

# Introduction

- Japanese: bimoraic minimality (e.g., Poser 1990, Itô 1990)
- Experiment I: monomoraic noun lengthening
  - Vowel length contrast: incompletely neutralized
- Experiment II: number recitation lengthening
  - Vowel length contrast: completely neutralized
- One phonological constraint → complete *and* incomplete neutralization

# (In)complete Vowel Lengthening: Japanese Monomoraic Lengthening as Incomplete Neutralization

Aaron Braver and Shigeto Kawahara

Rutgers, The State University of New Jersey

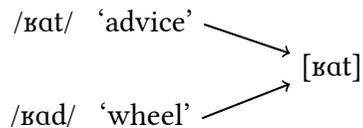
WCCFL 31  
9 February 2013

abraver@rutgers.edu  
www.aaronbraver.com

kawahara@rci.rutgers.edu  
rci.rutgers.edu/~kawahara

# Complete neutralization

- Complete neutralization: two underlyingly distinct segments become identical
- Classically-cited case: German final devoicing (Trubetzkoy 1939/1969, p. 235; Bloomfield 1933/1984, pp. 218-219; Jakobson et al. 1952/1975, p. 9; Hyman 1975, pp. 29, 71-72)
- The classic picture:



# Incomplete neutralization

- Incomplete neutralization: two underlyingly distinct segments become nearly identical
- Some small trace of the underlying distinction is manifested on the surface, in the direction of the canonical realization of the contrast
- /X/ → [Z<sup>(αF)</sup>] / (Context A)  
[αF]
- /Y/ → [Z<sup>(βF)</sup>] / (Context A)  
[βF]

## German devoicing, redux

- German devoicing is actually incompletely neutralizing (Port and O'Dell 1985)
  - /kʌt/ ≠ /kʌd/, even on the surface

## Phonetic duration and phonological length

Incomplete neutralization: often small surface difference in phonetic duration

*but*

We know of no previously-reported cases of incompletely neutralized phonological length distinctions<sup>1</sup>

<sup>1</sup> See discussion of trochaic lengthening in Hayes (1995) and final lengthening in Chickasaw in Gordon and Munro (2007), which suggest that vowel lengthening might be an area rich for investigation.

## Commonly-cited cases of incomplete neutralization

- German final devoicing (Port and O'Dell 1985, Mitleb 1981a,b, Dinnsen and Garcia-Zamor 1971, though see Fourakis and Iverson 1984)
- Catalan final devoicing (Dinnsen and Charles-Luce 1984)
- Polish final devoicing (Slowiaczek and Dinnsen 1985, Slowiaczek and Szymanska 1989)
- Russian final devoicing (Dmitrieva 2005)
- Dutch final devoicing (Warner et al. 2004, though see Warner et al. 2006)

## Questions

- (1) Can we expand the typology of incomplete neutralization to include new types of phonological contrasts?
- (2) When we say that a contrast is (in)completely neutralized, what is the scope of that claim?

# Japanese prefers minimally bimoraic words (Poser 1990, Itô 1990)

1990, Itô 1990)

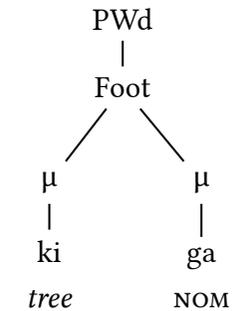
Nicknames map to bimoraic units

Name	Possible Nickname	Impossible Nickname
yumiko	(yumi) <sub>Ft</sub> -chaN	*(yu) <sub>Ft</sub> -chaN (1 mora)
megumi	(megu) <sub>Ft</sub> -chaN	*(me) <sub>Ft</sub> -chaN (1 mora)
keiko	(kei) <sub>Ft</sub> -chaN	*(ke) <sub>Ft</sub> -chaN (1 mora)
se	(see) <sub>Ft</sub> -chaN	*(se) <sub>Ft</sub> -chaN (1 mora)

# Monomoraic noun lengthening

Nouns with case particles

- Japanese has monomoraic nouns (e.g., *ki* 'tree')
- A case particle (e.g., *ga*, 'NOM') can provide the second mora



# Monomoraic noun lengthening

Nouns without case particles

Case particles can be dropped in colloquial speech

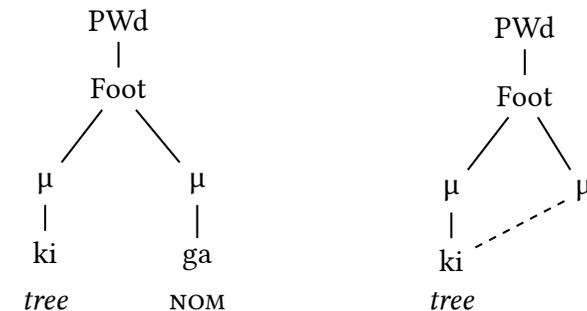
- (1) a. me-ga akai-yo  
b. me-∅ akai-yo  
'(Your) eyes are red'
- (2) a. te-o aratta?  
b. te-∅ aratta?  
'(Did you) wash (your) hands?'

Examples from Mori (2002)

# Monomoraic noun lengthening

Nouns without case particles

Monomoraic nouns without particles undergo lengthening of 40–50% (Mori 2002)



## Monomoraic noun lengthening

Nouns without case particles

...But:

- Japanese bimoraic syllables are generally 66–80% longer than monomoraic syllables (Beckman 1982, Hoequist 1983)
- Why only 40–50% longer, then?
  - Mori (2002): to preserve the length contrast

## Monomoraic lengthening as incomplete neutralization

Incomplete neutralization: some small trace of an underlying distinction remains on the surface

Does a trace of the underlying ‘shortness’ remain in lengthened nouns?

## What would it look like?

Monomoraic lengthening as complete vs. incomplete neutralization

Vowel duration if neutralization is *complete*

Short	
Lengthened	
Long	

Vowel duration if neutralization is *incomplete*

Short	
Lengthened	
Long	

## Motivation for Experiment I

- Two subclaims to prove incomplete neutralization:
  - lengthened nouns > short nouns (Mori 2002, but for only two nouns)
  - long nouns > lengthened nouns
    - Never shown for nouns with identical segmental content
- Most cases of incomplete neutralization: devoicing, feature/segment-level contrasts
- Itô (1990): Japanese bimoraicity requirement is ‘deep’ or ‘early’ in phonology

## Stimuli

- 11 sets of three sentences (n=33)
  - Monomoraic noun, with a particle ('short/prt')
  - Monomoraic noun, without a particle ('short/ $\emptyset$ ')
  - Underlyingly long noun ('long')
- Nouns within each set had the same segmental content
  - Accent was matched in 9 sets
- Standard Japanese orthography
- Long vowels indicated by either (a) kanji alone, or (b) kana with a length mark (ー)<sup>2</sup>
- See appendix

<sup>2</sup> Some 'long' morphemes written with kanji, had they been written in hiragana, would have been written as diphthongs. They are generally pronounced as long monophthongs, in spite of this orthographic convention (see Vance 2008, pp.63-68, for discussion).

## Sample stimuli sets

- |   |   |
|---|---|
| <p>(3) a. <u>short/prt</u><br/>         麩 か 素晴らしい<br/>         fu ga subarashi-i<br/>         gluten NOM excellent-PRES</p> <p>b. <u>short/<math>\emptyset</math></u><br/>         麩 素晴らしい<br/>         fu <math>\emptyset</math> subarashi-i<br/>         gluten <math>\emptyset</math> excellent-PRES</p> <p>c. <u>long</u><br/>         封 か とれた<br/>         fuu ga tore-ta<br/>         seal NOM come.off-PST</p> | <p>(4) a. <u>short/prt</u><br/>         血 か でた<br/>         chi ga de-ta<br/>         blood NOM going.out-PST</p> <p>b. <u>short/<math>\emptyset</math></u><br/>         血 でた<br/>         chi <math>\emptyset</math> de-ta<br/>         blood <math>\emptyset</math> going.out-PST</p> <p>c. <u>long</u><br/>         地位 か ある<br/>         chii ga aru<br/>         social.status NOM have</p> |
|---|---|

## Participants and recording information

- Participants
  - 7 native speakers of Japanese (one excluded)
  - Undergrad and grad students at Japanese universities
  - Paid ¥500 ( $\approx$ \$5)
- Recording details
  - Sound-attenuated room at International Christian University (Tokyo, Japan)
  - TASCAM DR-40 recorder

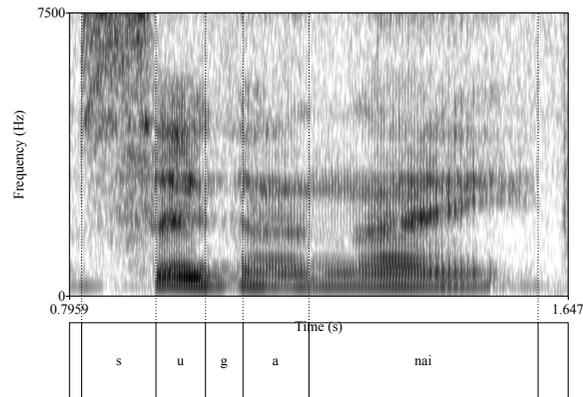
## Procedure

- 1 Speakers practiced all items once
- 2 Read all 33 sentences in random order
  - Speakers were instructed not to pause mid-sentence
- 3 Repeated 9 more times, re-randomized each time

# Acoustic measurements

## ■ Vowel duration

Speaker 14, 酔かがない (su ga nai), repetition 9



# Statistical analysis

Linear mixed model (via lme4 package in R).

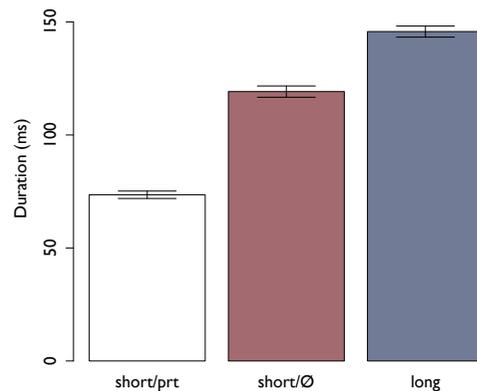
- Vowel duration was regressed against condition (short, lengthened, underlyingly long) as a fixed factor, and speaker and item as random factors
  - Planned contrasts (treatment coding): short vs. lengthened nouns, and lengthened vs. underlyingly long nouns.

# A three-way distinction

## Vowel duration

**Mean Vowel Duration**

Averaged over all speakers, items, and repetitions



Mean vowel durations

- short/prt: 73.54ms
- short/∅: 119.19ms
- long: 145.74ms

# Results

## Statistical significance

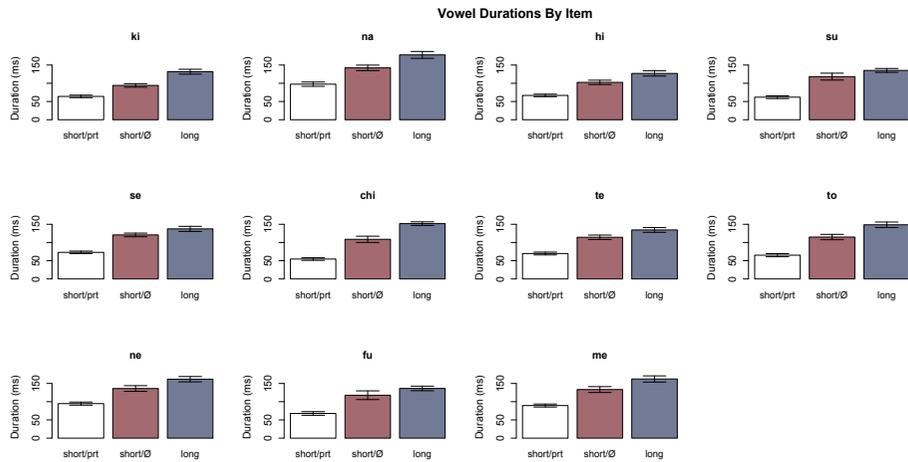
Condition has a significant effect on measured vowel duration<sup>3,4</sup>

- Short/prt vs. short/∅: mean difference -45.65ms,  $t = -8.018$ ,  $p < 0.001$
- Long vs. short/∅: mean difference 26.55ms,  $t = 1.369$ ,  $p < 0.05$

<sup>3</sup>  $p$  values estimated by Markov Chain Monte Carlo method, via languageR package in R.

<sup>4</sup> A t-test confirms the significance for the long vs. short/∅ vowel length distinction:  $t(1278.99) = -14.90$ ,  $p < 0.001$

# The pattern holds for all sets

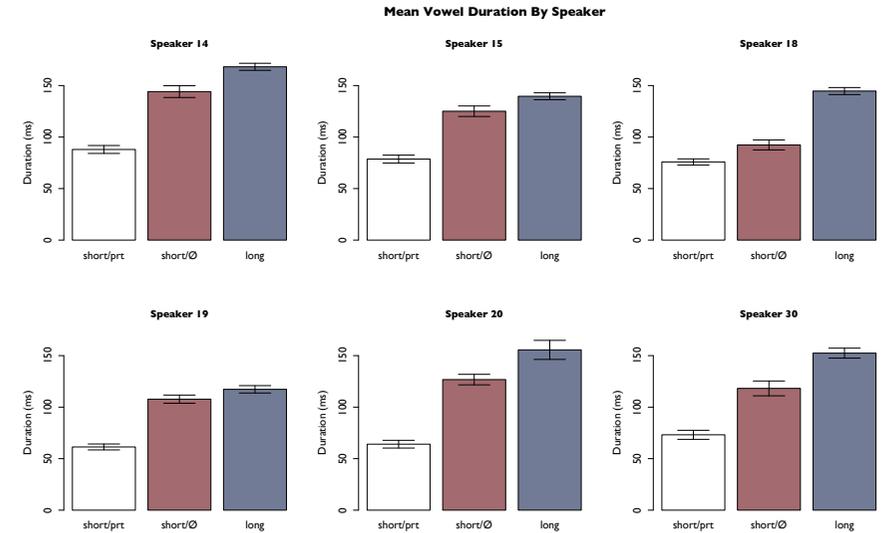


# Conclusions

Monomoraic nouns lengthen to meet the bimoraicity requirement

Vowel length is incompletely neutralized in this context

# And for all 6 speakers



# Implications for incomplete neutralization

- Most cases of incomplete neutralization are based on final devoicing
- Languages can incompletely neutralize a very different type of contrast (phonological length)
- A truly phonological process that leads to a case of incomplete neutralization which can't be relegated to phonetic implementation

## Experiment II

- Is the vowel length contrast incompletely neutralized *everywhere* in Japanese?
- Lengthening in a number recitation context, motivated by bimoraic minimality

## Telephone number recitation (Itô 1990)

- Each digit in a phone number stands as its own prosodic word
- If the digit has more than one mora, it gets used with no modification
  - 3: saN (μμ)
- If the digit has a bimoraic allomorph, that one gets used
  - 4: yoN (μμ), \*shi (μ)
- If a bimoraic allomorph does not exist, the digit is lengthened
  - 5: /go/ → [goo], \*[go]

### A sample phone number

4	5	9	-	3	2	8	4
yoN	goo	kyuu	(no)	saN	nii	hachi	yoN
*shi	*go				*ni		*shi

## Stimuli

### Main stimuli sets

- 2 sets of three phrases
  - Monomoraic number, non-lengthening context ('teens')
    - (juu-**ni**)<sub>Ft</sub> ban kara  
ten-two(=12) NUM from
  - Monomoraic number, lengthening context ('recitation')
    - ichi (**ni**)<sub>Ft</sub> san roku  
one two three six
  - Long noun, with identical segmental content ('long')
    - ano (**nii**)<sub>Ft</sub> san tachi  
those older.brother HON PL
- Target words shared segmental content, modulo vowel length
- Frames in matched in mora count

## Stimuli

### Additional stimuli sets

- 'Bimoraic' set (expectation: no lengthening)
  - san '3' in 'teens' and 'recitation' contexts
- 'Alternators' (expectation: bimoraic allomorph)
  - shi/yon '4' and ku/kyuu '9' in 'recitation' context

## Participants, recording information, procedure, and statistics

All details as in Experiment I, except:

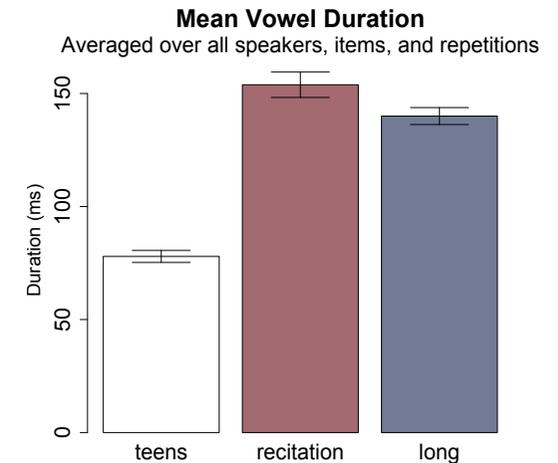
- 12 native speakers of Japanese (different from Experiment I)
- Each speaker read all items in random order 7 times

## Vowel duration

### Main sets

Mean vowel durations

- teens: 77.95ms
- recitation: 153.87ms
- long: 140.02ms



## Results

### Statistical significance

- ‘recitation’ (lengthened) vowels were significantly longer than ‘teens’ (short) vowels
  - mean difference: 75.92ms
  - $t = 10.586$
  - $p < 0.001$
- ‘recitation’ (lengthened) vowels are *not* significantly different from ‘long’ vowels
  - mean difference: 13.85ms
  - $t = 1.90$
  - *n.s.*

## Lengthened vs. long and the bimoraic set

- Lengthened ‘recitation’ vowels were slightly longer than ‘long’ numbers (mean difference: 13.85ms,  $t = 1.90$ , *n.s.*)
- Bimoraic set: comparable difference
  - ‘recitation’ vowels were 15.92ms longer than ‘teens’ vowels
- The ‘recitation’ condition may induce  $\approx 15$ ms of lengthening *beyond* bimoraic lengthening

## Alternator sets

- All speakers produced all tokens of all items using the bimoraic allomorph (i.e., yoN for ‘4’ and kyuu for ‘9’)

## Summary

- Experiment I: short/long vowel length contrast is *incompletely* neutralized in monomoraic noun lengthening
- Experiment II: short/long vowel length contrast appears *completely* neutralized in number recitation
- Duration-based length contrasts can be incompletely neutralized (Experiment I)
- A given contrast can be incompletely neutralized by one phonological process, but completely neutralized by a related process in the same language (Experiments I and II)

## Discussion

### Experiment II

- The short/long vowel length contrast appears to be *completely* neutralized in number recitation
- This lengthening is due to the same bimoraicity requirement as in Experiment I
- Non-significant difference between ‘recitation’ and ‘long’ vowels
  - Bimoraicity-lengthening +  $\approx 15$ ms additional lengthening

## Where does the difference come from?

A working hypothesis...

- Lexical vs. post-lexical levels (Kiparsky 1982a,b, 1985, Mohanan 1982, Kaisse and Shaw 1985)
- Monomoraic noun lengthening is conditioned by syntactic particles dropping ( $\rightarrow$  post-lexical)
- Allomorph selection in number recitation is affected by bimoraicity ( $\rightarrow$  lexical)
- Structure preservation (Kiparsky 1982a): lexical processes cannot introduce new segments

## Hypothesis

- Hypothesis: Only post-lexical processes can introduce incompletely neutralized contrasts
- Preliminary typological support:
  - Devoicing in Russian is incomplete (Dmitrieva et al. 2010), and occurs across word-boundaries (Padgett 2011)
  - Flapping in American English is incomplete (Braver under review, Herd et al. 2010) and occurs across word-boundaries

AND

- Manner neutralization in Korean codas is complete (Kim and Jongman 1996), and lexical (Kang 1993)

## Conclusion

- The typology of processes leading to incomplete neutralization must include those that affect contrasts of length or prosodic structure
- A given phonological contrast within a language can be completely *and* incompletely neutralized by different processes

## Thanks!

Thanks are due to the participants in our experiments, as well as the undergraduate lab assistants at the Rutgers Phonetics Laboratory who participated in this research: Natalie Drescher, Christopher Kish, Sarah Korostoff, Megan Moran, Melanie Pangilinan, and Jessica Trombetta. We received helpful comments from Bruce Tesar and Kristen Syrett. We also thank Professors Tomo Yoshida and Shin-ichiroo Sano for their help in making arrangements for recording at International Christian University, and the audience at the May 2012 meeting of the Tokyo Circle of Phonologists for their helpful comments. This project was supported in part by a JICUF Visiting Scholarship fund to the second author.

## References I

- Beckman, Mary (1982). *Segmental Duration and the 'Mora' in Japanese*. *Phonetica* 39:113–135.
- Bloomfield, Leonard (1933/1984). *Language*. University of Chicago Press, Chicago.
- Braver, Aaron (2011). *Incomplete Neutralization in American English Flapping: A Production Study*. In *Proceedings of the 34th Annual Penn Linguistics Colloquium*, volume 17 of *University of Pennsylvania Working Papers in Linguistics*. Penn Linguistics Club. <http://repository.upenn.edu/pwpl/vol17/iss1/5/>.
- Braver, Aaron (to appear). *Perception of Incompletely Neutralized /d/ and /t/ Flaps in American English*. In *Proceedings of the 42nd Annual Meeting of the North Eastern Linguistic Society*. UMass GLSA.
- Braver, Aaron (under review). *Imperceptible Incomplete Neutralization: Production, Identification, and Discrimination of /d/ and /t/ Flaps in American English*.
- Davidson, Lisa (2006). *Phonology, Phonetics, or Frequency: Influences on the Production of Non-Native Sequences*. *Journal of Phonetics* 34:104–137.
- Dinnsen, Daniel (1985). *A Re-Examination of Phonological Neutralization*. *Journal of Linguistics* 21(2):265–279.
- Dinnsen, Daniel and Charles-Luce, Jan (1984). *Phonological Neutralization, Phonetic Implementation and Individual Differences*. *Journal of Phonetics* 12:49–60.
- Dinnsen, Daniel A. and Garcia-Zamor, Marie (1971). *The three degrees of vowel length in German*. *Papers in Linguistics* 4:111–126.

## References II

- Dmitrieva, Olga (2005). *Incomplete Neutralization in Russian Final Devoicing: Acoustic Evidence from Native Speakers and Second Language Learners*. Master's Thesis, University of Kansas, Lawrence, Kansas.
- Dmitrieva, Olga; Jongman, Allard; and Sereno, Joan (2010). *Phonological Neutralization by Native and Non-Native Speakers: The Case of Russian Final Devoicing*. *Journal of Phonetics* 38(2):483–492.
- Fougeron, Cécile and Steriade, Donca (1997). *Does Deletion of French Schwa Lead to Neutralization of Lexical Distinctions?* In *Proceedings of the 5th European Conference on Speech Communication and Technology*, volume 7, pp. 943–946.
- Fourakis, Marios and Iverson, Gregory (1984). *On the 'Incomplete Neutralization' of German Final Obstruents*. *Phonetica* 41:140–149.
- Fourakis, Marios and Port, Robert (1986). *Stop Epenthesis in English*. *Journal of Phonetics* 14(2):197–221.
- Gerfen, Chip (2002). *Andalusian Codas*. *Probus* 14:247–277.
- Gordon, Matthew and Munro, Pamela (2007). *A Phonetic Study of Final Vowel Lengthening in Chickasaw*. *International Journal of American Linguistics* 7(3):293–330.
- Gouskova, Maria and Hall, Nancy (2009). *Acoustics of Unstressable Vowels in Lebanese Arabic*. In Steve Parker (ed.) *Phonological Argumentation: Essays on Evidence and Motivation*. Equinox Books.
- Hayes, Bruce (1995). *Metrical Stress Theory: Principles and Case Studies*. University of Chicago Press.
- Herd, Wendy; Jongman, Allard; and Sereno, Joan (2010). *An acoustic and perceptual analysis of /t/ and /d/ flaps in American English*. *Journal of Phonetics* 38:504–516.

## References III

- Hoequist, Charles E. (1983). *Durational Correlates of Linguistic Rhythm Categories*. *Phonetica* 40:19–31.
- Hyman, Larry (1975). *Phonology: Theory and Analysis*. Holt, Rinehart and Winston, New York.
- Itô, Junko (1990). *Prosodic Minimality in Japanese*. In Michael Ziolkowski, Manual Noske, and Karen Deaton (eds.) *Proceedings of Chicago Linguistic Society 26: Parasession on the Syllable in Phonetics and Phonology*, pp. 213–239. Chicago Linguistic Society, Chicago.
- Jakobson, Roman; Fant, Gunnar; and Halle, Morris (1952/1975). *Preliminaries to Speech Analysis: The Distinctive Features and Their Correlates*. MIT Press, Cambridge.
- Kaisse, Ellen M. and Shaw, Patricia A. (1985). *On the theory of Lexical Phonology*. *Phonology Yearbook* 2:1–30.
- Kang, Ongmi (1993). *Prosodic Word-Level Rules in Korean*. In *Japanese/Korean Linguistics*, volume 2, pp. 147–163. CSLI.
- Kim, Hyunsoon and Jongman, Allard (1996). *Acoustic and Perceptual Evidence for Complete Neutralization of Manner of Articulation in Korean*. *Journal of Phonetics* pp. 295–312.
- Kiparsky, Paul (1982a). *From Cyclic Phonology to Lexical Phonology*. In Harry van der Hulst and Norval Smith (eds.) *The Structure of Phonological Representations*, volume 1, pp. 131–175. Foris, Dordrecht.
- Kiparsky, Paul (1982b). *Lexical Phonology and Morphology*. In Ik-Hwan Lee (ed.) *Linguistics in the Morning Calm*, pp. 3–91. Hanshin.
- Kiparsky, Paul (1985). *Some consequences of Lexical Phonology*. *Phonology Yearbook* 2:85–138.

## References IV

- Labov, William; Jaeger, Malcah; and Steiner, Richard (1972). *A Quantitative Study of Language Change in Progress*. Technical Report NSF-GS-3287, University of Pennsylvania, US Regional Survey.
- Mitleb, Fares M. (1981a). *Segmental and non-segmental structure in phonetics: Evidence from foreign accent*. Doctoral Dissertation, Indiana University, Bloomington.
- Mitleb, Fares M. (1981b). *Temporal correlates of 'voicing' and its neutralization in German*. *Research in Phonetics* 2:173–192.
- Mohanan, K.P. (1982). *Lexical Phonology*. Doctoral Dissertation, Massachusetts Institute of Technology.
- Mori, Yoko (2002). *Lengthening of Japanese Monomoraic Nouns*. *Journal of Phonetics* 30(4):689–708.
- Padgett, Jaye (2011). *The Role of Prosody in Russian Voicing*. In Toni Borowsky, Shigeto Kawahara, Takahito Shinya, and Mariko Sugahara (eds.) *Prosody Matters: Essays in Honor of Elisabeth Selkirk*, pp. 181–207. Equinox.
- Port, Robert and O'Dell, Michael (1985). *Neutralization and Syllable-Final Voicing in German*. *Journal of Phonetics* 13:455–471.
- Poser, William (1990). *Evidence for Foot Structure in Japanese*. *Language* 66:78–105.
- Rudin, Catherine (1980). *Phonetic Evidence for a Phonological Rule: g-Deletion in Turkish*. *Research in Phonetics* 1:217–232.
- Slowiaczek, Louisa M. and Dinnsen, Daniel (1985). *On the Neutralizing Status of Polish Word-Final Devoicing*. *Journal of Phonetics* 13:325–341.

## References V

- Slowiaczek, Louisa M. and Szymanska, Helena (1989). *Perception of Word-Final Devoicing in Polish*. *Journal of Phonetics* 17:205–212.
- Trubetzkoy, Nikolai S. (1939/1969). *Grundzüge der Phonologie [Principles of phonology]*. Vandenhoeck and Ruprecht [Translated by Christiane A. M. Baltaxe 1969, University of California Press], Göttingen.
- Vance, Timothy J. (2008). *The Sounds of Japanese*. Cambridge University Press, Cambridge.
- Warner, Natasha; Good, Erin; Jongman, Allard; and Sereno, Joan (2006). *Orthographic vs. Morphological Incomplete Neutralization Effects*. *Journal of Phonetics* 34(2):285–293.
- Warner, Natasha; Jongman, Allard; Sereno, Joan; and Kemps, Rachèl (2004). *Incomplete Neutralization and other Sub-Phonemic Durational Differences in Production and Perception: Evidence from Dutch*. *Journal of Phonetics* 32:251–276.
- Yu, Alan C. L. (2007). *Understanding Near Mergers: The Case of Morphological Tone in Cantonese*. *Phonology* 24:187–214.

## Appendix: Experiment I Stimuli, Part I

Japanese orthography	Transcription	Gloss
木が倒れた。 木倒れた。 キー見つかった。	ki ga taore-ta ki taore-ta kii mitsukat-ta	tree NOM fall-PST tree NOM fall-PST key find-PST
菜が煮えた。 菜煮えた。 「なー」と言われた。	na ga nie-ta na nie-ta “naa” to iw-are-ta	vegetable NOM cook-PST vegetable cook-PST “DISC” COMP say-PSV-PST
火が消えた。 火消えた。 「ひー」と叫んだ。	hi ga kie-ta hi kie-ta “hii” to saken-da	fire NOM go.out-PST fire go.out-PST “INTERJECT.” COMP shout-PST
酢がない。 酢ない。 スーが見つからない。	su ga nai su nai suu ga mitsukar-anai	vinegar NOM NEG vinegar NEG Sue NOM find NEG

(continued...)

## Appendix: Experiment I Stimuli, Part II

Japanese orthography	Transcription	Gloss
背がのびた。 背のびた。 正の整数。	se ga nobi-ta se nobi-ta sei no seisuu	height NOM stretch-PST height stretch-PST positive MOD integer
血がでた。 血でた。 地位がある。	chi ga de-ta chi de-ta chii ga aru	blood NOM going.out-PST blood going.out-PST social.status NOM have
手がしびれた。 手しびれた。 低の長さ。	te ga shibire-ta te shibire-ta tei no nagasa	hand NOM become.numb-PST hand become.numb-PST base.of.shape MOD length
戸が壊れた。 戸壊れた。 「とー」と叫んだ。	to ga koware-ta to koware-ta “too” to saken-da	door NOM break-PST door break-PST “INTERJECT.” COMP shout-PST

(continued...)

## Appendix: Experiment I Stimuli, Part III

Japanese orthography	Transcription	Gloss
根がぬけた。 根ぬけた。 「ねー」と言われた。	ne ga nuke-ta ne nuke-ta “nee” to iw-are-ta	root NOM pull.out-PST root pull.out-PST “DISC” COMP say-PSV-PST
素晴らしい。 素晴らしい。 封がとれた。	fu ga subarashi-i fu subarashi-i fuu ga tore-ta	gluten NOM excellent-PRES gluten excellent-PRES seal NOM come.off-PST
目が腫れた。 目腫れた。 「メー」と鳴いた	me ga hare-ta me hare-ta “mee” to nai-ta	eye NOM swell-PST eye NOM swell-PST “[sheep sound]” COMP make.sound PST

## Appendix: Experiment II Stimuli

Set	Japanese orthography	Transcription	Gloss
Main ( <i>ni</i> )	1 2 番から	juu-ni ban kara	ten-two NUMBER from
	1 2 3 6	ichi ni san roku	one two three six
	あのにいさんたち	ano nii-san tachi	those older brother-HON PL
Main ( <i>go</i> )	1 5 番から	juu-go ban kara	ten-five NUMBER from
	1 5 7 8	ichi go nana hachi	one five seven eight
	あの豪くんたち	ano gou kun tachi	those (name) NAME.SUFFIX PL
Bimoraic ( <i>san</i> )	1 3 番から	juu-san ban kara	ten-three NUMBER from
	1 3 6 4	ichi san roku shi/yon	one three six four
Alternators	1 4 3 2	ichi shi/yon san ni	one four three two
	1 9 8 0	ichi ku/kyuu hachi zero	one nine eight zero