THE IMPACT OF PLACE OF ARTICULATION ON VOT FOR IRANIAN CLEFT PALATE CHILDREN

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ABSTRACT

The purpose of this study was to examine the impact of place of articulation on voice onset time (VOT) of Persian initial plosive productions for Iranian cleft palate children. Fifteen cleft palate children and twenty children born without cleft were asked to produce seven words in CVC syllabic pattern. The initial consonant of the syllable was a plosive; the vowel was the close, front vowel /i/ and the final consonant was a liquid /r/ or /l/. The results indicated that in the cleft group, just the same as the normal group, variation in VOT values according to the place of articulation was significant in voiceless plosives but it was not significant in voiced plosives. Moreover, compensatory articulation was considered as a strategy which acts in favor of the general pattern which argued that the further back the closure the longer the VOT values would be.

Keywords: voice onset time, velopharyngeal insufficiency, compensatory articulation, cleft lip and palate

1. INTRODUCTION

Previous studies on VOT variations according to place of articulation came to the general conclusion that VOT values increase as the place of articulation moves from anterior to posterior position in the vocal tract [7, 10, 11, 14]. Cho and Ladefoged [3], in their cross-linguistic study of the relation between VOT and place of articulation declared that physiological and aerodynamic characteristics might, to some extent, explain the variations of VOT associated with a difference in the place of articulation. However, for each place of articulation there are language specific differences.

Bijankhan and Nourbakhsh [1] claimed that Persian analyses of VOT values by place of articulation in adult speakers of standard contemporary Persian confirmed the previous studies and while in voiceless plosives the further back the closure the longer the VOT values would be, it is not the case in voiced plosives, i.e. the uvular sound /ɢ/ doesn't follow the general pattern.

The aim of this study is to examine the effect of the place of articulation on VOT of Persian initial plosive productions in Iranian cleft palate children in comparing with normal children. Cleft palate children develop compensatory articulation, i.e. they typically produce sounds farther back in the mouth or pharynx. For instance, instead of using the lips to block air and produce /p/ sound, the children with a cleft palate might make the constriction in vocal folds and produce a glottal stop. Hutters and BrØndsted [6] identified compensatory articulation as an active strategy which is adopted by cleft palate speakers in sound production. They mentioned that compensatory sounds are primarily glottal stops and pharyngeal fricatives. However, pharyngeal stops have been observed in cleft palate children [8, 12].

Therefore, variation of VOT values in cleft palate children according to the place of articulation comparing with normal children is important since it would reveal more facts about the articulatory strategies and mechanisms adopted by the cleft palate children in production of certain sounds and it also determines whether speech therapy is necessary or not.

2. METHOD

2.1. Participants

Fifteen cleft palate children as the experimental group and twenty normal children as the control group were selected as the participants of the study. From fifteen cleft children seven were male and eight were female. The cleft participants were all bilateral cleft lip and palate (BCLP), they had velopharyngeal insufficiency, they underwent two surgeries for repairing the cleft at three to six months of age, and they were between three to twelve years old. They didn't have any recording of other diagnosis; they also didn't have hearing

and larynx problem. Moreover, none of them had received speech therapy and their parents were in similar socioeconomic and educational level.
From twenty selected members of the normal group nine were male and eleven were female. None of them had any recording of diseases; their parents were also in similar educational level and socioeconomic status. They were between three to twelve years old.

The identified participants of both experimental and control groups were all native speakers of the Standard Contemporary Persian (SCP).

2.2. Materials

Seven meaningful or nonsense words in CVC syllabic pattern were considered as the materials of the study. The initial consonant of the syllable was a plosive, the vowel was the close, front vowel /i/ and the final consonant was a liquid /l/or /r/. The polsives under investigation were /p, t, k, b, d, g, ɢ/ i.e. the set of oral plosives with the traditional characteristics as follows:

/p, b/ bilabial plosives
/t, d/ lamino-dentalveolar plosives
/k, g/ dorsal plosives
/ɢ/ dorso-uvular plosive

In each set there are pair wise voice distinctions except for /ɢ/ which is a voiced dorso-uvular plosive without voiceless counterpart. The words which were selected as the materials of the study are as follows:

Table 1: The materials of the study.

PERSIAN ORTHGRAPHY	WORD	GLOSS
پیر	/pir/	'old'
بیر	/bir/	nonsense
تیر	/tir/	'name of a month'
دیر	/dir/	'late'
کیل	/kil/	nonsense
گیل	/gil/	nonsense
قیر	/ɢir/	'tar'

Choosing plosives and the high vowel /i/ has some advantages too. High- pressure consonants and high vowels are well documented as vulnerable speech sounds for individuals with cleft palate [13].These speech sounds constitute part of the sound inventory of all languages. In that regard, they can be considered as universal and so are most suitable for construction of speech samples no matter what language is spoken by the patient. Therefore to validly compare speech outcomes across languages, common principles for constructing particular speech samples involving these speech sounds should be used [5].

2.3. Data collection

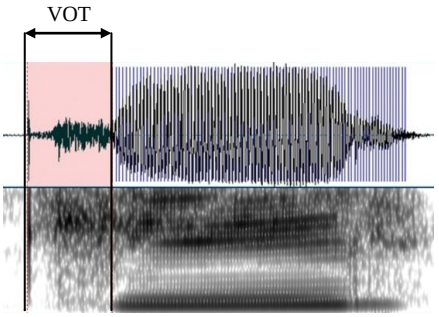
All recordings were made in a quiet room in the phonetic laboratory of the University of Tehran, using a high quality Shure microphone. The type of recording was Mono with the sampling frequency 44100 Hz. The microphone was positioned about 20 cm from the mouth of the speaker in a diagonal position. The items were presented out of context and the participants were asked to repeat them one by one with a pause and in a natural way, without any marked intonation.
Each speech samples was recorded, measured and analyzed by PRAAT [2].

2.4. Measurements and data analyses

In voiced plosives the first periodicity of vocal folds vibration is before the release or shortly after the release or it occurs simultaneously with the release. In voiceless plosives voicing occurs long time after the release. For measuring the VOT, the duration between the moment of the release and the first pulse of the larynx was considered.

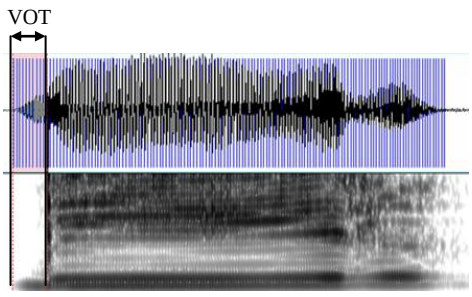
In figures 1 and 2 the vertical lines on the signal are pulses of the larynx.

Figure 1: Signal and spectrogram of the word /kil/.



VOT of /k/ from the word /kil/ is shown.
Positive VOT = 87 ms

Figure 2: Signal and spectrogram of the word /bir/.



VOT of /b/ from the word /bir/ is shown.
Negative VOT = 38 ms

2.5. Statistical analyses

The SPSS 17.0 statistical software was used for descriptive and analytic statistics. The descriptive statistics including mean (M), median (Md) and standard deviation (SD) were primarily calculated. One- Sample Kolmogorov –Smirnov Test was utilized to see whether the VOT values in both experimental and control groups were normally distributed. As it was the case, the Repeated Measurement Tests were performed on voiced and voiceless plosives separately in both groups to examine the effect of the place of articulation on VOT. An alpha level of 0.05 was set as the level of significance.

3. RESULTS AND DISCUSSION

In the statistical analyses of VOT both negative and positive values were included. The descriptive statistics of both groups are presented in table 2.

Table 2: The descriptive statistics of the VOT values. (The gray areas represent VOT values of the cleft group).

	/pir/	/bir/	/tir/	/dir/	/kil/	/gil/	/ɑir/
	71.69	-5.33	101.23	-30.50	108.93	23.31	-5.50
M	81.55	3.45	85.05	16.53	108.35	33.70	20.67
	55.00	7.50	105.00	-14.50	83.00	31.00	3.00
Md	73.00	9.50	84.00	17.00	108.50	32.00	18.50
	37.33	44.25	45.08	62.91	61.17	74.37	25.30
SD	34.69	23.01	30.22	15.10	25.23	33.92	15.86

As it is evident from table 2, there are considerable differences between the two groups regarding their mean, median as well as standard deviation in most cases.

The results indicated that voiceless plosives /p, t, k/ in cleft palate children and normal children follow the general pattern that VOT values increase as the place of articulation moves from anterior to posterior position in the vocal tract since the effect of the place of articulation was significant both in cleft palate children ($F(2, 22) = 4.91$, $p<0.05$) and normal children ($F(2, 38) = 7.89$, $p<0.001$). For voiced plosives /b, d, g, ɑ/ the effects of place of articulation on VOT were not significant in both groups. In the cleft group since by accepting the alpha level of 0.05 as the level of significance the Mauchly's Test was significant ($p = 0.037$, $x^2 = 12.106$) the character Green house – Geisser was used ($F(1.98, 11.87) = 2.85$, $p<0.09$). In the normal group as the Mauchly's Test was significant ($p< 0.05$, $x^2 = 16.05$) the character Green house – Geisser was utilized ($F(1.89, 30.20) = 7.79$, $p<0.002$). Thus in both groups for voiced plosives increasing in VOT values by moving from anterior to posterior position of vocal tract is not statistically significant. These results are in complete agreement with findings of Bijankhan and Nourbakhsh [1] for adult individuals in this regard.

Cho and Ladefoged [3] pointed to some reported causes of VOT variations due to place of articulation. Factors such as the volume of the cavity behind and in front of the point of articulatory contact area, change of glottal opening area (for voiceless aspirated stops) and temporal adjustment between closure duration and VOT are physiological and aerodynamic characteristics account for variations of VOT associated with a difference in the place of articulation.

The experiment was to demonstrate that compensatory articulation as an active strategy reduces the effect of velopharyngeal deficiency on VOT. In the absence of compensatory articulation, velopharyngeal insufficiency leads to the reduction of intraoral pressure which consequently causes an increase in the subglottal and supraglottal pressure difference. Since the vibration of vocal folds continues for a longer time till the pressure difference between the two sides of the larynx reaches zero, the mechanism of velopharyngeal insufficiency is in favor of voicing and increases the negative VOT values. To overcome the velopharyngeal insufficiency problem, BCLP patients narrow their vocal tract or change the place of articulation to an area in the vocal tract where obstruction of the air flow is possible which is known as compensatory articulation [4].

Thus the results could be explained by physiological and aerodynamic factors. What is really important is the fact that VOT values of cleft palate children showed the same behavior toward the place of articulation as those of normal children did. This could be explained by considering the compensatory articulation as an active strategy adopted by the cleft children against their VPI to reduce the effect of velopharyngeal deficiency and structural and anatomical problems due to their cleft. Therefore, not only compensatory articulation does not lead to violation of the general pattern but also it acts in favor of it.

4. REFERENCES

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