Abstract

A cross-linguistic perception experiment was conducted on Finnish (and Japanese) speakers on the categorization of consonant length. The results reveal (among others) that the consonant has to be acoustically longer to be perceived as geminate /pp/ when the initial syllable is CV, as compared to CVC, only when Finnish listeners listened to Finnish stimuli, and only when the target is on the third mora. This result highlights the relevance of a bi-moraic unit on length categorization in Finnish, instead of a local effect of preceding vowel length.

1. Research Questions

Q1: Can languages with quantity distinctions differ from one another? Q2: If language-specific knowledge affect quantity categorization, how?

1.1. Finnish and Japanese look similar in quantity contrast

- Mora-timed; single-geminate ratios are close (Table1)

syllable-timed		mora-timed		
language	ratio	language	ratio	
Swedish	1:1.24	Sinhara	1:1.76	
Norwegian	1:1.32	Lavantine	1:1.92	
Burmese	1:1.43	Japanese	1:2.14	
Icelandic	1:1.53	Hungarian	1:2.16	
Madurese	1:1.55	Finnish	1:2.25	
Bavarian	1:1.72	Bengali	1:2.30	
Italian	1:1.85	Turkish	1:2.95	

Table1. single-geminate ratio (from Ham, 2001: 213)

1.2. A cross-language study reveals no clear difference (Aoyama, 2001)

- Production: "the distinction between single and geminate nasals appears to be clearer in Finnish than in Japanese" (p. 42; Fig.1)

- → Effect of vowel duration covariation? -
- Perception: Almost identical single geminate threshold (Fig.2)





function of nasal duration (/hana/~/hanna/)

1.3. Finnish and Japanese are different in some aspects

(1) Different Word Prosody

within the whole word (/n/ vs. /nn/)

- Finnish: Primary stress fixed on word-initial syllable - Japanese: Pitch accent freely associated to any mora

(2) Different patterns of variation in segmental duration (\rightarrow § 2.1)

precedir

2.1. Contextual variation in segmental duration

(1) Finnish: Conditioned by word-initial syllable structure - V2 is phonetically longer when the word-initial syllable is $CV (\leftrightarrow CVC)$ = "half-long vowel" (Suomi, 2005, Fig.3)

Fig.3: Patterns of segmental duration in Finnish (reproduced from the data in Suomi, 2005)

158th Meeting of the Acoustical Society of America 29 October, 2009 San Antonio, Texas

The effect of word segmental structure on 4pSC4 consonant length categorization by Finnish speakers

Kenji Yoshida, Kenneth de Jong

Department of Linguistics Indiana University, Bloomington e-mail: keyoshid@umail.iu.edu website: http://www.indiana.edu/~lsl Pia-Maria Päiviö Department of Slavic Language and Literature University of Toronto

2. Acoustic Stimuli for Perception Experiment

I) Finnish & Japanese talkers (one each) produced the original

speech tokens (= 6 nonsese words, below)

(2) Silence intervals with **7 equal steps** (/p/ ~ /pp/) inserted

(3) Two types of **word-initial syllable** (**CV** / **CVC**)

(4) Target consonant located on **3rd / 4th mora**

6 nonsense words (3 minimal pairs)

al syllable	С	CVC	
~ <i>pp</i> on	3rd mora	4th mora	
gle	ma.ta. <mark>p</mark> a.na	ma.na.ta. <mark>p</mark> a.na	man.ta. <mark>p</mark> a.na
nate	ma.ta <mark>p.p</mark> a.na	ma.na.ta <mark>p.p</mark> a.na	man.ta <mark>p.p</mark> a.na
g vowel	half-long	half-long	short

--> 6(original tokens) × 2(talkers) × 7(silence intervals) = 84 stimuli



(2) Japanese: Conditioned by mora counts

- Tendency for the word with the same number of moras to have about the same overall duration (Port, et. al., 1987)

 \rightarrow - Duration of the preceding vowel covaries with single-geminate contrast → Can function as a cue to quantity categorization (Ofuka, et. al., 2005)



3. Experimental Procedure

- 22 Native speakers of Finnish performed an identification task
- Forced choice between the single / geminate consonant minimal pairs
- 84 Stimuli repeated in 9 sets in different randomized orders

3.1. Participants & procedure

- Age: 20 ~ 58 years old, median = 27.5
- (in Roman alphabet for Finnish and in hiragana syllabary for Japanese) session (unrelated words, no feedback)

- Conducted in a quite room in the Dept. of Speech Science, Univ. of Helsinki - The visual prompts (two choices) were shown on the laptop PC screen - The speech recording and practice trials were done before the listening - 17 Japanese speakers performed the same task (not included here)

3.2. Data analysis (Fig.4)

- Sharpness of identification: **slope** of sigmoid function
- Categorical boundary between single & geminate: Estimate of 50% /pp/ response (**50% threshold**)
- \rightarrow Corrected to raw values of silent intervals (msec.)





Fig.4: Percentage of /pp/ identification and estimation of parameters (examples, FIN01)

4. Predictions

- 1) **Talker's Effect:** Quantity contrast is sharper for L1 (Finnish) stimuli
- (2) **Original Source Effect:**
- The stimuli created from the original token with /pp/ tend to be identified as geminate.

(3) **Structure Effect** (initial syllable = CV / CVC) for **Finnish talker only**: Late /pp/ identification if initial syllable is CV (preceding half-long V) (4) **NO Word Position Effect** (target consonant /p~pp/ on 3rd or 4th μ): Equally late /pp/ identification for CV (for *mata-* & *manata-*)



- when the word-initial syllable is **CV** (*ma* > *man*-)



1) Geminate identification is late (longer silent interval needed) when the target is next to the word-initial bi-moraic unit

- Consonants should acoustically be longer to be identified as geminate at the initial position of the second bi-moraic unit
- → Not a local effect of difference in duration of the preceding vowel (≠"contextual effect" in Kingston et. al., 2009)
- Language-specific knowledge on word prosodic structure is relevant
- (2) The same effect was **not** observed for **Japanese** listeners
- \rightarrow "Quantity languages" may differ in quantity categorization

6.1. Relevance of moraic structure for quantity in Finnish - The initial two morae has been argued to be the the segmental domain of durational realization of stress and F0 realization of accent

- The consonant in the **initial position of the second bi-moraic unit** has to be acoustically longer to be perceived as geminate? (Fig.6)

> CVCVCVCVCVVC 100 200 300 400 500 600

Fig.7: Word-initial F0 excursion completes within the initial two morae (from Suomi et. al., 2003: 128)

We are grateful to Reijo Aulanko, Marjut Mäenpää, Seppo Kittilä and the Department of Speech Science at University of Helsinki for providing resources for the experiment in Finland, and to Donna Erickson, Takuya Oomae and Yosuke Igarashi for the experiment in Japan. We are also thankful to Reiko Mazuka, Akira Utsugi and people in Language Development Lab at RIKEN for their comments. This study was supported by 2009 Finlandia Foundation International Fellowship Award.

Aoyama, K. (2001). A psycholinguistic perspective on Finnish and Japanese prosody.

Ham, W. (2001). *Phonetic and phonological aspects of geminate timing*. New York: Routledge Kingston, J., S. Kawahara, D. Chambless, D. Mash & E. Brenner-Alsop. (2009). Contextual effects on the perception of duration. *Journal of Phonetics*, **37**, 297-320.

Ofuka, E., Y. Mori & S. Kiritani (2005). Perception of Japanese geminate stop: the effect of duration of the preceding/following vowels. J. of Phonet. Soc. JPN, 9-2, 59-65.

Port, R., J. Dalby & M. O'Dell. (1987). Evidence for mora timing in Japanese.

Suomi, K. (2005). Temporal conspiracy for a tonal end: segmental durations and accentual f0 movement in a quantity language. *Journal of Phonetics*, **33**, 291-309. Suomi, K., J. Toivonen & R. Ylitalo (2003). Durational and tonal correlates of accent in