The Phonetic Characteristics of Implosives in Two Chinese Dialects

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Abstract

What is the distinctive feature between the implosives and the voiced stops is one of the controversial issues in the study of implosives. It is found that the negative intra-oral pressure is not always present when pronouncing implosives; meanwhile positive intra-oral pressure is observed. This study is going to explore the phonological contrast between the implosives and the voiced stops by investigating their phonetic characteristics. Physiological record including the oral airflow and intraoral pressure are made to show the aerodynamic mechanism of implosives.

Introduction

The bilabial implosive [ɓ] and the alveolar implosive [ɗ] are found in some Southern Chinese dialects. The district includes Zhejiang, Guangdong, Guangxi, and Hainan provinces. Implosives distributed differently in each dialect. Among them, Wuyang dialect and Wenchang dialect represented two types of the distribution of implosives. In Wuyang dialect, which located in the southeast of Guangdong province near the Leizhou Peninsula, there are only implosives, but no voiced stops. So there is no contrast between implosives and the voiced stops. However, in Wenchang dialect, which is in the northeast of Hainan Island, there are both implosives and voiced stops, which contrast with each other. We are going to compare the phonetic and the physiological features of implosives in the two dialects, in order to found out what feature is the crucial feature of implosives and what is the feature appears when there is the need to distinguish the voiced stops.

I made record of 20 informants in Wuyang and 5 informants in Hainan. The record is made by Praat on my laptop. The acoustic analysis is made on Praat. The physiological record of a female informant of Wuyang dialect was made by PCquirer system, in the Phonetic Laboratory in City University of Hong Kong. Records of five male informants of Wenchang dialect were made in Hainan. The record of Wenchang informants was made by the PCquirer 516. The Sample Rate for four channels and for the audio wave is 11,000 Hz. The Filter Rate is 4,400 Hz.

Procedure:

- The recording involved putting a mask on the speaker’s face.
- The mask had two independent parts, the masker for capturing the oral air flow fits around the mouth and below the jaw. Above it the nasal airflow mask is fastened over the nose by a velcro band that goes around the head.
- There were two channels in the oral mask to catch the data of the oral flow and
the oral air pressure.

- One tube was put through the oral mask to the front part of the speaker’s mouth to get the intraoral air pressure, which did not interfere much with the bilabial articulation.
- There were also two channels in the nasal mask to catch the data of the nasal flow and nasal air pressure.
- A microphone recorded the audio data simultaneously.

And then the informant was asked to read a prepared wordlist putting on the masks.

Figure 1.2 The informant held the masks to record the physiological data.

1. The characteristics of implosives in Wuyang dialect.

Wuyang dialect is a kind of Yue dialect. The syllable structure is CV or CVC. The C in the start of the syllable is called the initial consonant. And only the nasals [m n η] and the inaudible released stops [p’ t’ k’] can appear in the coda place. The implosives can only appear in the initial position. A list of the initial consonants in Wuyang dialect is in below (table 1.1):

Table 1.1

<table>
<thead>
<tr>
<th></th>
<th>plosives</th>
<th>fricative</th>
<th>approximant</th>
<th>nasal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bilabial</td>
<td>ㅂ  pb'</td>
<td>f/v</td>
<td></td>
<td>m</td>
</tr>
<tr>
<td>Alveolar</td>
<td>ㄷ t t*</td>
<td>ts ts' s/l</td>
<td>l</td>
<td>n</td>
</tr>
<tr>
<td>Velar</td>
<td>ㅋ k'</td>
<td></td>
<td></td>
<td>η</td>
</tr>
<tr>
<td>Glottal</td>
<td></td>
<td></td>
<td></td>
<td>h</td>
</tr>
</tbody>
</table>

In Wuyang dialect there are three sets of plosives, implosives, the voiceless unaspirated stops and the voiceless aspirated stops. In the bilabial position, there are two, the voiced implosive [ɓ] and the voiceless aspirated stop [p’]; in the alveolar position, there are three, the voiced implosive
[d], the voiceless stop [t], and the voiceless aspirated stop [t’]; in the velar position, there are tow, the voiceless unaspirated and aspirated stops [k] and [k’].

In Wuyang dialect, only one group of stops is voiced, which is the implosive. And the voiced implosives exit only in the bilabial and the alveolar position, not in the velar position, which consists with the typological distribution of implosives. Implosives are contrasted with the voiceless aspirated stops. Because of the aspirated feature, it is not hard to distinguish implosives from the voiceless unaspirated stops. The implosives do not contrast with the voiceless unaspirated stops. However, in the alveolar position, the voiceless unaspirated stop [t], which derived from the affricate [ts], contrast with the implosive [d]. After all, there is no contrast between the implosive and the voiced stops in Wuyang dialect.

Since in Wuyang dialect, there is no contrast between implosives and the voiced stops, I expected that the implosives in Wuyang dialect might have some phonetic variants, such as the voiced stops.

The acoustic feature of implosives in Wuyang dialect is very clear. The VOT of the bilabial implosive varies from -50ms to -150ms. It has the regular vibration of the vocal folds before the release. The configuration of the waveform is the most important feature of implosives. Implosives have the increasingly stronger amplitude in the waveform (shown in Figure 1.1).

![Figure 1.1 The waveform of the bilabial implosive and the bilabial voiced stop](image)

The figure is the record of the waveform of the bilabial implosive [b] in [ba] in Wuyang dialect. The amplitude of the wave in the figure is increasing from the beginning of the vibration till the oral release.

According to the definition of the implosive (Catford 1988), “the downward movement of the larynx enlarges the space above the glottis, suddenly lowers the pressure there to below the atmospheric pressure…as a result there is a momentary influx of air into the mouth.” However, the record of the implosive in Wuyang dialect showed that the negative air pressure in the mouth is not always presented. Sometimes the intraoral pressure is above the atmospheric pressure (as shown in Figure1.3); sometimes it is below the atmospheric pressure (as shown in Figure1.4). The absent of negative air pressure in the mouth in producing implosives is also observed by Ladefoged (1964: 6 & 1971:26-27), Lindau (1984:152), Pinkerton (1986:125-139), Nihalani (1991), and Clements and Osu (2002).
Figure 1.3 The record of the bilabial implosive [ɓ] in the syllable [ɓa]. The first line is the audio record. The second is the oral flow; and the third is the intraoral pressure; the last line is the intraoral pressure after smooth.

It is very clear to see from the smoothed oral pressure that the pressure was below the atmospheric pressure. The record of the intraoral pressure showed that the glottis closed at first, and then with the decreasing of the pressure, the vocal folds began to vibrate. The vibration became stronger during the closure. With the airflow into the mouth, the pressure increased.
Figure 1.4 Another record of the bilabial implosive [ɓ] in the syllable [ɓa].
As shown in the record of the smoothed intraoral pressure, the pressure is above the atmospheric pressure. There is a trend for the pressure to be reduced, but it did not decrease to a negative pressure. Except the positive air pressure in the mouth, the amplitude of the vibration became stronger and stronger as shown in the record of oral pressure, which is the same as the former record in Figure 1.3.

Figure 1.5 The record of cheba [tsʰE ɓa], the first line is the audio wave, the second is the oral flow, and the last line is the intraoral pressure.
In the end of the first syllable, the oral flow ceased, with the intra-oral pressure increasing a lot. This is because the lips closed preparing for the next sound, the bilabial implosive [ɓ], but the airflow is still coming out into the mouth, so the pressure there was raised. Then the intraoral pressure began to decrease. This is because the glottis closed, no more air flew up through the glottis; and the larynx was lowered, the upper-glottal space enlarged, and the air pressure in the mouth decreased. However, since the air pressure in the mouth is too high in the beginning of the oral closure, even though the glottis was lowered, and the intraoral pressure was reduced, the air pressure in the mouth is higher than the air pressure outside the mouth. In this way, the mechanical movement of glottis reduced the air pressure, but whether the pressure is higher or lower than the pressure outside the mouth also depends on the original pressure in the mouth.

In the figure above, the vibration of the line represents the vibration of the vocal folds. In the beginning of the bilabial implosive [ɓ], the intraoral pressure has the increasingly stronger amplitude, which represented that the vibration of the vocal folds began vibrate weakly and then change to be stronger and stronger.

2. The characteristics of implosives in Wenchang dialect

Wenchang dialect is one kind of Min dialect. And the Wenchang dialect is regarded as the standard pronunciation of Hainan Min dialect. The initial consonants of Wenchang dialect are listed in below:\(^1\):

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<td>l</td>
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<td>h</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

There are three sets of plosives, the implosive, the voiced stops and the voiceless unaspirated stop. The implosives and the voiced stops are contrast with each other in the bilabial position and the alveolar position. There is velar voiced stop [ɡ], but no velar implosive.

In Wenchang dialect, since the implosive is contrast with the voice stop, what feature is used to distinguish the two sets of sound?

Both of the implosive and the voiced stop have the negative VOT. Both of them have the regular vibration before release. But they have different configuration of the wave. The implosive has the increasingly stronger amplitude of the vibration; the voiced stop does not have the increasingly stronger amplitude, of which the amplitude is increasingly weaker.

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\(^1\) Reference to Yun Weili 1987:9
Not as in Wuyang dialect, the implosive in Wenchang dialect behaves like the typical implosive with negative air pressure in the mouth. And the voiced stop is produced with positive intraoral pressure. Is this because in Wenchang dialect, the implosive contrasts with the voiced stop? The contrast of implosives and voiced stops is shown in Figure 2.2.

Figure 2.2 The record of the bilabial implosive [ɓ] in syllable [ɓa] (left), and the record of the bilabial voiced stop [b] in syllable [ba] (right).

The record of the intraoral pressure showed that the amplitude of the vibration became stronger before the oral release when pronouncing the implosive; but when pronouncing the voiced stop, the vibration start strongly and declined when approaching the oral release. The smoothed record of the intraoral pressure showed that, the pressure decreased and was below the atmospheric
pressure in the record of the implosive; but the pressure increased and was above the atmospheric pressure in the record of the voiced stop.

**Figure 2.3 The intervocalic [ɓ].** Oral flow and pressure during the bilabial implosive [ɓ] in Wenchang dialect. The carrying sentence is [sia te ɓu tu] (please say the word [ɓu]).

The record in Figure 2.3 shows an intervocalic [ɓ]. The oral pressure record showed that the vibration stopped between the vowel [e] and the following implosive, which showed the closing of the glottis. With the downward movement of the glottis, the pressure decreased. When the subglottal pressure was higher than the pressure above the glottis, the vocal folds began to vibrate. The vibration started weakly, and then the amplitude became stronger. With the air flew into the mouth, the pressure there was raised.

**Figure 2.4 The intervocalic [b].** The record of Oral flow and pressure during the bilabial voiced stop [b] in Wenchang dialect. The carrying sentence is [sia te bu tu] (please say the word [bu]).

Figure 2.4 shows the intervocalic [b]. The record of the intraoral pressure illustrated that the vibration did not stop between the vowel [e] and the following voiced stop. The oral pressure
record vibrated violently at the end of the syllable [te], because the lips closed but the glottis was still open. Then the air flew through the glottis vibrating it and raised the pressure in the mouth. When the air pressure in the mouth had build up, the amplitude of the vibration declined.

Therefore, the difference between implosives and voiced stops in Wenchang dialect can be summarized as:

- First, the air pressure in the mouth is negative when producing the implosive, but it is positive for the voiced stop.
- Secondly, during the oral closure, the glottis is closed in the beginning and moves downward when pronouncing the implosive; but not closed as for the voiced stop.
- Thirdly, for the implosive, since the glottis closes in the beginning of the of the oral closure, the transglottal airflow start weakly and gradually increases, which is shown in the record of oral pressure as the increasingly stronger amplitude of the vibration; but for the voiced stop, the glottis does not close, strong airflow breaks through it and vibrate the vocal folds, so the vibration is firstly strong and declines with the rising of the air pressure in the mouth. (see Figure 2.5)

![Figure 2.5 The transglottal air pressure of implosives (left) and voiced stops (right) before the explosion. Implosives are produced with increasing transglottal airflow; the voiced stops are produced with the decreasing transglottal airflow.](image)

For the first point, the negative air pressure in the mouth presents when there is the voiced stop in the phonology. But in Wuyang dialect, the air pressure in the mouth is not always negative, since there is no need to distinguish the voiced stop. As for the second and the third point, they are the same of the implosives in both the two dialects.

All the above differences can be explained by the different aerodynamic mechanism of implosives and that of the voiced stop. The implosive is glottalic initiated, as stated by Catford (1982:76). It is initiated by the sudden expansion of the supraglottal cavity, which generates negative pressure there. The downward movement of the closed glottis which initiates the vibration is crucial characteristics of implosives (Catford 1982:76). The downward movement of the glottis
would generate a decline of the air pressure in the mouth, even though it would not be negative. The air pressure may be higher than the atmospheric pressure if the original pressure in the mouth is too high. And since the glottis is closed in the start of the closure, the vibration of vocal folds starts with weak amplitude, and then become increasingly stronger.

The voiced stop is the pulmonic initiated. The pulmonic pressure controlled by the muscles generates the egressive airflow, which breaks through the glottis and vibrates the vocal folds. As the air flows up into the pharynx and mouth, the transglottal pressure difference will be abolished, and the vibration would be weakened. That’s why the intraoral pressure record shows that the amplitude of the vibration declines with the rising of the pressure.

By compare the implosives in the two dialects, the crucial characteristics of implosives is not the negative air pressure in the mouth, but the glottalic initiated mechanism. The glottalic initiated implosive has the declining oral pressure and the increasingly stronger amplitude of vibration. It is when the implosives contrast with the voiced stops in a phonology system, the negative intraoral pressure is used to distinguish the positive intraoral pressure of the voiced stops.

Reference:


Yun Weili (1987) Hainan Fang Yan (The Hainan Dialect), Aomen dong da xue (The East Asia University of Macao); Xianggang : Fa xing San lian shu dian Xianggang fen dian,