

Research on Stress in Bisyllabic Words of Mongolian¹

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[Abstract] This thesis proves that the main acoustic feature of Mongolian bisyllabic words is the duration of the vowels after analysis and generalization of the acoustic pattern of the prosodic features of monosyllabic and bisyllabic words of Mongolian based on the "Database of acoustic Parameters of the prosodic features of Mongolian" combined with perception experiments.

1, Introduction

1.1 A General Survey of the Researches on Mongolian Stress

In the researches on prosodic features, stress is a target point. While though some works have been in the researches on Mongolian stress, the defining of its position and nature is still unsettled since there is no lexical stress in Mongolian and most of researches mainly depend on "oral and ear". For instance, on stress position, most researches believe that Mongolian stress is a fixed accent, fixed on the first syllable, while some researchers hold that it is not fixed. On stress nature, most researchers believe that, Mongolian stress is a stress accent (stress accent theory); while others hold that besides stress accent, there is also pitch accent in Mongolian (pitch accent theory). In a word, there is get no commonly accepted conclusion proved with experimental phonetics on the issue of the position and nature of Mongolian stress (let alone prosodic pattern

of sentences). Therefore a systematically quantitative and qualitative analysis is necessary, which can not only raise the teaching and research level of Mongolian, but more importantly supply the Mongolian Speech technology project with a reliable data basis.

1.2 The Concept of Word Stress and Research clues

Hereby mentioned word refers to the prosodic word. In a word composed of two or more syllable, one of them must sound a little "heavier" or "stronger", this called prosodic word stress. In general, the acoustic correlates which produce the "stress" have some nature of a vowel, such as the aperture, the duration and tension of the vowel, and other acoustic features like the energy, duration, pitch range, and spectral tilt of the vowel.[1] However, the acoustic correlates are only a kind of objective stimulus, while concerning a language, the contributions these correlates have made toward stress perception are much different. So after we measured the various acoustic features of the vowels in multi syllabic words with acoustic analysis, we must conduct auditory distinguishing experiments. From the results the contributions the correlates have made toward stress perception of a specific language can be determined. Many mandarin Chinese stress researchers point out that stress makes the duration become longer and the pitch range wider,[2] Mongolian is an agglutinative language belonging to the family of Altai

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with not only complete "vowel harmony" phonologically, but also differences between long and short vowels. Considering that vowels play an important role in syllable, we chose the acoustic features of vowels as the acoustic correlates of syllabic stress. In our experiments, we firstly designed a group of experiments on monosyllabic words. Thus the influences of some factors upon the stress perception of bisyllabic words can be excluded. Based on this, bisyllabic, trisyllabic, and compound words, and sentences are analyzed acoustically. In this paper only stress in bisyllabic words is discussed.

II. Experimental Methods

2.1 Language Material Designing

Experimental words designing: 139 bisyllabic words including vowels, consonants, and all syllable varieties were selected according to Mongolian phonetic features. And bisyllabic words were separated into four groups: short-short, short-long, long-long, and long-short based on the nature of vowels.

Speaker: Mr. Soninsod, announce of Inner Mongolia Radio Station. He is from Chahar and has a typical, pure, clear, and consistent pronunciation. While recording, we let the speaker pronounce the words experimented in the same leading sentences "@n tS_hin... pE:n." (This is..), such as "@n tS_hin mAr pE:n." (this is a horse.)

Recording: inside the standard recording room in the Academy of Mongology of Inner Mongolia University. Sony digital recorder system (microphone, tuning center, and DAT recorder), Hi-Fi quality.

2.2 Acoustic Analysis

The duration of every syllable (SD) in word, the duration of the vowels (PD), the energy (PA), and the pitch contour starting point (Fs), the broken point (Fb), and the ending point (Fe) in every syllable were respectively measured by KAY model 3700 multi-speech. We put the results into Microsoft Excel to form a database of prosodic features. Every phone was transcribed using SAMPA code.

2.3 Perception Experiments

2.3.1 Experimental Subjects

People's subjective judgment is inevitably influenced by their mother tongue and the degrees of influence are different when people's educational level and specialties are different. Therefore three groups of people were selected as experimental subjects. Totally thirty subjects divide into three groups: ten people of group one are junior Mongolian Students from the Department of Mongolian Language and Literature and are dominantly influenced by linguistic knowledge; ten people in group 2 are Mongolian students from the Department of Mathematics and are recessively influenced by linguistic knowledge; ten people in group 3 are Chinese (Han) students who are Mongolian illiterate but has Chinese linguistic knowledge.

2.3.2 Perception Experiments Designing:

1) Inside a language lab with everyone hearing a headset to avoid the influence of uneven sound field.

2) 12 bisyllabic words were chosen from the language material recorded for acoustic analysis with every three words in one category (the data of one of every three does not accord with the statistical law). Questions such as first syllable stress, or second, or even stress is required to be answered.

3) Play every recording for five times with 3-second intervals between playing and 15-second intervals between words.

4) Before experiments, subjects were trained with bisyllabic words of the same type to master the criteria of auditory distinguishing.

III. Results

3.1 Results of Acoustic Analysis

1) Duration Distribution Pattern: first, long vowels in every type are all much longer than short vowels if syllable position is not taken into account (duration proportion 2:1 plus), which is the same as the proportion of long and short vowels in monosyllabic words, second, in long-long, short-short types the duration of vowels in the first syllables is longer than it in the second syllable, which we can call it as "position effect". See Table 1 and figure 1.

Table 1 Average of the acoustic parameters of the vowels in bisyllable words

Type \ Feature	short-short			short-long			long-long			long-short		
	The first syllable	The second syllable	Difference	The first syllable	The second syllable	Difference	The first syllable	The second syllable	Difference	The first syllable	The second syllable	Difference
Duration ms	99	66	33	94	151	-57	186	127	59	198	63	135
Pitch Hz	159	205	-46	146	189	-43	188	177	11	185	171	14
Energy dB	67 . 54	67 . 92	-0.4	65 . 97	70 . 32	-4. 4	72 . 89	70 . 39	2. 5	71 . 91	64 . 14	7. 8

2) Energy Distribution Pattern: "weak first strong second" pattern for words with a short vowel in the first syllable, etc, the short-short, short-long type, with differences as: -0.4dB and -4.4dB; while "strong first weak second" pattern for words with a long vowel in the first syllable etc, long-long, long-short type, with differences as: 2.5dB and 7.8dB. These figures are greatly connected with the figures of duration distribution. And the results are also the same as the monosyllabic words. See Table 1 figure 2.

3) Pitch Distribution Pattern: from figurative analysis of pitch in Table 1. It is known that in syllables with long vowels, a pitch of the long vowels is higher than the pitch of short vowels; and when the short vowel is in the second syllable, its pitch is higher than the first syllable, which are show most clearly in short-short type with a difference of 46 Hz. The meaning of this difference will be reflected in auditory distinguishing experiments.

3.2 Results of Perceptual Experiments:

Table 2 Results of stress distinguishing of different groups

Type \ T 值	Group 1	Group 2	Group 3	Average
short-short	-0.3	-0.3	-0.4	-0.35
short-long	0.06	-0.1	-0.4	-0.14
long-long	0.18	0.4	0.13	0.24
long-short	0.6	0.4	0.47	0.50

Caption: (1) $T = (qz - hz) / dz / (qz + hz + dz)$, when $dz = 0, t = (qz - hz) / (qz + hz + dz)$. $-1 < T < 1$.

$T = +1$ -- 0 percent taken by first stress; $T = 0$ equal stress; $T = -1$ -- 0 percent taken by second stress.

From Table 2 we can see that all positive figures were judged to be first stress, and all negative figures second stress. Though the proportion judged to be stress differs due to different word structures, based on the average of three groups combined with data of acoustic analysis, the following conclusion can be reached:

- 1) Syllables with a long vowel are judged to be stress syllable in short-long and long-short type;
- 2) The first syllable is judged to be stress syllable in long-long type because it is long than the second syllable (see Table 2): Above mentioned two points show that the duration feature of vowels have played a decisive role in stress perception, and pitch and energy only play minor roles;

3) In short-short type the second syllable is judged to be the stress syllable though the first syllable is longer (33 ms), which does not accords with the results of other three types, nor with traditional theory. After careful analysis, it turns out to be that the pitch of the second syllable is much higher than the first syllable and the duration dominant position of the first syllable, has to give way to the pitch of the second syllable, which shows that pitch plays decisive role in stress judging when duration of two syllables equal or similar to each other;

4) In short-long type, the results judged by the first groups are the reverts of the truth, etc, judging the syllable with a long vowel to be unstressed,

while group 3 (Chinese (Han) students) rate of correct judgment is highest. This is probably due to linguistic background. Mongolian linguistic tradition holds that the first syllable is "stressed", while Chinese students perceived the second syllable to be "stressed" purely from a longer duration.

IV. Discussion and Conclusion

4.1 The Nature of Mongolian Stress

Reasons of believing that duration is the main acoustic correlate of Mongolian stress are as follows: first, duration has a special meaning to Mongolian. From experiments we can see that the proportion of syllables with a long vowel perceived to be stressed is much high; second, in Mongolian there are long and short vowels distinct to each other, so duration of vowels is important in Mongolian. From the results of acoustic analysis it is seen the difference of duration is obvious with average 1:2.

4.2. Conclusion:

Based on the above mentioned acoustic analysis and perceptual distinguishing experiments, the following can be reached: duration is the major acoustic correlate of Mongolian stress, etc, the nature of Mongolian stress is duration; the stress distribution pattern of syllabic words is: first stress in long-long, long-short types of words and second stress in short-short, short-long types of words.

Bibliography

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Figure 1

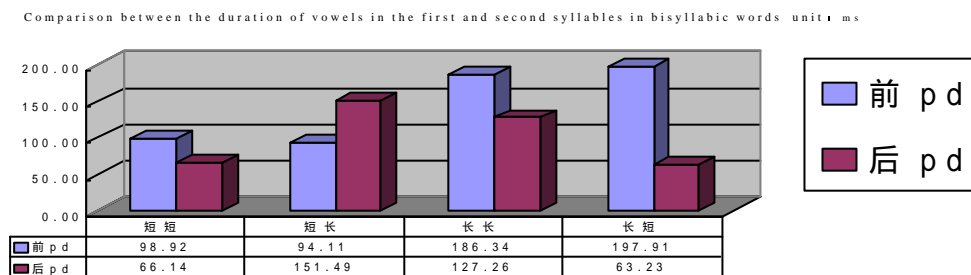


Figure 2

