

ELECTROPALATOGRAPHIC PATTERN OF CANTONESE SPEECH

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ABSTRACT - Electropalatograph (EPG) is a technique which provides visual display of the tongue contact with the hard palate. This paper describes the development of a systematic database of EPG patterns of all possible Cantonese syllables (about 1860). EPG version 3 was used in the data collection for the database. Syllable structure includes the following combinations: V, CV, VC, CVC and CVG. The EPG patterns of different consonants and vowels and consonant-vowel interaction are available in this database.

INTRODUCTION

The electropalatographic (EPG) technique provides visual display of the tongue contact with the hard palate. Both spatial and temporal details of tongue contact with the hard palate during articulation can be recorded. Hence details of place of articulation can be available through EPG. Studies in EPG on English speech have been conducted for the last 40 years and only two have been done on Cantonese speech. Up till now, there are no comprehensive studies of EPG data of normal speech of both normal English and Cantonese. In order to interpret EPG patterns of disordered speech, e.g. developmental articulation disorders, cleft palate speech, dysarthric speech, etc, it is most important to have the normal data as the norm for comparison. Hence a systematic database of EPG patterns of all possible Cantonese syllables (about 1860) is developed (So & Thelwall 1996).

METHOD

Speech material and recording

The speech material was made up by selecting all real words from theoretically possible combinations of onsets, vowels, final consonants and tones. The number of real words from this combinations was 1863. The target words were randomised and produced between two /a/ vowels, that is, /a/ target word /a/.

So far, all the recordings were from a female adult, native Cantonese speaker with normal hearing and articulation. All recordings were done in a sound-proof room in the Dept. of Speech and Hearing Sciences at The University of Hong Kong using EPG and a digital recorder simultaneously.

Instrumentation

Reading Electropalatograph version 3 (EPG3) (Fig. 1) was used in this study for recording the Cantonese EPG speech patterns. This equipment consists of three main parts, the Multiplexer unit, the EPG3 Main Unit and the Interface Card. In addition, an artificial palate, a graphic printer, a digital audio recorder and a microphone are required.

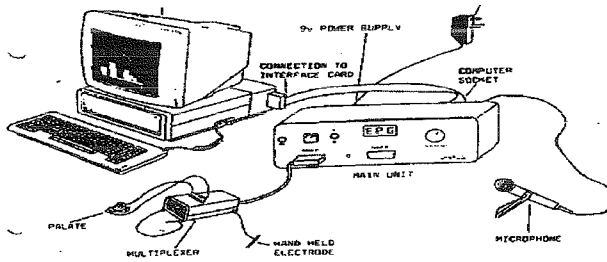


Figure 1. Diagram of The Reading EPG3 system. Source: EPG3 manual, p.2.

Artificial palate

The subject wears an artificial palate which is made from acrylic, about 1 mm thick. The palate contains 62 silver electrodes exposed to the lingual surface, according to a predetermined scheme based on anatomical landmarks (Fig. 2). They are arranged in eight horizontal rows with eight electrodes in each row, except the first (the most anterior) which has six. (Fig. 3)

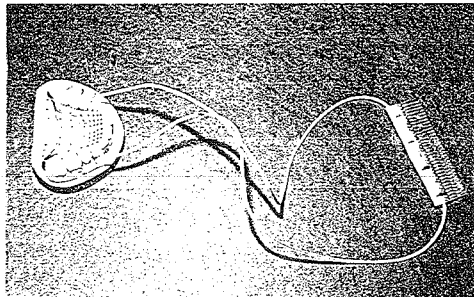


Figure 2. An acrylic plate for EPG

	Row No.	
000000	1	alveolar zone
000 . 0000	2	
0 0	3	
0 0	4	Palatal zone
0 0	5	
0 0	6	
00 0	7	velor zone
00 00	8	

Figure 3. Reference zones for the electrode positions (zeros indicate tongue contact)

Patterns of contact between the tongue and the artificial palate are processed and displayed on the VDU of an IBM PC. Permanent records are available in the form of computer printouts of palatal contact (Fig 4). The lingual-palate contact is shown in each palate diagram by the presence of a zero, with the top of each diagram being the alveolar region and the lower part the junction between the hard and soft palate is shown in each palate diagram.

For fuller state-of-art details of electrode placement, types of artificial palate and palate manufacture, the reader is referred to the more extensive description in Hardcastle, Joes, Knight, Trudgeon & Calder, 1989.

Division of the artificial palate

To focus the attention to the spatial and temporal aspects of Cantonese consonants in next part, six annotation points (which define the degree of articulatory closure at certain relevant and identifiable points at time) were selected from the full EPG printouts. For the details of the criteria for location of the six annotation points, please refer to Gibbon, Dent and Hardcastle (1993).

The duration of the sounds was measured from the first frame of complete constriction to the last, i.e., the time between annotation points 2 to 5.

EPG PATTERNS OF SPECIFIC CONSONANTS OF CANTONESE SPEECH

Alveolar targets /t, t^h/

The salient feature of producing alveolar plosives is the formation of closure in the alveolar region, i.e., row 1 and 2. There is a complete lateral seal along the margins of the palate to prevent lateral air escape during sound production. This articulatory gesture is then held for a period of time. This allows the built-up in intra-oral pressure, after that is released first in the alveolar region, again in rows 1-4.

Alveolar fricative /s/

On EPG, the alveolar grooved pattern is a characteristic feature of the alveolar fricative /s/. There is a complete lateral seal along the margins of the palate with a narrow grooved configuration in the most anterior rows, i.e., groove formed in rows 1-2, to allow air to pass through during sound production.

Velar targets /k, k^h/

The velar plosive pattern is characterized by lateral contact from row 4 to row 8 with a complete contact across the most posterior row. This articulatory gesture is then held for a period of time. This allows the built-up in intra-oral pressure, after which it is released first in the velar region, again in rows 4-8.

Affricates /ts/ and /ts^h/

An affricate involves a stop closure followed by a fricative release. In Cantonese, the alveolar affricate /ts/ is considered as a production of the alveolar /t/ immediately followed by the alveolar fricative /s/. On EPG, the complete anterior closure represents the stop component while the complete groove pattern refers to the fricative release.

EPG PATTERNS OF CANTONESE VOWELS OF DIFFERENT TONGUE POSITIONS.

Comparing the EPG patterns of /ku/ with /ka/, contacts in the back vowel /u/ are found at the clearly posterior region of the palate. While comparing the EPG patterns of /ki/ with /ka/ EPG patterns of the front vowel /i/ is characterised by extensive anterior and lateral contact.

ADVANTAGES OF EPG DATA

1. EPG data of normal speech helps to reveal the clinical relevant articulatory characteristics: e.g. the different extent of double articulation of plosives across different vowels. The EPG data in this study can be compared to that of speech disordered clients; the difference in EPG data can provide insights into possible origins of perceptual errors, and illustrates how EPG information can lead to a more rationalized approach to treatment.
2. The Findings in many papers revealed the low reliability of perceptual assessment (e.g., Gibbon, Dent, & Hardcastle, 1993; Gibbon, Hardcastle, & Moore, 1991). EPG assessment can give a more objective and reliable information to supplement perceptual assessment.
3. The EPG analysis reveals whether there is significant articulatory placement, which cannot be detected from perceptual analysis and may have important implication for articulation assessment and speech treatment. (Hardcastle & Morgan, 1982; Hardcastle, Gibbon & Jones, 1991). For example, many clinicians, fail to detect the occurrence of double articulation by perceptual judgement.

FUTURE STUDY

In future, more EPG data of subjects with normal speech can be collected for analysis. Variations of EPG patterns of normal speech can be thus available for future reference.

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