Uighur Consonants and Electropalatograph

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Abstract

This paper aims at analyzing the contact between tongue and hard palate during production of consonants and co-articulation in Uyghur by means of Electropalatograph (EPG). Under the same manner of place, plosives involve more tongue-palate contact than affricates, and affricates involve more contact with higher centrality than fricatives; laterals concentrate their tongue-palate contacts on alveolar, resulting high anteriority and centrality; nasal trill involve alveolar contact with high posteriority and centrality. Their tongue characteristics of onset are obtained: middle of tongue tip /d/, /t/ and behind of tongue /g/, /k/ involve much more tongue-palate contact; front of tongue tip /s/, /z/ and front of tongue /ʃ/, /ʒ/ involve more contact with higher centrality than front of tongue /ʧ/, /ʤ/; middle of tongue tip /l/ concentrate their tongue-palate contacts on alveolar, resulting high centrality; middle of tongue tip /n/ involve alveolar contact with high posteriority and centrality; middle of tongue tip /r/ contacts with tongue – palate, resulting high centrality and rearwardality.

Keywords: Electropalatograph, Uighur, Coarticulation

I. Introduction

Traditional Linguists have analyzed articulation places and manners of different consonants and coarticulations on the basis of auditory recognition, however, some of those founded theories are very abstract without convincing proves. Then a new subject, called experimental linguistics, emerged, which aims at convincingly explaining a series of phonetic phenomenon. With widely-using techniques and new research approach, the tide of experimental linguistics has brought a lot of new views towards traidtional linguistics. In this paper, a useful approach research tool called electro-palatal will be introduced to deepen your understanding towards co-articulation in Uighur.

II. EPG and its artificial palatal

The increasing development of computer technique has changed human being's traditional mode of production and life completely. Radiography and palategraph have shown some basic information of consonant:

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its key palace of articulation and static linguopalatal contact, laying the foundation of the research on speech production. However, these equipment and methods cannot reflect the dynamic process of speech production. Fortunately, the invention of Electropalatography (EPG) makes up for the deficiency by recording detailed linguopalatal contact during speech production. EPG is a kind of artificial palatal used by researchers to analyze the speech production process of consonants. During speech production, the artificial palatal will transmit the tongue-palatal contact information to the computer. EPG involves a psedudo-palate with 62 electrodes or 96 electrodes to obtain the linguopalatal contact information. EPG has been used in the fields of correction of articulation disorders and foreign language teaching, and it is in recent years that EPG is widely used in the study of linguistic study. The psedudo-palate in this paper is embedded with 62 electrodes. It records 100 frames of linguopalatal contact information per minute.

The following is the structure of EPG artificial palatal.

Figure 1. Total contact of Uighur affricates.

Table I Syllable Type of Uyghur

Types of syllables	Total syllables
V	8
VC	192
VCC	249
CV	192
CVC	2868
CVCC	59
CVCV	168

From Fig. 1, it is can be observed that EPG artificial palatal is embedded with sixty two electrodes, which can acquire the contact information when tongue contacts the electrodes in the artificial palatal. All the sixty two electrodes will judge whether the tongue organ contacts them or not. Then a matrix included contact tongue-palatal information will be formed and stored as a single file.

III. Experimental Program

A.Word list design

/a/,/i/,/u/ are the most special articulated vowels, for which /a/ is with the widest openness, /i/ is with the narrowest openness, and /u/ is with the most posterity. Then those three vowels are chosen to collocate with consoants in Uyghur. Table 1 is all the consonants that can be located after /a/, /i/, /u/.

Table II Collocation between vowels /a/, /i/, /u/ and consonants

conso-nants / vowels	t	l	s	z	ʃ	q	h	j	ʧ	ŋ	ʁ	r	N
a	at	al	as	az	aʃ	aq	ah	aj	a ʧ	a ŋ	aʁ	ar	an
i	it	il	is	iz	iʃ	iq	ih	ij	iʧ	i ŋ	iʁ	ir	in
u	ut	ul	us	uz	uʃ	uq	uh	uj	uʧ	u ŋ	uʁ	ur	un

This paper will magnify the tiny differences among syllables with same vowel or same voiceless consonant by analyzing the colocation between vowels /a/, /i/, /u/ and consonants.

B.Signals acquisition and processing

Two speech producers, a young male and a young female are chosen to read our designed syllables in this experimental.And two speech producers are native Uyghur without speech production illness. EPG signals are recorded by Palatometer 6300, setting 100Hz as EPG sampling rate and 16000Hz as audio sampling rate.

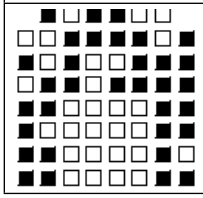
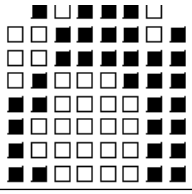
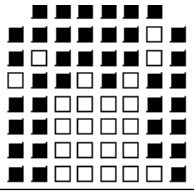
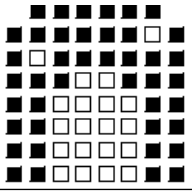
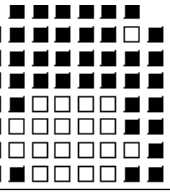
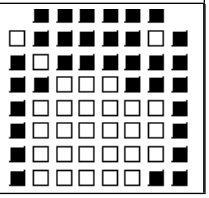
After signal acquisition, all EPG and audio signals are processed by Matlab Program. The processing includes signal cutting and parameters compute. Signal cutting bases on the principle of choosing the most stable onset frame of EPG matrix as the representative of a consonant in a certain syllable. After signal cutting, the computing of chosen key matrixes is also practiced by Matlab to obtain some scientific parameters. And those parameters consist of two domains: contacted electrodes area percentage parameters and distribution parameters. In order to compare and analyze, all those parameters will be presented in percentage.

IV. Coarticulation in Uighur VC syllable

A. Effect of vowel on consonant /t/

Table 2 demonstrates the cut key matrixes of consonant /t/ in different syllables, however, all these syllables ends with the same consonant /t/, but begins with /a/, /i/ or /u/.From those matrixes, it can be observed clearly that there seems no obvious differences between male and female when they produce the same syllable. But there do exist vital differences among different syllables.

Table III EPG of consonants /t/ in different syllables

at		it		ut	
male	female	male	female	male	female
					

Among those matrixes, both /at/ matrixes is without full contact in the first two ranks, however, /it/ and /ut/ matrixes are nearly full contact in the first two rank. To make the comparison more vividly and scientifically, just move our focus on Fig. 2 and Figure3.

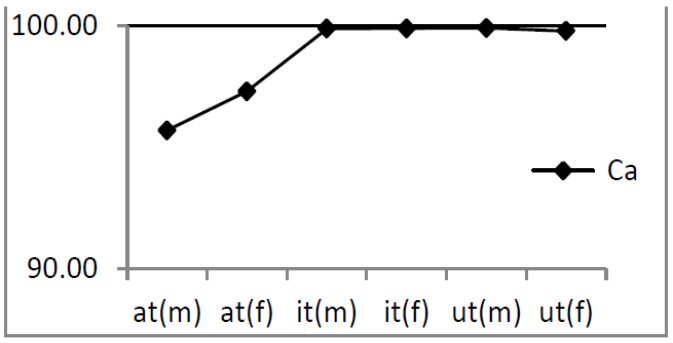


Figure 2. Contact Anteriority distribution percentage for consonant /t/.

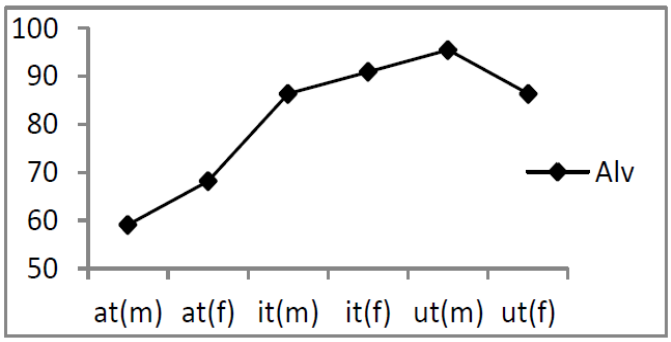


Figure 3. Contact alveolar distribution percentage for consonant /t/.

In Fig.2 and Figure.3, (m) means syllable pronounced by male, and (f) by female. It presents the tongue-palatal contact anteriority and alveolar distribution, which mainly includes the first three ranks of the matrix. Parameter Ca in syllable /at/ is relatively lower than that in syllables /it/ and /ut/. What's more, Param-

eter Alv is much more obvious in in their differences: Ca of /t/ in /at/ is much less than that in /it/ and /ut/. And this can be concluded: when producing /at/, speech producers don't constrain their tongue tip as strongly as producing /it/ and /ut/.

B. Effect of vowel on consonant /s/

Table 4 demonstrates the key matrixes of consonant /s/ in different syllable ended with the same consonant /t/. From those matrixes, male and female producers also indicate the speech production consistency in same syllable. But there do exist vital differences among different syllables. The biggest difference is velar contact among them.

C.Effect of vowel on consonant /l /

Fig. 4 demonstrates velar distribution percentage for consonant /l/, where the velar percentage of /us/ is higher than the others. That's because the tongue-palatal contact of /us/ is more in the last rank / than that of /as/ and /is/. In the last rank of the key matrixes, there exists more contact on its right in /us/, two electrodes, however, there only one contacted electrode on the right of the last rank in /as/ and /us/.

Table IV EPG of consonants /s/ in different syllables

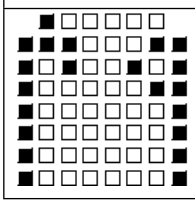
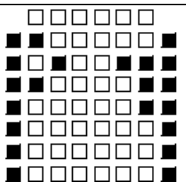
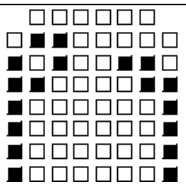
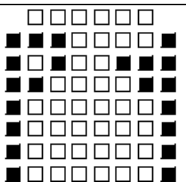
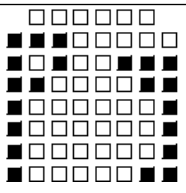
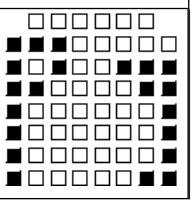
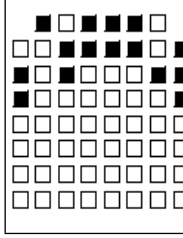
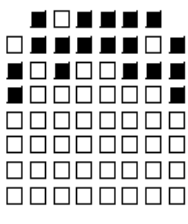
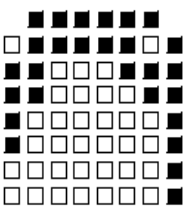
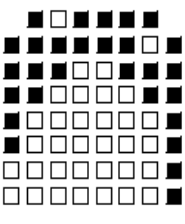
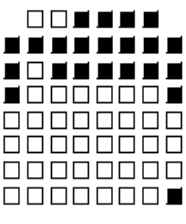
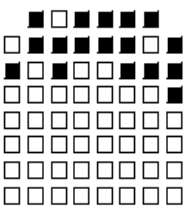
as		is		us	
male	female	male	female	male	female
					

Table 4 demonstrates the key matrixes of consonant /l/ in different syllable ended with the same consonant /t/. There seems exists no speech production difference in gender, but exist obvious differences among different syllables. Both sides of the last four ranks electrodes are contacted in syllable /il/ while it is a totally different situation in syllables /al/ and /ul/. However, the contact mode in syllables /al/ and /ul/ are almost the same.

To make the date more valid and convincible, the above key matrixes are computed, then the computed data is presented in Fig. 4, which demonstrate the post palatal distribution percentage for consonant /l/. It is can be observed apparently that consonant in syllable /il/ is with much higher post palatal distribution.

TABLE V EPG of consonants /s/ in different syllables

al		il		ul	
male	female	male	female	male	female
					

V. Summary

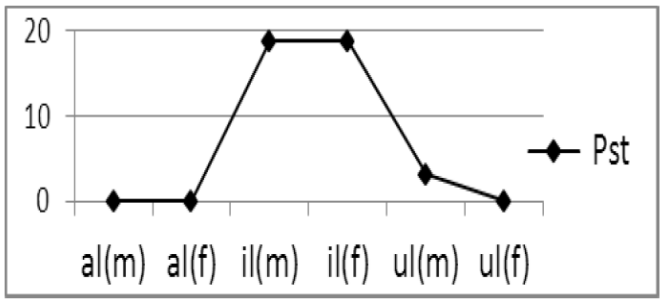
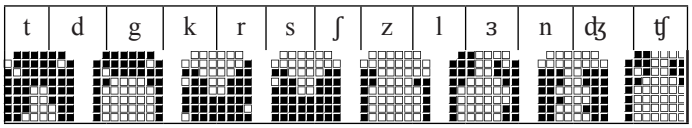


Figure 4. Post palatal distribution percentage for consonant /l/.



In Uyghur, the voiceless consonant would convey some articulation places and manners information of its anterior vowels within syllables. Under the same manner of place, plosives involve more tongue-palate contact than affricates, and affricates involve more contact with higher centrality than fricatives; laterals concentrate their tongue-palate contacts on alveolar, resulting high anteriority and centrality; nasal trill involve alveolar contact with high posteriority and situations lead to that the tongue characteristics of the same consonant after different kinds of vowels are different from each other by slightly changing theirs original articulation places to coarticulated with their anterior vowels, sometimes even changing their articulation manners. However, the degree of this kind of affection hasn't analyzed, which will be investigated in future research.

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