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Acoustic Analysis of Temporal Parameters of Affricates Constriction in Turkish Language Spoken in Tabriz

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1. INTRODUCTION

Many languages have phonemes in their inventory that result from the combination of two different consonants and have a different manner of articulation. Affricates are created by the sequence of a stop and fricative consonant at the same place of articulation (Ledefoged, 2014; Crystal, 2008; Hayward, 2000; Johnson, 1997). Mahmoodzade (2009: 65) quoting Deihl and Castleman (1996: 192-200) states that the closure is one of the most important acoustic parameters in the affricate/fricative contrast. Also, the frication duration is another important cue to distinguish fricative from affricate consonants. In addition to frication and closure, the amplitude rise time is also one of the acoustic features that contrast fricatives and affricates. Amplitude rise time increases more rapidly than fricatives (Hayward, 2000; Johnson, 1997). Hayward also states that the closure duration and frication length are shorter than stop and fricatives respectively. The constriction of affricates consists of closure region of stop and frication region of fricative (2000, 368). Affricate consonants have received less attention, but in recent years, some studies have looked at affricates' properties in different languages such as Hindi (Dixit and Hoffman, 2004), Korean (Kim, 2001; 2004), Italian (Falowski and Bendeto, 2011) and two dialects in Catalan (Recasens and Spinosa, 2007). Mitani *et al.,* (2006) examined the perceptual distinction of voiceless fricative and affricate in Japanese. They found that many acoustic cues, including frication length and amplitude rise time play a role in distinguishing / ʃ / and / ʧ / in Japanese. Studies have been conducted in English to contrast the manner and place of articulation and also to investigate the differentiation between affricate and fricative consonants. Repp *et al.,* (1978) compared the manner of articulation in / ʃ / and / ʧ / and showed that by reducing the frication length in the middle part of the frication, similar changes occur in the manner of two consonants. They conducted another experiment which also stated that the short interval is one of the important cues between affricates and fricatives in the term of manner of articulation.

Azerbaijani or Azeri language belongs to the branch of a Turkic language family that has many speakers in the northwest of Iran and is one of the oldest languages that have been used during various historical periods. Turkish is an agglutinative language and has an Altaic origin (Hayat, 2001; Rashidian, 2013). The languages of

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ethnic groups such as Turks, Mongols, Tunghuz and Manchu are also Altaic, which have similarities with Uralic languages. It has 24 consonants and 9 vowels, of which 4 consonants including / ʦ /, / ʣ /, / ʧ / and / ʤ / are affricate consonants (Ghaffarvand Makari and Warner, 2017). Due to the lack of phonological studies in this language especially affricates, we decided to study the acoustic features of affricates / ʦ / and / ʣ /.

2. MATERIALS AND METHODS

The present study conducted to investigate affricate consonants of the Turkish language. For this purpose, ten speakers of Turkish language, 5 men and 5 women participated in the experiment. The mean age of participants was 30.5. The recorded eighteen Turkish words were VC, CV and VCV syllables consisting of the affricates / ʦ / and / ʣ / in three Turkish vowel environment / ɑ /, / i / and / u /. The effect of different three high and low vowels was examined on silence duration, frication duration, and amplitude rise time. Stimuli were repeated 3 times by the participants in the experiment (18 samples × 10 speakers × 3 replicates). Acoustic analysis was performed in PRAAT software and SPSS software version 23 was used for statistical analysis. Closure and frication duration and amplitude rise time calculated manually on the spectrogram. The duration of closure was measured in the middle and final position, but due to the uncertainty of the closure initial phase at the beginning of the word (Castleman, 1997; Mahmoodzade, 1388: 85), this parameter was not measured in CV syllable. The amplitude rise time was also measured in a time span of frication onset to the point where the frication reaches the maximum amplitude (Mahmoodzade, 2009: 91).

3. RESULTS AND DISCUSSION

Acoustic analysis of Turkish affricates showed that voicing had no effect on the duration of silence and cannot be used as a cue to distinguish the voicing parameter in these consonants. The difference between the mean duration of frication and amplitude rise time indicates that these two parameters are considered as acoustic cues in voicing. In addition to voicing, other factors such as consonant position and vowel environment were also examined. The consonant position also showed a significant effect on silence duration, frication duration and amplitude rise time, so that the average of all three parameters is higher in the final position. The results related to the vowel environment / ɑ /, / i / and / u / on the duration of silence, the duration of frication and amplitude rise time indicate that the length of silence in the vowel environment / ɑ / and / i / and the frication duration and amplitude rise time are also longer in the / i / and / u / vowel environment.

4. CONCLUSION

The results showed that voicing has no effect on closure duration in Turkish affricates. However, the frication duration and amplitude rise time are affected by voicing. In addition to the voicing feature, the consonant position in the syllable and vowel environment were also examined. tests results showed that the consonant position in syllable and vowel environments has a significant effect on closure duration, frication duration, and amplitude rise time and all three parameters are longer in the final position. Also, the closure and frication duration are longer in the presence of /ɑ, i/ and /i, u/ respectively. High amplitude rise time obtained in the presence of high vowels.

Keywords: Acoustic Phonology, Affricate Consonants, Amplitude Rise Time, Closure Duration, Frication Duration, Temporal Parameters, Turkish Language