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# An Acoustic Description of Stop Consonants and Vowels in Sorani Kurdish and English

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**Abstract**

This study aims to document and describe the speech sounds and sound inventory that are present in Sorani which is dialect of Kurdish and compare the results with their English counterparts. The research concentrates on the voicing system and the quality of Sorani sounds which are measured by using the voice onset time (VOT) of the stop consonants, and the first three formants of the vowel sounds; the closure duration of voiceless stop consonants in medial position is measured as well.

Ten native speakers of the Sorani dialect (5 males and 5 females) participated in this experiment. All speakers are between 20 and 50 years of age, were born in Sulaimanyiah, migrated to the US, and remain in the US at the time of recording. Speakers have been recorded using a Marantz PMD671 digital recorder and an Electro-voice 671BL microphone. Recordings will take place in a quiet atmosphere, in order to eliminate interference from background noise. The English measurements are taken from some previous studies that depended on the same kind of measurement strategy.

**Key words**:
Sorani, Stop Consonants, vowels, Voice onset time

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## Introduction

Sorani is a dialect of Kurdish, an Indo-Iranian language (Abdullah 1967, Bodnarchuk 2000) language spoken in western Asia by Kurds. Sorani Kurdish is spoken in the northern part of Iraq, specifically in Erbil, Sulaimanyiah, and Kikuk; it is also spoken in Mahabad, Sanandaj, Marewan, Bana, and Saqiz in Iran. The Sorani dialect is considered the official dialect of the Kurdistan regional government in Iraq, and is the language of art and literature (Abdulla 1976, Bodnarchuk, 2000).

This study aims to describe the stop consonants and vowels of Sorani with a particular focus on the voice onset time (VOT) and closure duration distinctions of the stops and formant frequencies of the vowels.

## materials

Ten native speakers of Sorani (5 males and 5 females) participated in this experiment. All speakers were between 20 and 50 years of age, were born in Sulaimanyiah, migrated to the US, and were in the US at the time of recording.

All stop consonants were recorded in word-initial and word-medial positions preceding the vowel [æ] whenever possible (Tables 1 and 2). All vowels were recorded in the frame [r_z], resulting in five words and three non-words. There is not universal agreement regarding the number of vowels in Sorani; the present study used an eight-vowel system (Ahmed, 2004), but some other reports (e.g., Fattah, 1997) argue that Sorani has nine vowels. English vowel and consonant sounds have been used and later in the paper both data (the Sorani and English) have been compared to reach the results.

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**Table (Table 1. List of consonants (word-initial)**

| Consonant | Word | Gloss | Consonant | Word | Gloss |
|---|---|---|---|---|---|
| [p] | [pæt] | 'rope' | [s] | [sær] | 'head' |
| [b] | [bærd] | 'stone' | [z] | [zæq] | 'bright' |
| [t] | [tæl] | 'wire' | [S] | [Sær] | 'war' |
| [d] | [dær] | ' wood' | [ʒ] | [ʒæm] | 'meal' |
| [k] | [kæm] | 'little' | [x] | [xaw] | 'sleep' |
| [g] | [gæl] | ' nation' | [ɣ] | [ɣæm] | 'sadness' |
| [ʔ] | [naʔ] | 'no' | [h] | [hæm] | 'sadness' |
| [m] | [mær] | 'sheep' | [ʕ] | [ʕomar] | 'Omar' |
| [n] | [næwt] | 'oil' | [tS] | [tSæw] | 'eye' |
| [ŋ] | [hæŋ] | 'bee' | [dʒ] | [dʒæm] | 'bowel' |
| [r] | [kær] | 'deaf' | [ɬ] | [leɬ] | 'blur' |
| [ɾ] | [roisht] | 'donkey' | [w] | [wæk] | 'like' |
| [f] | [fæl] | 'in bulk' | [l] | [læf] | 'coil' |
| [v] | [vɑn] | 'car' | [j] | [jari] | 'game' |
| [ħ] | [ħæsn] | Proper name | | | |

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**Table 2. List of consonants (word-medial)**

| Consonant | Word | Gloss |
|---|---|---|
| [p] | [pæpʊlæ] | 'butterfly' |
| [t] | [ħæmætæɬ | Proper name |
| [k] | [mækæ] | 'holy city' |
| [b] | [bææbæ] | 'lost effort' |
| [d] | [dæmædm] | 'argument' |
| [g] | [dærgæ] | 'door' |

**Table 3. List of vowels**

| Vowel | Word | Gloss |
|---|---|---|
| [i] | [riz] | (nonword) |
| [I] | [rIz] | 'line' |
| [e] | [rez] | 'respect' |
| [æ] | [ræz] | 'grape yard' |
| [u] | [ruz] | (nonword) |
| [ʊ] | [rʊz] | (nonword) |
| [o] | [roz] | a kind of flower |
| [ɑ] | [rɑz] | 'fortune' (luck) |

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**Table4. Sorani consonant inventory**

| | Bilabial | Labiodental | Alveolar | Postalveolar | Palatal | Velar | Pharyngeal | Glottal |
|---|---|---|---|---|---|---|---|---|
| Plosive | p b | | t d | | | k g | | ʔ |
| Nasal | M | | N | | | ŋ | | |
| Trill | | | R | | | | | |
| Tap or flap | | | ɾ | | | | | |
| Fricative | | f v | s z | ʃ ʒ | | x ɣ | ħ ʕ | h |
| Affricate | | | | tʃ dʒ | | | | |
| Lateral fricative | | | ɬ | | | | | |
| Approximant | w | | | | j | | | |
| Lateral approximant | | | L | | | | | |

## Methods

Speakers were recorded using a Marantz PMD671 digital recorder and an Electro-voice 671BL microphone. Recordings took place in a quiet atmosphere, in order to eliminate interference from background noise.

Acoustic analysis was performed using the speech analysis software program Praat 4.04 (Boersma&Weenink 2010). Using Praat, measurements were recorded for F1, F2, F3, and duration for each of the vowels. Formant frequencies were measured at the mid-point of the vowels, using the formant analysis function in Praat. Vowel duration was measured using PRAAT-generated graphic displays of synchronized waveforms and spectrograms, as shown in Figure 1.

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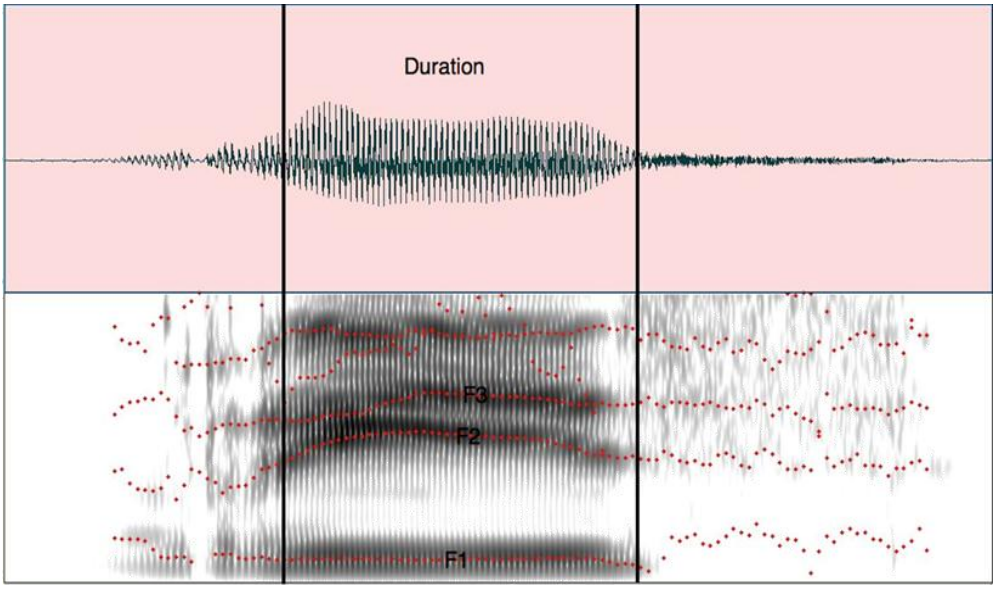


**Figure 1: Measurement of [u] Duration in [ruz]**

## Results

All the recordings have been measured and the results were as the following:

**Table 5: VOT the mean values for [b-d-g] initially (females and males)**

| Name | Sound | VOT (ms) | Sound | VOT (ms) | Sound | VOT (ms) |
|---|---|---|---|---|---|---|
| M. Mean | [p] | 39 | [t] | 57 | [k] | 73 |
| Fe. Mean | [p] | 46 | [t] | 61 | [k] | 69 |
| Mean | [p] | 43 | [t] | 59 | [k] | 71 |

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**Table 6: VOT the mean values for [b-d-g] medially (females and males)**

| Name | Sound | VOT (ms) | Sound | VOT (ms) | Sound | VOT (ms) |
|---|---|---|---|---|---|---|
| M. Mean | [b] | -129 | [d] | -118 | [g] | -109 |
| Fe. Mean | [b] | -138 | [d] | -125 | [g] | -88 |
| Mean | [b] | -134 | [d] | -122 | [g] | -98 |

Sorani has 29 consonant sounds as shown in table (4). It has seven stop consonants, six of them have been studied in this paper and one did not for some technical reasons, four voiceless and three voiced. The voiceless stop consonants were all produced with aspiration in the present study, indicated by positive VOTs ([p]: 43 ms in initial position, 50 ms in medial position; [t]: 72 ms initial,40 ms medial; [k]:71 ms initial,54 ms medial). The glottal stop/ ʔ /does not occur word-initially and thus was not analyzed. On the other hand, the voiced stops were produced with prevoicing, indicated by negative VOTs ([d]: -118 ms initial, -74 ms medial).

## Discussion

1-Vowels

Sorani has 8 vowel sounds which are shown in figure 2. Figures 3 and 4 show the F1 and (F2 – F1) vowel spaces for female and male speakers, respectively.

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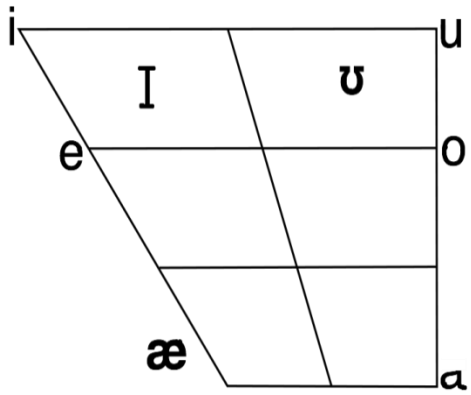


**Figure 1. Sorani vowel quadrilateral**

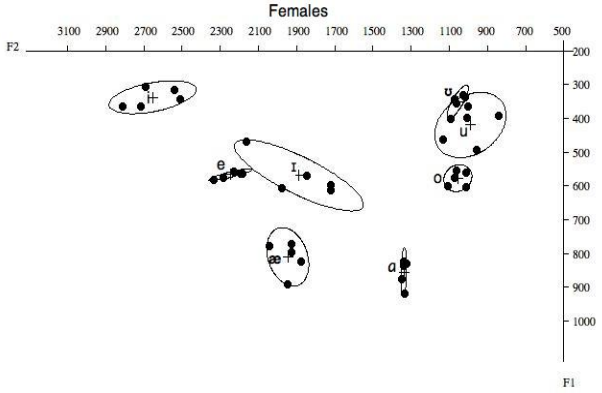


**Figure 2. F2 and F2 vowel space for female speaker**

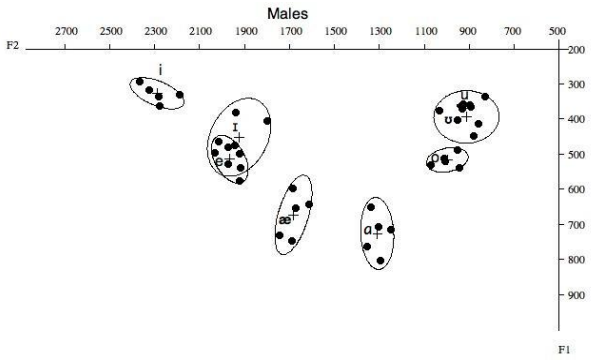


**Figure 3. F2 and F2 vowel space for female speakers**

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As can be seen from the plots of the vowel space (Figs. 2 and 3), the vowels of Sorani generally are produced with the formant frequencies expected based on their transcription. A few vowel pairs, however, show overlapping formant frequencies. As shown in Fig. 2 for the female speakers, the front vowels /e/ and /I/ are very close to one another and the back vowels /u/and /ʊ/ exhibit substantial overlap; a similar pattern holds for the male speakers. This overlap raises the question of how the speakers tell these vowels apart. One way that might help to figure this out is checking the duration of those two vowels to see if there difference can be attributed to the difference in their duration.

2-**English Consonants:**

Keating (1984) mentions that English has a great deal of positional variation in the VOTs of the sounds. English is known to contrast voiced and voiceless phonemes in word-initial position, while voiced stops are said to have two possible phonetic realizations, voiced or voiceless unaspirated (Keating, Linker, & Huffman, 1983; Keating, 1984; Docherty, 1992). Lisker and Abramson (1964) provide two sets of VOT values for English voiced stops (/b, d, g/), one with a positive short lag, and the other with a negative voicing lead. They further suggest that only a single type of phonetic representation is produced by each native speaker. Klatt (1975) measures VOT values for English stops and reports positive values for both voiced /b, d, g/ and voiceless unaspirated stops /p, t, k/. Keating (1984) also points out that English voiced stops are sometimes pronounced with some lead values but mainly with short lag and long lag. Table 1 shows mean VOTs for English stops, as reported by Lisker and Abramson (1964), Klatt (1975), and

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Docherty (1992). Table 1. Mean VOTs for English stops as reported by Lisker& Abramson, 1964 (AE) Klatt, 1975 Docherty, 1992 (BE)

**Table 6:(AE=American English; BE=British English. All measurements are in milliseconds (ms). Note: /p', t', k'/ represents voiceless aspirated stops, while /p, t, k/ refers to voiceless unaspirated stops.**

| | Lisker& Abramson, 1964 (AE) | Klatt, 1975 | Docherty, 1992 (BE) |
|---|---|---|---|
| | Mean | ean | mean |
| /p'/ | 58 | 7 | 42 |
| /t'/ | 70 | 5 | 64 |
| /k'/ | 80 | 0 | 62 |
| /p/ | | 2 | |
| /t/ | | 3 | |
| /k/ | | 0 | |
| /b/ | 1/-101 | 1 | 15 |
| /d/ | 5/-102 | 7 | 21 |
| /g/ | 21/-88 | 27 | 27 |

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**English Vowels**

Ladefoged (2015) states that there are two places of articulation features for every vowel. One feature describes the HORIZONTAL position of the tongue in the mouth, while the other feature describes the VERTICAL position of the tongue in the mouth.

•Horizontal (front – to – back) position in the mouth:

1- Front vowels: Produced with the tongue in the front of the mouth.

-[i, ɪ, e, ɛ, æ] have the feature [+front]

2-Central vowels: Produced with the tongue in the center of the mouth.

- [ a, aɪ] have the feature [+central]

3- Back vowels: Produced with the tongue in the back of the mouth.

-[ʌ, ɑ, o, ɔ, u, ʊ] have the feature [+back]

•Vertical (high – to – low) position in the mouth:

4-High vowels: Produced with the tongue high in the mouth.

-[i, ɪ, u, ʊ] have the feature [+high]

5- Mid vowels: Produced with the tongue in the middle of the mouth.

- [e, ɛ, ʌ, o, ɔ] have the feature [+mid]

6-Low vowels: Produced with the tongue low in the mouth.

- [æ, a, ɑ] have the feature [+low]

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•We can describe each vowel in terms of these two Place of Articulation features. For Example… [i] is [+front, +high] [u] is [+back, +high]

[ɛ] is [+front, +mid] [aɪ] is [+central, +low]

**Rounding**

•Vowels can be [+rounded] or [-rounded].

• [+rounded] vowels are made with the lips rounded (forming an 'o' shape) as [o, ɔ, u, ʊ] have the feature [+rounded]

• [-rounded] vowels are made with the lips not rounded as [i, ɪ, e, ɛ, æ, #, a, ʌ, ɑ]

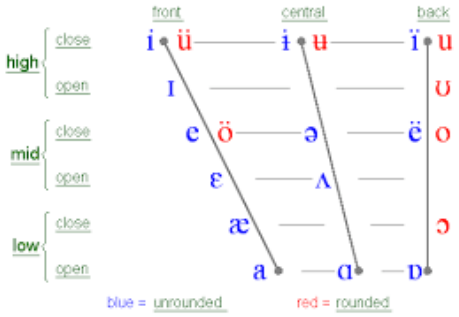


**Figure4**:https://www.internationalphoneticassociation.org/

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**Conclusion**

Even Sorani Kurdish and English share many features on their consonants however, there are many variations in the exact measurement of the voice onset time of the consonant sounds, for example, the VOT of /p/ initially in Sorani was 43ms as shown in table (5) while the VOT of /p/ according to Lisker& Abramson, 1964 (AE) was 58ms and those two different measurements needs more studies to say exactly what is going on there is it because the different context in which they both occur or because the effect of the adjacent sounds of both of them. The same can be applied to the other sounds and measurements. The other clear point that distinguishes the two languages is that there is a great deal of aspiration that accompanied the production of voiceless consonants in Sorani Kurdish and that was not the case in English. Regarding the vowel sounds there are differences in the measured frequencies in both languages in addition to the great overlapping that appears in the plotting of the vowels sounds in Sorani figures (3, 4) and we cannot see such an overlapping in the English vowel sounds. This can attributed to the different contexts of the vowels besides the different features of the two languages.

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# توصيف صوتي للاصوات التوقفية واصوات العلة في اللغة الكردية السورانية واللغة الانكليزية

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**خلاصة البحث**

تهدف الدراسة الحالية الى توثيق اصوات الكلام و قائمة الاصوات للهجة "سوراني " وتوصيفها وهي احد لهجات اللغه الكرديه ومن ثم مقارنه النتائج المستقاة مع نظيراتها في اللغه الأنكليزيه .يركز البحث الحالي على نظام الاصوات المهموسه وعلى نوعية أصوات اللهجة السورانية التي تقاس بأستخدام خاصية بداية الصوت المهموس VOT لأصوات الوقف الساكنه وصفات اصوات الكلام للاصوات الثلاثة الاولى المهموسه وفترة الأغلاق لاصوات الوقف الغير مهموسة في الموقع الوسطي .لقد اشترك 10 افراد من ناطقي اللهجة السورانية ( 5 ذكور و 5 أناث ) في تجربة الدراسة الحالية ولقد كان عمر جميع افراد العينة مابين 20-50 سنة الذين هم من تولد مدينة السليمانية ومن المهاجرين الى الولايات المتحده الأمريكيه .سوف تسجل اصوات افراد العينة في اجواء صافية لغرض منع التداخل اللغوي الذي قد يحصل .لقد اخذت القياسات للغه الانكليزيه من بعض الدراسات السابقه التي اعتمدت على نفس ستراتيجية القياس للدراسة الحالية

**الكلمات المفتاحية :** سورانيس , الاصوات التوقفية , اصوات , اصوات الوقف الساكنة .

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