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24.941J / 6.543J / 9.587J / HST.727J The Lexicon and Its Features  
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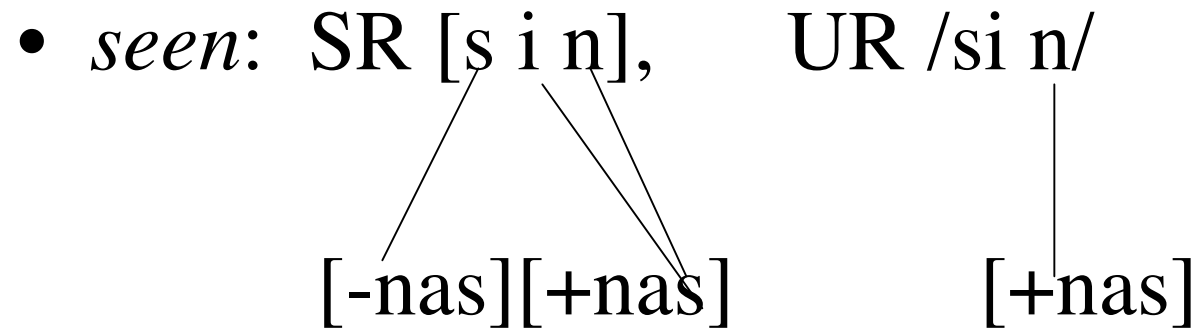
# Distinctive features in lexical entries

24.941/6.729

- Underspecification, briefly
- From signal to underspecified lexical entries:  
Lahiri and Marslen-Wilson 1991  
Lahiri and Reetz 2002
- Underspecification in more detail

# Underspecification

- Feature values present in SR are absent in UR



# Surface underspecification

- Throughout the segment, F-value is determined by external context.
- Cohn 1989:  
nasal airflow in English V:  
~~NVC~~; ~~CVN~~; ~~NVN~~
- *Permanent* underspecification:  
no evidence of F value at UR or SR

# Relates to contrast

- French, also in Cohn 1989:

NVC; CVN; NVN

- Oral vowels are fully oral in French because they contrast with nasal vowels.

# Temporary underspecification

E.g. Hungarian [i], [e:] act as if they lack [-back].

Why omit feature values from UR?

(a) Can't tell what they are

(b) To shrink the lexicon

“unmarked” feature values targeted for omission

(c) To solve the invariance/variability problem:

if surface value of F varies between [+F] and [-F] and the lexical entry contains [0F], neither surface value will contradict the lexical specification.

These reasons correspond to different theories of underspecification: data may support some but not others.

Lahiri and Marslen-Wilson invoke (b) and (c).

# Can't tell UR value

- Segment alternates

Turkish ACC: **kuuz-u, kul-u, dif-i, gyl-y**

- All SR values are guaranteed by context sensitive rules.

FH:  $V \rightarrow [\alpha \text{ back}] / V[\alpha \text{ back}]C_{0\_}$

RH:  $[+\text{high}] \rightarrow [\alpha \text{ rd}] / V[\alpha \text{ rd}]C_{0\_}$



# Shrink the lexicon

- For any binary feature, one SR value can be left out of lexicon and entered by rule

**V -> [+nas] / \_[+nas]            s[**in**]**

**[+cont] -> [-nas]/            s[**i**]**

- Sometimes both values:

**[+son, -cont] -> [+nasal]**

# UR

	s	i	n
sonorant	-	+	+
continuant	+	+	-
consonantal	+	-	+
nasal			

# [+son, -cont, -lateral] -> [+nasal]

	s	i	n
sonorant	-	+	+
continuant	+	+	-
consonantal	+	-	+
nasal			+

**[-cons] -> [+nasal]/\_ [+nasal]**

	s	ĩ	n
sonorant	-	+	+
continuant	+	+	-
consonantal	+	-	+
nasal		+	+

# [+cont] -> [-nasal]

	s	ĩ	n
sonorant	-	+	+
continuant	+	+	-
consonantal	+	-	+
nasal	-	+	+

Basic hypothesis of phonological analysis: "...every linguistic item has a single unique underlying representation which is minimally specified in its phonetic description."

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For more complete definition, see page 252 of Lahiri, Aditi, and William Marslen-Wilson.

"The Mental Representation of Lexical Form: A Phonological Approach to the Recognition Lexicon." *Cognition* 38 (1991): 245-294.

# Many ways to shrink the lexicon

- Why leave [ $\pm$ nasal] values out of UR when we can do that with [ $\pm$ sonorant] values?
- Redundancy Rules and URs:

/n/ = [+nasal]:

**[+nasal] -> [+sonorant]**

/s/ = [-nasal, +cons]:

**[-nasal, +cons] -> [-sonorant]**

/i/ = [-cons]:

**[-cons] -> [+sonorant]; [-cons] -> [-nasal]**

**[-cons] -> [+nasal]/ \_\_[+nasal]**

# UR

	s	i	n
nasal			+
continuant	+	+	-
consonantal	+	-	+
sonorant			



# [+nasal] -> [+sonorant]

	s	i	n
nasal			+
continuant	+	+	-
consonantal	+	-	+
sonorant			+

# [-nasal, +cons] -> [-sonorant]

	s	i	n
nasal	-		+
continuant	+	+	-
consonantal	+	-	+
sonorant	-		+

**[-cons] -> [+nasal]/ \_\_[+nasal]**

	s	i	n
nasal	-	+	+
continuant	+	+	-
consonantal	+	-	+
sonorant	-		+

# [-cons] -> [+sonorant]

	s	i	n
nasal	-	+	+
continuant	+	+	-
consonantal	+	-	+
sonorant	-	+	+

"In SPE-type underlying representations, features were assigned marked or unmarked values which were translated into binary '+' or '-' values by marking conventions..."

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For more explanation, see page 253 of Lahiri, Aditi, and William Marslen-Wilson.

"The Mental Representation of Lexical Form: A Phonological Approach to the Recognition Lexicon." *Cognition* 38 (1991): 245-294.

# Lahiri and Marslen Wilson

- Which mental representation of the word is matched against the signal?
- SR?      [s̃ɪn]
- UR?      /sin/ ?
- if so what F-values does the UR contain?
- How is the stimulus-form match achieved?

# Resulting UR, SR: Bengali

	<i>Bengali</i>					
	CVN		CVC		CVC	
<b>Underlying</b>	V	C	V	C	V	C
		[+nas]			[+nas]	
<b>Surface</b>	V	C	V	C	V	C
	↙					
		[+nas]			[+nas]	

Figure by MIT OpenCourseWare. Adapted from p. 259 in: Lahiri, Aditi, and William Marslen-Wilson. "The Mental Representation of Lexical Form: A Phonological Approach to the Recognition Lexicon." *Cognition* 38 (1991): 245-294.

# UR, SR: English

	<i>English</i>			
	CVN		CVC	
Underlying	V	C   [+nas]	V	C
Surface	V	C   [+nas]	V	C

Figure by MIT OpenCourseWare. Adapted from p. 259 in: Lahiri, Aditi, and William Marslen-Wilson. "The Mental Representation of Lexical Form: A Phonological Approach to the Recognition Lexicon." *Cognition* 38 (1991): 245-294.



# Lexical access model

- Access is continuously attempted
- Begin with multiple access of all words consistent with first information received. Cohort.
- Activation level for lexical entries increases as more supporting evidence is processed.
- It decreases as more mismatching evidence arises.
- Decision is competitive: a candidate may be best in cohort without being a perfect fit to the stimulus.

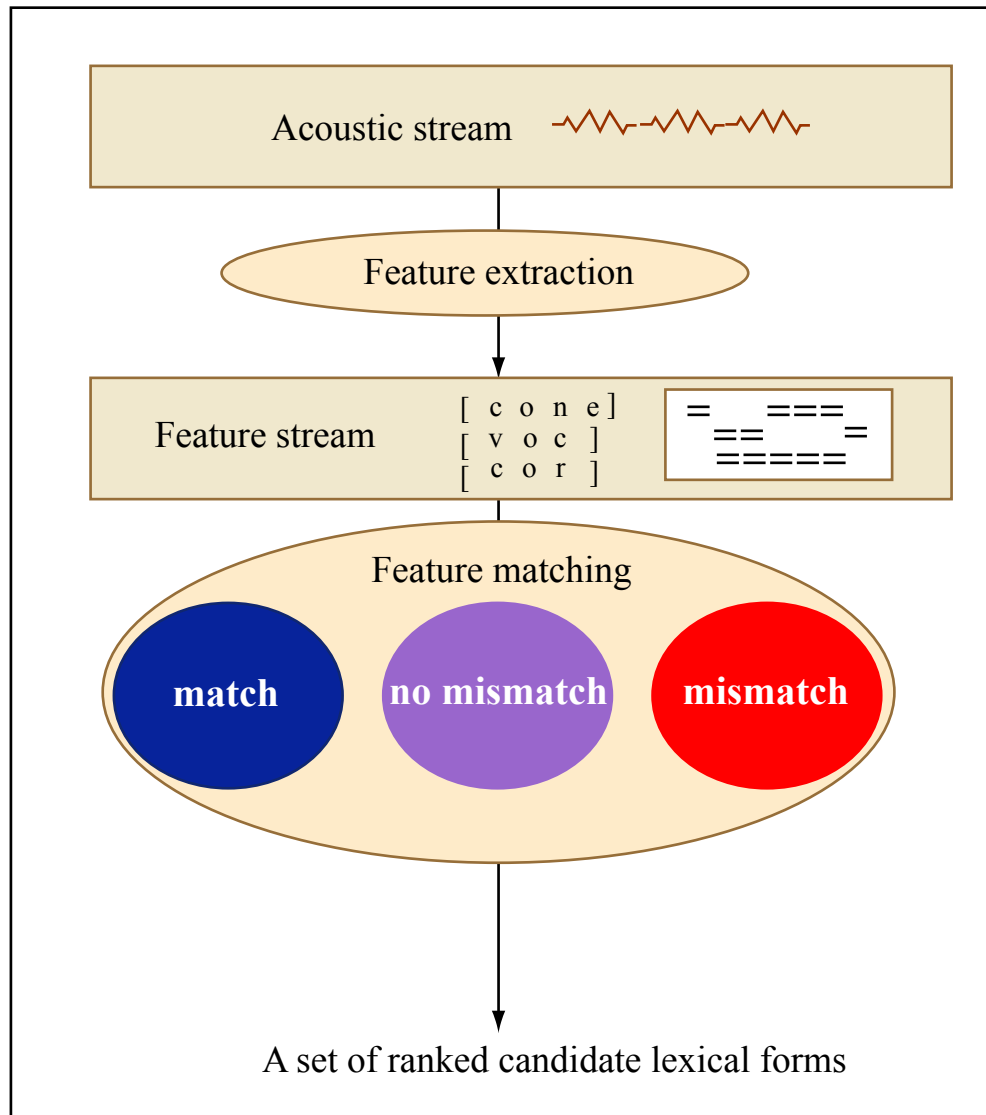


Figure by MIT OpenCourseWare.

Signal feature	Lexical feature	Matching condition
F	F	match
F		no mismatch
F	X	mismatch ( $F \rightarrow \neg X$ )
	F	

Figure by MIT OpenCourseWare.

# Gating experiment

- Subjects presented with an incomplete fragment taken from beginning of word: e.g. CV from a CVC word.
- Task is to identify a complete word.

# Gates for *grade*

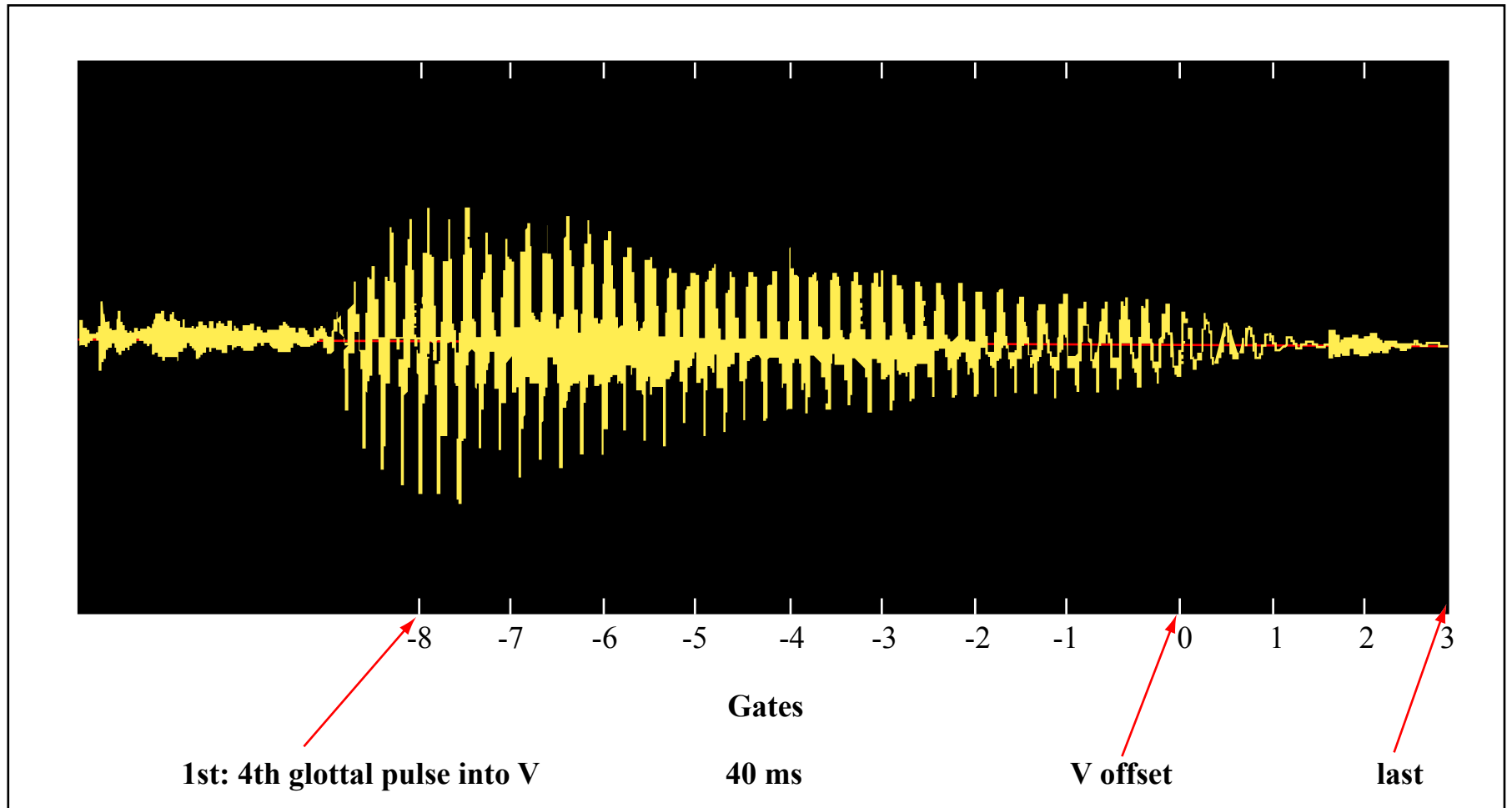


Figure by MIT OpenCourseWare. Adapted from Figure 2 (p. 267) in Lahiri, Aditi, and William Marslen-Wilson. "The Mental Representation of Lexical Form: A Phonological Approach to the Recognition Lexicon." *Cognition* 38 (1991): 245-294.

- CV[+nas]C, CVN, CVC words probably differ in duration:
  - CV[+nas]C tend to contain just long V's (M.Ohala 1973)
  - CVN tend to have short V's,
  - Voiceless C shorten Vs in Hindi. (JASA 2001 115, 5, pp. 2540)
- If so, the first few gates may present different points in the V depending on whether they originate as CV[+nas]C, CVN, or CVC.
- Also CV[+nas]C words might get more gates.
- Not clear if this affected the outcome.

# Predictions of signal-UR match: Bengali stimuli, CV gate

signal	lexical	Matching condition
+nasal	C <u>V</u> N	+/0: No mismatch
-nasal	C <u>V</u> N	-/0: No mismatch
+nasal	C <u>V</u> C	<b>+/+ : Match</b>
-nasal	C <u>V</u> C <sub>[-nas]</sub>	<b>-/+ : Mismatch</b>
+nasal	C <u>V</u> C <sub>[-nas]</sub>	+/0: No mismatch
-nasal	C <u>V</u> C	-/0: No mismatch

- 1) CVC responses should predominate in response to any CV stimulus onset
- 2) CVC, CVN responses should be evenly split in response to CV or CV stimulus onsets.

# Bengali: cnt'd

signal	lexical	Matching condition
+nasal	CV <u>N</u>	<b>Match</b>
-nasal	CV <u>N</u>	<b>Mismatch</b>
+nasal	C <u>V</u> C	No mismatch
-nasal	C <u>V</u> C	No mismatch
+nasal	CVC <u></u>	No mismatch
-nasal	CVC <u></u>	No mismatch

These predictions hold only if nasal C's are [+nasal] in UR.



# Predictions of signal-UR match: English

signal	lexical	Matching condition
+nasal	C <u>V</u> N	No mismatch
-nasal	C <u>V</u> N	No mismatch
+nasal	C <u>V</u> C	No mismatch
-nasal	C <u>V</u> C	No mismatch
+nasal	C <u>V</u> C	No mismatch
-nasal	C <u>V</u> C	No mismatch

# English: cnt'd

signal	lexical	Matching condition
+nasal	CV <u>N</u>	<b>Match</b>
-nasal	CV <u>N</u>	<b>Mismatch</b>
+nasal	CVC <u> </u>	No mismatch
-nasal	CVC <u> </u>	No mismatch
+nasal	CVC <u> </u>	No mismatch
-nasal	CVC <u> </u>	No mismatch

# Predictions of signal-SR match: Bengali

signal	lexical	Matching condition
+nasal	C <u>V</u> N	<b>Match</b>
-nasal	C <u>V</u> N	<b>Mismatch</b>
+nasal	C <u>V</u> C	<b>Match</b>
-nasal	C <u>V</u> C	<b>Mismatch</b>
+nasal	C <u>V</u> C	<b>Mismatch</b>
-nasal	C <u>V</u> C	<b>Match</b>

# Bengali signal-SR: cnt'd

signal	lexical	Matching condition
+nasal	<u>CV</u> N	<b>Match</b>
-nasal	<u>CV</u> N	<b>Mismatch</b>
+nasal	<u>CVC</u>	<b>Match</b>
-nasal	<u>CVC</u>	<b>Mismatch</b>
+nasal	<u>CVC</u>	<b>Mismatch</b>
-nasal	<u>CVC</u>	<b>Mismatch</b>

# 21 Bengali triplets, real words

	CVC	CVN	CV <sub>[+nas]</sub> C
SR	kap	kām	kāp
UR	kap	kam	kāp

Members of any triplet matched for perceived frequency

# 20 Bengali doubles

	CVC	CVN	CV <sub>[+nas]</sub> C
SR	lop	lõm	missing
UR	lop	lom	missing

# 20 English doubles

Matching the Bengali doubles in  $C_i$  and  $C_f$

	CVC	CVN
SR	lop	lõm
UR	lop	lom

# Stimuli

- 2 English tapes: practice + 1 word from each doublet
- 3 Bengali tapes: practice + 1 word from each B-triplet
- 2 Bengali tapes: 1 word from each B-doublet
- each subject hears same # of CVN, CVC, CV<sub>[+nas]</sub>C words
- 6s intervals between stimuli
- 28 B English subjects
- 60 Bengali subjects: 36 for triplet tapes, 24 for doublet tapes.



# Results over all gates up to 0 gate

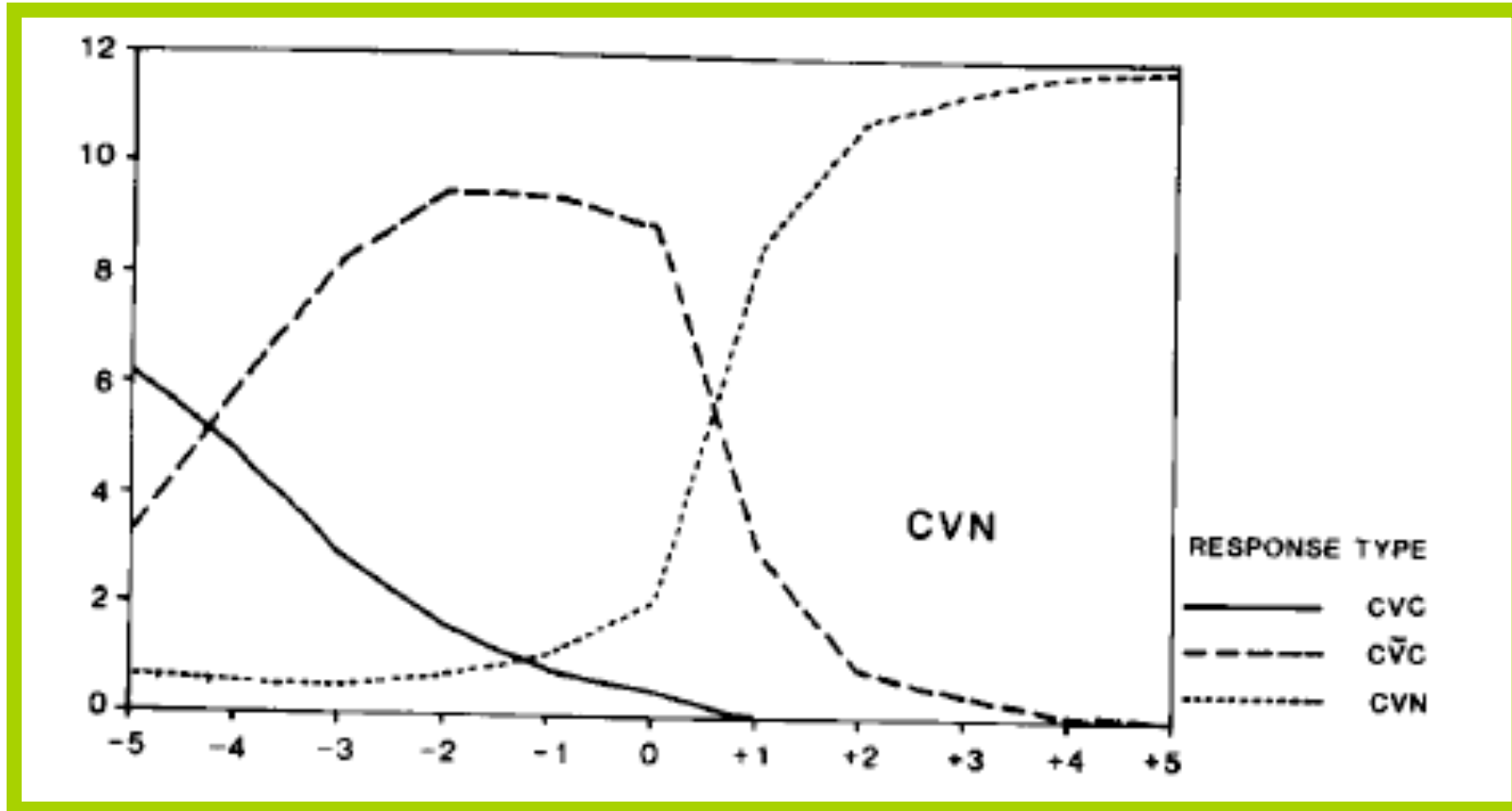
Stimulus	Type of Response		
	CVC	CVC	CVN
CVC	80.3	0.7	13.4
CVC	33.2	56.8	5.2
CVN	23.5	63.0	7.9

*Bengali triplets: Percentage responses up to vowel offset*

CV[+nas]C and CVN elicit very similar responses

Figure by MIT OpenCourseWare. Adapted from Table 2 in Lahiri, Aditi, and William Marslen-Wilson. "The Mental Representation of Lexical Form: A Phonological Approach to the Recognition Lexicon." *Cognition* 38 (1991): 245-294.

# CVN stimuli: note $\Delta$ CVC vs. CVN responses



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Source: Lahiri, Aditi, and William Marslen-Wilson. "The Mental Representation of Lexical Form: A Phonological Approach to the Recognition Lexicon." *Cognition* 38 (1991): 245-294.

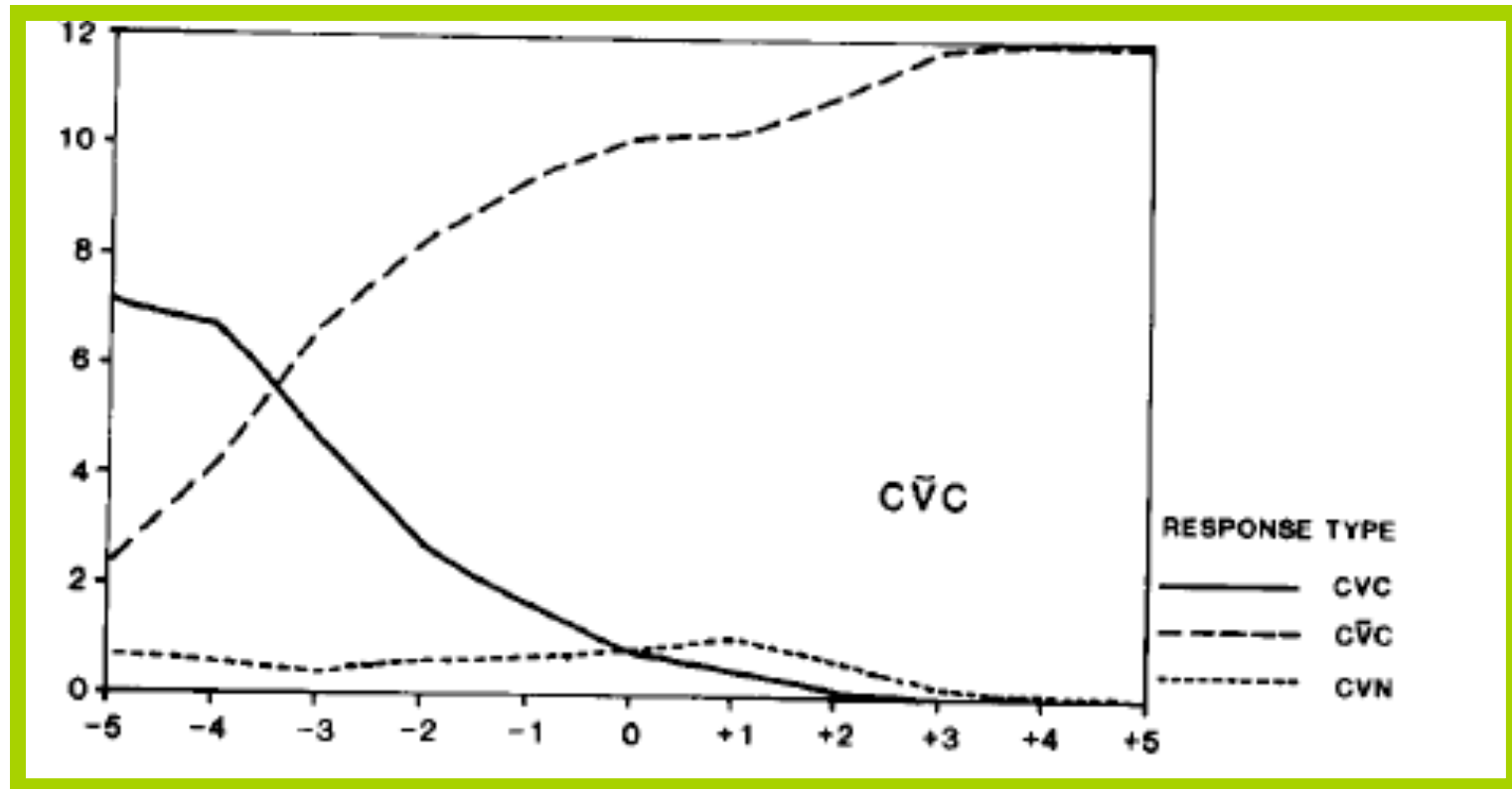
# Relevance to underspecification

- At or before gate 0, the signal indicates a nasal V.
- The lexicon offers a perfect match:  $CV_{[+nas]}C$
- The CVN lexical items do not match (or mismatch) the signal, if the V is listed as oral or underspecified.
- So underspecification makes them a less good fit.
- Large number of CVC responses in early gates suggests a ‘no-mismatch’ effect - no [-nasal] value on the UR of oral V’s - but this turns out to be a statistics driven bias for CVC.

# Why isn't perceived nasality in

- Bengali CVN attributed to an upcoming N?
- Preference to interpret the signal locally.

# CVC stimuli



lexical frequency effect (CVC:67%; CVN 16%; CVC 17%) explains the difference between actual numbers of CV<sub>[+nas]</sub>C and CVC responses and predictions.

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Source: Lahiri, Aditi, and William Marslen-Wilson. "The Mental Representation of Lexical Form: A Phonological Approach to the Recognition Lexicon." *Cognition* 38 (1991): 245-294.

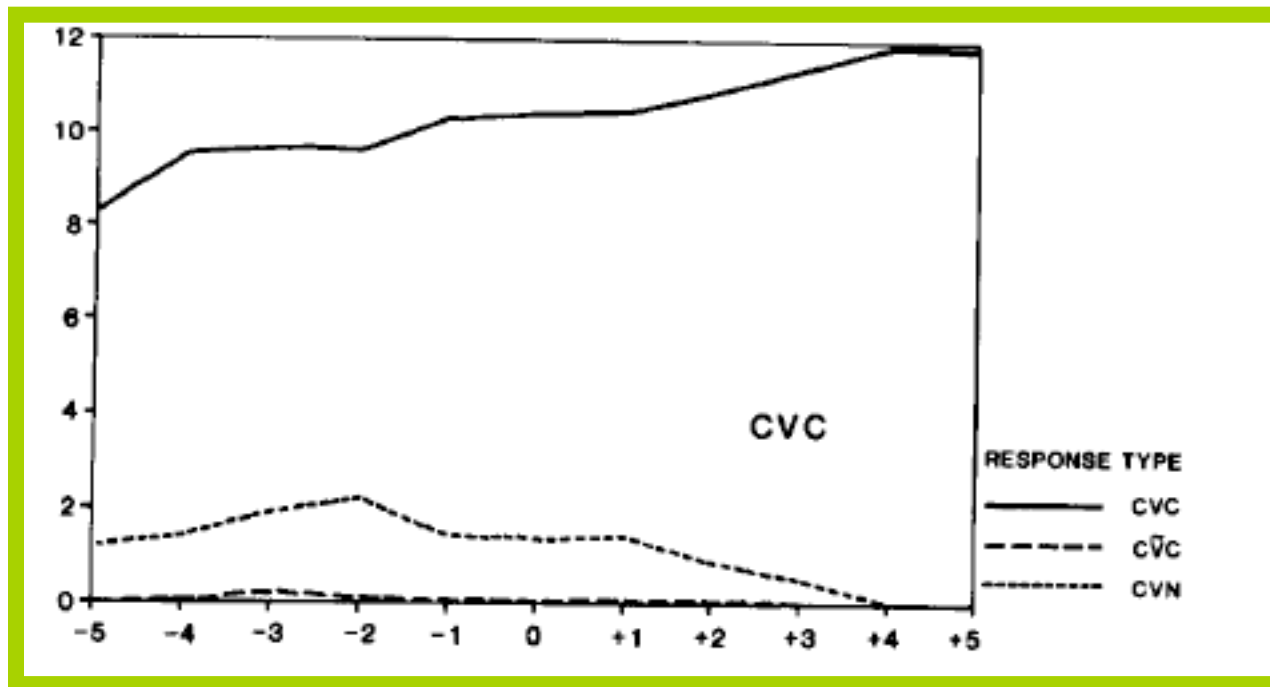
# Relevance to underspecification

- Same as before:

Up to gate 0 stimulus gives just information about a nasal V. That should be consistent with CVN and  $CV_{[+nas]}C$  but it isn't, because their lexical entries differ.

# CVC stimuli:

should elicit equal # CVN and CVC responses up to V-offset



lexical frequency effect (CVC:67%; CVN 16%; CVC 17%)  
explains difference.

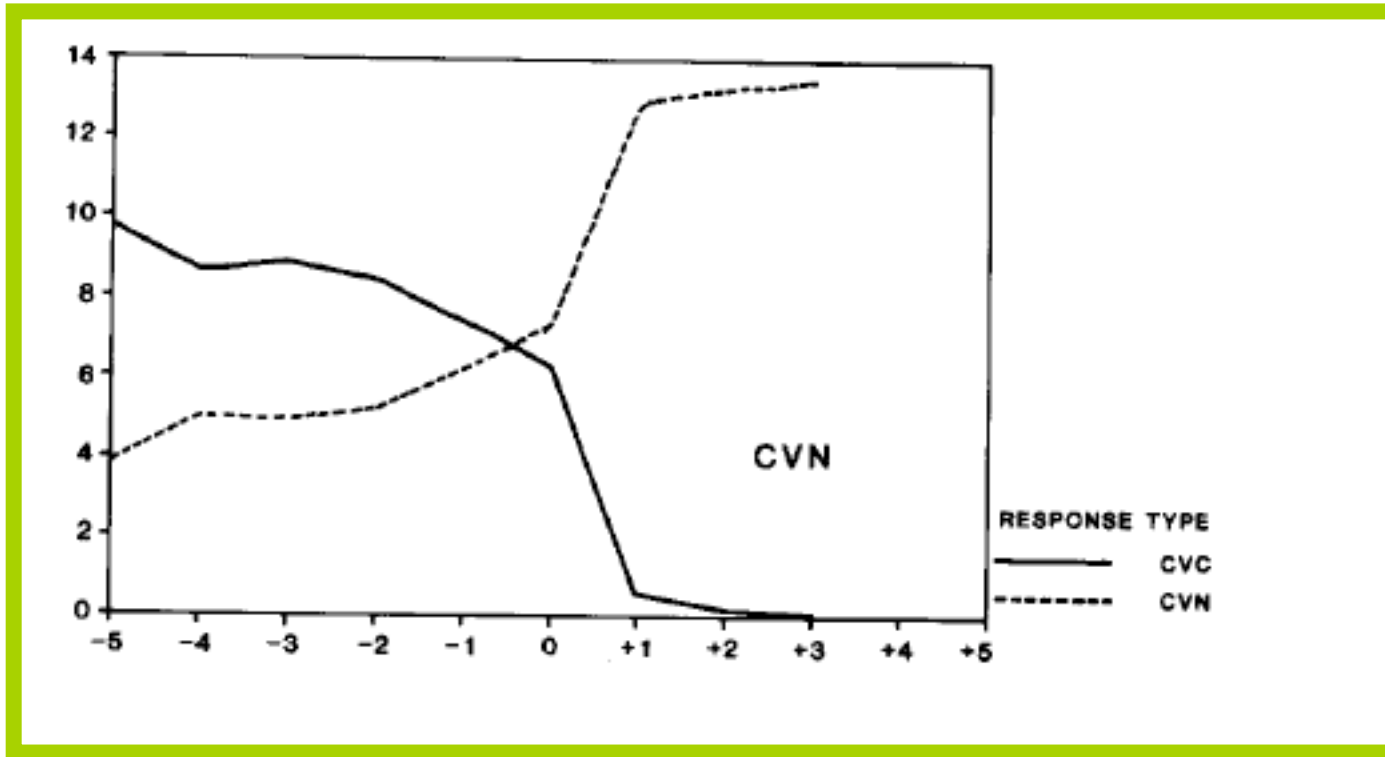
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Source: Lahiri, Aditi, and William Marslen-Wilson. "The Mental Representation of Lexical Form: A Phonological Approach to the Recognition Lexicon." *Cognition* 38 (1991): 245-294.

# Relevance to underspecification

- Up to 21 % of CVN responses to oral V of CVC.
- Higher than for the nasal V of CVN,  $CV_{[+nas]}C$
- **This is inconsistent with the listed form of the CVN word containing nasality on V.**
- This is consistent with having an unspecified or oral V in the lexical entry of CVN.
- 21%, not 50%, because of the pro-CVC bias.



# English CVN



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# English CVN

Stimulus	<i>Type of Response</i>	
	CVC	CVN
CVC	83.4	16.6
CVN	59.3	40.7

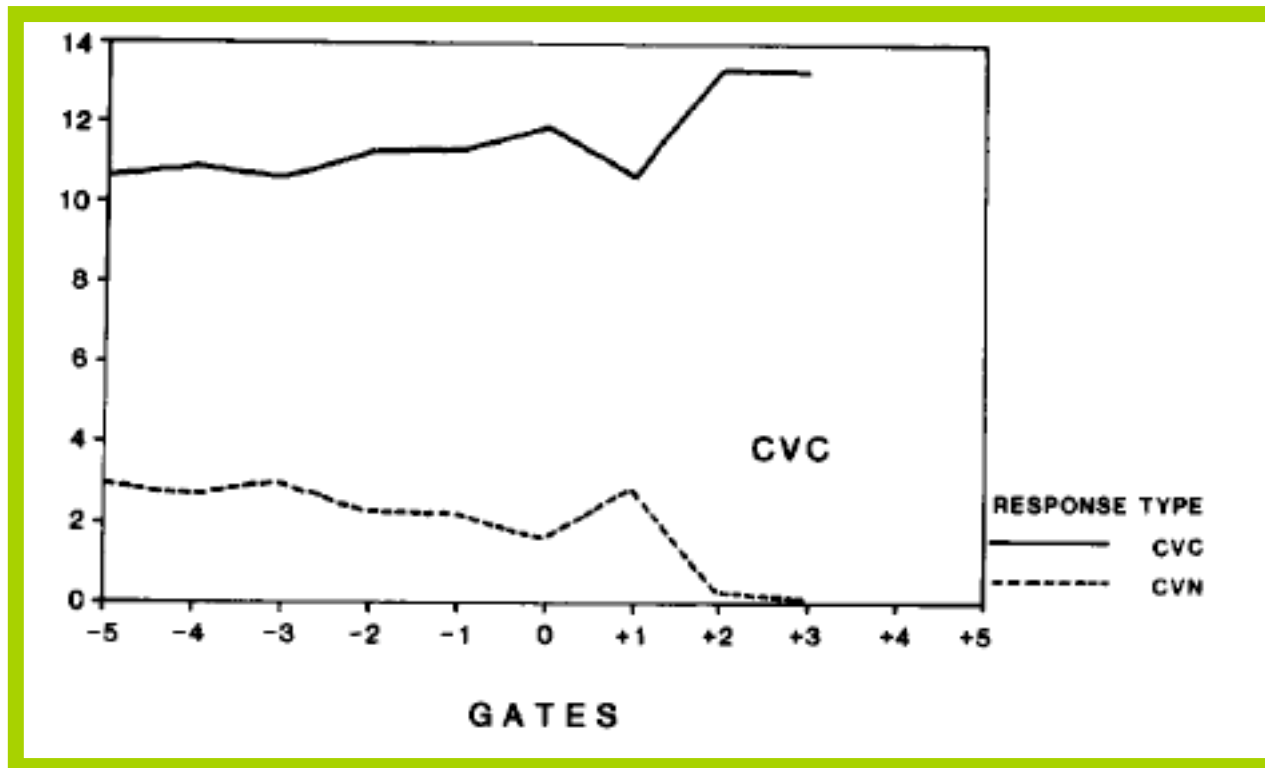
*English doublets: Percentage responses up to vowel offset*

Figure by MIT OpenCourseWare. Adapted from Table 3 in Lahiri, Aditi and William Marslen-Wilson. "The Mental Representation of Lexical Form: A Phonological Approach to the Recognition Lexicon." *Cognition* 38 (1991): 245-294.

# Relevance to underspecification

- More CVC than CVN lexical entries:  
explains preference for CVC up to gate -2
- Increase in CVN responses from gate -2 to gate 0  
should be interpreted as increasing evidence for  
upcoming N.
- No English CV(C): so perceived [+nas] in signal must  
be attributed to an upcoming segment. That explains  
larger % of CVN than in Bengali in the early gates.
- **The large total of CVC responses up to gate 0  
suggests that V in CVN is not entered as [+nasal] in  
the lexicon.**

# English CVC



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# Relevance to underspecification

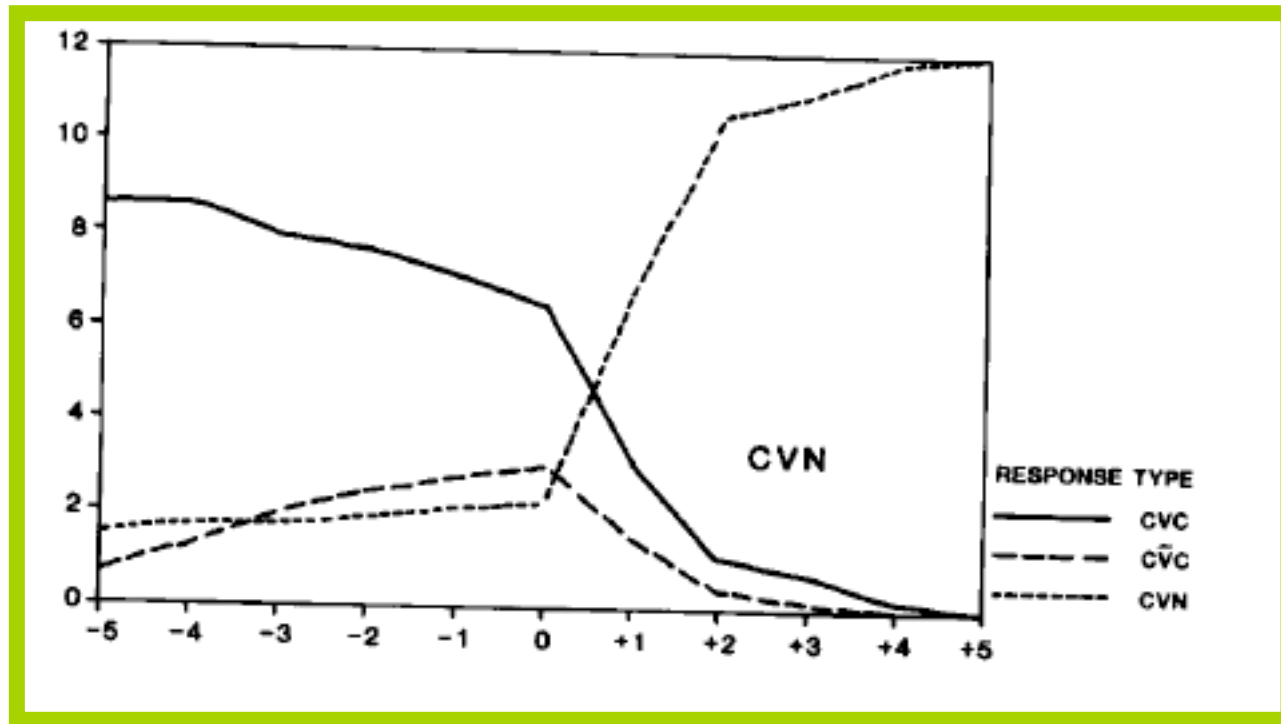
- Up to 17% CVN responses to completely oral V's
- **This is inconsistent with lexical listing of nasality on the vowel.**
- It's consistent with the vowel being listed as underspecified or as oral.

# Can't do better than "No mismatch" for V in CVC

The underspecification of oral vowels in the recognition lexicon is reflected in the unformativeness of the absence of nasality in guiding lexical choice (for a language where there are no underlyingly nasal vowels). Hearing more of an oral vowel in English does not significantly increase the number of CVC responses or decrease the number of CVN responses. The slight drop off over

I don't think this is relevant to underspecification: hearing more of an oral vowel should be very relevant because it rules out an upcoming nasal segment. This should be so even with an underspecified lexicon: the listener ought to change his estimate of the target item (CVC vs. CVN) as evidence of orality mounts. We have an unexplained fact here, not something that underspecification sheds light on.

# Bengali doublets: CVN



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# Interpretation

- Two striking things here: roughly equal number of CV<sub>[+nas]</sub>C and CVN responses up to gate 0.

“Instead of producing the CVN that was lexically available, listeners produced as responses CVC’s that were phonologically closely related to to the CV sequence they were hearing.” p.279

- No big increase in CVN responses up to gate 0.

“the perceptual representations of CVN and CVC vowels seem to be truly indifferent to the presence or absence of nasalization in the signal.” (p. 280)

- Does underspecification explain these points?  
Shouldn’t Bengali doublets work like English doublets?



# Overall

- What is debated here is the UR of nasalized vowels in CVN and of oral vowels in CVC.
- Underspecification predicts these are [0 nasal].
- Full specification predicts, incorrectly:

CVN = [+nasal]

CVC = [-nasal]

# A third option interpretation

- The lexical entry for [CṼN] is /CṼN/, as claimed.
- Not because a lexical minimality principle forces elimination of redundant F's from lexicon.
- But because nasality is parsed out of the Ṽ in [CṼN] and attributed to the neighboring N. (cf. Gow literature to be presented.)
- why do that? How can Bengali speakers exclude the possibility that [CṼN] is /CṼN/, if not forced by lexical minimality?

# Ferguson and Chowdhury 1960 (Hindi)

- “Next to nasal consonants there is no oral-nasal contrast. In this environment the vowels are somewhat nasalized[...] but since **nasality in this position is optional** and since oral vowels in general are unmarked and much more frequent in the language these ‘neutralized’ vowels next to nasals C’s are regarded here as oral.”  
*Language* 36, 1, 37

# If V-nasality is optional in CVN

- then distributional evidence (variation CVN~ CVN vs. invariant CVC) tells speakers that V̄ in CVN has a different representation from other V̄: it's an effect of context.
- Under this interpretation, lexical entries are **abstract** - they reduce surface variability to invariance - but they're **not minimal** i.e. by dropping surface invariant F's.
- Under this interpretation, there is no possibility of treating N's as oral C's in UR (= [+son, +cons, -lateral]).

# Results replicated for Hindi

- By Ohala and Ohala 1995, who give a different interpretation to L&MW's views:
- O&O believe that the listener's ability to match vowel nasalization to an /N/ in English CVN demonstrates that the signal is mapped to SR. "By allowing the listener to access a form exhibiting [coarticulatory nasalization of V by N] they have endorsed the SR hypothesis."
- The listener has access to all the features in the signal; nothing in L&MW's story says that listeners can't re-assign these F's to various segments.

# The real test

- Of the underspecification theory outlined by L&MW involves context-free redundancy effects:
- Cases of this sort have been reported (e.g. Lahiri and Reetz 2002 and later Lahiri and colleagues)
- If [t] = [0place] the matches below should be equally good “No mismatch” candidates

[ta] [pa] [ka]

/ta/

# Coronal vs. Labial primes

- Target: Zug ‘train’
- Acoustic primes:
  - T: Bahn [ba:n] ‘railroad’
  - P: \*Bahm [ba:m]
- Predicted: both T and P primes should facilitate reaction to target, since both [ba:n] and [ba:m] activate *Bahn* /ba:N/, N nasal unspecified for place.

prime	Maus	Bahn	Bahm	Bahp	Bahl
RT	590	*558	*570	598	588

# Coronal vs. Labial primes

- Target: Krach ‘crash’
- Acoustic primes:
  - P: Lärm [lærm] ‘noise’
  - T: \*Lärn
- Predicted: only P primes should facilitate reaction to target, since only [m] activates /m/ while [n] mismatches.

prime	Krach	Lärm	Lärn	Lärp	Lärs
RT	598	*571	599	590	591



# Coronal vs. Labial primes

- Target: Krach ‘crash’
- Acoustic primes:
  - P: Lärm [lærm] ‘noise’
  - T: \*Lärn
- Predicted: only P primes should facilitate reaction to target, since only [m] activates /m/ while [n] mismatches.

Why one might still be sceptical:  
most phonological evidence for  
underspecification is better  
attributed to other factors.

# Markedness and underspecification

- “[-nasal] is not specified because it is unmarked”
- Diagnostics of unmarked status (Trubetzkoy 1938)
  - implied in implicational laws:
    - e.g. if nasalized V then oral V (French vs. Italian)
  - target structure in context-free neutralization processes:
    - e.g. no contrast of nasality in stressless syllables (Acehnese)
      - only nasal V’s after nasal segment, only oral otherwise.
- Diagnostics of underspecified status (Archangeli 1983)
  - target of assimilation/deletion
    - e.g. oral C (e.g. /**d**/) assimilate to nasals, not vice-versa.
  - target structure in epenthesis
    - illustrative conjecture: epenthetic segments are not nasalized, unless by assimilation
  - invisible in long-distance processes, inert
    - E.g. oral segments betw. trigger and target don’t block some nasal assimilations: Kikongo **nsuk-idi** ‘we washed’ vs. **tunik-ini** ‘we ground’

For features like [ $\pm$ nasal], diagnostics of unmarkedness and underspecification converge on the same value.

Hence the conjecture:  
unmarked = underspecified in UR.

# Caveat

- Some asymmetry between marked and unmarked values holds cross-linguistically for some F's:
  - nasal, round, spread/constricted glottis.
- But it is hard to show or false for others:
  - [+high] and [-high] are marked or not in this sense only in combination with other features. [+voice] and [-voice] are each marked in some contexts ( $\_ \#$ ,  $V\_V$ ,  $N\_$ ; Flemming 2004).
  - More examples in Steriade 1995 in Goldsmith (ed.), latest in Rice 2006 in de Lacy (ed.) *Cambridge Handbook*

# Deletion, insertion in rule-based underspecification

- Underspecified segments more likely to be deleted because they have fewer or no features.
- More likely to be inserted because you only insert their X slots, not the features: the latter come from the application of context-free redundancy rules.

# Underspecification and faithfulness

- In a grammar with a faithfulness component, a value that is identified as  $[0F]$  is more deletable than  $[\alpha F]$ : no MAX F violation
- But any feature inserted will cause a DEP F violation, so to distinguish between features more or less likely to be inserted we need rankings of DEP F, not underspecification.

# N-ary scales and underspecification

- Binary differences can be characterized, with underspecification, as  $[\alpha F]$ - $[0F]$ :
  - Catalan coda **t, d** assimilates to **p, b** and **k, g**:
  - **p** and **k** do not assimilate to each other or to **t, d**.
  - so  $[0Place]$  assimilates to  $[\alpha Place]$
- But for n-ary scales ( $n > 3$ ) of assimilation, deletability or epenthesis, underspecification explains only a fragment of the data to be analyzed.



# Unmarked $\neq$ underspecified

- 3<sup>+</sup>-step hierarchies in assimilation, deletion and insertion
  - Korean Place Assimilation (Jun 1995, 2004): **K > P > T**
    - **tp, tk -> pp, kk**                      **pt, kt** intact.
    - **pk -> kk ~ pk**                              **kp** intact
  - Coalescence/F-Sensitive Elision in hiatus (Casali 1997): **a > e > i**
  - Japanese epenthesis(Ito&Mester 1995): **o/t, d\_ ; i/tʃ, k\_ ; u/other**  
**C\_ > other V**
- coronal = [0 place]: explains 1/2 of Korean pattern of assimilation.
- **u** = [0 high, 0back]: does not explain **i, o** vs. other preference
- Other hierarchies of deletion and assimilation cannot be recoded as [αF]-[0F]: root vs. affix segment, initial vs. non-initial.

# Unmarked $\neq$ underspecified

- The hierarchies are analyzable with MAX/DEP rankings:
  - MAX F/root  $\gg$  MAX F/affix
  - MAX Dorsal  $\gg$  MAX Labial  $\gg$  MAX Coronal
  - MAX/DEP [+Low]  $\gg$  MAX/DEP [-High]  $\gg$  MAX/DEP [+High]
- Perhaps all the necessary MAX/DEP rankings can be predicted from effects of input-output similarity.
  - Preference for [o] over [u] in epenthesis after t, d\_ in Japanese is indirectly aimed at preventing DEP [strident] IO violations.
- Then the uses of underspecification are subsumed by mechanisms needed independently.
- Maybe not all that is clear as yet. What is clear is that underspecification accounts for just a fragment of the patterns it was designed to explain.