The research for the effect of speaking rate to segmental reduction

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ABSTRACT

This paper mainly researches the speaking rate effect for segmental reduction in a phrase word. Four speakers spoke eight words with different speaking rates. The investigation includes the durational variation of each syllable, the durational variation of each semi-syllable and the total word duration variation. Different speakers’ material in read speech was explored at last.

1. INTRODUCTION

1.1 The question of reduction

It is well known that speaking rate affects segmental duration. This effect can change the segment. For example, it can make vowel schwa or shorter. Reduction is the most phenomena in continuous speech. As this case appears, its duration, intensity, fundamental frequency and sound quality will change. Duration is evidently shorter. If it is more serious, the segment will be deleted. Some factors affect segment reduction such as stress, accent, and number of syllable in a word [1]. At the same time, segment will vary itself. Reduction is closely contacted with duration shorting. Speaking rate is an important factor making segmental reduction. Certainly quart-syllable word read in continuous speech will be affected by the context and speaking rate according to different speaker’s speaking inhabit.

1.2 Chinese syllable and word

Chinese has style monosyllable word. Most mono-syllable is one word with entire meaning. Some mono-syllable is not one word. Bi-syllable, tri-syllable and quart-syllable can be a word.

The research for tri-syllabic word and quart-syllabic word shows that the second syllable is the easiest one to be affected and then the end syllable [2] [3]. In continuous speech, it is easy to pronounce these words naturally. In Chinese it is either syllable duration change or the initial/final change. According to the author’s investigation, reduction phenomena is very universal in Beijing Mandarin. Speaking rate is an important factor.

1.3 speaking rate

Speakers pronounce syllable and word faster in continuous speech than in isolated context. Sound variation often occurs in continuous speech. Speaking rate is an important factor affecting segment reduction. This paper explores the effect of speaking rate to segment. Also this paper will compare quart-syllable word read in continuous speech with read in isolated context.

2. EXPERIMENT

2.1 Materials

Eight words were selected. The material includes: er4 shi2 fen1 bei4, san1 shi2 fen1 bei4, si4 shi2 fen1 bei4, wu3 shi2 fen1 bei4, liu4 shi2 fen1 bei4, qi1 shi2 fen1 bei4, ba1 shi2 fen1 bei4, jiu3 shi2 fen1 bei4. They are quart-syllable word.

The same quart-syllable word Materials were selected from a read corpus including ten speakers. The syllable and word durations were measured.

2.2 Method

Four speakers read 8 quart-syllable words with different speaking rates. Each syllable, semi-syllable and word durations were got. The segmental reduction was analyzed. There are three ways to give different duration, syllable, semi-syllable and word duration. The comparing with average syllable and percentage were got within a word. At last, this paper gives four speakers’ results.

Quart-syllable word materials from read speech were got from labeling*.
3. RESULT

Syllable, semi-syllable and word durations within a word were got. There are similar representations among different speakers. Here mainly gives one speaker’s results.

3.1 syllable duration variation

Fig.1 gives each syllable’s duration of speaker CA within a word in different speaking rate. It is evident that each syllable’s durations are shorter gradually as the rate from slow to fast. The second syllable deletes as the rate is the fastest. The third and the last syllable become shorter gradually as the rate increases.

Fig.2 gives the difference of each syllable’s duration with the average syllable length. The results show that the first and second syllables have greater change than the last two syllables. The first syllable is shorter than the average value in the first rate. But the others are longer than the average value. The second syllable is longer than the average value in the first rate. But the others are shorter than the average value. The last syllable is a little shorter than the average value as the rate is at the last rate.

The results show that the second syllable decreases mostly in the quart-syllable word. It seems that the first syllable has a negative representation with the second syllable. The results show that the first two syllables are a little shorter than the last two syllables. It is consistent with the study in Wang [2]. The position determines syllable length as phoneme and vowel length depending on the position within a word [4].

3.2 semi-syllable duration variation

Furthermore, semi-syllable duration is given in Fig.4. According to Fig.4, ‘shi’ and ‘f’ show great change. ‘shi’ syllable lost vowel. Fricative ‘sh’ and ‘f’ are shortening than in isolated condition. The second syllable will be short as the speaking rate increases.

There is complementary between initial and final within a syllable [5]. For the same articulation place of initial and final “shi”, final will be easy to be reduced. Another reason is the position within the word. Normally, the second syllable within a
quart-syllable is unstressed syllable position. “shi” is unstressed syllable. As the speaking rate increases, this syllable will be reduced. Within this syllable, final is easier to be reduced than initial. Though the experiments just consider the effect of speaking rate but the natural stressed and unstressed exist within a word. Reduced syllable is caused by the two reasons in experiments.

3.3 word duration variation

![Fig. 5 word duration in different speaking rate](image)

Fig. 5 gives word duration in different speaking rate. It is very clear that word duration shows declination from long to short. It seems regular pattern. In order to explore the universal representation, different words with different syllable structure were got in Fig. 6.

![Fig. 6 word duration (eight words)](image)

Fig. 6 shows eight words spoken in different rates. The tendency is very similar. So the tendency line can be got. The results indicate the duration distributions are similar within different words,, It can be explained by the consistent controlling mechanism in human brain.

3.4 comparing with read speech

The other materials selected from read speech corpus with ten speakers’ pronunciation. Here is the word “er4 shi2 fen1 bei4” in Fig.7. Fig.7 gives the syllable percentage within a word. “fen” shows the most percentage among four syllables.

![Fig. 7 syllable duration from read speech](image)

Table 1 gives four syllable durations. The unit is second. According to average, “shi” is the shortest syllable.

<table>
<thead>
<tr>
<th></th>
<th>er</th>
<th>shi</th>
<th>fen</th>
<th>bei</th>
</tr>
</thead>
<tbody>
<tr>
<td>av</td>
<td>0.244</td>
<td>0.209</td>
<td>0.334</td>
<td>0.213</td>
</tr>
<tr>
<td>sd</td>
<td>0.018</td>
<td>0.039</td>
<td>0.032</td>
<td>0.030</td>
</tr>
</tbody>
</table>

Table 1 the average and standard deviation of “er shi fen bei” duration

Table 2 gives the average durations of all words in this type. The unit is millisecond. The last syllable is the shortest one and the second syllable is 10ms longer than the last one. But the second syllable has larger standard deviation than the last one.

<table>
<thead>
<tr>
<th></th>
<th>av</th>
<th>shi</th>
<th>fen</th>
<th>bei</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>178</td>
<td>150</td>
<td>213</td>
<td>140</td>
</tr>
<tr>
<td>sd</td>
<td>38</td>
<td>48</td>
<td>28</td>
<td>32</td>
</tr>
</tbody>
</table>

Table 2 the average syllable durations of the same type

![Fig. 8 Syllable duration percentage within a word of ten speakers](image)

Fig. 8 gives ten speakers’ materials. Each syllable duration percentage within a word is
given. According to average percentage, four syllable duration percentage as following:

| Percentage | 26% | 22% | 31% | 21% |

It is very clear the second and the last syllable are very close. From Fig. 8 representation, the second syllable has a larger variation range than the last one. It represents the second syllable is variability. But the entire duration of this type word is close as next figure.

Fig. 9 word duration with ten speakers

Fig. 9 gives word duration with ten speakers. There is a change range about 400ms. It is caused mostly by different syllable within a word. For the same syllable structure word, it is approximate.

4 conclusions

According to the results, three conclusions can be got. The first is the second syllable is not stability and easy to reduce within a word from this experiment materials. The second is that there is similar durational tendency in different syllable structure within a quart-syllable in different speaking rate. The third is there is consistent durational controlling mechanism among different speakers.

* The data are got from a procedure made by Dr. Xiong Ziyu and thanks for his help.

Conferences