

ACOUSTIC CUES ON INTERSYLLABIC BOUNDARY IN (C)VNNV STRUCTURE

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ABSTRACT

The purpose of this study is to investigate the acoustic cues on intersyllabic boundary in the (C)VNNV structure of Standard Chinese by examining the variation on amplitude, formant frequency and duration during the period of the -NN-. Relevant acoustic measurements were made and a limited perception test was conducted. The experimental results show that some acoustic cues do exist in the boundary between two syllables. That is, an amplitude valley occurs between -N and N-, the nasal duration of -NN- is systematically longer than single -N or N-, and the formant pattern of -NN- is different from that of -N or N-. Moreover, according to the perception test, the transitional area and its duration between two syllables can be estimated, and it roughly matches with the location of the amplitude valley.

I. INTRODUCTION

This report is a part of the research work on intersyllabic juncture in Standard Chinese. Juncture, as the cue of segmental boundary, is a common phenomenon between different speech units. It is true that the juncture is quite complex and rather difficult to deal with. However, it is an important issue from both theoretical and practical point of view, so, it cannot be avoided in

speech research.

With respect to Standard Chinese, Hockett(1947) and Chao(1968) mentioned some phenomena in connection with juncture, but experimental approach was first made by Xu(1986). He found that the most ambiguous situation occurred between two adjacent [n] nasals. Since the nasal [n] is a consonant, it can serve both as initial and final ending in a syllable in Standard Chinese. Consequently, it often gives rise to some difficulty in determining the syllabic boundary between the adjacent syllables in (C)VNNV. He only pointed out that the duration of -NN- in (C)VNNV structure is longer than that of single -N or N- in monosyllables. We try to carry this research forward to see if there are any regular patterns that can be regarded as the further acoustic cues of intersyllabic boundary during the period of -NN-.

II. MATERIALS AND METHODS

In this study, 24 (C)VNNV disyllables were selected as the experimental words. They are all normally stressed and meaningful words. These materials were produced by two native male speakers, and the audiorecording was made with P-Kenwood Recorder in the soundproof of the Phonetic Lab, Institute of Linguistics, CASS. All the materials

were stored as waveform in the disk. Acoustic analysis and measurements were made through Kay 5500 and ASL program.

In normal spectrogram, the amplitude contour of -NN- period appears rather flat and difficult to differentiate any distinctive variation. In order to further observe its precise structure, the amplitude contours of all the -NN- parts were extended by using ASL program, and the measurements were made at the point of every ten milliseconds.

In order to examine time-varying situation of -NN-, formant frequencies under 3KHz were measured at the onset, midpoint and offset of the -NN- respectively according to their spectrogram.

The durations of the nasals both in monosyllables and disyllables were got from the spectrogram on 5500 sonagraph, and the durational ratios of -N or N- to the whole words were calculated as well.

Another durational measurements related to the transition portion between -N or N- in the -NN- were made by an editing and listening test through 5500 sonagraph. That is, first, the duration of the nasal ending -N from the onset of the -NN- forward was increased until the first syllable heard well; then gradually the duration of the initial N- from offset of the -NN- backward was increased until the second syllable was heard well. The rest of -NN- was the transition between the final ending -N

and the initial N-, and its duration could be calculated. Thus, an intersyllabic boundary is supposed to falling into this period.

III. RESULT AND DISCUSSION

Experimental results can be summarized by Fig.1 to fig.3 and Table1.

3.1 Amplitude

Fig.1 shows two examples of the extended amplitude contour of the -NN- period from the data measured in this investigation. It is clear that there is an amplitude valley during the -NN- period. It indicates that there must exist a turning area of the energy, though the turning point cannot be determined precisely. Usually, the energy of a syllable is gradually rising at the beginning and falling at the end, so the turning area observed here should be regarded as a cue of the intersyllabic boundary.

Table 1. The average duration ratios of initial N-, final -N in monosyllables and of -NN- in disyllabic words, as well as the transition durations between -N and N- in -NN-.

		N-	-N	-NN-	Tn
	rate%	14.5	17	27	10
C	sd	5.8	6.5	6.3	3.6
	n	40	20	24	24
	rate%	22	23	32	14.5
M	sd	3.7	5.6	8.0	5.5
	n	44	49	23	23

3.2 Duration

Duration data are given in Table1, where the ratios are calculated from the mean durations to -N or N- to entire monosyllable and

of -NN- to the whole disyllabic word respectively. According to the data shown in this table, the -NN- is evidently longer than either the single -N or single N-. This further confirms Xu's report (1986), and it is also similar to that in Tamil (Balasubramanian, T, 1982). It means that there may be a boundary existed somewhere during the -NN-.

The data in the last column of Table 1 are the duration of transition between -N and N- in the -NN- determined by editing and listening test. It makes the boundary location in a narrower and more limited period, which period can be seen from the spectrogram shown in Fig.1.

Moreover, an extended amplitude contour of the -NN- is given in Fig.2 as well. As compared with the position of the transition and the corresponding amplitude contour, an interesting phenomenon can be observed, that the amplitude valley roughly matches with the period of the transition. It further indicates that the intersyllabic boundary does locate in this period.

3.3 Formant pattern

Fig.3 shows the formant patterns of -N in syllable AN, N- in syllable NA and -NN- in word ANNA. Which are drawn according to the frequencies measured from this investigation. From the comparison of these patterns, we can see that the entire pattern of -NN- is evidently different from that of -N or N-. The

formant frequency of -NN- varies from the onset to the offset, roughly speaking, the former part is more similar to that of -N, and the later to that of N-, and the middle part is different from either of -N and of N-.

CONCLUSION

Experimental results described above indicate that there do exist some acoustic cues for the intersyllabic boundary: a distinctive valley of amplitude occurs in the period of the -NN-; the differences both of duration and of formant pattern are found between the -NN- and the -N or N-; an estimated transition period is determined and the amplitude valley falls into this period.

ACKNOWLEDGMENT

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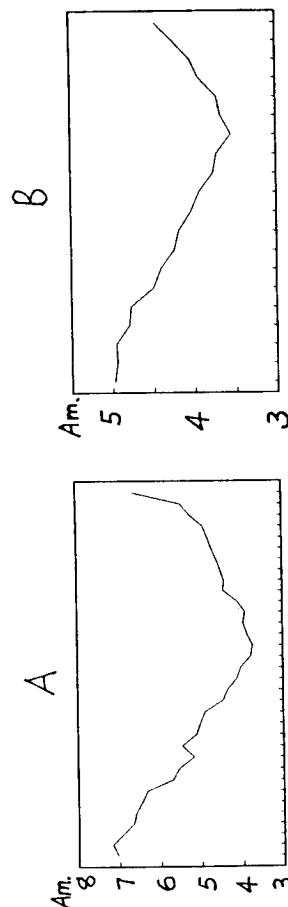


Fig. 2 The diagrams of amplitude tendency in -NN- portion, A is subject M(22), B is subject C(24).

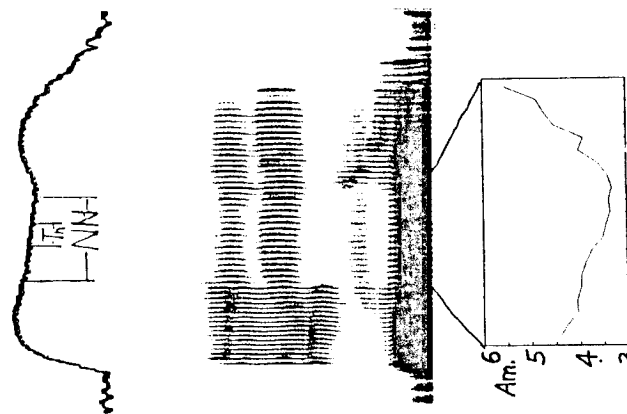


Fig. 1 An example of measuring the -NN- in disyllable, the word is Yunnu [yn nu]

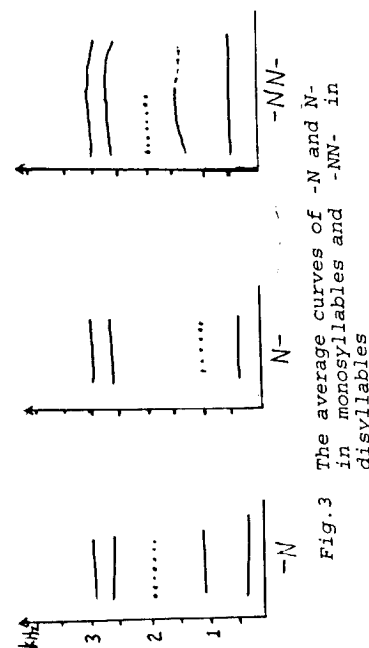


Fig. 3 The average curves of -N and N- in monosyllables and -NN- in disyllables