Incomplete neutralization with weighted phonetic constraints

Aaron Braver
Texas Tech University
www.aaronbraver.com

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Overview

- Incomplete neutralization (IN) is problematic for classical modular feed-forward grammars
- Case study: Japanese monomoraic lengthening
- My claim: IN is (largely) due to Paradigm Uniformity
- Model: weighted constraints forcing compromise

Roadmap

- Incomplete neutralization
- Japanese monomoraic noun lengthening
- Previous accounts
- Weighted Paradigm Uniformity
- (Other cases of IN?)

Neutralization

Neutralization

- Complete neutralization
  - *The surface acoustic realization of the contrast between two underlyingly distinct segments is completely identical*
- Incomplete neutralization
  - *The surface acoustic realization of the contrast between two underlyingly distinct segments is less distinct than the segments' canonical realizations in a non-neutralizing context, but they are not completely identical*

Classical example of IN

- German final devoicing (Mitleb 1981a,b, Port et al. 1981, Port & O'Dell 1985, Röttger et al. 2014, inter alia)
- /ʁad/ ≠ /ʁat/
  - Preceding vowel duration
  - Aspiration duration
  - Voicing during closure
  - Closure duration

Other examples of IN

- More final devoicing
  - Catalan (Dinnsen & Charles Luce 1984), Dutch (Warner et al. 2004), Russian (Dmitrieva 2005), Polish (Slowiaczek & Dinnsen 1985)
- American English flapping (Braver 2014, Fisher & Hirsh 1976, Zue & Laferriere 1979)
- Morphological tone in Cantonese (Yu 2007)
- Coda Aspiration in Andalusian Spanish (Gerfen 2002)
- Monomoraic noun lengthening in Japanese (Mori 2002, Braver & Kawahara 2014, 2016)

Observation: what can be incomplete?

- Many cases deal with [voice] in some way
- Suprasegmental features (Cantonese, Japanese)
- Often realized through length distinctions

Modular feed-forward grammars

- Phonetics and phonology are separate modules
- Information flows in one direction

Japanese monomoraic lengthening

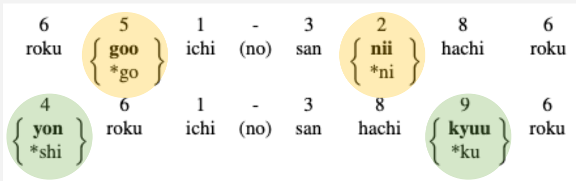
Japanese bimoraicity requirement

- Japanese requires that all prosodic words (ω) have at least two moras (Itô 1990, Mester 1990, Poser 1990, Mori 2002, Itô & Mester 2003)
- Bimoraic template in a variety of word-formation patterns:
  - Nickname formation
  - Loanword abbreviation
  - Verbal root reduplication
  - Scheduling compounds
  - Telephone number recitation

Nickname formation

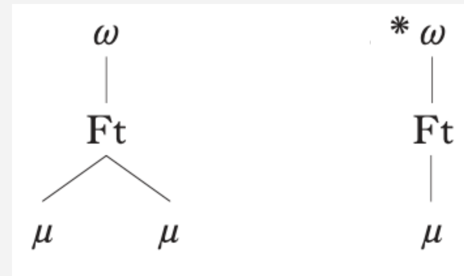
Wasaburoo	(full name)	b.	Kotomi	(full name)
Wasa(-chan)	(2 moras)		Koto(-chan)	(2 moras)
*Wa(-chan)	(1 mora)		Koc(-chan)	(2 moras)
			*Ko(-chan)	(1 mora)

Telephone number recitation



Lengthening
Allomorph substitution

Bimoraicity requirement

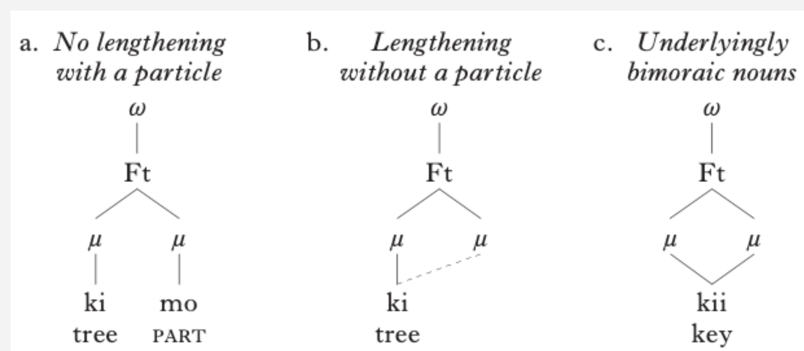


And yet…

- Perfectly cromulent Japanese nouns:

Orthography	Romaji	Gloss
木	ki	tree
酢	su	vinegar
都	to	city
背	se	height

Monomoraic lengthening



Monomoraic lengthening is incompletely neutralizing

Sample stimulus set (from Braver & Kawahara 2016)

	condition	*orthography*	
a.	short, with particle	木もなくしたよ。	ki mo nakushita yo tree also lost DISC
b.	short, no particle	木なくしたよ。	ki nakushita yo tree lost DISC
c.	long	キーなくしたよ。	kii nakushita yo key lost DISC

Monomoraic lengthening is incompletely neutralizing

condition	mean	SD	rounded
unlengthened short (with particle)	54.99	21.89	50
lengthened short (without particle)	124.98	34.91	125
underlyingly long (without particle)	157.45	39.21	150

Table I

Means, standard deviations and rounded values for vowel duration of nouns (in ms), from Braver & Kawahara (2016) (12 speakers, 15 sets of 3 nouns (= 45 items in total), 7 repetitions).

Some previous accounts of IN

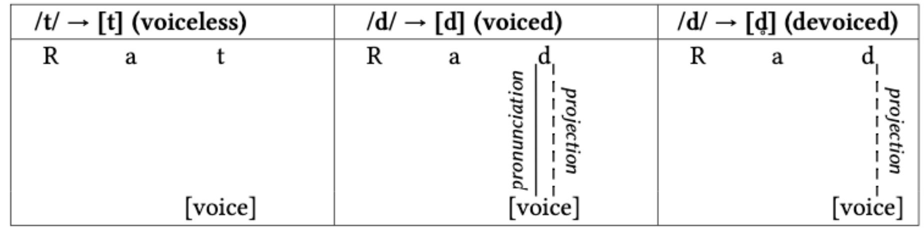
Interleaved phonetic and phonological rules

- Anderson (1975) on flapping:
  - Phonetic rule applies first:
    - V→ [+long] /_ [+voice]
  - Phonological rule applies second:
    - {t,d} → [ɾ] / V _ V̌

Turbidity Theory

- Under Turbidity Theory (Goldrick 2000), segments can be linked to features by:
  - *Projection*: "abstract, structural relationship"
  - *Pronunciation*: "describes the output realization of structure)
- Van Oostendorp's (2008) strategy: underlyingly voiceless segments are distinct from devoiced segments in the phonological output

Turbidity theory



Candidate chains

- Gouskova & Hall (2009) let phonetics see a segment's derivational history via a Candidate Chain (McCarthy 2007)
- Lebanese Arabic epenthetic vowels are either shorter, backer, or both than lexical vowels

Candidate chain for epenthesis of [i]
/CC/ <CC, CɨC, CəC, CiC>

Other proposals

- Exemplar-based (Yu 2007)
- Phonology has fine-grained control of phonetics; context-dependent realization is just like allophony (Kingston and Diel 1994, Yu 2011)
- "Cascading activation" (Goldrick & Blumstein 2006)

Paradigm uniformity

- An early example from Steriade (2000)

a.	*bas retrouvé*	[ba ʁ̱ətʁuve]	'stocking found again'
b.	*bas r'trouvé*	[ba ʁ̱tʁuve]	'stocking found again'
c.	*bar trouvé*	[baʁ̱ tʁuve]	'bar found'

- ʁ in (b) surfaces "with qualities that would only be appropriate if the schwa was still present"

Paradigm uniformity and basehood

Paradigm uniformity

- Benua (1997): Just as bases and reduplicants are related, so too are forms within the same morphological paradigm
  - Faithfulness to paradigm members vs. markedness leads to under- or over-application of phonological processes
- Steriade (2000): This happens with fine phonetic detail, too

Basehood

- Which member of the paradigm are you faithful to?
- Morphological complexity (Benua 1997)
- Orthographic form (influence on IN: Fourakis and Iverson 1984, Warner et al. 2006)
- Frequency (Mańczak 1958, Steriade 2013)
- Maximal informativeness (Albright 2002a,b)

Basehood in the Japanese paradigm

- With particle: ki mo…
- Without particle: ki ∅…
- Long: kii…

Japanese basehood: morphological complexity?

- With particle: ki mo…
- Without particle: ki ∅…
- Long: kii…

Japanese basehood: orthography?

- With particle: fu mo… 麩も
- Without particle: fu ∅… 麩
- Long: fuu… 封

- Length not usually encoded…

Japanese basehood: frequency?

o (ACC)	*no* (GEN)	*ni* (DAT)	*ga* (NOM)	*wa* (TOP)	∅
1121 17.11%	1002 15.30%	965 14.73%	847 12.93%	672 10.26%	764 11.66%

Table III

Frequency of most common particles in the NPCMJ corpus. Percentages indicate frequency among all nouns ($n = 6550$).

Japanese basehood: maximal informativeness

- *…learners select the base form that is maximally informative, in the sense that it preserves the most contrasts, and permits accurate productive generation of as many forms of as many words as possible.* (Albright 2002a)
- *…suffering from the fewest phonological neutralizations, and maintaining the most contrast* (Albright 2002b)
- *Phonological neutralizations obscure underlying contrasts, therefore forms which undergo neutralization may be less informative than forms which do not* (Braver 2020)

An assumption about informativeness

- Even incomplete neutralizations are still "bad" for informativeness since a contrast is obscured
- (We can debate later whether they're as bad as complete neutralizations)

- So: [*ki Ø*] is less informative than [*ki mo*]

Pitch accent neutralization (background)

- PWds in Japanese may carry a pitch accent, realized as H on the accented mora, with L on all following moras
- (If a word has no pitch accent, it is usually realized as LH, unless only one mora, in which case H)

a.	*unaccented*	ame+ga LHH	'candy-NOM'
	accented	a'me+ga HLL	'rain-NOM'
b.	*initial accent*	ka'ta+ga HLL	'shoulder-NOM'
	peninitial accent	kata'+ga LHL	'model-NOM'

Pitch accent neutralization

- In phrase-final short syllables, it is sometimes impossible to tell whether the final mora is accented or not (McCawley 1968)
- Without particle (contrast obscured)

accented	ki' H	'tree'
unaccented	ki H	'spirit'

- With particle (contrast returns)

accented	ki'+ga HL	'tree-NOM'
unaccented	ki+ga HH	'spirit-NOM'

The Weighted Paradigm Uniformity theory of incomplete neutralization

Assumption: weighted phonetic constraints

- Model assumes that weighted constraints can interact with fine phonetic detail
- Either:
  - Phonology first, then phonetics with weighted constraints (à la Zsiga 2000)

    or
  - Merged phonetics and phonology with weighted constraints (à la Flemming 2001)

TargetDur constraints

- DUR(μ)=TARGETDUR(μ)
  - The duration of a mora-bearing unit which bears a single mora in the output should match the target (canonical) output duration for that mora-bearing unit when it bears one mora.
  - *cost* = *w**(*TargetDur*(μ) – Dur(cand))^2
- DUR(μμ)=TARGETDUR(μμ)
  - Same as above, *mutatis mutandis*
- (Along the lines of Flemming 2001's C-DURATION and σ-DURATION)
- (Also assume DEP(μ) and FTBIN(μ))

What are the targets?

condition	mean	SD	rounded
unlengthened short (with particle)	54.99	21.89	50
lengthened short (without particle)	124.98	34.91	125
underlyingly long (without particle)	157.45	39.21	150

- TARGETDUR(μ) = 50ms
- TARGETDUR(μμ) = 150ms

Targeting short vowels

- Assuming *w*=1

/<u>ki</u> mo/ (unlengthened short)	DUR(μ)=TARGETDUR(μ)
a. V duration = 30 ms	400 (1 × (50 – 30)²)
b. V duration = 40 ms	100 (1 × (50 – 40)²)
☞ c. V duration = 50 ms	0 (1 × (50 – 50)²)
d. V duration = 60 ms	100 (1 × (50 – 60)²)
e. V duration = 70 ms	400 (1 × (50 – 70)²)

Targeting long vowels

- Assuming *w*=1

/kii (μμ)/	DUR(μμ)=TARGDUR(μμ)	FTBIN(μ)	DEP(μ)	*total*
i. [μμ] V dur=130 ms	400 (1 × (150 – 130)²)	0	0	400
ii. [μμ] V dur=140 ms	100 (1 × (150 – 140)²)	0	0	100
☞ iii. [μμ] V dur=150 ms	0 (1 × (150 – 150)²)	0	0	0
iv. [μ] V dur=150 ms	0 (*vacuous*)	2	0	2
v. [μμ] V dur=160 ms	100 (1 × (150 – 160)²)	0	0	100
vi. [μμ] V dur=170 ms	400 (1 × (150 – 170)²)	0	0	400

Without another constraint…

- Assuming *w*=1

/ki Ø (μ)/				
i. [μμ] V dur=130 ms	400 (1 × (150 – 130)²)	0	1	401
ii. [μμ] V dur=140 ms	100 (1 × (150 – 140)²)	0	1	101
☞ iii. [μμ] V dur=150 ms	0 (1 × (150 – 150)²)	0	1	1
iv. [μ] V dur=150 ms	0 (*vacuous*)	2	0	2
v. [μμ] V dur=160 ms	100 (1 × (150 – 160)²)	0	1	101
vi. [μμ] V dur=170 ms	400 (1 × (150 – 170)²)	0	1	401

OO-ID(dur)

- The duration of a segment in the candidate should be faithful to the duration of the same segment in the base
- *cost = w*(Dur(cand)* – Dur(base))²
- Again assuming *w=1:*

/<u>ki</u> Ø/$_\omega$ (lengthened short)	OO-ID(dur)
a. V duration = 25 ms	625 (1 × (25 – 50)²)
☞ b. V duration = 50 ms	0 (1 × (50 – 50)²)
c. V duration = 75 ms	625 (1 × (75 – 50)²)
d. V duration = 100 ms	2500 (1 × (100 – 50)²)

Interaction forces compromise

- DUR(μμ)=TARGETDUR(μμ) pressures underlyingly monomoraic but surface-bimoraic nouns without particles like [ki ∅] towards 150ms
- OO-ID (dur) pressures the same nouns towards 50ms (base [ki] is 50ms)
- Desired result: 125ms

Interaction forces compromise

Lengthened V dur (ms)	*cost*(OO-ID(dur)) $w_{\mathrm{ID}}(Dur(cand) - Dur(base))^2$	*cost*(DUR($\mu\mu$)=TARGDUR($\mu\mu$)) $w_{\mu\mu}(TargDur(\mu\mu) - Dur(\mu\mu))^2$	*total cost*
75	$1 \times (75 - 50)^2$	$3 \times (150 - 75)^2$	17500
100	$1 \times (100 - 50)^2$	$3 \times (150 - 100)^2$	10000
125	$1 \times (125 - 50)^2$	$3 \times (150 - 125)^2$	7500
150	$1 \times (150 - 50)^2$	$3 \times (150 - 150)^2$	10000

Table IV

Costs for given lengthened short vowel durations, where $w_{\mathrm{Id}} = 1$, $w_{\mu\mu} = 3$, $TargetDur(\mu) = 50$ ms and $TargetDur(\mu\mu) = 150$ ms.

Other cases of IN

What about other cases of IN?

w_{Id}	$w_{\mu\mu}$	lengthened vowel duration
2	1	83.33
1	1	100.00
1	2	116.17
1	3	125.00
1	4	130.00

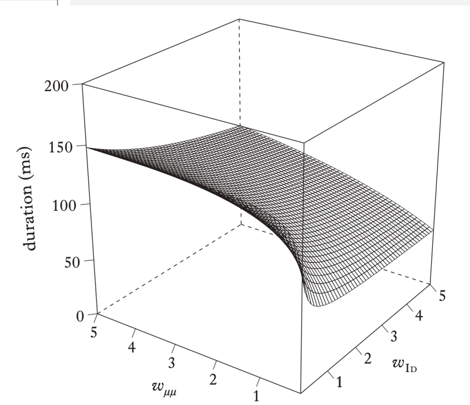


Figure 2

Predicted lengthened vowel duration, given weights for w_{Id} and $w_{\mu\mu}$ (TARGETDUR(μ)=50 ms; TARGETDUR($\mu\mu$)=150 ms).

(German) final devoicing

- In /ʁad/ → [ʁa˞t], what is the base?
- Perhaps nom pl. Räder? Gen sg Rades?
  - Can't be simplicity: Rad [ʁa˞t] is the simplest
  - Frequency: maybe if we combine all forms with –e...
  - Orthography: works, but...
  - Informativeness: tbd

AmE flapping

- In 'writer' /ɹɑɪtəɹ/ → [ɹɑɪɾəɹ], what is the base?
  - Possibly simplicity: 'write' is the simplest and you *shorten* to be uniform
  - Frequency: perhaps 'write' is more frequent than 'writer'
  - Orthography: works, but...
  - Informativeness: tbd

Thank you

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