The Acoustic Analysis of Kazak Vowel /e/

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Abstract. Phonetic experiments with Kazak words including vowel /e/ in different positions were undertaken, and formant values of the onset point and the offset point of the sounding process of each /e/ have been extracted and analyzed. The results and finding indicate that vowel /e/ in Kazak is not a diphthong but a monphthong.

1. Introduction

There are 9 vowels in Kazak /ɑ/, /æ/, /e/, /o/, /ø/, /u/, /y/, /ə/ and /ɨ/ (Here, the IPA are cited from *A Course of Acoustic Phonetics*[1] and *Modern Kazak Practical Grammar*[2].). Generally, the 9 vowels are divided into two groups according to the tongue positions in pronouncing, that is front vowels/æ/, /e/, /ø/, /y/, /ɨ/ and back vowels /ɑ/, /o/, /u/, /ə/. "At present, all the 9 vowels are recognized as monophthongs in the research field of Kazak in China, while vowels /e/ and /o/ are demonstrated to be diphthongs by the current research results in Kazakhstan"[3]. Besides, based on an acoustic analysis of vowel /i/ (Here /i/ is the same as /ɨ/.) and a comparison of tongue positions of the Kazak vowel with its possible counterparts in the cardinal vowel pattern, Zheng Huan has demonstrated that "Kazak vowel /i/ is actually not the vowel [i] (front high vowel), [ɨ] (central high vowel) or [ɣ] (back semi-high vowel), [e‾] is a better IPA for the phoneme instead"[4].

Obviously, there are still disputes in Kazak vowel system, and this is why in this paper, the phonetic marker "/ /" is used instead of "[ ]". "/ /" is the marker for broad transcription, in which the phonetic symbol is a phoneme, standing for a series of possible allophones, while "[ ]" is the marker for narrow transcription in which the phonetic symbol stands for the exact pronunciation of a certain sound[5]. Kazak vowel /e/ is recognized as a front high monophthong by most researchers in China but is believed be to a diphthong in Kazakhstan, while in China's research it also has been reported that when /e/ is the first letter of a word, /j/ is often added before it in pronouncing[6]. Therefore, more researches are needed to solve the dispute. This paper centers on the properties of Kazak vowel /e/ by means of acoustic analysis.

2. Research Design

To monophthongs, the tamber is decided by the first three formants, among which the first two formants F1 and F2 are especially sensitive to the changes of lips and tongue positions, thereafter, the values of F1 and F2 are usually taken as the main elements in vowel depiction[7]. Comparatively speaking, each monophthong has a stable and unique formant pattern. In diphthong pronouncing, a process of sliding from one phoneme to another one can be perceived. Lips and tongue positions change with the sliding between the two phonemes, leaving an unequivalent distribution of stress and strength between the two phonemes[8]. Most important, there must be two apparent formant patterns in the acoustic properties of a diphthong. Therefore, with the help of formant pattern and comparison of formant values, whether a vowel is a monophthong or a diphthong can be testified.

2.1 Words for Pronouncing

In order to guarantee all possible positions of /e/ in words, and all possible influences of consonants to the pronunciation of /e/, 200 Kazak words involving all six syllable types (v, vc, vcc, cv, cvc, cvcc) were filtered. The syllable numbers of the words were ranged from 1 to 4, and the letters before and after /e/ covered all the 22 consonants of Kazak (Consonants /f/ and /v/ are only used in

borrowed words, and borrowed words are not included in this research for certain reason.) The sample of the word list for pronouncing is in figure 1.

WN	IPA	ST	SN	KAZAK	WC	CE
WN001	ej	VC	1	ەي	exclam.	〈叹〉 嗯，唔，嘿
WN002	ek	VC	1	ەك	verb.	〈动〉 (1) 种，种植，耕种，栽植
WN003	el	VC	1	ەل	noun.	〈名〉 (1) 人民，民众，群众，众人
WN004	eŋ	VC	1	ەڭ	adv.	〈副〉 （和形容词连用，构成最高级）最，很
WN005	ep	VC	1	ەپ	noun.	〈名〉 (1) 巧妙的方法，灵活的措施，熟练的技术，擅长，窍门，门道
WN006	ex	VC	1	ەح	exclam.	〈叹〉 （表示可惜，责备等意思）哎 ，嘿 ，哎呀

WN						
WN036	eneʃ	VCVC	2	ەنەش	noun.	〈名〉 对岳母，婆母的昵称。
WN037	erek	VCVC	2	ەرەك	adv.	〈副〉 特别地，特殊地，格外地，分外地，奇特地
WN038	eren	VCVC	2	ەرەن	adv.	〈副〉 特别地，特殊地，格外地
WN039	erew	VCVC	2	ەرەۋ	adv.	〈副〉 随随便便，盲目，无目的。
WN040	esej	VCVC	2	ەسەي	verb.	〈动〉 长大，成长，懂事，变得成熟
WN041	esen	VCVC	2	ەسەن	adj.	〈形〉 平安的，安好的，安生的，安全的

WN						
WN070	eselew	VCVCVC	3	ەسەلەۋ	verbl.	سەلە 的不定式。
WN071	exeles	VCVCVC	3	ەحەلەس	verb.	〈动〉 争吵，吵嚷，争执，争论
WN072	eheles	VCVCVC	3	ەھەلەس	verb.	〈动〉 (1) 争吵，争论，发生纠纷 (2) 和好，言归于好。
WN073	eneles	VCVCVC	3	ەنەلەس	adj.	〈形〉 (1) 同一个婆婆的 （妯娌）(2) 吃同一个母亲奶长大的，由同母所生的。
WN074	ereges	VCVCVC	3	ەرەگەس	noun.	〈名〉争论，争执，争辩，纠纷
WN075	etenelew	VCVCVCVC	4	ەتەنەلەۋ	adj.	〈形〉 比较亲密的，较为密切的，有些亲近的。

Fig. 1 Samples of world list for pronouncing

※ WN=world number, IPA= International Phonetic Alphabet, ST=syllable type, SN=syllable number, WC=word class, CE=Chinese equivalents

2.2 Subjects

To testify whether the Kazak vowel /e/ is a monophthong or a diphthong, only the comparison of formant patterns and formant values of the onset part and the offset part of the vowel's sounding process is required. Thus, the difference in formant values between males and females can be neglected. Furthermore, because of the physical features of females, the resonance is relatively weak in their pronouncing, so it is often difficult to extract data from females' sound signals. Therefore, only 4 male subjects were invited in the research. All of them are at the age between 18 to 22 and from different counties in Xinjiang Province, which are in the area of north-east dialect.

2.3 Data Collection

The phonetic signals were recoded at the studio with the software Audition 3.0 (Chinese version) and the equipments of a laptop computer, an external sound card of Yamaha Steinberg UR242 with USB Audio Interface, and a Sony Omni directional microphone. Signals were collected at the sampling rate of 16000Hz, 16-bit, single track and saved as Microsoft .wav file.

The signals were then cut into separate and named according to the sequence of the subjects and the words. For example, M1001 is the file name of the sound of the first word pronounced by the first male, so on and so forth. Praat was used for the analysis and formants collection as that in figure 2.

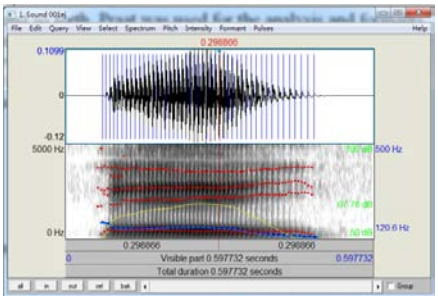

Fig. 2 Sample of wideband spectrum of KZK word /ej/(ەي)

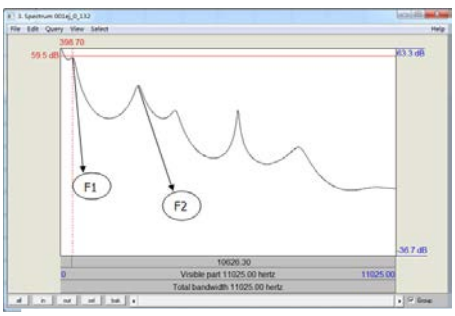

Fig. 3 Sample of formant analysis by LPC

Because the formant values extracted by Praat automatically are not always exact, LPC analysis was taken to get the formant values of the front part and the back part of the vowel's sounding process. One point on the front part and the back part of each vowel /e/ was extracted respectively for LPC analysis. The sampling rate of the signals was set at 16000Hz, so the prediction order was set at 16 in LPC analysis[9]. The sample of formant values by LPC analysis is as that in figure 3. If the first two formants are not typical (This phenomenon is common to F1.) in the condition of prediction order=16, then the prediction order is set at 20, and the formant distribution in this condition can be taken as a reference merely, like that in figure 4.

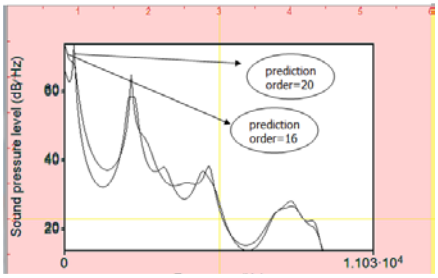

Fig. 4 The formant distributions in different prediction orders

3. Results Analysis and Findings

The formant values extracted from LPC were put into Excel for detailed analysis.

3.1 Properties of Vowel /e/ as the Initial

Data in table 1 are formant values of vowel /e/ as the initial letter of the words. The data indicate that there is not a great difference between the formant values of onset point and offset point, no matter in the term of F1 or F2. Therefore, vowel /e/ has no apparent properties of a diphthong, and this can also be demonstrated by the vowels' relative tongue position in figure 5. The distribution of most vowels in figure 5 is centered on one point, and only three vowels scatter away from the point, which contribute a little to the differentiation of the vowels.

Table 1. Formant values of vowel /e/

IPA	KZK	onset point		offset point	
		F1	F2	F1	F2
ej	ەي	399	2557	382	2541
ek	ەك	382	2557	431	2458
el	ەل	349	2508	449	2557
eŋ	ەڭ	399	2541	423	2151
ep	ەپ	382	2491	465	2474
ex	ەح	332	2258	465	2474
eʃ	ەش	366	2557	465	2491
ez	ەز	283	2392	449	2474
em	ەم	366	2507	399	2507
en	ەن	432	2441	415	2474
er	ەر	415	2474	465	2408
es	ەس	432	2524	449	2606
et	ەت	332	2541	432	2458

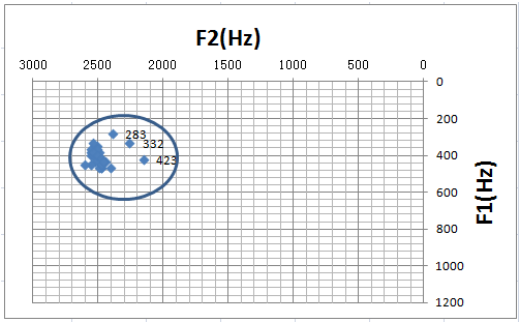

Fig. 5 Distribution of vowel /e/ as initials

However, in auditory perception, an obvious /i/ or /j/ can be recognized before the vowel /e/, and evidence can be drawn from the wideband spectrum of some words, such as that in figure 6. Both of the wideband spectrums in figure 6 show that there is a short bending part on F1 and F2 at the beginning of the sounding process, which only takes up no more than 0.04 second. This can be taken as the phonetic property reflected in the transition from a consonant to a vowel, but not the

property reflected in the sliding process from one vowel phoneme to another in a diphthong like what is displayed in figure 7. In a diphthong, both of the two phonemes take up a relatively long time although one is shorter and the other one is longer according to the stress allocation between them. For example, in figure 7 the wideband spectrum of diphthong /ia/ indicates the phoneme /i/ takes about 0.188 second, while the phoneme /a/ takes a little more time, because diphthong /ia/ in Monguor language is a back stress one.

Therefore, the phoneme before vowel /e/ perceived in audition should not be vowel [i], but be the semi-vowel [j] instead, and it can be believed Kazak vowel /e/ as initials is not a diphthong, but should be a monophthong [e].

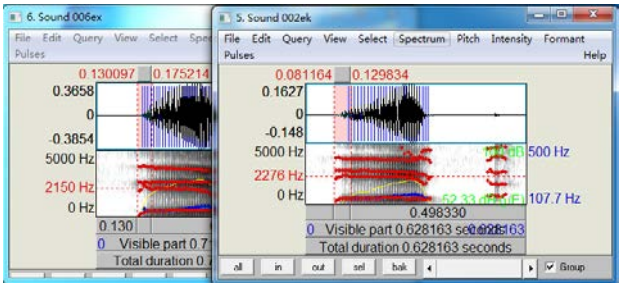

Fig. 6 Sample of wideband spectrum of words /ek/ and /ex/

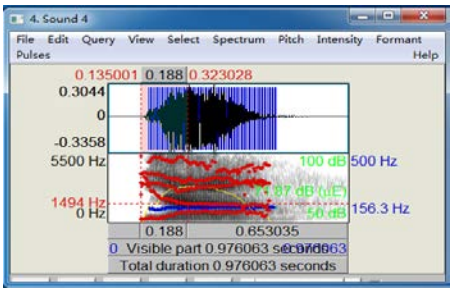

Fig. 7 Sample of wideband spectrum of diphthong /ia/ in Monguor language

3.2 Properties of Vowel /e/ in the Middle and End Positions

Data in table 2 are formant values of vowel /e/ in the middle and end positions of the words. The data indicate that there is either no great difference between the formant values of onset point and offset point both in terms of F1 and F2. Therefore, vowel /e/ in the middle and end positions show properties of an exact monophthong and this has been demonstrated by the vowels' relative tongue position in figure 8. The distribution of all vowels in figure 8 is centered in one area, and no obvious border of groups can be recognized.

Table 2. Formant values of some vowel /e/ in the middle and end positions

IPA	KZK	onset point		offset point	
		F1	F2	F1	F2
ebe	ەبە	399	2524	432	2574
ege	ەگە	349	2328	365	2328
ese	ەسە	365	2500	400	2500
ele	ەلە	400	2467	400	2190
ene	ەنە	400	2431	400	2397
ebep	ەبەپ	365	2362	434	2328
egej	ەگەي	331	2259	365	2293
eken	ەكەن	434	2431	400	2156
ekew[a]	ەكەۋ	365	2224	400	2086
ekeʃ	ەكەش	400	2328	434	2259

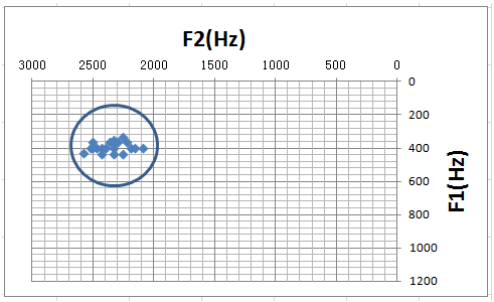

Fig. 8 Distribution of vowel /e/ in the middle and end positions

It is indicated in figure 8 that there is a limited scattering distribution in horizon (F2), and this is to some extent affected by the assimilation of the consonants before and/or after the vowel. A typical case of assimilation ekew[a] (ەكەۋ) is in table 2. The formant values of the offset point of the second vowel /e/ is 400Hz (F1) and 2086Hz (F2), which is much lower than the common values of F2 in other words. F2 is degraded by the assimilation of the semi-vowel /w/, which is shown in figure 9.

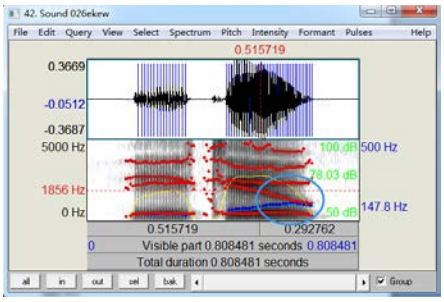

Figure 9. The sample of wideband spectrum of ekew[a] (مکەۋ)

4. Summary

The above results analysis and findings of the phonetic experiment have offered fundamental evidences to the conclusion that Kazak vowel /e/ is not a diphthong but a monophthong, although the semi-vowel /j/ is often added before it, especially when /e/ is in the initial.

However, to get the most exact properties of vowel /e/ in Kazak, more researches and evidences are always necessary and not enough.

5. Acknowledgments

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6. References

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