# THE DURATION OF VOWEL REPRESENTING KASRE IZAFAT IN THE COMPOUND WORDS OF URDU LANGUAGE

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## ABSTRACT

The primary aim of this paper is to explore the duration of the vowel involved in Kasre Izafat in compound words of Urdu. Various sentences, spoken by various speakers, were recorded and analyzed using specialized speech analysis software. Results suggest that the vowel is indeed short. The paper also sheds light on the topics of vowel duration and co-articulation. Furthermore, for the sake of analysis, stress rules of Urdu are also discussed in light of earlier Urdu phonetic publications.

## 1. INTRODUCTION

Urdu, along with Hindi, belongs to the family of Indo-Aryan Languages. However unlike Hindi not much work, with regard to Phonetics and Phonology, is done on Urdu. In spite of this, among the few rules defined, there is a rule in Urdu that no word ends with a short vowel (Bukhari, 1985, p.18). But in case of compound words, with punctuations like the zair (ـِ) mark at the end of the first word, the possibility of a short vowel existing at the intermediary word boundary remains an open question. This paper aims to investigate this very situation.

## 2. LITERATURE REVIEW

To investigate the vowels, specifically their duration, it is vital to have knowledge of the factors that affect vowel duration. Therefore vowel duration is reviewed. Furthermore a closer study of Urdu with respect to those factors is essential in order to successfully measure the duration.

### 2.1 Vowel Duration

Vowels are greatly affected in duration by a number of factors such as the identity of the following consonant, the rate of speaking, the syllable stress, the number of syllables in the word, the position of the word in the phrase or sentence, the type of word and the importance or emphasis assigned to the word by the speaker (Pickett, 1999, p. 87). In languages it is commonly observed that stress increases the duration significantly. However both the vowel quality and intensity only contribute minimally to the increase. But this is certainly not true for all languages as in the case of Estonian, where unstressed vowels are longer than stressed ones (Lehiste, 1970). Furthermore stress not only increases duration but also correlates to the intensity of formants (Napoli, 1996). Importance of the position and word type on vowel duration can be seen from the fact that a result of an experiment revealed that the longest vowels are those that are stressed and occur at the end of phrases, clauses or sentences. On the other hand vowels appearing in the beginning of a word are much shorter, in duration, when stressed. This phenomenon can be explained partly with the help of the word final lengthening effect that causes the final rhyme of a word to be less short then it actually may have been. Apart from the word final lengthening another reason can be due to the characteristics of the consonants following the vowel. Since it is observed that voiceless stops shorten the preceding vowel's duration while, on the contrary, nasal consonants lengthen the duration.

Another factor affecting the vowel duration is the rate of speaking. If the speed of speaking were fast then the time given to the speech organs (tongue, lips and the rest) to meet the targets required for properly uttering the phonemes would be less then required. Thus the duration of the vowels and consonants too would decrease (but this decrease is more evident for vowels) (Pickett, 1999).

### 2.2 Co-Articulation

Besides the vowel duration factor another phenomenon that can potentially affect acoustic analysis is co-articulation. Co-articulation is a term used to refer to the influences of one sound on the articulation of other sounds in the same utterance. This happens mainly when the tongue articulation fails to attain certain targets. This failure may be due to time shortage (if speaking fast) or by target anticipation. It is anticipatory because the movements for a sequence of sounds, syllables and words seem to prepare for later articulatory patterns. This results in current parts of the utterance, being spoken, to be affected. In fact Pickett says co-articulation is the rule in speech production. Hence, it is common for consecutive or adjacent phonemes to affect each other (Pickett, 1999). Thus it becomes imperative to keep co-articulation in mind during acoustic analysis of the speech signal.

### 2.3 Stress in Urdu

Since, stress is a key factor affecting vowel duration. So, a review of the rules regarding stress needs to be addressed. In Urdu, lexical stress doesn't change the meaning of the word like it does in English. In English for example, stress on the 'in' syllable makes 'insult' a noun while the stress on the 'sult' syllable makes 'insult' a verb.

In Urdu the lengthening effect is not treated as a supra-segmental feature but rather it, along with tone and stress, does affect intonation patterns. Irrespective of that, lengthening does play a vital role in the rhythmic formation, as well as smooth flow of the sentence.

In Urdu there are three short vowels [ʊ], [ɪ] and [ə] for which punctuation marks paish (ـُ), zair(ـِ), zabar(ـَ) are used respectively (Khan, 1997). One reason of why stress is not distinctive in Urdu may be because the words are not distinguished on the basis of stress alone. Rather the stressing and de-stressing of syllables is linked to syllable weight. As a rule though, tense or stressed vowels are phonetically long (Kachru, 1987).

According to another study done by Hussain (1997, p.121) lexical stress alters the phonetic properties of both vowels and consonants (Among others, the duration of both, the vowels and consonants, also increases). Furthermore long vowels in the initial syllable are, on average, twice as long as short vowels in the initial syllable. Besides the durational increase due to stress is different for vowels in different syllables. Another result of the study was that the vowel duration increases least when the stressed vowel is in the initial syllable and most when it is in the last syllable (as reviewed earlier word final lengthening may have a role to play here) (Hussain, 1997, p. 121).

### 2.4 Summary

Duration of a vowel depends on many factors of which stress is very common and important. With respect to Urdu, stress does exist but may be unimportant phonetically as pointed out by some authors. Though stress does affect vowels phonetically, by elongating that vowel.

Co-articulation is also an important issue when acoustic analysis is being done because it is happening all the time. The occurrence of co-articulation can make it difficult to identify the exact boundaries of vowels accurately.

## 3. Methodology

As seen from the reviewed literature, in the previous section, the zair (ـِ) punctuation mark would produce a short vowel (/ɪ/) sound. On the other hand it is also reviewed that stress could elongate the short vowel to some extent. Keeping these things in mind, an experiment is to be devised such that the vowel (/ɪ/) is verified as a short vowel.

### 3.1 Stimuli

For the proper verification of the short vowel, compound words were taken which had the zair (ـِ) punctuation mark at the end of the first word. Words were taken from the Urdu lexicon and where possible highly familiar words were selected. The experiment was

designed with limited knowledge of the phonology and phonetics of Urdu.

Furthermore ten most familiar words were selected without any apparent consideration on their particular word structure. Table 1 is the list of words used for the experiment.

**TABLE 1 Words, along with their phonetic transcription, used in the experiment.**

| Words | Transcription |
|---|---|
| Quaid-e-Azam (Founder of Pakistan) | qaid ɪ azəm |
| Rad-e-Amal (Reaction) | rəd ɪ amal |
| Minar-e-Pakistan (A monument) | mɪnar ɪ pakɪsʈan |
| Bagh-e-Jinnnah (Name of a garden) | bayʰ ɪ dʒɪnã |
| Aqwam-e-Mutahida (United Nations) | aqvam ɪ mʊʈəhɪɖa |
| Janab-e-Aali (Your Honour) | dʒənab ɪ ali |
| Sitara-e-Imtiaz (Honorary medal) | sɪʈara ɪ ɪmʈɪaz |
| Azab-e-Qabr (Torment of grave) | azab ɪ qəbər |
| Dawat-e-Aam (Open invitation) | ɖawət ɪ am |
| Sahib-e-Hasiat (Capable person) | sahɪb ɪ hesɪəʈ |

The bold symbol is the targeted short vowel. Each word was embedded in a carrier sentence. Table 2 is the list of words that contained the selected long vowel (The selected long vowel is bold and separated with space in order to clarify it).
The transcription of the entire sentences is given in the Appendix A.

### 3.2 Apparatus

The apparatus used for the experiment can be categorized into two broad categories: Recording apparatus and Speech Analysis apparatus. The recording apparatus included first and foremost a dynamic microphone (low rated impedance (Z) of 150-180Ω) with a frequency response of 80 to 14000Hz. The microphone used, also had a built-in locking on/off switch on it. Furthermore a high quality integrated stereo amplifier supported the microphone. All coupled with a very high standard Sound-Blaster Card ensured minimum loss of data to noise and other interferences. Along with that Praat 4. 0 sound recording system, The SoundRecorder, was used (configured to produce 16KHz WAV files).

The Speech Analysis apparatus included the Praat 4.0 speech analyzer and the Speech Analyzer 1.5. Furthermore a pair of high performing speakers was used. Beside that Microsoft Excel is used for storing the time durations as well as doing the statistical analysis.

**TABLE 2 Words containing the selected long vowels.**

| Words | Transcription |
|---|---|
| Azadi (Independence) | az **a** ɖi |
| Shadeed (Extreme) | ʃəɖ **i** ɖ |
| Sair (Recreational tour) | s **æ** r |
| Bagh (Garden) | b **a** ɣʰ |
| Pantalis (fourty-five) | peɳʈ **a** lis |
| Janab (Sir) | dʒən **a** b |
| Sitara (Star) | sɪʈ **a** ra |
| Hamaen (We) | həm **ẽ** |
| Iftar (Breaking of fast) | ɪfʈ **a** r |
| Ko (About) | k **o** |

### 3.3 Speakers

Speakers are an important part of the experiment. Six male speakers are used in the experiment, referred to as RS, AG, BA, AK, SS and GS. All of the six speakers' native language is Urdu. Besides, all of

them are currently students pursuing a bachelor's degree in Computer Science from National University of Computer and Emerging Sciences (NUCES). All of the speakers can understand Punjabi. AG and GS also speak Punjabi actively during their daily-life routine. All the speakers were judged to have normal speech and hearing. All the speakers were naïve about the purpose of the experiment. Two speakers, GS and SS, had no prior experience of doing any phonetic or speech experiment of any sort. On the contrary the remaining four have been participating in some sort of phonetic or speech related experiments in the current past.

### 3.4 Procedures

First, ten compound words of Urdu, with the zair (ـِ) punctuation placed at the end of the first word, are sought. These ten words are made into ten sentences. In order to avoid emphatic stress and intonation, possibly affecting the vowel durations, these sentences are created as simple statements. All of these ten sentences are then written legibly on ten cards (Each card containing one sentence). All of the ten cards are properly shuffled and presented to the speaker.

The speakers were advised to read the sentences out as if speaking them in their daily routine, keeping the sentences as simple statements and not introducing any sort of undue intonation or emphatic stress. Furthermore they were cautioned not to recite the sentences too slowly or too quick, but rather at their natural speaking pace.

Each sentence was recorded one at a time. Once the ten sentences were recorded, the speakers were given a short break while the cards were reshuffled. They then read the cards again. The whole procedure was repeated five times in a block-randomized design. By doing this each speaker ended up recording five files per sentence. Thus there were fifty files per speaker. And since there are six speakers so all in all there were three hundred recorded files in total to be analyzed. For each sentence, the duration of each speaker's long and short vowels, measured in seconds, was recorded in Microsoft Excel spread-sheets. The normalized vowel durations were also calculated and stored in those spreadsheets.

### 3.5 Analysis

For analysis Praat 4.0 speech analysis tool, along with the Speech Analyzer was used. Both tools provide the facilities for inspecting the spectrogram along with the proper zooming and time duration calculation facilities.

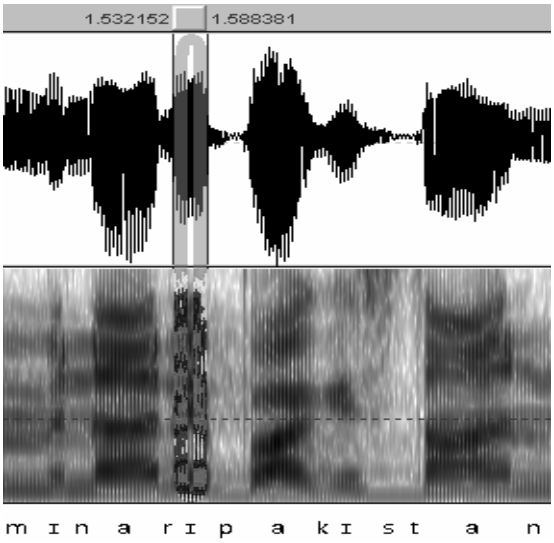


**FIGURE 1 Spectrogram, marking duration of /ɪ/**

For analysis, time duration (in seconds) of the targeted vowel is measured alongside with the duration of any one of the long vowels spoken in the sentence (For the purpose of proper comparison, the chosen long vowel in a sentence remains the same for each of the speaker). Due to the varying speaker speaking pace, care needs to be taken in selecting the long vowel. For proper and effective interpretation the targeted vowel duration is normalized that is its ratio with the long vowel is taken. This would thus give us the relative length of the targeted vowel with respect to the long vowel selected leading to a conclusive inference of the result.

For each vowel the time duration (in seconds) is calculated by subtracting the time of the marker at the offset of the vowel with the one on its onset. As in Figure1 the duration for the short vowel is measured by subtracting the values indicated on the top

of the window. The software shows both times in seconds. It is to be noted that the duration marked in the figure is actually demarcated by properly zooming in to get the proper limits of the vowel boundary. Furthermore co-articulation also comes into play, as a speaker's natural speaking pace may be fast enough to cause it. As reviewed, the duration of the vowel in co-articulation is calculated between boundaries in which that vowel can be distinctly heard and that the formants remain fairly constant. Figure 2 shows that case.

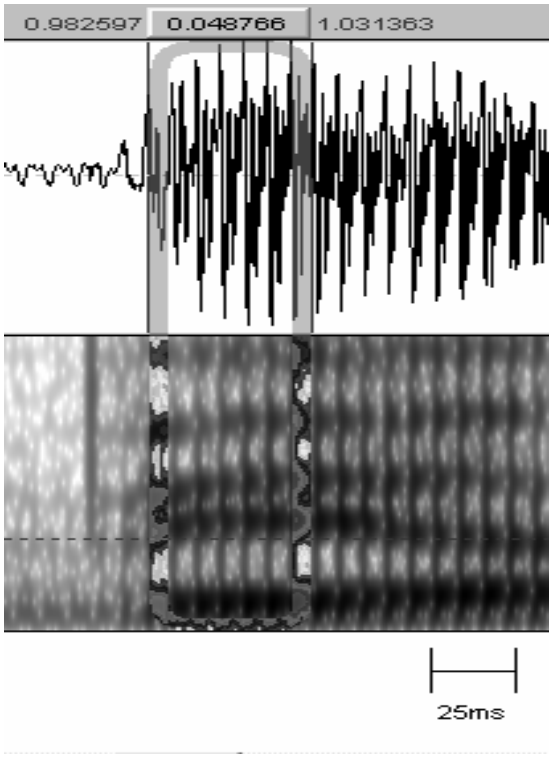


**FIGURE 2 spectrogram, marking the duration of /ɪ/ when co-articulated with the vowel following it.**

## 4. Results

Figure 3 shows the variation of vowel duration made by each of the six speakers. Firstly the Normalized Vowel Duration is calculated by dividing the duration of the short vowel, in seconds, with that of the long vowel, also in seconds. The figure also shows the minimum, average and the maximum values of the normalized vowel. Each speaker's minimum value is calculated by first selecting the smallest value of the five recordings of every sentence. Consequently, ten lowest values are extracted, one from each of the ten sentences. Thus each speaker's minimum

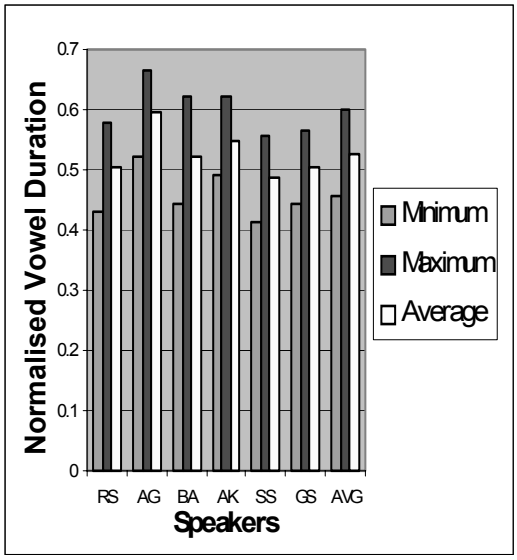


**FIGURE 3 Maximum, minimum and average values of Normalized Vowel Duration of each speaker.**

value is taken as the average of these ten values. Similarly the highest value among the five recordings of every sentence is extracted. This leads to ten highest values one from each sentence. The average of these ten values yields the average maximum value that the speaker achieved. Calculating the average value is just the same. Instead of selecting the minimum or maximum value, the average of the five recordings is calculated. Since there are ten sentences, ten average values are extracted. The average of these ten numbers would give the average value per speaker per sentence. Average bars are also plotted alongside the six speaker bars. The minimum value is the average of the six lowest values as plotted in the figure. It is the case for the average's maximum and average values.

Figure 4 shows a line graph depicting the maximum, minimum and average vowel durations per sentence. For calculating the maximum value, an average of the five recordings is done for each of the six speakers. Then of those six averages the maximum is chosen. Calculating the minimum value is similar to that of the maximum value. Similarly for the average

value, the average of five recordings is done. Finally the Average of the six average values would yield an average value of all the speakers per sentence.

Furthermore the figure shows a thick horizontal line just above the 0.5 mark. This is actually the average of the ten average values.

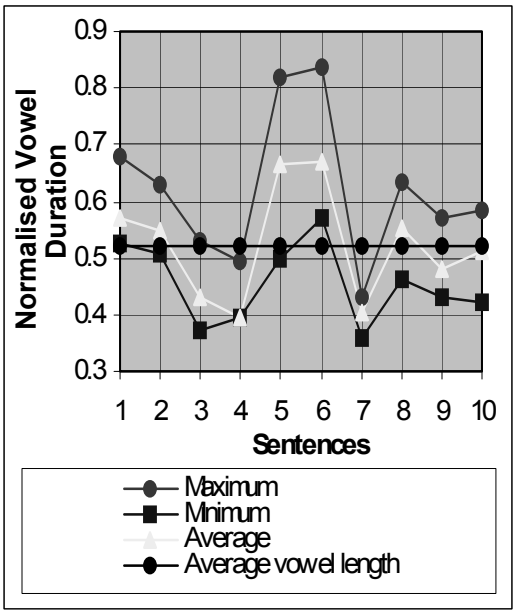


**FIGURE 4: maximum, minimum and average normalized vowel duration of each sentence.**

## 5. Discussions

The results suggest that the duration of the short vowel /ɪ/ is on average less then that of the long vowel. The long vowel is on average double in duration as compared to the short vowel (approx 0.52 in ratio to a long vowel).

The range of duration of the short vowel, however, varied from speaker to speaker and also from sentence to sentence. The range, though, was from approximately 0.3 to 0.8, but that was by some speakers in a handful of cases.

By looking at the figures in the Appendix B (p.13-14) it can be seen that most of speakers altered the lengths of vowel even for the same sentence suggesting that they were perhaps stressing the short vowel just a bit at times. Apart from this, the short vowel comes right at the end of the first word of the compound word suggesting that word final lengthening may be playing its role, in elongating the last rhyme of the word, which in this case would be the short vowel. However if the results of all the sentences are viewed, it can be seen that the duration on some instances (like sentence 4 and 6, Appendix B p. 13-14) remain small. This usually happened if the second word of the compound word starts with a consonant (sentence 5, Appendix B p. 13-14, being a big exception). On the contrary the duration of vowel altered greatly when the second word started with a vowel. Some speakers kept it smaller on some occasions and elongated it a bit on other occasions. Another trend observed was that some speakers (usually AG and BA), keeping up with their natural pace, usually preferred to stop in between the two words thus elongating the short vowel just a bit while others didn't. The others, where possible, carried on uttering the second word resulting in co-articulation. The vowels have to be different though as this wasn't observed in sentence 7 (Appendix B p. 13-14) where most speakers preferred to break the compound after the first word.

All in all, irrespective of variations, the duration of the vowel remained about half the size of a long vowel suggesting that it remained a short vowel (approximately 0.52 in ratio to a long vowel). This further leads to the conclusion that kasre Izafat represents a short vowel and in consonant-vowel (CV) configuration (with 'V' being the short vowel) can occur exceptionally at word ending in compound words.

## 6. References

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## 7. APPENDICIES

### Appendix A Transcription of sentences used for the experiment

Following are the transcriptions of the sentences used in the experiment. The short vowel (/ɪ/) and the long vowel used for normalization of vowel duration are shown in bold face.

1. həmẽ qaidɪ azəm nə azadi ḍəlai.
   (We got independence because of Quaid -e- Azam).

2. us ka reḍɪ amal bəhoṭ ʃədid ṭʰa.
   (His reaction was very extreme).

3. həm sær kər næ mɪnarɪ pakɪsṭan gae.
   (We made a recreational trip to Minar-e-Pakistan).

4. lahor ke məʃhur baɣõ mẽ ek baɣʰ baɣʰɪ dʒɪna hæ.
   Bagh-e-Jinnah is one of the famous gardens of Lahore).

5. aqvamɪ muṭəhɪḍa unis sɔ pænṭalis mẽ kaim hui.
   (United Nations was formed in 1945).

6. dʒənabɪ ali uñ ko baizəṭ bəri kija dʒae.
   (I request Your Honor to set him free).

7. mudʒʰe sɪtaraɪ ɪmtɪaz dija dʒae.
   (Award me Sitara-e-Imtiaz).

8. həmẽ azabɪ qəbər se bətʃna tʃahije.
   (We should save ourselves from the torments of the grave).

9. un ki ɪftar parti mẽ səb ko davətɪ am he.
   (There is an open invitation for their Iftar party).

10. sahɪbɪ hesɪəṭ logõ ko ɣarib logõ ki mədəd kərni tʃahije.
    (Rich people should help the poor).

## Appendix B Results of the Experiment

Below is the experiment result data. All values are durations in seconds except for the normalization column, which is the ratio of short vowel to the long vowel.

**TABLE B.1 Sentence 1**

| Speaker | target vowel | long vowel (az**a**di) | normalised |
|---|---|---|---|
| RS | 0.052 | 0.092 | 0.565 |
| | | | |
| AG | 0.057 | 0.098 | 0.577 |
| | | | |
| BA | 0.061 | 0.111 | 0.553 |
| | | | |
| AK | 0.060 | 0.089 | 0.680 |
| | | | |
| SS | 0.051 | 0.098 | 0.524 |
| | | | |
| GS | 0.055 | 0.105 | 0.529 |
| | | | |
| ***Sentence Average*** | ***0.056*** | ***0.099*** | ***0.571*** |
| | | | |

**TABLE B.2 Sentence 2**

| Speaker | target vowel | long vowel (shad**i**d) | normalised |
|---|---|---|---|
| RS | 0.056 | 0.094 | 0.594 |
| | | | |
| AG | 0.072 | 0.115 | 0.627 |
| | | | |
| BA | 0.059 | 0.114 | 0.523 |
| | | | |
| AK | 0.053 | 0.103 | 0.513 |
| | | | |
| SS | 0.046 | 0.092 | 0.506 |
| | | | |
| GS | 0.065 | 0.125 | 0.519 |
| | | | |
| ***Sentence Average*** | ***0.058*** | ***0.107*** | ***0.547*** |

**TABLE B.3 Sentence 3**

| Speaker | target vowel | long vowel (s**e**r) | normalised |
|---|---|---|---|
| RS | 0.060 | 0.113 | 0.529 |
| | | | |
| AG | 0.063 | 0.135 | 0.464 |
| | | | |
| BA | 0.062 | 0.168 | 0.374 |
| | | | |
| AK | 0.058 | 0.141 | 0.411 |
| | | | |
| SS | 0.051 | 0.135 | 0.380 |
| | | | |
| GS | 0.069 | 0.163 | 0.427 |
| | | | |
| **Sentence Average** | **0.060** | **0.143** | **0.431** |

**TABLE B.4 Sentence 4**

| Speaker | target vowel | long vowel (b**a**gh) | normalised |
|---|---|---|---|
| RS | 0.069 | 0.166 | 0.418 |
| | | | |
| AG | 0.079 | 0.161 | 0.493 |
| | | | |
| BA | 0.075 | 0.186 | 0.397 |
| | | | |
| AK | 0.081 | 0.176 | 0.463 |
| | | | |
| SS | 0.081 | 0.183 | 0.449 |
| | | | |
| GS | 0.090 | 0.200 | 0.453 |
| | | | |
| ***Sentence Average*** | ***0.079*** | ***0.179*** | ***0.445*** |

**TABLE B.5 Sentence 5**

| Speaker | target vowel | long vowel (-t**a**lis) | normalised |
|---|---|---|---|
| RS | 0.050 | 0.080 | 0.618 |
| | | | |
| AG | 0.077 | 0.094 | 0.818 |
| | | | |
| BA | 0.069 | 0.102 | 0.675 |
| | | | |
| AK | 0.062 | 0.086 | 0.723 |
| | | | |
| SS | 0.057 | 0.087 | 0.654 |
| | | | |
| GS | 0.057 | 0.115 | 0.500 |
| | | | |
| ***Sentence Average*** | ***0.062*** | ***0.094*** | ***0.665*** |

**TABLE B.6 Sentence 6**

| Speaker | target vowel | long vowel (jan**a**b**)** | normalised |
|---|---|---|---|
| RS | 0.063 | 0.115 | 0.549 |
| | | | |
| AG | 0.079 | 0.095 | 0.837 |
| | | | |
| BA | 0.066 | 0.117 | 0.570 |
| | | | |
| AK | 0.073 | 0.097 | 0.755 |
| | | | |
| SS | 0.064 | 0.110 | 0.586 |
| | | | |
| GS | 0.084 | 0.117 | 0.716 |
| | | | |
| ***Sentence Average*** | ***0.072*** | ***0.109*** | ***0.669*** |

**TABLE B.7 Sentence 7**

| Speaker | target vowel | long vowel (sit**a**ra-**)** | normalised |
|---|---|---|---|
| RS | 0.045 | 0.111 | 0.401 |
| | | | |
| AG | 0.054 | 0.125 | 0.432 |
| | | | |
| BA | 0.051 | 0.120 | 0.421 |
| | | | |
| AK | 0.046 | 0.128 | 0.358 |
| | | | |
| SS | 0.045 | 0.109 | 0.409 |
| | | | |
| GS | 0.052 | 0.132 | 0.390 |
| | | | |
| ***Sentence Average*** | ***0.049*** | ***0.121*** | ***0.402*** |

**TABLE B.8 Sentence 8**

| Speaker | target vowel | long vowel (ham**ae**n**)** | normalised |
|---|---|---|---|
| RS | 0.058 | 0.118 | 0.495 |
| | | | |
| AG | 0.073 | 0.126 | 0.577 |
| | | | |
| BA | 0.069 | 0.110 | 0.634 |
| | | | |
| AK | 0.062 | 0.117 | 0.533 |
| | | | |
| SS | 0.052 | 0.114 | 0.460 |
| | | | |
| GS | 0.074 | 0.122 | 0.606 |
| | | | |
| ***Sentence Average*** | ***0.065*** | ***0.118*** | ***0.551*** |

**TABLE B.9 Sentence 9**

| Speaker | target vowel | long vowel (ift**a**r**)** | normalised |
|---|---|---|---|
| RS | 0.052 | 0.121 | 0.430 |
| | | | |
| AG | 0.076 | 0.134 | 0.570 |
| | | | |
| BA | 0.081 | 0.161 | 0.504 |
| | | | |
| AK | 0.062 | 0.133 | 0.468 |
| | | | |
| SS | 0.057 | 0.132 | 0.439 |
| | | | |
| GS | 0.082 | 0.171 | 0.476 |
| | | | |
| ***Sentence Average*** | ***0.068*** | ***0.142*** | ***0.481*** |

**TABLE B.10 Sentence 10**

| Speaker | target vowel | long vowel (k**o**) | normalised |
|---|---|---|---|
| RS | 0.058 | 0.126 | 0.464 |
| | | | |
| AG | 0.071 | 0.124 | 0.574 |
| | | | |
| BA | 0.088 | 0.153 | 0.582 |
| | | | |
| AK | 0.077 | 0.133 | 0.581 |
| | | | |
| SS | 0.059 | 0.131 | 0.456 |
| | | | |
| GS | 0.074 | 0.175 | 0.421 |
| | | | |
| ***Sentence Average*** | ***0.071*** | ***0.140*** | ***0.513*** |

**Following are the distribution of normalized short vowel duration of each speaker with respect to sentences:**

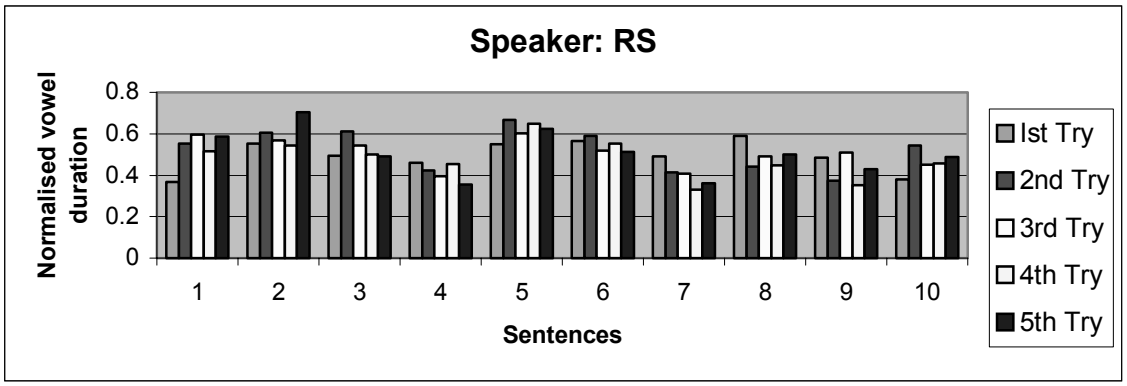


**FIGURE B.1: Variation of vowel duration of speaker RS across the ten sentences.**

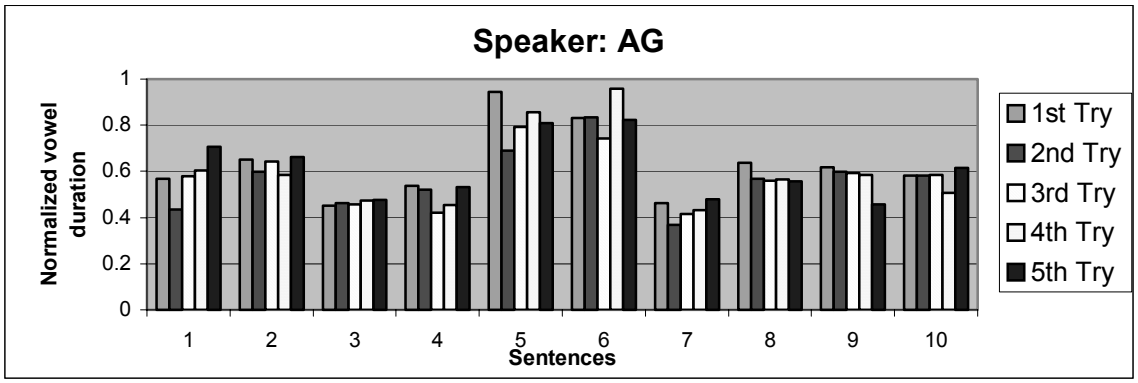


**FIGURE B.2: Variation of vowel duration of speaker AG across the ten sentences.**

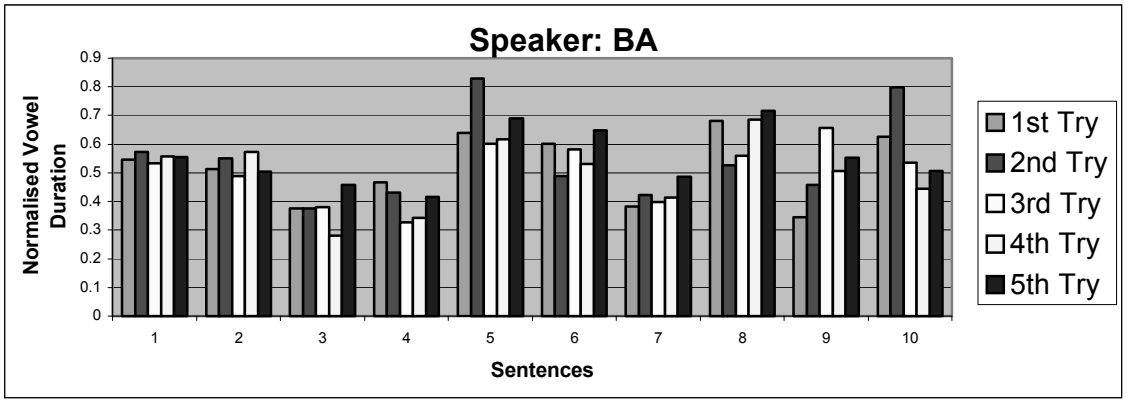


**FIGURE B.3: Variation of vowel duration of speaker BA across the ten sentences.**

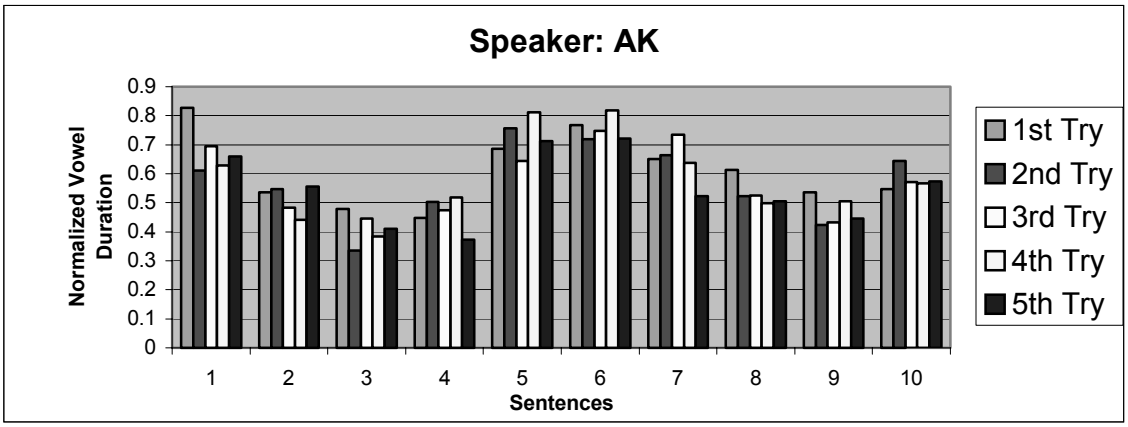


**FIGURE B.4: Variation of vowel duration of speaker AK across the ten sentences.**

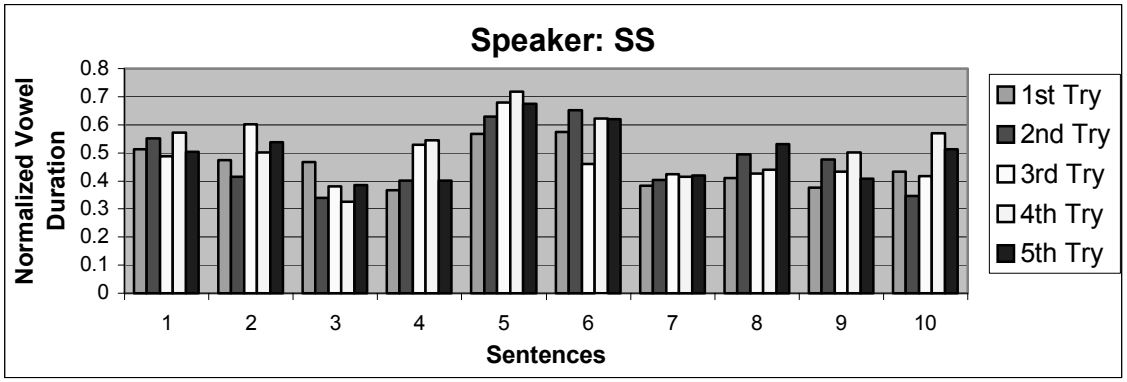


**FIGURE B.5: Variation of vowel duration of speaker SS across the ten sentences.**

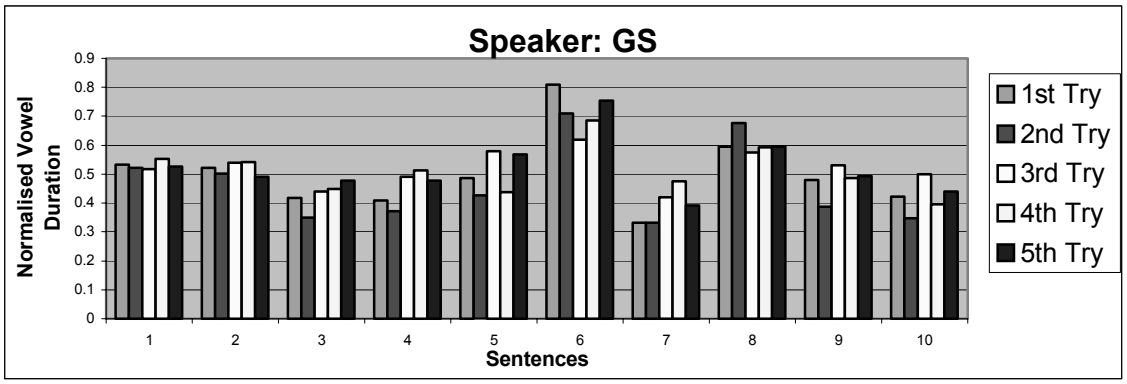


**FIGURE B.6: Variation of vowel duration of speaker GS across the ten sentences.**