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jongho@snu.ac.kr

Phonological variation in Seoul Korean

n-insertion

Jongho Jun
(Seoul National Universiry)

Roadmap

I. Introduction

II. Trends in existing words

III. Analysis

IV. Learning simulation

V. Wug test

I. Introduction: n-insertion in Seoul Korean

- $\varnothing \rightarrow n / \mathbf{C_1]_{M1}\_\_ [_{M2}i/j}$

  ($M_{1,2}$ = morpheme; C_1 = M1-final consonant)

i. prefix-stem

/təs-jaŋmal/	[tən**n**jaŋmal]	‘anklet socks’
/hot^h-ipul/	[hon**n**ipul]	‘unlined comforter’

ii. compound

/com-jak/	[com**n**jak]	‘mothball’
/som-ipul/	[som**n**ipul]	‘cotton sheet’

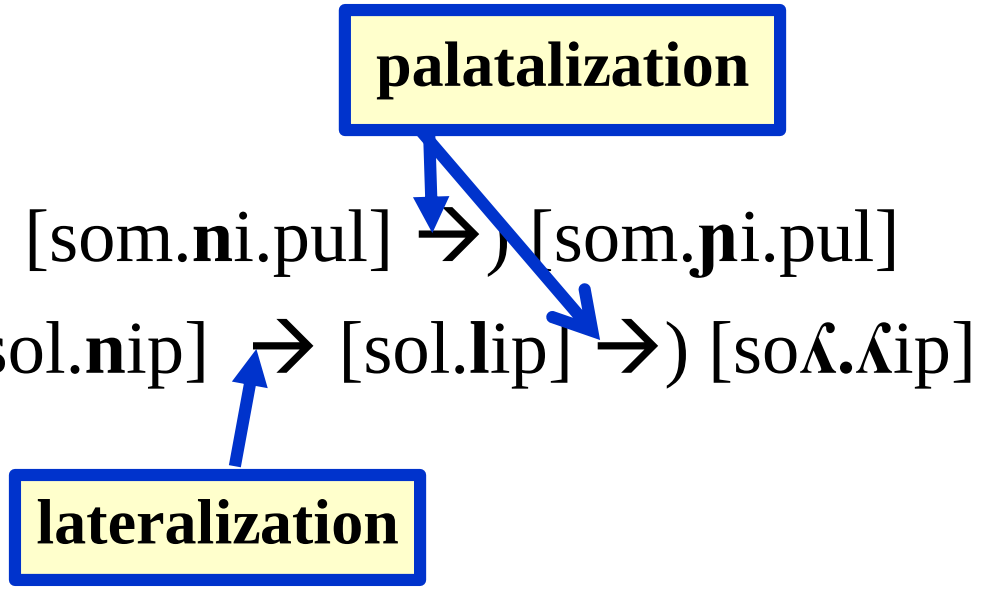
iii. Phrase

/mək-**ɨ**l # jəs/ [məkɨ**l**jət] ‘taffy that (someone) will eat’

/han # il/[han**n**il] ‘thing that (someone) has done’

Epenthetic consonant /n/

- phonetically realized as palatalized coronal sonorants, [ɲ] and [ʎ] (after a lateral)



C1 is always phonetically realized as a nasal.

- **Obstruent Nasalization**: an obstruent becomes a nasal before a nasal.

  /kiə**p**-jesan/ [ki.ə**m**.nje.san] ‘corporation budget’

  /pa**t^{h}**-ilaŋ/ [pa**n**.nilaŋ] ‘the ridge of a field’

- Except when the C1 is a lateral.

N-insertion is an **optional** process.

/kəmjəl/ [kəmjəl] ~ [kəm**n**jəl] ‘censorship’

/hot^{h}-ipul/ [hotipul] ~ [hon**n**ipul] ‘unlined comforter’

- Ref. Kim-Renaud (1975: 150), Ko (1992: 32), Kwak (1992: 84), Han (1993: 124-5), Lee (1996: 167-71), Kim et al. (2002: 46), Bae (2003: 240-3), Oh (2006: 119), M. Ahn (2009: 279)

➢ Is there any phonological tendency within variation involved in n-insertion?

Phonological effects in novel words (Hwang 2008)

Hwang performed a productivity test on Seoul Korean n-insertion, employing loan and wug words in Korean.

N-insertion is less likely …

- before [i] than before [j]. (**Syllabicity effect**)
- after obstruents. (**Obstruency effect**)
- after /ŋ/ cf. other sonorants. (**Velar nasal effect**)

Questions

- Where do these asymmetries come from?
- Why do Seoul Korean speakers apply n-insertion to novel words less frequently before [i] and after obstruents and /ŋ/?

- One possible answer
  - They do so with existing Korean words.
  - In the production of novel words, they use their knowledge about existing Korean words.
- To see whether and, if so, to what extent this is true, I have investigated the n-insertion patterns of **existing** Seoul Korean words.

II. Trends in existing words

Three sources

- Dictionary
- Previous survey and experimental studies
- My own survey

Summary: dictionary and previous survey/experiments

- (O = confirmed; X = not confirmed)

Effect	Dictionary	Previous survey/experiment
syllabicity	O	O
obstruency	O	X
velar nasal	X	O

Survey: method

- Test words: 304 multi-morphemic words with /j/-initial M2 in my dictionary database.
- Participants: 22 Seoul Korean speakers
- Survey form
  - ✓ Both inserted and non-inserted forms for each test word were presented in standard Korean orthography. (N.B. Basic syllable divisions can be seen in the written words.)
  - ✓ The participants were asked to choose what they think is their pronunciation, among the following three (or two) choices:

Response choices

	e.g. tok+jak	noŋ+jak
(i) **inserted** form:	toŋ.**n**jak	noŋ.**n**jak
(ii) non-inserted form (**resyllabified**)	to.kjak	--
(iii) non-inserted form (**aligned**)	tok.jak	noŋ.jak

Results of the current survey

- Insertion rate by C1 types (# of words shown in parentheses; son = [m, n, l])

son	**obs**	**ŋ**
0.49 (138)	**0.41** (72)	**0.38** (93)

- The results support both **obstruency** and **velar nasal** effects.

A mixed effect logistic regression model

- The results of the present survey are fitted with the lmer function from the lme4 package (Bates et al. 2011) in R (R Development Core Team 2014).
- Dependent variable is binary, i.e., n-inserted or not.
- Each subject and each test word were included as random intercepts.

Fixed factors (A mixed effect logistic regression model)

(underlined= reference level)

- C1 type (son, obs, ŋ)
- M2-initial vocoid (jV: ja, jə, je, jo, ju)
- M1 syllable number (sylnum1)
- M2 syllable number (sylnum2)
- M1 origin (native, sino, loan)
- M2 origin (native, sino)
- Token frequency in Sejong corpus (log(sejong.freq + 1))

Results: A logistic regression model (Fixed effects)

	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	-1.42277	0.54856	-2.594	0.00950 **
C1 = ŋ	**-0.52689**	0.20386	-2.585	0.00975 **
C1 = obs	**-0.67327**	0.21823	-3.085	0.00203 **
jV = jə	0.05239	0.21762	0.241	0.80975
jV = je	0.97724	0.76042	1.285	0.19875
jV = jo	0.18659	0.28376	0.658	0.51081
jV = ju	**0.90350**	0.30948	2.919	0.00351 **
sylnum1	**1.40994**	0.15263	9.237	< 2e-16 ***
sylnum2	-0.18613	0.14169	-1.314	0.18898
M1.origin = loan	-0.36726	0.78783	-0.466	0.64110
M1.origin = sino	-0.60207	0.31764	-1.895	0.05803 .
M2.origin = sino	-0.16558	0.36607	-0.452	0.65105
log(sejong.freq + 1)	-0.08942	0.08665	-1.032	0.30211

- Significant factors: marked in boldface
- Negative numbers under estimate indicate a factor discourages n-insertion.

Height & length effects

- Insertion rate by M2-initial vocoid sequence

	ja	jə	je	jo	**ju**
Insertion rate	0.40	0.42	0.47	0.44	**0.57**
# word	73	149	4	43	34

- Insertion rate by M1 length
  - a. Monosyllabic: **0.29** (140 words)
  - b. Disyllabic: **0.56** (154 words)
  - c. Longer: Trisyllabic 0.67 (7 words), Quadrisyllabic 0.31 (1 word), Pentasyllabic 0.72 (1 word)

Summary: n-insertion in **existing** Korean words

N-insertion is …

- less likely before /i/ than before /j/. (**Syllabicity** effect)
- less likely after obstruent C1 consonant. (**Obstruency** effect)
- less likely after /ŋ/. (**Velar nasal** effect)
- **more likely** before a glide /j/ followed by a high vowel. (**Height** effect)
- less likely with monosyllabic M1. (**Length** effect)

III. Analysis

- I analyze the observed patterns of Seoul Korean n-insertion by adopting Optimality-theoretic (OT) constraints which are assigned numerical weights within the framework of the maxent model.
- I discuss what constraints are responsible for the occurrence of Seoul Korean n-insertion and the observed asymmetric phonological trends.
- The specific weights of the constraints are determined by the results of a learning simulation.

Main variants

	som+ipul	com+jak	Constraints violated
a. Inserted	som.**n**ipul	com.**n**jak	DEP-n, *CODA
b. **Resyllabified**	so.m]ipul	co.m]jak	**ALIGN-R**
c. Aligned	som.ipul	i. com.[ja]$_N$k	*CODA, ONSET
		ii. com.j[a]$_N$k	*CODA, **V-NUC**

- **ALIGN-MORPH-R** (ALIGN-R)

  The right edge of a morpheme coincides with the right edge of a syllable.

  - Adopted by most previous studies on Korean n-insertion.
  - Active in Korean, independently of n-insertion.

ALIGN-R

VCV → V.CV

- An intervocalic consonant (except /ŋ/) is always syllabified as an onset: /aka/ [a.ka] ‘baby’.

VC+V → V.CV ~ VC.V

- E.g., compounding.
- The intervocalic consonant is variably syllabified between an onset or a coda.
- J. Park (2001: 730, citing J. Lee 1992: 42)

  i. /sikol+ai/ [si.ko.ra.i] ~ [si.kol.a.i] ‘a country-bred child’

  cf. /sikol/ ‘country’, /ai/ ‘child’

  ii. /mul+ori/ [mu.ro.ri] ~ [mul.o.ri] ‘a wild duck’

  cf. /mul/ ‘water’, /oli/ ‘duck’

- N.B. Allophonic variation of a singleton liquid: [l] in the coda and [r] in the onset.

Main variants

	som+ipul	com+jak	Constraints violated
a. Inserted	som.**n**ipul	com.**n**jak	DEP-n, *CODA
b. Resyllabified	so.m]ipul	co.m]jak	ALIGN-R
c. **Aligned**	som.ipul	**i.** com.**[ja]**$_N$k	*CODA, ONSET
		ii. com.**j[a]**$_N$k	*CODA, **V-NUC**

i. Glides in Korean are syllabified in the nucleus.

- Ref. Kim Renaud (1975), J. Kim (1986), H. Sohn (1987), Y. Kang (1991), Kim & Kim (1991), J. Park (2001), K. Kang (2003), and Y. Yun (2004)

ii. Glides may occupy the onset when it's empty (J. Park 2001, Y. Yun 2004)**.**
I assume that (ii), not (i), is the attested variant.

- **V-NUC**: [-consonantal] segments must be in the nucleus. (Rubach 2000)

Constraints: phonological effects

- **Obstruency** effect
  - Due to automatic **Obstruent Nasalization** in Korean
  - **IDENT(sonorant)**

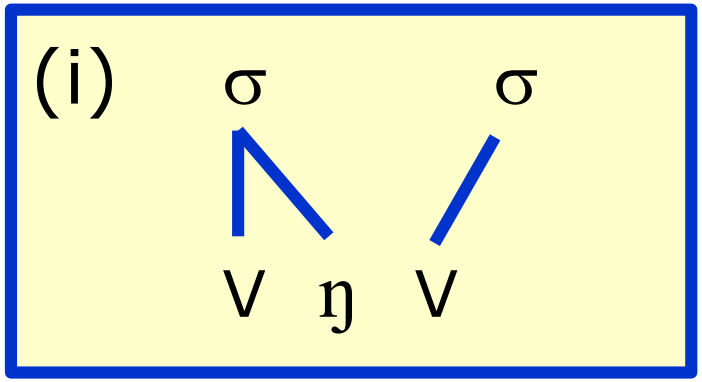
		Id(son)
a. /to**k**+jak/	[to**ŋ.n**jak]	*
b. /co**m**+jak/	[co**m**.**n**jak]	✓

Velar nasal effect

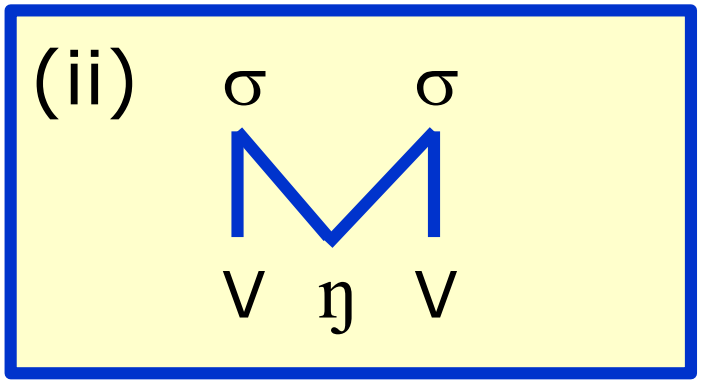
- In Korean, /ŋ/ is special.
- No Korean words begin with /ŋ/.
  - ***[$_{\sigma}$ŋ** "No velar nasal in the (word-initial) onset."
  - Ref. J. Kim 1986, Y. Kim 2013, C. Chung 2001, S. Park 2008 and many others.
- Does this constraint prevent the **intervocalic** /ŋ/ from occupying the onset position?

Velar nasal between vowels

- Two options
  - syllabified exclusively in the coda



  - Ambisyllabic



Ambisyllabic /ŋ/

- “When the velar nasal occurs between vowels, it is difficult to determine whether it is a coda of a preceding syllable or an onset of the following syllable.” (Huh 1984: 208)

- Nasal consonant duration
  - coda >> onset
  - **coda >> VŋV ≈ onset**

Nasal consonant duration

- From Y. Hwang (2002) (msec; C = lenis stop)

	coda (blue) ↓ V_CV	**onset** (yellow) ↓ V_V
m	179.12 (43.01)	66.27 (9.78)
n	170.77 (36.54)	80.22 (9.08)
ŋ	171.47 (38.10)	**87.15** (28.74)

- V**ŋ**V: much shorter than obvious coda nasals.

Avoidance of ONSET violation in Korean

- E.g. vocative suffix allomorphs
  - –**a** when the noun ends in a consonant: e.g. /tasom-a/
  - –**ja** when the noun ends in a vowel: e.g. /somi-ja/
- /-ja/ is chosen to satisfy ONSET.

- When the noun ends in **/ŋ/, -a** is chosen.

  e.g. /saraŋ**-a**/, not */saraŋ-ja/
  - This suggests that V**ŋ**V satisfies ONSET.
  - Thus, the velar nasal cannot be exclusively syllabified in the coda.

Velar nasal effect

- The velar nasal in Korean can be ambisyllabic unlike other consonants.
- Under the assumption that an ambisyllabic /**ŋ**/ may satisfy both ONSET and ALIGN-R, words with /**ŋ**/ C1 would be more likely to surface as such, resisting n-insertion.
- *AMBISYLLABIC (*AMBI)

  "The (velar nasal) consonant is not ambisyllabic."

Remaining effects: parameterized DEP

- **Syllabicity** effect: DEP-n/_ **i** > DEP-n/_ **j**
- **Height** effect: DEP-n/_ j**[-high]** > DEP-n/_ j**[+high]**
- Epenthetic /n/: DEP-**t**/_{i, j}, DEP-**m**/_{i, j} … > DEP-n/_{i, j}
- Before high front vocoids:

  DEP-n/_**a**, DEP-n/_**u** … > DEP-n/_{i, j}

- These ranking/weight differences may be understood under P-map (Steriade 2001, 2009)

P-map (Steriade 2001, 2009)

- A segment can be inserted or deleted only when its insertion or deletion is not so obtrusive in perception.
- The segment most confusable with zero is predicted to be chosen as the epenthetic segment.
- Its choice is determined based on a context-dependent hierarchy of perceptual similarity between the input and output.
- Common epenthetic C = [ʔ], [h], [j, w] (next to homorganic V's)
  - ✓ No coarticulatory influence on the neighboring segments
  - ✓ V-**ʔ**V, V-**h**V, or V-**G**V, are the most similar input-output pairs.

➢ Internal ranking of DEP constraints:

DEP-**p,t,k**/__V > DEP-**ʔ**/__V

P-map in Korean

- /n/ → [ɲ] / __ {i, j} (Allophonic palatalization)
- Input-output pairs involving n-insertion are similar just like V-GV
  - ✓ i-**n**i (or, more precisely, i-ɲi)
  - ✓ j-**n**j (or j-ɲj)

  Cf. i-ti, i-mi …; a-na, u-nu …

DEP-**t**/_{i, j}, DEP-**m**/_{i, j} ..

> DEP-n/_{i, j}

DEP-n/_**a**, DEP-n/_**u** …

More on epenthetic /n/ before /i, j/

- /i, j/ are high vocoids with a **low frequency resonance**, and they are **acoustically like nasals** (Borden & Harris 1984).
- Camouflage: placing a new segment right next to an existing segment similar to it must not be prominent.
- Inserting a nasal (i.e. /n/) next to a nasal-like segment (i.e. /i, j/) would be less prominent than …
  - ✓ inserting **a non-nasal** segment to a nasal-like segment
  - ✓ inserting a nasal **to a true oral segment**.

P-map: Syllabicity effect

- /nj/ is phonetically realized as almost (if not completely) a single segment [ɲ] (O. Kang 2003; Lee & Lee 2006)

  /nj/ → [ɲ(j)] cf. /ni/ → [ɲi]

- Input-output pairs

	j-nj	i-ni
palatalization	j-ɲj	i-ɲi
j-reduction	j-ɲ	i-ɲi
similarity	>>	

- DEP-n/_ **i** > DEP-n/_ **j**

P-map: Height effect

- N-insertion would not be prominent before /i, j/.
- One reason: they are high vocoids with a low frequency resonance, and they are acoustically like nasals.
- If /j/ is followed by a **high** vowel, its **low frequency resonance can be fully maintained** (at least longer than when it is followed by a non-high vowel), thus being more similar in perceptual nasality to its corresponding output with n-insertion, i.e. [ɲ].
- Similarity of Input-output pairs:

  j-ɲ/_[+high] > j-ɲ/_[-high]

- DEP-n/_ j**[-high]** > DEP-n/_ j**[+high]**

IV. Learning simulation

- Maxent (Maximum entropy) learner implemented in OTSoft (Hayes, Tesar & Zuraw 2013)
- Input learning/training data: the results of my own survey
- The current survey data have responses only to words with /j/-initial M2, not words with /i/-initial M2. Only the relevant constraints were employed in the simulation. For instance, DEP-n/_i was excluded.
- The frequencies of inserted and non-inserted forms (resyllabified or aligned) are taken from the relevant distribution in the results of the current survey, as shown below.

Training data: j[-high]

C1 type	Response type	Frequency	Proportion
ŋ	Inserted	715	**0.381**
	Resyllabified	0	0
	aligned	1160	0.619
obs	Inserted	538	**0.385**
	Resyllabified	588	0.421
	aligned	271	0.194
son	Inserted	1304	**0.472**
	Resyllabified	926	0.335
	aligned	533	0.193

Training data: j[+high]

C1 type	Response type	Frequency	Proportion
ŋ	Inserted	95	**0.424**
	Resyllabified	0	0
	aligned	129	0.576
obs	Inserted	127	**0.635**
	Resyllabified	27	0.135
	aligned	46	0.23
son	Inserted	217	**0.644**
	Resyllabified	31	0.092
	aligned	89	0.264

Additional training data

- 25,110 words with /VC_1+V_2/ ($V_2 \neq$ i/j)
  - /sikol+ai/ → [si.ko.ra.i] (resyllabified: 63%)
    [si.kol.a.i] (aligned: 37%)
  - These are added for the purpose of capturing the fact that ALIGN-R and ONSET are in competition in Korean phonology.
  - Otherwise, all optimal outputs would satisfy ONSET.
- Non-inserted forms (from the results of my own survey)
  - Resyllabified 1,572 (63%)
  - Aligned 939 (37%)

  Total 2,511
- I need a large number of words where M2 begins with vocoids other than /j/: 25,110 = 10 x 2,511.

Constraint weights learned

*[ŋ	50	ID(son)	0.479
ONSET	2.321	DEP-n/_ j[+high]	0.069
ALIGN-R	1.762	*CODA	0.065
*V-NUC	1.699	*AMBI	0.0
DEP-n/_ j[-high]	0.708		

Observed (yellow) and learned (blue) insertion rates (%)

	j[-high]			j[+high]		
	son	obs	ŋ	son	obs	ŋ
Input (observed)	0.472	0.385	0.381	0.644	0.635	0.424
Prediction (learned)	**0.515**	**0.397**	**0.31**	**0.668**	**0.553**	**0.46**

- The obstruency, velar nasal and height effects in the training data were reproduced.

V. Wug test

- I performed a novel word experiment on n-insertion in Seoul Korean.
- Purpose: to find out whether Seoul Korean speakers are aware of all the trends observed in existing words.

Experimental tokens

- All test words consist of two morphemes, **loanword** M1 and **wug** stem M2: e.g. /t^hap + jucenol/ cf. / t^hap / ‘top’.
- M1, which is either **mono** or **di-syllabic**, ends with one of seven consonants, /m, n, ŋ, l, p, s, k/.
- M2 begins with one of /**i, ju, ja**/.
- The total number of test items is **84** (2 (syllable count) x 7 (coda) x 3 (vocoid type) x 2 repeating blocks).
- The same number of control items (vowel-final M1 or /**a, e**/-initial M2) were adopted.

Method

- Participants: 37 Seoul Korean speakers
- In the test form, both inserted and non-inserted forms for each word were presented in standard Korean orthography.
- The experimenter told the participants that the words in the test form are made-up compound nouns for new chemical products.
- The participants were instructed to choose their pronunciation of each of the given compounds, from three choices, inserted, resyllabified and aligned. (When C1 = [ŋ], no “resyllabified” choice was given.)

Results (wug test)

- Insertion rate by C1 type (# of the relevant responses shown in parentheses)

son	obs	ŋ
0.28 (197)	**0.22** (187)	**0.10** (61)

- It seems both **obstruency** and **velar nasal** effects are confirmed.

A mixed effect logistic regression model

- The results of the present survey are fitted with the lmer function from the lme4 package (Bates et al. 2011) in R (R Development Core Team 2014).
- Dependent variable is binary, i.e., n-inserted or not.
- Random intercepts were set for item and subject. Random slopes were set only for subject.
- Fixed factors (underlined= reference level)
  - ✓ **C1 type** (son, obs, ŋ)
  - ✓ **M2-initial vocoid** (jV: ja, ju, i)
  - ✓ **M1 syllable number** (sylnum1)

Results: A mixed effect logistic regression model (wug test: fixed effects)

	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	0.01263	0.63853	0.020	0.9842
C1 = ŋ	**-2.40162**	0.49805	-4.822	1.42e-06 ***
C1 = obs	**-0.65958**	0.29942	-2.203	0.0276 *
V = i	**-2.97401**	0.43785	-6.792	1.10e-11 ***
V = ju	0.58794	0.30093	1.954	0.0507 .
sylnum1	-0.46375	0.28532	-1.625	0.1041

- All three main effects, syllabicity, obstruency and velar nasal: confirmed
- Height effect: (almost) confirmed
- Length effect: NOT confirmed

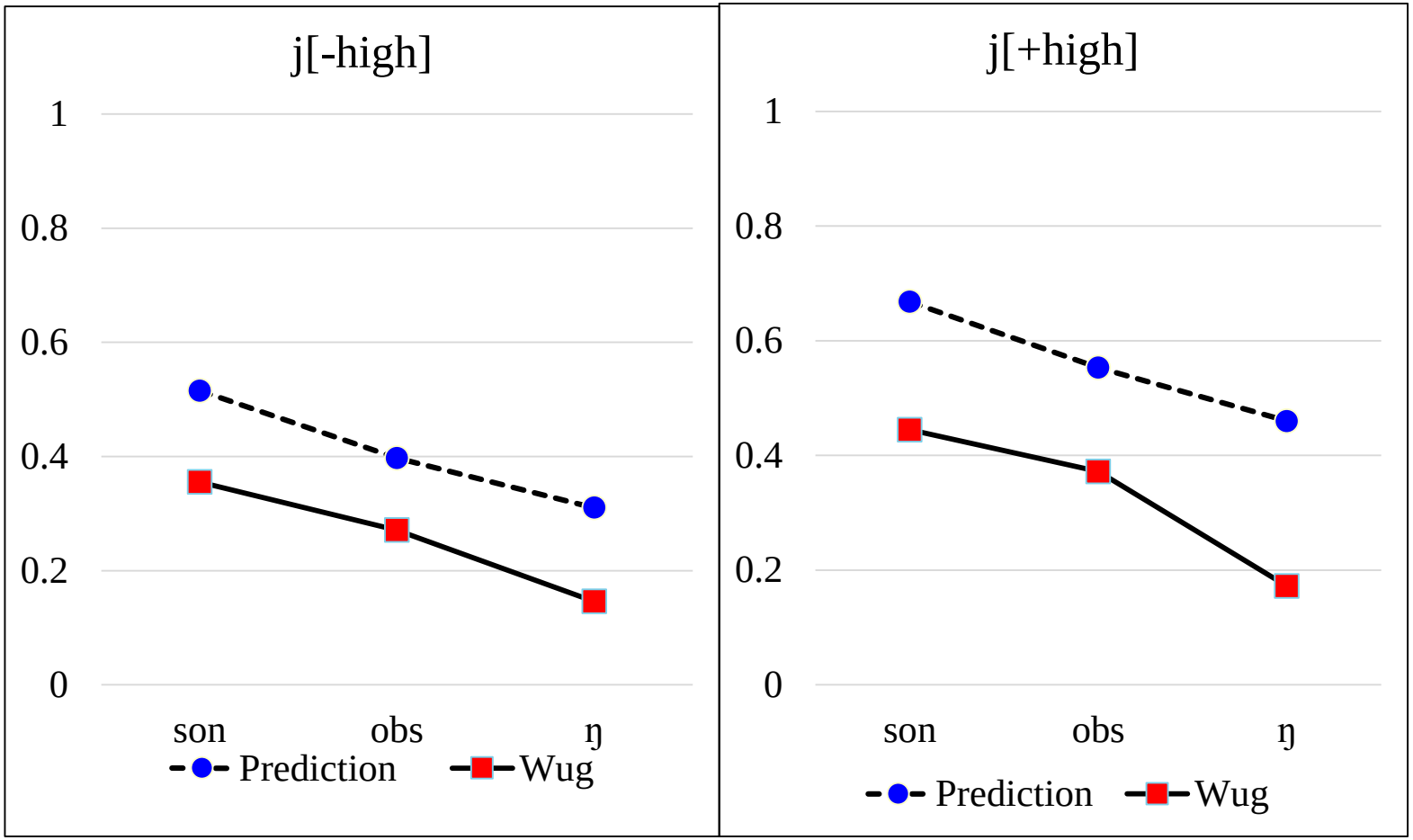
Wug test results (blue) vs. MaxEnt model prediction (yellow)

- Let us consider how well these wug test results are matched with the predictions of the Maxent model learning simulations.

- Insertion rate by C1 type and M2-initial vocoids

	j[-high]			**j[+high]**		
	son	obs	ŋ	son	obs	ŋ
Maxent model prediction	0.515	0.397	0.31	0.668	0.553	0.46
Wug test result	0.355	0.271	0.146	0.445	0.372	0.172

Plot of insertion rate by C1 type and M2-initial vocoids



- Prediction = predictions of Maxent model; Wug = wug test results

Conclusion

- Most of the trends observed from the existing words were mirrored in Seoul Korean speakers' production and intuition on novel words.
  - ✓ Frequency matching behavior (Hayes & Londe 2006, Hayes et al. 2009, Zuraw 2010): Speakers know such trends.
- Their internalized grammar has been formalized by adopting OT constraints.
- Its learning has been implemented in a maxent learner.
- Some crucial effects were analyzed under P-map.
- Length effect: only in existing words, not novel words.
  - ✓ This suggests that speakers do not learn all statistically prominent patterns in existing words.
  - ✓ This might mean that the length of M1 is a phonologically unnatural factor for the application of n-insertion (Becker et al. 2011; Hayes & White 2014).

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