Incomplete neutralization from language-specific abstraction: Huai'an Mandarin

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Overview

- Incomplete neutralization: lexicon "bypasses" phonology and influences phonetics directly

- Difficult for most standard models of phonology

- Proposal: neutralization arises from interplay and mixing of different co-occurring (language-specific) levels of abstraction (*a la* Construction Grammar)

- Consequence: "deep" lexical values can directly influence phonetic realization

Incomplete neutralization

- Classic case: Dutch, German and other languages have final devoicing, but still fine-grained phonetic cue differences between final underlyingly voiced and voiceless sounds (e.g., Warner et al. 2004)

		UR	SR	phonetic realization
Dutch	*'wheel'*	/rad/	|rat|	$[rat_d]$
	'rat'	/rat/	|rat|	$[rat_t]$

- Surface representation has lost voicing contrast
- How does information about contrast reach phonetic realization?

Further empirical case studies

- Japanese long vs. lengthened vowels (Braver & Kawahara 2016, Braver 2019)
  - Length contrast in vowels: ki 'tree' vs. kii 'key'
  - Monosyllabic NPs are lengthened: ki-mo 'tree also' vs. kiː 'tree'
  - However, lengthened short vowels are still systematically shorter than long vowels in same prosodic position: duration(*kiː*) < duration(*kii*)

- Mandarin underlying vs. derived Tone 3 (Du & Durvasula 2022; Zeng et al. 2025, this conference)
  - Huai'an: Contrast between T1<>T3: pa^1 'play with' vs. pa^3 'smash (to eat)'
  - Sandhi prohibits *T1-T1, creates new T3: /u^2 pa^1 xa^1/ → [u^2 **pa³** xa^1]
  - Derived T3 = underlying T3 in phonology, but not in phonetic realization

Theoretical proposals

- Van Oostendorp (2008): Containment theory of faithfulness leaves traces of UR in surface phonology, may be exploited by phonetics (*Containment*)

- Braver (2019): Paradigm uniformity is active in phonetic realization and biases realizations towards un-neutralized paradigm members (*Paradigm pressures*)

- Nelson & Heinz (2022, 2025): Direct route from the lexical intention to the phonetics
(*Enriched architecture*)

Proposals vs. Case studies

- Braver (2019) argues Japanese case is incompatible with the Containment solution, since it is neutralization to a structurally marked situation (bimoraic rather than monomoraic)

- Mandarin appears to be incompatible with paradigm pressures, as tone adjustments appear to operate on the phrase level

- Enriched architectures should be sufficient to account for all three, but are enrichments also necessary for these phenomena?

	Containment	Paradigm pressures	Enriched architecture
Dutch devoicing	✓	✓	✓
Japanese lengthening	✗	✓	✓
Mandarin tone sandhi	?	✗	✓

My contribution

- Goal: account for Mandarin case study with standard architecture (i.e., lexicon → phonology → phonetics)

- Means: apply insights of Containment idea (hidden parts of surface representation pass on UR information to phonetics) to prosodic cases, adding explicit phonetic constraints (Flemming 2001, Braver 2019)

- Implementation: language-specific abstraction levels and constraints in the spirit of Construction Grammar (e.g., Goldberg 1995) – combined with an OT-style analysis

Data: Huai'an Mandarin

- Case study that is prosodic and non-paradigm-based

- Based on between-word tonal adjustments

- Tone inventory (Du & Durvasula):
  - Tone 1: high falling
  - Tone 2: high rising
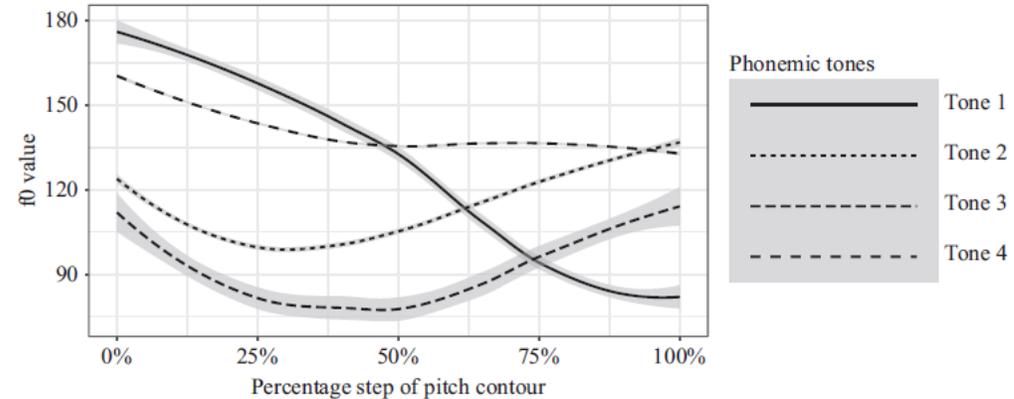 - Tone 3: low rising
  - Tone 4: high level

Figure 1. Tonal contour of phonemic tones in Huai'an.

Figure taken from Du & Durvasula

Phonological side: Neutralizing tone sandhi

- *T1-T1: first syllable changes to T3 (optional process)

$/u^2$ pa^1 $xa^1/ \rightarrow [u^2$ pa^3 $xa^1]$ 'Mr. Wu^2 plays with shrimp'
MH HL HL   MH LM HL

- *T3-T3: first syllable changes to T2 (obligatory)

$/u^3$ pa^3 $xa^1/ \rightarrow [u^2$ pa^3 $xa^1]$ 'Mr. Wu^3 smashes shrimp (to eat)'
LM LM HL   MH LM HL

- T1 sandhi feeds T3 sandhi: derived T3 counts as true T3 (neutralization)

$/u^3$ pa^1 $xa^1/ \rightarrow (u^3$ pa^3 $xa^1 \rightarrow) [u^2$ pa^3 $xa^1]$ 'Mr. Wu^3 plays with shrimp'
LM HL HL   LM LM HL   MH LM HL

Examples from Du & Durvasula

Phonetic side: T1/T3 contrast remains expressed

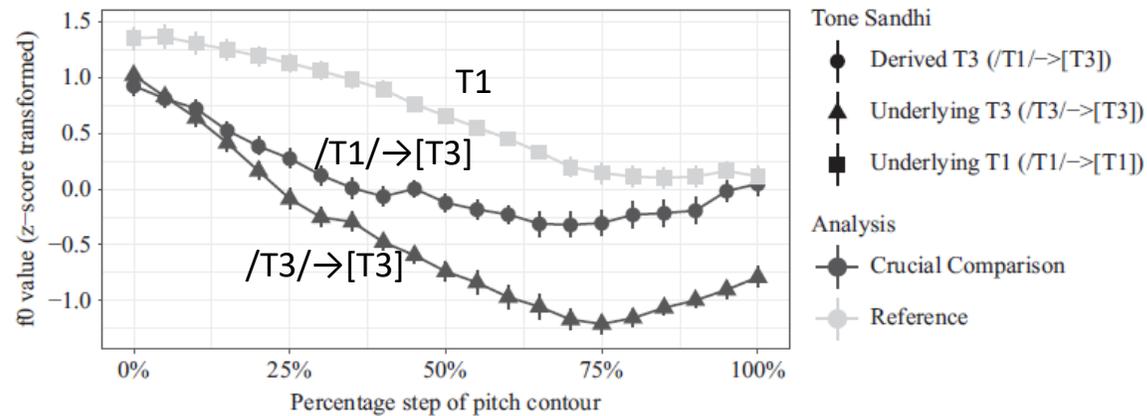- T3 derived from /T1/ is realized differently from underlying T3 (closer to the high tone of T1)

Figure 3. *Comparison of second-syllable contours in Experiment 1 (Tone 1; error bars indicate standard error).*

Figure taken from Du & Durvasula

Analytic framework

- Language-specific abstraction – at least some phonological representational elements are emergent from distributional learning (e.g., Mielke 2004, Dresher 2009, Mayer 2020)

e.g. language-specific (un)natural classes can get their own feature dimension; but also "deeper" features – like [T] for functional voicelessness in Canadian Raising: wr[əɪɾ$_{[+T]}$]er – r[aɪɾ$_{[-T]}$]er

- Constraints are at least partially language specific (cf. Hayes and Wilson 2008) and can mix different levels of abstraction

e.g., in syntax [I hope this N finds you well], [the Adj-er the Adj-er] (Goldberg 2025); in phonology: *[aɪ]C$_{[+T]}$

  - Useful for interplay between systematic syntax versus idioms and fixed expressions – but also for interplay between lexical and phonotactic effects

Levels of abstraction in this case

- We need access to a surface, near-phonetic representation of tone
  - In this case, 6 levels from lowest to highest, corresponding to graph in Du & Durvasula (2022) – 0 through 5; but likely to be continuous
- We need a way to refer to tone categories T1, T2 etc., since tone sandhi prohibits certain sequences of tone categories
  - *T1-T1 is changed to T3-T1, *T3-T3 is changed to T2-T3
- From distributional learning and incomplete neutralization data, speakers may have abstracted deeper categories of tones:
  - [α], normally corresponds to [T1], but to [T2] or [T3] in sandhi
  - [γ] corresponds to [T3], but to [T2] in sandhi

General setup of analysis

- Canonical T1 syllables underlyingly have [α], canonical T3 syllables underlyingly have [γ] and grammar has constraints *[α,T2], *[α,T3], *[γ,T2]

/pa$^{γ:3}$/ /pa$^{α:1}$/ /xa$^{α:1}$/

- High-ranked *T1-T1, *T3-T3 force certain syllables to be realized with mismatching tones

/u$^{γ:3}$ pa$^{α:1}$ xa$^{α:1}$ / (→ u$^{γ:3}$ pa$^{α:3}$ xa$^{α:1}$) → u$^{γ:2}$ pa$^{α:3}$ xa$^{α:1}$

- Constraints on the realization of T3 and tones over [α] syllables compete to create blended T1/T3 melody (inspired by Braver 2019) – this requires weighted constraints (Harmonic Grammar)

/pa$^{α:1}$ xa$^{α:1}$/ → [p**áàā**$^{α:3}$ xa$^{α:1}$]   /pa$^{γ:3}$ xa$^{α:1}$/ → [páàà$^{γ:3}$ xa$^{α:1}$]

Details: data

- 3 actual data points based on Du and Durvasula (F0 realization quantized to 3 time points and 5 height points):

/(u^2) pa$^{\gamma:3}$ xa$^{\alpha:1}$ / → [(u^2) páà̀$^{\gamma:3}$ xa$^{\alpha:1}$]   Mr. Wu^2 plays with shrimp

/(u^2) pa$^{\alpha:1}$ xa$^{\alpha:1}$ / → [(u^2) páàā$^{\alpha:3}$ xa$^{\alpha:1}$]   Mr. Wu^2 smashes shrimp (to eat)

/u$^{\gamma:3}$ pa$^{\alpha:1}$ xa$^{\alpha:1}$ / → [u$^{\gamma:2}$ páàā$^{\alpha:3}$ xa$^{\alpha:1}$]   Mr. Wu^3 smashes shrimp (to eat)

- 4 Richness-of-the-Base inputs:

/pa$^{\alpha:3}$ xa$^{\alpha:1}$/ /pa$^{\alpha:3}$/ (underlying T3 with [α] should behave like T1)
/pa$^{\gamma:3}$ xa$^{\alpha:1}$/ /pa$^{\alpha:1}$/ (underlying T1 with [γ] should behave like T3)

- Surface values considered: {u^2,u^3}, {pa^1,pa^3} *x* all quantized F0 values between T3 (v́ v̏ v̀) and T1 (v̋ v̄ v̄)

Details: constraints

- Tonal constraints:

*T1   *[α,T3] *T1-T1   *T3-T3   weight = 20
Ident(T)   weight = 1

- F0 realization constraints link Tone value (Tx$_j$: any tone on index *j*) to desired quantized F0 value (0 and 5) at start, middle, or end of the syllable

- Violations: distance between true and desired value is squared, then negative summed as per Braver (2019)

T1=v̋(5)vv   T1=vv̄(3)v   T1=vvv̄(3)   T3=v́(4)vv   weight = 5

α=v̋(5)vv   α=vv̄(3)v   α=vvv̄(3)   weight = 3

T3=vv̌(0)v   T3=vvv̀(1)   weight = 1

Underlying T3: canonical melody

/u$^{β:2}$ pa$^{γ:3}$ xa$^{α:1}$/	w = 20	20	20	5	5	3	1	1	Harmony
*T1-T1 *T3-T3	*T1	*[α, T3]	T3=́vvv	T1=̋vvv T1=v̄vv T1=vv̄v	α=̋vvv α=v̄vv α=vv̄	T3=v̀v T3=vv̀	I$_D$(T)		
u^2 pa̋$_5$ā$_3$ā$_3^1$ xa^1	-1	-2						-1	-61
u^2 pá$_4$à$_2$ā$_3^1$ xa^1	-1	-2			-1-1-0=-2			-1	-71
u^2 pa̋$_5$ā$_3$ā$_3^3$ xa^1		-1		-1			-(3²)-(2²)=-13		-38
u^2 pá$_4$à$_2$ā$_3^3$ xa^1		-1					-(2²)-(2²)=-8		-28
☞ u^2 pá$_4$à$_0$à$_1^3$ xa^1		-1							**-20**

Derived T3: incomplete neutralization

/$u^{β:2}$ pa$^{α:1}$ xa$^{α:1}$/	w = 20	20	20	5	5	3	1	1	Harmony
	*T1-T1 *T3-T3	*T1	*[α, T3]	T3=v́̋vv	T1=v́̋vv T1=vv̄v T1=vvv̄	α=v́̋vv α=vv̄v α=vvv̄	T3=vv̀v T3=vvv̀	I$_D$(T)	
u^2 pá̋$_5$ā$_3$ā$_{3j}^1$ xa$_j^1$	-1	-2							-60
u^2 pá$_4$à$_2$ā$_{3j}^1$ xa$_j^1$	-1	-2			-1-1-0=-2	-1-1-0=-2			-76
u^2 pá̋$_5$ā$_3$ā$_{3j}^3$ xa$_j^1$		-1	-1	-1			-(3²)-(2²)=-13	-1	-59
☞ u^2 pá$_4$à$_2$ā$_{3j}^3$ xa$_j^1$		-1	-1			-1-1-0=-2	-(2²)-(2²)=-8	-1	**-55**
u^2 pá$_4$à̀$_0$à$_{1j}^3$ xa$_j^1$		-1	-1			-1-(3²)-(2²)=-14		-1	-83

Derived T3 triggers T3 sandhi

$/u^{\gamma:3}\ pa^{\alpha:1}\ xa^{\alpha:1}/$	w = 20	20	20	5	5	3	1	1	Harmony
	*T1-T1 *T3-T3	*T1	*[α, T3]	T3=v́vv	T1=v̋vv T1=vv̄v T1=vvv̄	α=v̋vv α=vv̄v α=vvv̄	T3=vv̀v T3=vvv̀	$I_D(T)$	
$u^3\ pá̋_5ā_3ā_{3j}^1\ xa_j^1$	-1	-2							-60
$u^3\ pá_4à_2ā_{3j}^3\ xa_j^1$	**-1**	-1	-1			-1-1-0=-2	$-(2^2)-(2^2)=-8$	-1	-75
☞ $u^2\ pá_4à_2ā_{3j}^3\ xa_j^1$		-1	-1			-1-1-0=-2	$-(2^2)-(2^2)=-8$	-2	**-56**
$u^2\ pá_4ā̀_0à_{1j}^3\ xa_j^1$		-1	-1			$-1-(3^2)-(2^2)=-14$		-2	-84

Generalizability

- /γ,T3/ vs. /α,T1/ undergo **both** phonological neutralization (derived T3 triggers T3 sandhi) **and** phonetic differentiation (derived T3 is realized as a compromise between T1/T3 melodies)

- Behaviour of ROTB inputs shows that no fully neutralizing alternations are expected even in novel words:
  - /γ,T1/ behaves like /γ,T3/: /pa$^{γ:1}$/ → [pa$^{γ:3}$], /pa$^{γ:1}$ xa$^{α:1}$ / → [páàà$^{γ:3}$ xa$^{α:1}$]
  - /α,T3/ behaves like /α,T1/: /pa$^{α:3}$/ → [pa$^{α:1}$], /pa$^{α:3}$ xa$^{α:1}$/ → [páàā$^{α:3}$ xa$^{α:1}$]

- Crucially: candidates that change underlying [α] and [γ] not considered
  - Not digestible by phonological system? Lexical entry constraints? Work in progress

Discussion

- Current approach successfully revives Van Oostendorp's (2008) idea that neutralized contrasts can be "smuggled" through phonetically inert aspects of surface structure

- Braver's (2019) phonetic constraints, based on Flemming (2001), allow an explicit account of the F0 contours

- Thus, if this account holds, enriched architectures do not appear to be strictly necessary for incomplete neutralization

- Potential to implement cascading activation using multiple levels of representational abstraction (cf. Zeng et al. 2025, this conference)

Conclusion

- Indexed constraints can provide a mechanism to account for incomplete neutralization with a standard grammar architecture
- Also provide an account of opacity (Nazarov 2019; also present in Van Oostendorp 2008)
- Crucial idea: indexation remains constant throughout phonological derivation
- More detailed analysis of F0 trajectories needed, and intersection with processing, lexical intention aspects
- Additional work: Japanese lengthening, other cases of incomplete neutralization

Thank you!

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