

英文要旨

Title : Acoustic study on production of the Japanese ‘sokuon’ at different speech rates

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Abstract

The present dissertation uses phonetic experiment to define acoustic cues of a Japanese geminate consonant, also called ‘sokuon’, based on the acoustic analysis of speech of different speech rates.

Chapter 1 briefly touches the aim of this research and introduces the background to it.

Chapter 2 lists most of the relevant studies related to the topic and discusses their outcomes. Furthermore, it explains the aim and plan of this research.

It is generally agreed that duration is the main cue for distinguishing geminate consonants from a singleton. However, there is a disagreement among authors regarding the criteria for measuring duration of a consonant.

First of all, many of the previous studies define a geminate consonant with a duration ratio between a double and a single consonant (Han 1962a, Beckman 1982, Sato 1998, etc.), which in other words suggests that a geminate consonant is always perceived through comparison with a singleton.

Another view in question is presented by Sato (1977), who claims that duration of a geminate consonant is comparable to an average duration value for a mora. The basis for such thinking seems to be in the isochronous character of Japanese morae but it is difficult to think that such a complex process as computing average duration value of a

mora in a word and, based on that value, adjusting duration of a geminate consonant, would exist in the production and perception of a geminate consonant.

The most recognized work on the topic is the one by Fujisaki & Sugito (1977), who claim the relation of a geminate consonant to a preceding 'sound'. However, the theory contains some questionable aspects in that it is unclear whether perception of a geminate consonant is interpreted with duration ratio between a consonant (including closure and friction) and a preceding mora, or between a consonant and a preceding vowel.

Finally, even though speech rate is thought to have great influence on duration of individual sounds, researches on the above topic have rarely been conducted.

Thus the purpose of this experiment is to examine mainly the theory by Fujisaki & Sugito (1977) as well as other theories, and to clarify the nature of a geminate consonant by verifying how changes in speech rate influence its production.

Chapter 3 and 4 describe a phonetic experiment about geminate consonants of different place and manner of production. Results bring to the discussion on relation between speech rate and acoustic characteristics of a geminate consonant. Findings are given following the discussion.

In the experiment, speech rate is considered as a an ever changing continuum with a wide range of possible speech rates from slow to fast, in which a geminate consonant is analyzed in terms of its production. Fujisaki & Sugito (1977)'s theory is examined with test words of CVCV type.

5 subjects were instructed to utter 12 pairs of test words containing either a geminate consonant or a singleton of different place and manner of production. Material was read at three different speech rates, fast, normal, and slow.

Most of the previous researches that have investigated speech rate, divide it into three main categories, slow, normal and fast, and measure average values for each of the categories. Yet divisions among the categories are thought ambiguous since there is a possibility, for example, that what was supposed to be slow speech is actually

pronounced faster than a normal speech. Therefore the present paper avoids classification of utterances into categories, and instead recognizes speech as a continuum of ever changing speech rate.

The results of the experiment are as follows.

1) Validity of regarding VOT as part of a vowel

Beckman (1982) pointed out the necessity of clarifying whether VOT is being included into duration of a consonant or a vowel, when conducting a research on a geminate consonant. Even though later studies (Beckman 1984, Sato 1988) used both ways of analysis, none of them offer an explanation which of the two choices is more valid.

This research provides experimental evidence for the VOT to be included into the duration of the preceding vowel, based on scattergrams showing dispersion differences between a singleton and a geminate consonant.

The conclusion is reconfirmed with a pattern of ratio distributions for a singleton and a geminate consonant, which shows much clearer polarization when VOT is considered as a vowel rather than a consonant.

2) Geminate consonant is determined by C/M1 ratio, rather than C/V1 ratio

Fujisaki & Sugito (1977) stated that perception of a geminate consonant is determined by 'relative duration ratio between a geminate and a preceding sound'. However, even though in the research by Fujisaki & Sugito (1977) it is possible to read the 'sound' either as 'preceding vowel' or as 'preceding mora', many of the later works following Fujisaki & Sugito (1977) assume that the perception of a geminate consonant is determined by relative ratio to a preceding vowel. Whether it is a ratio between a consonant and a preceding vowel (C/V1 ratio) or a preceding mora (C/M1 ratio), was examined in this paper.

The scattergram, which indicates the relation of C/V1 and C/M1 with word duration (= speech rate) , revealed that the ratio of C/V1 and C/M1 changes with the speech rate, and furthermore that the ratios of C/V1 and C/M1 increase as speech rate decreases. In other words, the above relative ratios vary with the change of speech rate, and C/V1 ratio as well as C/M1 ratio concerning a geminate consonant, are in negative correlation with speech rate.

Furthermore it was found that distribution rates of C/M1 ratio for a singleton and a geminate consonant are much more polarized than those of C/V1 ratio. In other words, production of a geminate consonant production takes duration of a preceding mora as a criterion while it adjusts duration of a geminate consonant so it can stay above a certain ratio.

3) Distinction between a singleton and a geminate consonant and the role of a following vowel

Production experiment was conducted considering speech rate as a continuum. Results show that with the increase of speech rate, distributions of C/M1 ratio for a singleton and a geminate consonant are close to each other and even overlap in some cases (Figure 3.20). This finding is something that hasn't been pointed out in any of the previous studies, not even for normal speech alone. In addition, C/M1 ratio values for a geminate consonant are those that approach values of a singleton.

There rises a question why a certain sound is perceived as a geminate consonant even though C/M1 ratio is not sufficient for it to be qualified as one? The problem suggests that there should be another cue discriminating a geminate consonant from a singleton.

It is my understanding that no reports have yet been published on the role of the following vowel in a geminate consonant production, or rather, it has been generally presumed that following vowel has no influence on perception of geminate consonant. (Hirato & Watanabe, 1987)

Results of this research show that C/V2 ratio distributions for a singleton and a

geminate are extremely well polarized, a tendency also proven for C/M1 ratio.

Furthermore, cases of distribution overlapping that appeared with C/M1 ratio alone were clearly polarized when both C/M1 ratio and C/V2 ratio were taken as criteria (Figure 3.35). This suggests that, in production of a geminate consonant, a singleton and a geminate consonant are discriminated under the condition that both, C/M1 ratio as well as the C/V2 ratio are above a certain value, which is maintained through duration adjustment of a consonant.

In other words, not only the C/M1 ratio but also the C/V2 ratio should be considered as one of the acoustic cues to discriminate between a singleton and a geminate consonant. Such existence of several acoustic cues represents abundance of information thought to be of great use in perception where discrimination for more than 20 phonemes takes place in just one second (Borden et al. 2002), and it is predicted that duration of a following vowel would be an important factor in perception of a geminate consonant.

4) Relation between cues for phoneme discrimination and speech rate

Up to the present, many researches dealing with production of a geminate consonant obtained their results by using normal speech rate only, and researches that dealt with continuously varying speech rates are close to none. As a consequence, a question, how cues for distinguishing a singleton and a geminate consonant work in regard to the change of speech rate, has yet to be clarified.

Considering continuously changing speech rate, results show that C/M1 ratio for a geminate consonant increases with the decrease of speech rate, and that the range of such ratio change is large. But in contrast, it has been found that the range of C/M1 ratio change for a singleton is strictly limited (Figure 3.14~ Figure 3.18). This in other words means that as the speech rate decreases, distinction between a geminate consonant and a singleton becomes clearer, and it is a singleton, rather than a geminate consonant, that is sensitively restricted by C/M1 ratio.

Issue on a singleton and a geminate consonant taken on in the present paper closely relates to the phonological problem of a distinction between short and long. As for further investigation, newly developed ideas in the present paper should be expanded further to fit in the Japanese moraic vowel and moraic nasal also. An overall investigation is then expected to bring general conclusion on the topic.

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