (FSR)
Substitution of a C with a FS in RED (Y98, N&V03)
e.g. *doctor-schmoctor*, *table-schmable*

Bengali FSR (K07)
Substitution of a C with /t/ in RED, meaning 'X, etc.'

In most cases, use FS /t/: /loha/ 'iron' → /t̪oha t̪oha/
/bʱaii/ 'heavy' → /b̪ʱaii t̪aii/

But use backup FS /f/ or /m/ for /t/-initial words: /tana/ 'pulling' → /t̪ana f̪ana/
*/t̪ana t̪ana/ not OK

Gradient behavior for words starting with **/t/-like C**: /tʰoŋa/ 'bag' → /t̪ʰoŋa f̪oŋa/
??/t̪ʰoŋa t̪oŋa/ 21% OK
/doɹa/ 'stripe' → /d̪oɹa f̪oɹa/
?/d̪oɹa t̪oɹa/ 39% OK



Rate of /t/-avoidance = related to similarity?

Similarity = **confusability**?

If /t/-avoidance reflects confusability, the most to least confusable ftrs would be:

[asp], [voi], MinPl, [cont], MajPl, [son]

Methods

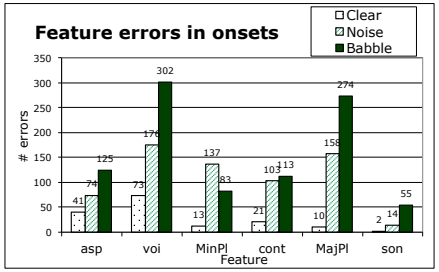
- **Multiple Forced Choice** experiment in Praat
- **24 listeners**
- Heard σs via headphones
- Clicked on letter perceived
- **3 added noise conditions** from NOISEX database
  - **Babble**: multi-talker speech
  - **Noise**: pink noise
  - **Clear**: no noise
- **54 legal σs**: [Ca], [aC]
- **3 noise blocks, 3 reps**
- Pseudorandomized
- **459 trials** analyzed (/sa as aɾ/ removed)

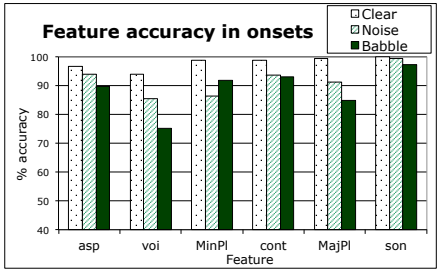
Confusion rates: onsets

Clear (92.0% accuracy)
- Most errors in **[voi] & [asp]**

Babble (59.2% accuracy)

Noise (69.7% accuracy)
- Errors reflect **percept of loud, high-fq burst**
  - 122/146 [cont] errors: fricatives heard as stops
  - 123/161 MinPl errors: dentals heard as alveolars
  - 95/158 MajPl errors: non-[cor] heard as [cor]



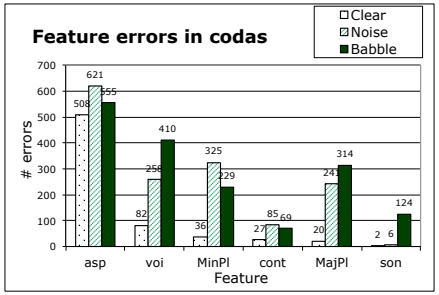


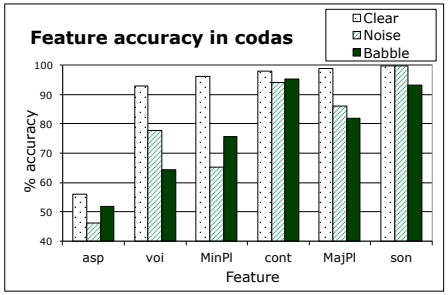
Confusion rates: codas

Clear (65.5% accuracy)
- **[asp] ~chance**: 56%
  - Perc. neutralization, cf. Hindi (A&A68)
- MinPl: percept of high-fq noise
  - 31 [cor] misheard as alveolar
  - 5 alv misheard as non-alv

Babble (33.7% accuracy)

Noise (38.8% accuracy)
- MinPl: percept of **(messy,) high-fq noise**
  - 194 [cor] misheard as alveolar, 131 as alveolopalatal
  - [cor] never misheard as dental





Correlations with FSR similarity

- **Does confusability reflect the notion of similarity used in FSR?**
- What are the **highest similarity scores** between each C and /t/, as derived from **confusions of /C t/**?
  $Similarity_{Ct}$ = (C,t + t,C) / (C,C + t,t)

Onsets
Cle: /d/ .28, /dʱ/ .03, /tʰ/ .03, /p/ .01, /k/ .01…
Noi: /d/ .40, /t/ .29, /k/ .06, /tʰ/ .03, /dʱ/ .02…
Bab: /d/ .62, /k/ .17, /t/ .13, /dʱ/ .10, /bʱ/ .06…

Codas
Cle: /tʰ/ .91, /tʰ/ .09, /tɕ/ .07, /tɕʰ/ .06, /d/ .03…
Noi: /tʰ/ 1.0, /tʰ/ .63, /kʰ/ .48, /t/ .47, /tɕʰ/ .30…
Bab: /tʰ/ .90, /d/ .90, /dʱ/ .79, /k/ .65, /gʱ/ .51…

/t/-avoidance rates in FSR
/tʰ/ .78, /d/ .61, /t/ .55, /tɕʰ/ .54, /t̪ʰ/ .49…

Avoidance in FSR is best correlated with coda similarity (r^2 = .69–.75)

Conclusions and comparisons

First confusion matrices for Bengali
[voi], [asp], [cont] confused in onset
[asp], [voi], MinPl confused in coda

Coda confusions are best correlated with FS /t/-avoidance rates; **surprising as FSR targets onsets!**

/t/-avoidance may reflect **confusability across positions, noise contexts**

Compare to confusability in **other lgs**:

English
Onset: Place, [cont], [voi]/[asp], [son] (M&N55)
Onset/coda: [voi]/[asp], Place, [cont]/[son] (C&a04)

Hindi
Onset: Place, [son], [voi], [cont], [asp] (A&A68)
Coda: [asp], [son], Place, [voi], [cont] (A&A68)

References and acknowledgments

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