VOICING IN PERSIAN WORD-FINAL OBSTRUENTS

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1. INTRODUCTION

Analysis of voiced-voiceless contrast in final position in various languages has been the topic of numerous studies (see e.g. Charles-Luce, 1985, for German; Dmitrieva et al., 2010, for Russian). Some studies show that word final voiced obstruents get fully devoiced, resulting in complete, phonological neutralization (e.g. Jassem & Richter, 1989). Others provide evidence that final devoicing is phonetically incomplete with resulting obstruents being different from their voiceless counterparts (e.g. Burton & Robblee, 1997).

Persian obstruents exhibit a two-way voicing contrast, (voiced vs. voiceless), which is also maintained in word-final position. These obstruents can appear both as single (e.g. /xiz/ "jump" vs. /xis/ "wet".) as well as in clusters (e.g. /Gæbz/ "receipt" vs. /habs/ "imprison"). Previous studies have noted that voiced obstruents may be partially devoiced when occurring word-finally (e.g. Mahootian, 1997:288). However, there haven't been any phonetic studies of this process in Persian.

The goal of the present study was to investigate the acoustic properties of voicing of Persian obstruents in both word-final single consonants and clusters, and to find whether any instances of devoicing (or voicing), if present, is partial or complete. For this purpose an acoustic analysis of voicing in Persian word-final obstruents is conducted based on the data gathered from 6 Persian native speakers.

2. METHODS

2.1 Participants

Six Persian native speakers, three females and three males, were recorded. All of them were native speakers of the Tehrani dialect of Persian, ranging in age from 22-29 years old, except for one participant who was 51 years old. None of them had ever lived outside of Iran for more than 5 years or had any history of hearing or speaking disorders.

2.2 Materials

Speech materials consisted of 22 words presented within the carrier sentence, "hala bɛgin ___." ("now say ___."). Among these words, 10 ended in a cluster (C1C2: stop+fricative or vice versa) as in /dʒæzb/ "attract", and 6 ended in a single consonant (C#) as in /ʃæb/ "night". The target consonants were fricatives [s] and [z] and stops [p] and [b] in the context of the vowel [æ] (or [a] in 6 words). Six words with the same consonants in intervocalic position (VCV) were recorded as controls as in /Gæzæb/ "anger". All items were real Persian words with high frequency of usage, except four nonsense words. Each sentence was repeated six times throughout the recording session.

2.3 Acoustic Measurements

Three temporal measurements were applied to the target fricatives and stops: 1- duration of the consonant: longer stop closure or frication duration is associated with voicelessness (e.g. Dinnsen & Charles-Luce, 1984), 2- duration of the preceding vowel: duration of the vowels followed by a voiced consonant is often longer compared to the vowels preceding voiceless consonants (e.g. Burton & Robblee, 1997), and 3- duration of the voice bar: voiced consonants often have a visible voice bar at lower frequencies; on the other hand, voiceless or partially devoiced consonants have no or very short voice bars (e.g. Warner et al., 2004).

3. ANALYSIS AND RESULTS

Separate sets of two and three-way repeated measure ANOVAs were run for fricatives and stops for each of the three measurements. Three independent factors were: 1- Position (C1: the first consonant in a cluster, C2: the second consonant in a cluster, VC, and VCV). Only the results related to the first three levels are discussed in the current paper. 2- Context voice (voiced and voiceless): underlying voicing of the neighbouring obstruent within a cluster. 3- Voice (voiced and voiceless): underlying voicing of the obstruent.

As indicated in Table 1 the interaction between the factors Position and Voice was in most cases significant except for consonant duration and vowel duration for stops. The interaction between the factors Voice and Context voice was also significant except for duration of voice bar. On the other hand no significant interaction between Position and Context voice was indicated for any of the measurements.

Table 1. Summary results of 2-way and 3-way repeated measure ANOVAs for all measurements.

Measure-ments	Factor / Sound	Position-Voice		Position-Context		Voice-Context	
		F3(3,15)	*p*	F(1,5)	*P*	F(1,5)	*p*
C-Dur	Fric	15.61	**<.001**	1.11	0.3	22.99	**0.004**
	Stop	1.02	0.4	0.56	0.4	10.89	**0.02**
V-Dur	Fric	(2,10) 5.16	**0.02**	N/A	N/A	9.07	**0.02**
	Stop	(2,10) 1.12	0.3	N/A	N/A	88.83	**<.001**
Vbar-Dur	Fric	7.39	**0.002**	0.43	0.5	0.47	0.5
	Stop	4.3	**0.02**	0.9	0.3	0.11	0.7

For consonant duration and vowel duration (Figure 1a,b), the results of t-test and Tukey HSD post hoc analysis indicated that final voiced and voiceless stops or fricatives in clusters (C2) were not significantly different when preceded by a voiceless consonant. The same results were observed when the target sounds were followed by a voiceless consonant. However, overall in all cases where there was an interaction between Position and Voice, voiceless consonants were significantly longer compared to their voiced counterparts regardless of their position. For duration of voice bar (Figure 1c), no significant difference was indicated between voiced and voiceless fricatives in C2 and voiced and voiceless stops in C2 and VC (also C1) positions ($\mu \approx 1.2$ ms).

a.

b.

c.

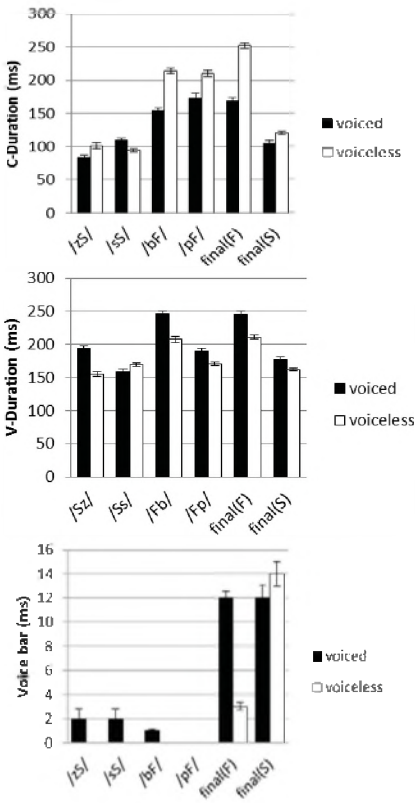

Figure 1. Means and standard errors (error bars) of consonant duration, vowel duration and duration of the voice bar for voiced and voiceless fricatives (F) and stops (S) in cluster and as single.

4. DISCUSSION AND CONCLUSION

The results of the acoustic analyses suggest that, contrary to the previous literature (e.g. Majidi & Ternes, 1999), in Persian word-final voiced obstruents are not always devoiced. The only indication of devoicing of word-final single obstruents was observed in the results from duration of the voice bar for stops but not for fricatives. Within final obstruent clusters, however, evidence from duration of voice bar indicated final devoicing for both fricatives and stops. Since none of the instances of final devoicing was supported by all measurements, they are not considered to be complete. This was consistent with what has been indicated in Persian literature (e.g. Mahootian, 1997:288). The results are also in line with the findings of some previous studies on final devoicing in other languages, which does not support the traditional view that processes such as voicing neutralization are phonological and thus categorical (e.g. Dinnsen, 1985; Dmitrieva et al., 2010). However, as it has been noted (e.g. Jassem & Richter, 1989), some possible limitations of the current investigation could be the effect of using orthography in presenting the stimuli, participants' careful reading style as well as knowledge of other languages which are suggested to be potentially influential on the results of the acoustic analyses.

In addition to final devoicing, the results also indicate that voicing assimilation in favour of the voiceless sound affects obstruents within word-final clusters in Persian. Since there were cases of both regressive and progressive voicing assimilation, no particular preference for direction of assimilation was observed.

Whether the current results can be generalized to other types of Persian word-final single consonants and consonant clusters is a question which needs to be investigated further in future studies. In addition it will be of interest to include results of other known measures such as spectral information and amplitude differences, among others.

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