Perception and Representation of Bengali Nasal Vowels

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Introduction

Background

A central question regarding nasality is whether it is represented with a privative feature [NASAL] or an equipollent set of [+NASAL] and [-NASAL].

Different proposals have been put forward:

- Chomsky and Halle (1968: 316): [nasal] as an equipollent feature, proposing NASAL and NONNASAL
- Cohn (1993) & Trigo (1993): nasal and oral vowels represented as [+nasal] and [-nasal] when they are used contrastively (e.g. in French and Lusitanian Portuguese) but as privative in languages like English
- underspecification approaches (e.g. FUL; Lahiri & Reetz 2002, 2010): [NASAL] as a privative feature even in languages like Bengali where it minimally distinguishes between two different phonemes

Previous experimental research (e.g. Lahiri & Marslen-Wilson 1991 and Ohala & Ohala 1995) provide some evidence for underspecified representation of oral vowels and a privative feature [NASAL] but further evidence is needed.

An additional question relates to how listeners use the representational information in their processing of nasality in general and, in the context of this study, nasal vowels in particular.

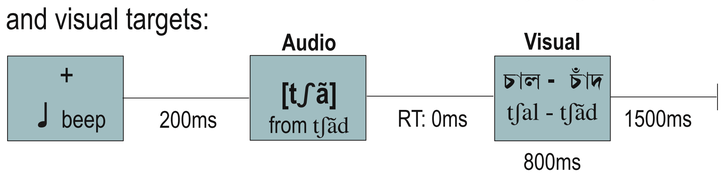
Questions & Hypotheses:

1. Is nasality represented with a privative feature or with an equipollent set of features?
2. Do listeners distinguish between underlying and contextual nasality?
3. Are listeners' perceptions guided by underlying representations or surface cues?

Methods

Stimuli & Experimental Design

3 cross-modal forced-choice tasks with auditory fragment primes and visual targets:



Experiments 1 & 2: *Doublets*

- 14 doublet pairs CVC & CVN (NoCṼC set)
- 14 doublet pairs CVC & CṼC (NoCVN set)

	Doublet NoCṼC		Doublet NoCVN	
Prime	[tĩ(n)]	[ti]	[dʒʰã]	[dʒʰa]
Target 1	tin - til	til - tin	dʒʰal - dʒʰãp	dʒʰãp - dʒʰal
Target 2	til - tin	tin - til	dʒʰãp - dʒʰal	dʒʰal - dʒʰãp

Experiment 3: *Triplets*

- set of 14 triplets (CVC, CVN and CṼC)
- only two target options displayed
- results in two conditions: MATCH and NEITHER

Triplets			
Prime	[tʃã]	[tʃa(n)]	[tʃa]
Targets Block 1	tʃan - tʃãd tʃal - tʃan tʃãd - tʃal	tʃan - tʃãd tʃal - tʃan tʃãd - tʃal	tʃan - tʃãd tʃal - tʃan tʃãd - tʃal
Targets Block 2	tʃãd - tʃan tʃan - tʃal tʃal - tʃãd	tʃãd - tʃan tʃan - tʃal tʃal - tʃãd	tʃãd - tʃan tʃan - tʃal tʃal - tʃãd

All stimuli were recorded by a female native speaker and subsequently truncated and normalised in PRAAT.

Participants

All tasks were conducted at Gokhale Memorial Girls' College in Calcutta, India. The participants were 56 female undergraduate students (age range 19-23) with no hearing or reading impairments.

Predictions

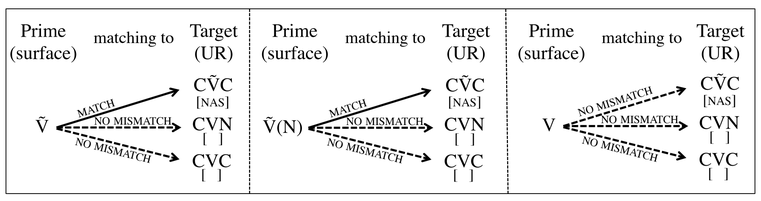


Figure 1 *Predictions made by an underspecifcation account*

The only real match conditions predicted by an underspecification account like FUL (Lahiri & Reetz 2002, 2010) would be between a CṼC prime and its identical CṼC target as well as between a CVN prime and a CṼC target. In all other cases the model predicts no-mismatch since neither the signal nor the target (or both) are specified for nasality.

Faster reaction time and greater accuracy is expected for match conditions compared to no-mismatch conditions.

Results

Doublet results – errors and RT

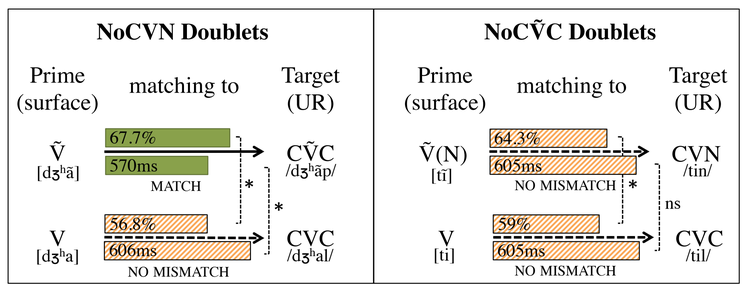
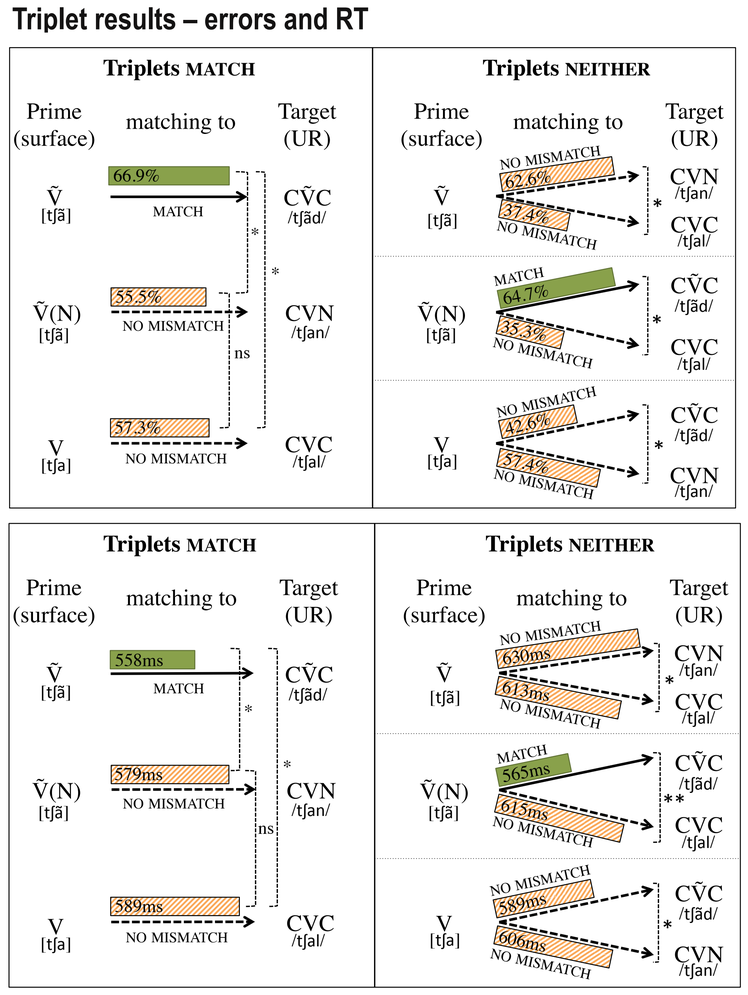


Figure 2 & Table 1 *RT and error results for doublet conditions*

	NoCVN set				NoCṼC set			
Prime	CṼC		CVC		CVN		CVC	
Correct	Y	N	Y	N	Y	N	Y	N
% correct	67.7	32.3	56.8	43.2	64.3	35.7	59.0	41.0
RT (correct)	570ms		606ms		605ms		605ms	

Triplet results – errors and RT



Figures 3 & 4 *Error and RT results for triplet conditions*

Table 2 *Error and RT results for triplet conditions*

	MATCH					
Prime	CṼC		CVN		CVC	
correct	Y	N	Y	N	Y	N
% correct	66.9	33.1	55.5	44.5	57.3	42.7
RT correct	558ms		579ms		589ms	
	NEITHER					
Prime	CṼC		CVN		CVC	
chosen	CVC	CVN	CṼC	CVC	CṼC	CVN
% chosen	37.4	62.6	64.7	35.3	42,6	57.4
RT (ms)	613	630	565	615	589	606

Key Findings

Overall

In all conditions where an identity match was possible, listeners identified the correct target well above chance (Triplets MATCH: $\chi^2(1) = 176.99$, $p < .001$; Doublets: $\chi^2(1) = 176.07$, $p < .001$).

Doublets

NoCVN set (choice between CṼC and CVC targets):

- significantly faster responses to matching targets after CṼC primes (e.g. [bã] from [bãdʰ] led to a significantly faster identity match than [ba] from [bad])

➔The vowel in the CṼC word is specified for [NASAL] and thus is a better match for its identity fragment, while the vowel in the CVC word is unspecified and results in a no-mismatch although they are identical.

➔An equipollent approach (i.e. [-NASAL] for oral vowels) would predict no difference in RT since both conditions would result in a real match

NoCṼC set (choice between CVN and CVC targets):

- both vowels are underspecified which is reflected in the RTs as they do not differ significantly but are both considerably slower than those after the CṼC primes in the NoCVN set

Triplet MATCH

- only the condition with CṼC primes results in significantly faster RTs (real match)
- no significant difference in RTs after CVC and CVN primes (both significantly slower than RTs after CṼC primes)
- error data shows an identical pattern, with correct responses provided significantly more frequently after CṼC primes than after CVN or CVC primes

Triplet NEITHER

- After CVN prime, CṼC targets are chosen significantly faster than CVC targets.
- CṼC and CVC primes, both no-mismatch conditions, lead to marginally significant differences between RTs.
- The degree of facilitation is significantly greater after CVN primes than after CṼC and CVC primes

➔If CVN words were represented with [NASAL] listeners should respond faster to CVN words after a fragment prime from a CṼC word.

➔CVC fragment primes where no identity match is available show that it is not the case that oral vowels are being matched, since the CṼC targets are responded to marginally faster.

➔Error data shows listeners' use of surface cues especially when no nasal vowel target is available but nasality is present in the prime.

Conclusions

- Listeners use lexical representations in processing and recognition and a real match facilitates processing.
- Across experiments, reaction time data provides information on underlying representations and shows that real matches between the acoustic signal of the prime and the representation of the target lead to faster reaction times.
- The error data shows that any nasality in the signal predisposes the listener to choose a target with an underlying nasal vowel (CṼC and CVN to CṼC), unless there is no such target in which case surface matching of nasality is used (CṼC prime to CVN target).
- RT and error data both provide clear support for an underspecification account of nasality with [NASAL] as a privative feature.

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Selected References

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