Probing knowledge of similarity through puns

Shigeto Kawahara
kawahara@rci.rutgers.edu

Rutgers

MIT, April 17th 2009

Theoretical background

- Some kind of similarity seems important in shaping phonological patterns.
- Speakers can change /A/ to [B] if A and B are "percetually sufficiently similar" (Steriade, 2001/2008, *et seq*).

Some examples

- Nasals are more likely to assimilate in place than oral consonants (Jun, 1995): nasal pairs are sufficiently similar whereas oral pairs are "too different".
- A voicing contrast is more likely to neutralize than other manner contrasts (Steriade, 2001/2008): minimal pairs differing in voicing are similar enough to be interchangeable.
- In Japanese loanwords, geminates are more likely to devoice than singletons, and a voicing contrast is less perceptible in geminates than in singletons (Kawahara, 2006).

The overall goal

- The less the perceptual change, the more likely it occurs.
- In other words, speakers exert stronger grammatical pressure against a larger perceptual change.
- I attempt to provide further support for this principle from the perspective of imperfect puns (*dajare*).

Part I: Consonantal similarity (Kawahara & Shinohara, 2009)

- Japanese speakers traditionally create puns by combining two similar sounding words or phrases.
- Examples: *Arumikan-no ue-no aru mikan*, *Aizusan-no aisu*, *okosama-o okosanai-de*.
- Corresponding sounds do not need to be identical, but nevertheless need to be "similar" (Cutler & Otake, 2002; Shinohara, 2004; Kawahara, 2007; Steriade, 2003; Zwicky & Zwicky, 1986).

Question and approach

- What do we mean by "similar"?
- Perceptually similar? *as per* Steriade (2001/2008)?
- A traditional 'introspection-based' approach does not seem appropriate to answer this question (Shattuck-Hufnagel, 1986).
- One can (only?) answer this question with a statistical/experimental approach.

Method

- We collected 2371 examples of imperfect puns from online websites as well as through elicitation.
- We defined pun domains as sequences of moras with matching vowels: okosama-o okosanaide.
- We counted a number of mismatched consonant pairs (e.g. the [m-n] pair in the above example; 535 consonant pairs in total).

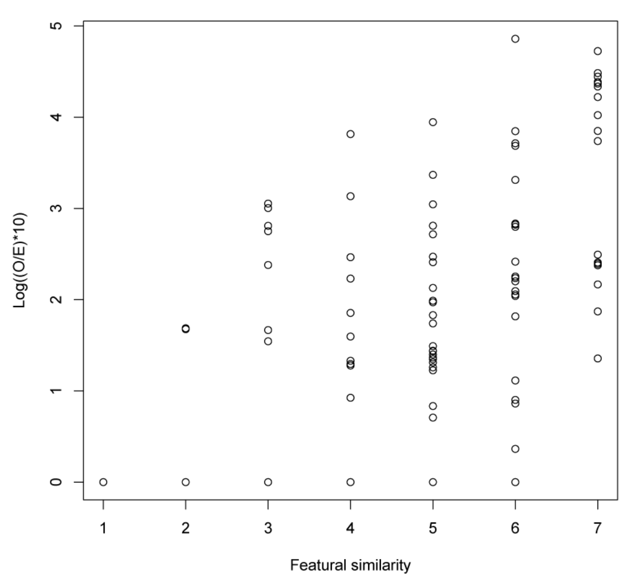
O/E ratios

- We need a measure of combinability of two consonants—the likelihood of two consonants making a pun pair.
- Suppose that an [A]–[B] pair occurs more often than an [A]–[C] pair, can we say that the [A]–[B] pair is more combinable than the [A]–[C] pair?
- Not necessarily, because [B] might simply be more frequent than [C].
- O/E values provide a nice measure. They are observed frequency relativized with respect to expected frequency.

O/E ratios cont'd

- To statistically establish the relation between similarity and combinability in puns, we started out with a simple version of featural similarity.
- Featural similarity is defined in terms of the number of shared feature specifications (Bailey & Hahn, 2005; Shattuck-Hufnagel, 1986, and others).

Correlation



Combinability and (featural) similarity correlate with each other ($r_s = .497, p < .001$)

Evidence for perceptual similarity

Featural similarity accounts for some broad patterns, but it fails to capture some aspects of pun pairings:

1. Contextual effect of [place].
2. Different saliency of different features.
3. The effect of a phonologically inert feature.
4. Similarity with ϕ.

Evidence I: Contextual effects

- Nasals are more likely to assimilate in place than oral consonants (Mohanan, 1993).
- A [place] contrast is known to be less salient in nasal consonants than in oral consonants (Boersma, 1998; Jun, 1995; Mohr & Wang, 1968; Pols, 1983).
- The parallel in the pun pattern:

m-n: 8.85	b-d: 1.09	p-t: 1.11
	b-g: .65	p-k: 1.08
	d-g: .39	t-k: .87

Evidence I: Contextual effects

- Speakers indeed consider the [m-n] pair as more similar than any other kind of oral consonant minimal pair.
- The contribution of [place] to similarity differs depending on whether it is hosted by nasals or oral consonants.
- The featural similarity model cannot explain this observation.

Evidence 2: Saliency of different features

- A [voice] contrast is less perceptible than [nas] and [cont] contrasts (Kawahara, 2009; Steriade, 2001/2008).
- Again the parallel in pun pattern:

cont		nasal		voice	
p-ɸ:	5.58	b-m:	4.68	p-b:	8.51
t-s:	.90	d-n:	1.12	t-d:	7.64
d-z:	1.68			k-g:	8.03
				s-z:	11.3
				ʃ-ʒ:	6.81

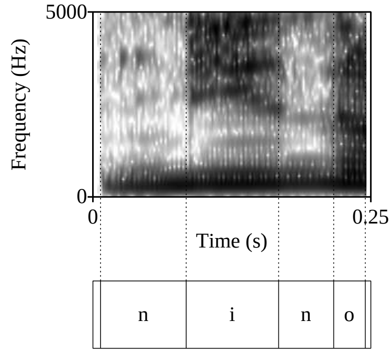
Evidence 3: Effect of phonologically inert features

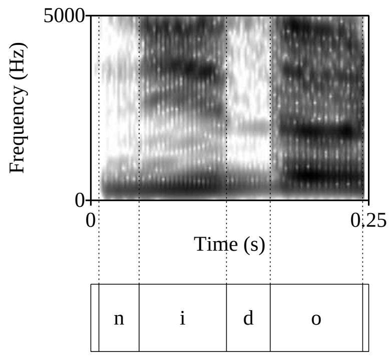
	Voiced obstruents	Voiceless obstruents
Paired with sonorants	63 (**18.2%**)	30 (**6.0%**)
Total	346	497

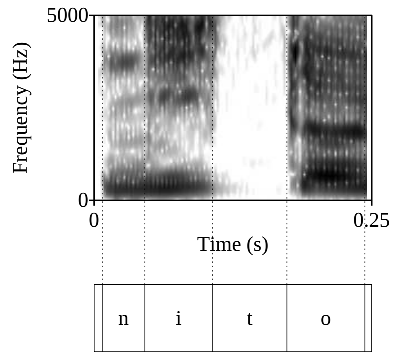
- Speakers combine sonorants more often with voiced obstruents than with voiceless obstruents ($z = 5.22, p < .001$).

Perceptual explanation

- The fact that sonorants are more combinable with voiced obstruents than with voiceless obstruents might be related to:
  - Low frequency energy.
  - Intervocalic lenition of voiced stops to approximants (Kawahara, 2006).







But phonologically...

- The [+voice] feature of Japanese sonorants is inert: it does not trigger Lymans Law:
  - Japanese does not allow two occurrences of voiced consonants within single stems. But only voiced obstruents count as voiced consonants.
  - The [+voice] feature on sonorants is underspecified (Itô & Mester, 1986), sonorants do not bear [voice] at all (Mester & Itô, 1989) or sonorants and obstruents bear different [voice] features (Rice, 1993).

Evidence 4: Similarity with ϕ.

- The list of consonants that often correspond with ϕ:
  [w]: 6.25, [r]: 4.59, [h]: 3.72, [m]: 2.54, [n]: 1.49, [k]: 1.39.
- These are consonants that blend into their environments, and hence are perceptually close to ϕ.
  - [w] blends into surrounding vowels (Myers & Hansen, 2005).
  - [r] is very short (Nakamura, 2002).
  - [h] again blends into surrounding vowels (Keating, 1988).
  - [m] and [n] have blurry transitions (Downing, 2005).
  - [k] coarticulates with surrounding vowels (de Lacy & Kingston, 2006).

Summary of Part I

- Speakers minimize the perceptual disparities between two corresponding elements in puns.
- Here we find non-trivial parallels with purely phonological patterns.
  - Place assimilation asymmetry and the perceptibility of nasal and oral consonants.
  - Neutralizability of [voice] with respect to other features.
  - Speakers epenthesize perceptually least intrusive segments.

Part II: Vowel mismatch (Kawahara & Shinohara, 2008)

- Speakers can combine two words minimally different in one vowel.
- For example, *shibuya-wa shibiya* and *haidegaa-no zense-wa haedekka*.
- We collected 547 examples of such mismatched vowels, calculated the O/E ratios for each pair, and took their reciprocals as distance between the five vowels.

Vocalic distances

Table: The O/E ratios of the five vowels.

	a	e	o	i	u
a	0	1.60	2.13	0.72	0.78
e		0	0.74	1.90	0.55
o			0	0.46	1.54
i				0	2.06
u					0

Distances between the five vowels are calculated as the reciprocals of O/E ratios.

Vowel mismatch

Two dimensional representations of the distance matrix:

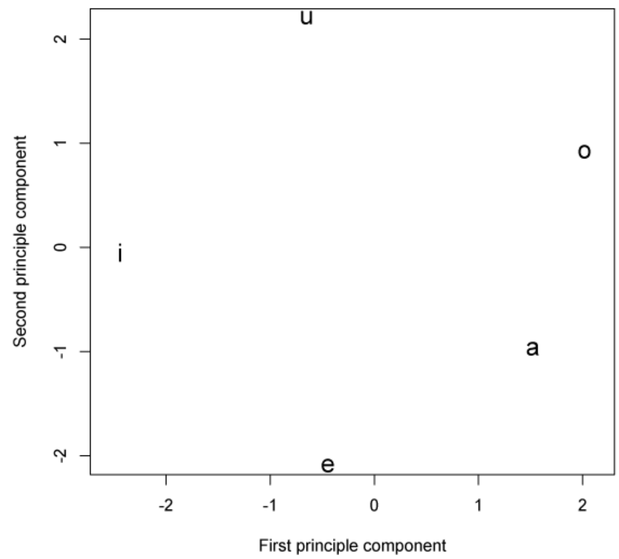


Figure: A PCA analysis of the vowel distance matrix computed based on combinability in puns.

Vowel mismatch

- Evidence for psychoacoustic similarity.
  1. [a] is closer to [o] than [e].
  2. [i] and [u] are closer to each other than [o] and [e].
- These patterns match with acoustic properties of Japanese vowels (Keating & Huffman, 1984; Nishi, Strange, Akahane-Yamada, Kubo, & Trent-Brown, 2008).
- These patterns on the other hand cannot be explained in terms of featural similarity.
- The distance matrix statistically correlates with a distance matrix created based on euclidean distances of F1/F2 bark values of Hirahara and Kato (1992) ($r = .647, p = .043$).

Part III: Positional effects (Kawahara & Shinohara, to appear)

- We have seen that speakers minimize the differences between corresponding segments in imperfect puns, just as in phonology.
- Then it may be that positions of mismatches matter: in phonology, speakers avoid mismatches between inputs and outputs in phonetically and psycholinguistically prominent positions (Beckman, 1998; Steriade, 1994).

Experiment I: Psycholinguistic prominence

The first experiment tested whether speakers avoid mismatches in initial positions. Initial syllables play an important role in word recognition.

- Hearing initial portions of words help listeners to retrieve the whole words (Horowitz, Chilian, & Dunnigan, 1969; Horowitz, White, & Atwood, 1968).
- In "tip-of-the-tongue" phenomena, speakers can guess the first sound more accurately than non-initial sounds (A. Brown, 1991; R. Brown & MacNeill, 1966).
- Also, in tip-of-the-tongue situations, initial sounds help retrieve the whole word (Freedman & Landauer, 1966).

Psycholinguistic prominence cont'd

- Listeners are faster when detecting mispronunciations in non-initial positions (Cole & Jakimik, 1980; Cole, 1973)—once they hear initial syllables, they anticipate what's coming next.
- Sound symbolism—particular images associated with particular sounds—is stronger word-initially than non-word-initially (Bruch, 1986; Kawahara, Shinohara, & Uchimoto, 2008).

Phonological privilege of initial positions

Initial syllables exhibit a privileged status in phonology.

- In Sino-Japanese, while initial syllables can contain a variety of consonants, second syllables only allow [t] and [k] (Kawahara, Nishimura, & Ono, 2002; Tateishi, 1990).
- If there were an underlying form like /sasu/ (*as per* Richness of the Base), then speakers avoid changing the initial [s] but not the final [s] (perhaps to [satu]).
- In other words, speakers would avoid making changes in initial syllables.

Correspondence Theory

In terms of Correspondence Theory (McCarthy & Prince, 1995):

In phonology (input-output correspondence):

Input	/	s_i	a_j	s_k	u_l	/
Output	[	s_i	a_j	t_k	u_l	]

Likewise in pun formation (surface-to-surface correspondence):

Word 1	[	s_i	a_j	s_k	u_l	]
Word 2	[	s_i	a_j	t_k	u_l	]

Method 1

- The experiment was a wellformed judgement task.
- The stimuli were pairs of words that contain a pair of sounds that minimally differ in voicing ([t-d], [d-t], [s-z], [z-s], [k-g], [g-k]).
- To control for the distance between corresponding words, they were always separated by one-mora particle.
- Two conditions:
  - Initial mismatches (e.g. *sasetsu-ni zasetsu*).
  - Internal mismatch (e.g. *hisashi-ni hizashi*).

Method 2

- We asked two questions: how funny it is and how acceptable it is as a pun pair in a 1-4 scale.
- We included the first question, so that the participants would tease apart these questions.

- The questionnaire started with two sample questions, with one example which is clearly an example of a Japanese imperfect pun and one example which clearly is not.
- 37 speakers participated in this study, but we excluded eight of them because they did not consider the good example as a good pun or considered the bad example as a good pun.

Result

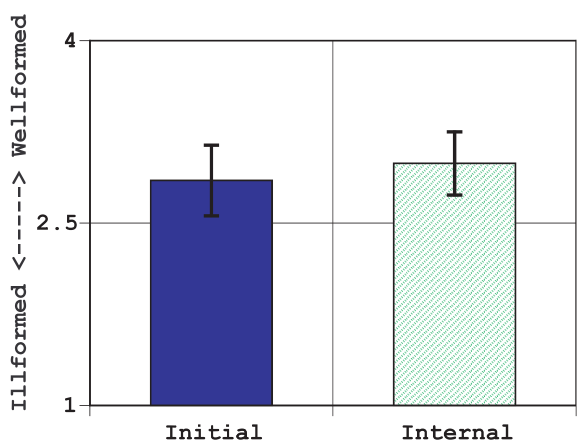


Figure: Wellformedness of puns with initial mismatches and those with internal mismatches. The error bars = 95% CIs.

Speakers judged mismatches in initial syllables less acceptable than those in non-initial syllables ($z = 2.59, p = .01$ by a non-parametric Wilxocon signed-ranks test).

Discussion

Speakers avoid mismatches in a psycholinguistically prominent position, both in phonology and pun formation.

Phonology

Input	/	s_i	a_j	s_k	u_l	/
Output	[	s_i	a_j	t_k	u_l	]

Pun formation

Word 1	[	s_i	a_j	s_k	u_l	]
Word 2	[	s_i	a_j	t_k	u_l	]

Experiment II: Introduction

The second experiment tested whether speakers avoid mismatches in long vowels.

- Long vowels are, by definition, phonetically long.
- Different long vowels are more different from each other than different short vowels (Steriade, 2003)—an [aa]-[ii] pair is more different than an [a]-[i] pair.
- A change in long vowels would be more perceptible also because speakers hyperarticulate long vowels more than short vowels. As a result, long vowels are more dispersed than short vowels (Hirata & Tsukada, 2003; Hisagi, Nishi, & Strange, 2008).

Phonological privilege of long vowels

- Hindi for example allows a surface nasality contrast in long vowels, but not in short vowels (Steriade, 1994).
- A hypothetical underlying /tããtã/ would map to [tããta].
- In phonology speakers avoid making changes—or neutralizing contrasts—more in long vowels than in short vowels.

Correspondence Theory again

In phonology (input-output correspondence):

Input	/	t$_i$	ãã$_j$	t$_k$	ã$_l$	/
Output	[	t$_i$	ãã$_j$	t$_k$	a$_l$	]

In pun formation (surface-to-surface correspondence):

Word 1	[	t$_i$	ãã$_j$	t$_k$	ã$_l$	]
Word 2	[	t$_i$	ãã$_j$	t$_k$	a$_l$	]

Method

- The design had two fully crossed factors: 10 vowel combinations ([a-i], [a-u], [a-e], [a-o], [i-u], [i-e], [i-o], [u-e], [u-o], [e-o]) $\times$ 2 lengths (short vs. long).
- An example of a crucial pair was: *jookuu-no jookaa* vs. *rippu-ga rippa*.
- Other details were identical to Experiment 1, except that we had four sample questions (two good examples and two bad examples).
- 26 speakers participated in the study.

Result

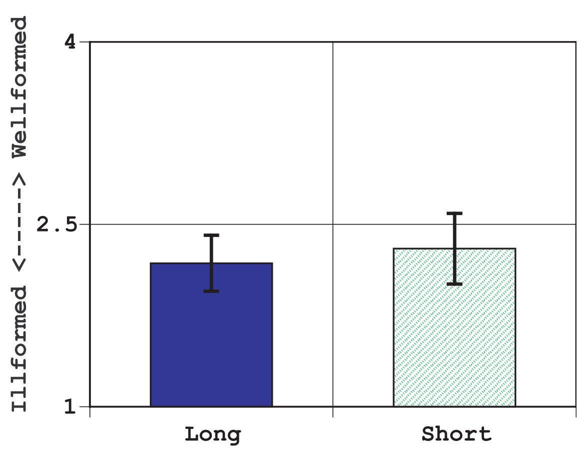


Figure: Wellformedness of puns with long vowel mismatches and short vowel mismatches.

Speakers rated those with long mismatches as worse than short mismatches (2.93, $p < .001$).

Discussion

Japanese speakers avoid mismatches in long vowels more than mismatches in short vowels

Phonology

Input	/	t_i	$\tilde{a}\tilde{a}_j$	t_k	$\tilde{a}_l$	/
Output	[	t_i	$\tilde{a}\tilde{a}_j$	t_k	a_l	]

Pun formation

Word 1	[	t_i	$\tilde{a}\tilde{a}$	t_k	$\tilde{a}_l$	]
Word 2	[	t_i	$\tilde{a}\tilde{a}_j$	t_k	a_l	]

Summary and discussion of Part III

- Speakers avoid disparties between corresponding elements more in prominent positions (initial syllables, long vowels) than in non-prominent positions.
- The same principle holds both in puns and in phonology.
- We again found non-trivial parallels between phonology and pun patterns.

Overall summary

- Speakers minimize perceptual disparties between corresponding segments in puns.
- In this sense, we find non-trivial parallels between pun pairing patterns and phonological patterns.
- We can probe our knowledge of similarity through studying puns.
- Pun patterns are understudied—they thus provide an untapped resource for future research.

Future directions and on-going research

- Analyses of other pun patterns in Japanese (see my website).
- Analyses of other languages (Beattie & Schwade, 2009).
- Investigation of knowledge of similarity through direct perception tests (Kawahara, 2009).

Bailey, T., & Hahn, U. (2005). Phoneme similarity and confusability. *Journal of Memory and Language*, *52*, 339-362.

Beattie, A., & Schwade, A. (2009). *Korean tongue twisters and linguistic similarity.* A talk presented at Harvard undergraduate linguistics conference.

Beckman, J. (1998). *Positional faithfulness*. Unpublished doctoral dissertation, University of Massachusetts, Amherst.

Boersma, P. (1998). *Functional phonology: Formalizing the interaction between articulatory and perceptual drives*. The Hague: Holland Academic Graphics.

Brown, A. (1991). A review of the tip-of-the-tongue experience. *Psychological Bulletin*, *109*(2), 204-223.

Brown, R., & MacNeill, D. (1966). The 'tip of the tongue' phenomenon. *Journal of Verbal Learning and Verbal Behavior*, *5*(4), 325-337.

Bruch, J. (1986). Expressive phonemes in Japanese. *Kansas Working Papers in Linguistics*, *11*, 1-8.

Cole, R. (1973). Listening for mispronunciations: A measure of what we hear during speech. *Perception & Psychophysics*, *13*, 153-156.

Cole, R., & Jakimik, J. (1980). How are syllables used to recognize words?

Journal of Acoustical Society of America, *67*(3), 965-970.

Cutler, A., & Otake, T. (2002). Rhythmic categories in spoken-word recognition. *Journal of Memory and Language*, *46*(2), 296-322.

de Lacy, P., & Kingston, J. (2006). *Synchronic explanation.* (ms. University of Massachusetts and Rutgers University)

Downing, L. (2005). On the ambiguous segmental status of nasal in homorganic nc sequences. In M. van Oostendorp & J. M. van der Weijer (Eds.), *The internal organization of phonological segments* (p. 183-216). Berlin: Mouton de Gruyter.

Freedman, J., & Landauer, T. (1966). Retrieval of long-term memory: "tip-of-the-tongue" phenomenon. *Psychonomic Science*, *4*(8), 309-310.

Hirahara, T., & Kato, H. (1992). The effect of F0 on vowel identification. In Y. Tohkura, E. V. Vatikiotis-Bateson, & Y. Sagisaka (Eds.), *Speech perception, production and linguistic structure* (p. 89-112). Tokyo: Ohmsha.

Hirata, Y., & Tsukada, K. (2003). The effects of speaking rates and vowel length on formant movements in Japanese. In A. Agwuele, W. Warren, & S.-H. Park (Eds.), *Proceedings of the 2003 Texas*

Linguistic Society Conference (p. 73-85). Somerville, MA: Cascadilla Press.

Hisagi, M., Nishi, K., & Strange, W. (2008). Acoustic properties of Japanese and English vowels: Effects of phonetic and prosodic context. In M. Endo-Hudson, S.-A. Jun, P. Sells, P. M. Clancy, S. Iwasaki, & S. Sung-Ock (Eds.), *Japanese/Korean linguistics 13.* Stanford: CSLI.

Horowitz, L., Chilian, P., & Dunnigan, K. (1969). Word fragments and their reintegrative powers. *Journal of Experimental Psychology*, *80*(2), 392-394.

Horowitz, L., White, M., & Atwood, D. (1968). Word fragments as aids to recall: The organization of a word. *Journal of Experimental Psychology*, *76*(2), 219-226.

Itô, J., & Mester, A. (1986). The phonology of voicing in Japanese: Theoretical consequences for morphological accessibility. *Linguistic Inquiry*, *17*, 49-73.

Jun, J. (1995). *Perceptual and articulatory factors in place assimilation: An optimality theoretic approach*. Unpublished doctoral dissertation, University of California, Los Angeles.

Kawahara, S. (2006). A faithfulness ranking projected from a perceptibility scale: The case of voicing in Japanese. *Language*, *82*(3), 536-574.

Kawahara, S. (2007). Half-rhymes in Japanese rap lyrics and knowledge of similarity. *Journal of East Asian Linguistics*, *16*(2), 113-144.

Kawahara, S. (2009). Faithfulness, correspondence, and perceptual similarity: Hypotheses and experiments. *Journal of the Phonetic Society of Japan*, *13*(2).

Kawahara, S., Nishimura, K., & Ono, H. (2002). Unveiling the unmarkedness of Sino-Japanese. In W. McClure (Ed.), *Japanese/Korean linguistics 12* (p. 140-151). Stanford: CSLI.

Kawahara, S., & Shinohara, K. (2008). *Calculating vocalic similarity through puns.* ms (Rutgers University and Tokyo University of Agriculture and Technology).

Kawahara, S., & Shinohara, K. (2009). The role of psychoacoustic similarity in Japanese puns: A corpus study. *Journal of Linguistics*, *45*(1), 111-138.

Kawahara, S., & Shinohara, K. (to appear). Phonetic and psycholinguistic prominences in pun formation: Experimental evidence for positional faithfulness. In W. McClure & M. den Dikken (Eds.),

Japanese/Korean linguistics 18. Stanford: CSLI.
Kawahara, S., Shinohara, K., & Uchimoto, Y. (2008). A positional effect in sound symbolism: An experimental study. In *Proceedings of the japan cognitive linguistics association 8* (p. 417-427). Tokyo: JCLA.
Keating, P. A. (1988). Underspecification in phonetics. *Phonology*, *5*, 275-292.
Keating, P. A., & Huffman, M. (1984). Vowel variation in Japanese. *Phonetica*, *41*, 191-207.
McCarthy, J. J., & Prince, A. (1995). Faithfulness and reduplicative identity. In J. Beckman, L. Walsh Dickey, & S. Urbanczyk (Eds.), *University of Massachusetts occasional papers in linguistics 18* (p. 249-384). Amherst: GLSA.
Mester, A., & Itô, J. (1989). Feature predictability and underspecification: Palatal prosody in Japanese mimetics. *Language*, *65*, 258-93.
Mohanan, K. P. (1993). Fields of attraction in phonology. In J. Goldsmith (Ed.), *The last phonological rule: Reflections on constraints and derivations* (p. 61-116). Chicago: University of Chicago Press.
Mohr, B., & Wang, W. S. (1968). Perceptual distance and the specification of phonological features. *Phonetica*, *18*, 31-45.

Myers, S., & Hansen, B. (2005). The origin of vowel-length neutralization in vocoid sequences. *Phonology*, *22*, 317-344.
Nakamura, M. (2002). The articulation of the Japanese /r/ and some implications for phonological acquisition. *Phonological Studies*, *5*, 55-62.
Nishi, K., Strange, W., Akahane-Yamada, R., Kubo, R., & Trent-Brown, S. A. (2008). Acoustic and perceptual similarity of Japanese and American English vowels. *Journal of Acoustical Society of America*, *124*(1), 576–588.
Pols, L. (1983). Three mode principle component analysis of confusion matrices, based on the identification of Dutch consonants, under various conditions of noise and reverberation. *Speech Communication*, *2*, 275-293.
Rice, K. (1993). A reexamination of the feature [sonorant]: The status of sonorant obstruents. *Language*, *69*, 308-344.
Shattuck-Hufnagel, S. (1986). The representation of phonological information during speech production planning: Evidence from vowel errors in spontaneous speech. *Phonology Yearbook*, *3*, 117-149.
Shinohara, S. (2004). *A note on the Japanese pun, dajare: Two sources of*

phonological similarity. (ms. Laboratoire de Psycheologie Experimentale)

Steriade, D. (1994). *Positional neutralization and the expression of contrast.* (ms. University of California, Los Angeles)

Steriade, D. (2001/2008). The phonology of perceptibility effect: The p-map and its consequences for constraint organization. In K. Hanson & S. Inkelas (Eds.), *The nature of the word* (p. 151-179). Cambridge: MIT Press. (originally circulated in 2001)

Steriade, D. (2003). Knowledge of similarity and narrow lexical override. In P. M. Nowak, C. Yoquelet, & D. Mortensen (Eds.), *Proceedings of Berkeley Linguistics Society 29* (p. 583-598). Berkeley: BLS.

Tateishi, K. (1990). Phonology of Sino-Japanese morphemes. In G. Lamontagne & A. Taub (Eds.), *University of Massachusetts Occasional Papers in Linguistics 13* (p. 209-235). Amherst: GLSA.

Zwicky, A., & Zwicky, E. (1986). Imperfect puns, markedness, and phonological similarity: With fronds like these, who needs anemones? *Folia Linguistica*, *20*, 493-503.