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Vowel Structure of Urdu

Abstract: *The following paper is presented to establish Urdu vowel structure. In this paper we have discussed the vowel structures of Urdu, which have been defined by previous researchers. We have introduced a few short vowels and proven their existence, phonetically and phonologically. We have ultimately concluded that there are fourteen vowels in Urdu, out of which, seven are long and seven are short (corresponding to each long vowel).*

Keywords: *vowels, Urdu, formants*

1. INTRODUCTION

Vowels, more open than consonants, are an integral part of every language of the world. Vowel systems differ largely in complexity and density from language to language.

Some languages such as Classical Arabic and Australian Aboriginal languages have as few as three vowels. On the other hand, languages such as English are rich in vowel contrasts, with many variations across the English-speaking world (Clark & Yallop, 1999). The smaller the number of vowels, the lesser is their articulatory space from each other and vice versa. Languages have a natural way of adjusting their vowels in the vowel space.

The vowels are usually towards the outer edges of the vowel space in a three-vowel system. Five-vowel systems are comparatively widespread, considering the increase in the number of vowels. Often, each short vowel corresponds to a long vowel. Languages tend to prefer rounded lips for back vowels and unrounded for front vowels (Clark & Yallop, 1999), i.e., each short vowel has properties similar to its corresponding long vowel.

This work investigates the vowel system of Urdu. Also focused here is the need for some short vowels in addition to the system give by Kachru (1987, table 3.1), Khan (1997, 41), and Hussain (1997). The contrasts in Kachru (1987, table 3.1), Khan (1997, p.41), and Hussain's (1997) systems are also under consideration.

2. LITERATURE REVIEW

Figure 1 shows the relative vowel qualities

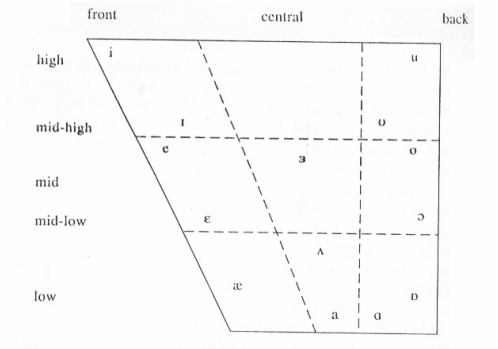


Figure 1: Relative vowel qualities

Vowel chart showing the relative vowel qualities represented by some of the symbols used in transcribing English (Ladefoged, 1999).

2.1. Phonetic Review

Vowel sounds are produced, with the air stream passageway comparatively open and due to lesser restriction by the lips and tongue that in consonants. Vowels can be described in terms of:

1) the position of the tongue body, and
2) the particular shape of the lips.

Vowels are called high, low, front, and back if they are produced by respectively raising, lowering, forwarding and retracting the tongue. The retraction movement merges freely with the raising, lowering or retaining of the tongue in the neutral place, although the tongue cannot be raised and lowered at the same time. Figure 1 shows the vowel symbols and their relative vowel qualities.

Two characteristic pitches largely distinguish vowels. The higher of the two goes downward throughout the series {i, ʔ, e, ʔ, œ, ʔ, ʔ, o, u}. The other pitch goes upward for the first four vowels and then downward for the next four. These characteristic overtones are called the formants of the vowels; the lower is known as the first formant and the higher as the second formant. There is another characteristic overtone, the third formant, which is also present, but there is no simple way of demonstrating its pitch (Ladefoged, 1999).

Daniel Jones devised the set of cardinal vowels to provide standard reference points, or 'cardinal' points, to accurately place vowel descriptions. They do not characterize any particular language or languages but form a kind of grid imposed upon the space in which the tongue moves. There are sixteen cardinal vowels in all, eight primary and eight secondary. Each set of eight contains two boundary vowels. They may have spread neutral or rounded lips (Clark & Yallop, 1999).

2.1. Phonological Review

Natural classes are formed when individual sounds tend to model with certain other sounds in the overall framework of any given language. In phonological alternations, natural classes define two things:

1) a set of segments participating in the alternation,
2) a conditioning environment.

According to (Bokhari, 1985), there are fourteen oral vowels in Urdu – seven long and seven short. According to (Kachru, 1987), (Khan, 1997), and (Hussain, 1997), there are ten oral vowels in all - seven long and three short.

Furthermore, Bokhari asserts that there are fourteen nasal vowels corresponding to each of the fourteen oral vowels. Kachru (1987, table 3.1) does not mention any such listing. Khan (1997, p.41) says that nasal vowels are

articulated by just opening the velo-pharyngeal port without any other change in the articulatory configuration. Both, Hussain (1997) and Dr Khan (1997) term the nasal vowels as allophonic variations of the corresponding oral vowels. This work does not cover the nasal vowels.

The oral vowels of Urdu and their examples are listed in Table 1 and Table 2 (Hussain, 1997).

Table 1: Long vowels with examples

Long Vowels		
i	Bin	"flute"
e	Bel	"train"
Æ/?	bæl/b?l	"cow"
?	bal	"hair"
?	s?	"hundred"
o	k^hol	"to open"
u	dur	"far"

Table 2: Short vowels with examples

Short Vowels		
?	s?r	"head"
?	b?lli	"cat"
?	b? ra	"bad"

Pairs of words differing in only one phoneme are known as Minimal Pairs. To establish vowels phonologically a minimal pair using the two vowels is needed.

3. METHODOLOGY

To investigate the vowel structure we used Urdu speakers with a Punjabi background. The speakers were familiar with both Urdu and Punjabi, however their native language was Urdu.

Ten speakers were used – five males and five females. The vowels used for experimentation were non-nasal æ, e, I, ?, o, u, ?, ?, ?, a, ? and the vowels in the first, stressed syllable of the three words ?ohr?t (dental), b?h?t and beht?r. The conditioning used for the first eleven vowels was 'b' and 'l'. The last three words were used in order to pronounce the associated vowels, since they cannot be pronounced in the context provided. These words were included because it was felt that they contained vowels not included in the established short vowels in Urdu.

The following blocks of vowels are made. {æ, e, i}, { ?, o, u }, { ?, ?, ? }, {?ohr?t, b?h?t and beht?r} and 'a' and '?' vowel. For the purpose of randomization, not only block randomization was used, but the vowels were also randomized regardless of their block boundaries. Five block randomized repetitions of each word were recorded by the ten speakers.

The words used were single stressed, monosyllabic words. The stimulus consists of single syllable stressed words for the established vowel system according to Kachru (1987, table 3.1), Khan (1997, p.41), and Hussain (1997).

The words taken for the vowels æ, e, I, ?, o, u, ?, ?, ?, a, ?, are all monosyllabic. Hence stress is present on the only vowel in these words. However, '?ohr?t, 'b?h?t and 'beht?r are bi-syllabic. But the stress is on the first syllable in all three. Consequently, none of the words chosen exhibit different behavior with respect to stress. In '?ohr?t', 'b?h?t and 'beht?r, the symbol ['], is a stress mark that has been placed before the syllable carrying the main stress. Stress should always be marked in words of more than one syllable.

Vowels were recorded using Praat and the "*.wav" files were saved. The recordings were acoustically analyzed using the software Winsnoori, which provided the spectrograms of the sound waves. Duration, fundamental frequency, f0, and first three formant frequencies were measured for all fourteen vowels of Urdu - seven long and seven short for a detailed analysis of all the vowels.

The average of all the readings were taken. Separate graphs were plotted for males and females the graph was plotted with F2 along x-axis and F1 along y-axis to form the vowel quadrilateral.

4. RESULTS

The general trends observed in male and female speakers are as follows:

4.1 Duration

The durations of long vowels, æ, e, i, ?, o, u, ?, ?, ?, a, for both male and female speakers is around 200 ms, the averages of which are shown in the Tables 3 and 4.

The duration of short vowels, however, shows variations. The duration of short vowels ?, ?, ?, ? is between 120 to 130 for males and 140 to 170 for females. ?ohr?t, b?h?t and beht?r have comparatively shorter durations. The duration is observed to be around 70 for males and from 80 to 100 for females.

4.2 Fundamental frequency (f_0) variation

It was observed that the fundamental frequency is less for open vowels and more for less open ones. It follows the same trend throughout the sample. Thus, f_0 for vowel 'a', potentially the most open vowels is lowest. It is highest for the least open vowel 'u'. However, vowel 'a' exhibits a slight deviation in certain cases. This leads to another observation. Within a block, frequency decreases as the vowel goes to openness and vice versa. For instance, f_0 is minimum for æ and maximum for i within the block {æ, e, i}.

4.3 Formant frequencies (F1 and F2)

Figures 1 and 2 show the vowel structure of Urdu as observed from the analyzed data. These graphs were plotted using the average values from the analyzed data (see Table 3 and Table 4).

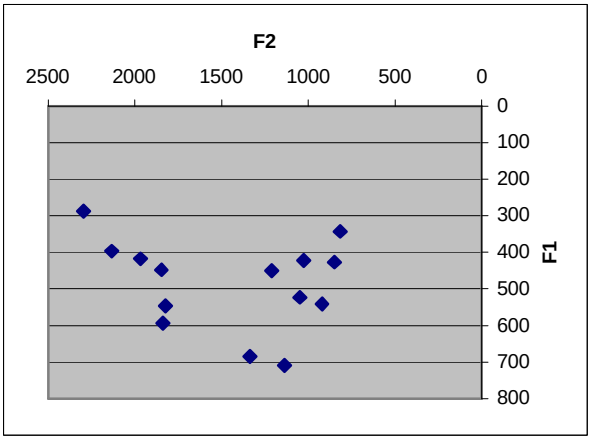


Figure 2 Formant Frequency Graph of Male Speakers

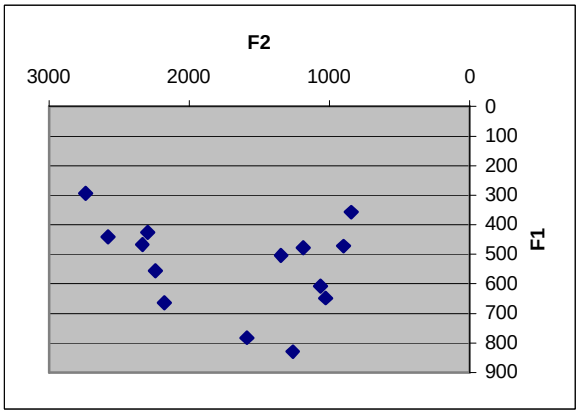


Figure 3 Formant Frequency Graph of Female Speakers

It is clear from the charts that there are fourteen distinct points, which are also phonetically distinct.

5. DISCUSSION

Research work has already been done on establishing the vowel structure of Urdu. Our work focuses on establishing our vowel system and comparing it to the others.

Table 3 shows the averages of our observations of the values of male speakers and Table 4 shows the average values of the female speakers. The mean of duration of each vowel spoken, the fundamental frequency variation, the formant frequencies F1, and F2 and the higher formant frequency F3 are shown in the tables both for the male speakers and the female speakers.

5.1. Duration

The durations of all the cardinal vowels are found to be the same as those already established by our predecessors. The durations of the short vowels are also same as the durations observed before. The durations of the new introduced vowels are too small. This difference in length introduces a major quantitative difference. Due to this visible difference (as shown in Tables 3 and 4), it is clear that the vowels in the first stressed syllable of word ʔeher cannot be represented by long vowel 'æ'. It needs a short vowel representation.

5.2. Fundamental Frequency f_0

According to our observation the f_0 is highest for 'u' and lowest for 'a'. However, the observations by Hussain (1997) show that 'ʔ' has the highest frequency and it is lowest for 'æ' in most of the cases. There is variation in this trend for some speakers. The general tendency followed by the speakers of Hussain (1997) is also followed by some of our speakers.

The trend of f_0 within blocks is same as that observed by Hussain (1997) i.e. low frequency for open vowels and higher for less open ones.

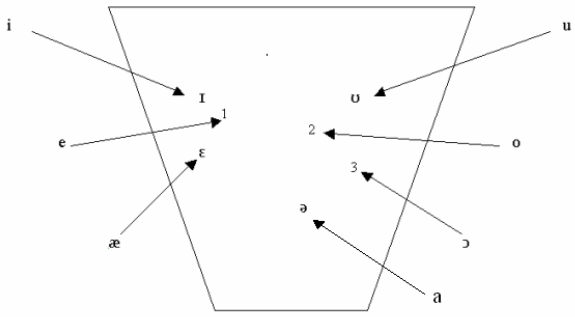
5.3. Formant Frequencies

The formant frequencies of all the vowels excluding 'ʔ', and those in the first syllable of ʔohrʔt, bʔhʔt and behtʔr are observed to be the same as those established by Hussain (1997). There is slight variation, but the difference does not change the quality. Also, the frequencies observed by us are they are same as those defined by Ladefoged for 'i', 'ʔ', 'a', 'ʔ' and 'u' vowels. The frequencies are however different for 'ʔ', 'æ', and 'ʔ'. The higher frequencies are higher in all the cases for these vowels, compared to Ladefoged.

Hussain uses 'ʔ' and 'æ' as separate vowels, and so does Bokhari. However, Kachru (1987, table 3.1) and Khan (1997, p.41) use 'ʔ' for the long vowels in place of 'æ'. The latter two use this symbol for a long vowel because they are not convinced of the presence of the short vowel of 'æ'. Therefore, they use vowel 'ʔ' for both b'æ'l and ʔeher, although the former is a long vowel and the latter is a short vowel.

The frequencies f_1 and f_2 of vowel 'ʔ', and first syllable vowels of ʔohrʔt, bʔhʔt and behtar are close to, but different from, those of 'æ', 'o', 'ʔ' and 'e'. The former short vowels are, therefore, qualitatively different from the latter ones. There is phonetic difference in the two sets. In this way it can be stated that these former ones are separate short vowels mapped onto the latter ones, with qualitative (the formant frequencies and f_0) and quantitative (duration) phonetic difference.

Hence this observation leads to the conclusion that 'ʔ' is the short vowel of 'æ' and those found in the first syllable of ʔohrʔt, bʔhʔt and behtar are the short vowels mapped onto 'o', 'ʔ' and 'e' respectively. The mapping of these vowels is described in Figure 4.



1 – First vowel of behtʔr
2 – Second vowel of ʔohrʔt
3 – Third vowel of bʔhʔt

Figure 4 Mapping of Short Vowels on the Long Vowels

Table 3 Averages of Male Speakers

	Duration	F0	F1	F2	F3
æ	235	128	594	1839	2563
e	231	131	397	2134	2684
i	224	137	288	2297	2939
ʔ	244	127	541	922	2524
o	244	136	427	849	2506
u	222	141	343	818	2413
ʔ	130	129	652	1336	2576
ʔ	122	136	418	1967	2589
ʔ	125	137	423	1026	2409
ʔ	136	128	547	1823	2628

a	239	124	710	1137	2648
?ohr?t	74	135	450	1210	2311
b?h?t	79	126	523	1048	2528
beht?r	71	129	448	1848	2448

Table 4 Averages of Female Speakers

	Duration	F0	F1	F2	F3
æ	235	128	594	1839	2563
e	231	131	397	2134	2684
i	224	137	288	2297	2939
?	244	127	541	922	2524
o	244	136	427	849	2506
u	222	141	343	818	2413
?	130	129	652	1336	2576
?	122	136	418	1967	2589
?	125	137	423	1026	2409
?	136	128	547	1823	2628
a	239	124	710	1137	2648
?ohr?t	74	135	450	1210	2311
b?h?t	79	126	523	1048	2528
beht?r	71	129	448	1848	2448

5.4 Phonologcal Discussion

Hussain (1997) mentions in his thesis that in Urdu, only long vowels and consonants are written. Short vowels are only represented by diacritics i.e. *zabar*, *zer* and *pesh*. They do not have any graphemic representation. Since all the short vowels mentioned above i.e. ? as in ??hr, and those in the first (stressed) syllable of the other three words i.e., ?ohr?t, b?h?t and beht?r, are also written using only the diacritics and not the graphemes. Hence providing evidence that we need to have separate representation for these vowels. However, it can be proved that these sounds are phonemes.

There is an interesting trend of f_0 for the short vowels. It is found that the f_0 of long vowels map onto their corresponding short vowels. As it has been described by Hussain (1997) that all the rounded long vowels map onto '?', spread vowels map onto '?' and 'a' maps onto '?', it is observed that all short vowels have, somehow, a link to the longer ones. The f_0 of the short vowels '?' and '?' are quite different from 'u' and 'a' respectively. However, the f_0 of '?' maps onto 'i' and '?' maps onto 'æ'. The f_0 of the vowels in the first syllable of ?ohr?t, b?h?t and beht?r map onto 'o', '?' and 'e' respectively. This observation leads to the conclusion that Urdu has seven long and seven short vowels corresponding to each long vowel.

'?' and the first syllable short vowels of ?ohr?t, b?h?t and beht?r are pronounced with their specific articulation. If other vowels are inserted in their place, they become non-words and funny to listen to. Therefore there is phonological difference along with phonetic. This is the reason why ??h?r cannot be pronounced as ??hr or ?æhr. This pronunciation loses the meaning of the word and it does not belong to the language anymore. It is clear that we need short vowels corresponding to e, o, ? and æ. Hence, they can be different phonologically. However stronger proofs and further research is needed.

6. CONCLUSION

This work has investigated the vowel system of Urdu. The system established by Kachru (1987, table 3.1), Khan (1997, p.41), and Hussain (1997) has undergone some additions.

Kachru (1987, table 3.1) and Khan (1997, p.41) have used the vowel ? whereas Hussain (1997) considers the sound to be closer to vowel æ. The observations made lead to the conclusion that the vowels æ and ? both exist separately, with æ mapping on ?. The f0s for both the vowels are same, but the duration for æ is longer than ?. They have different characteristics both quantitatively and qualitatively. One of these corresponding, similar vowels is long and the other is short and hence fulfils the need of missing vowel.

The remaining three new short vowels are also included in the investigated vowel system. The vowel in ??h?t is mapped onto the vowel ? that in beht?r is mapped onto e and the vowel in ?ohr?t is mapped onto o. These three short vowels are established to overcome the shortage of vowels in the pre-established vowel system. They have durations even shorter than those of the already established short vowels. Moreover, they have the same f0s as those of the long vowels, which map onto them. But they have different values for F1, F2, and F3. This is a proof of their separate existence.

This proves the existence of vowels phonetically, but further work needs to be done to establish them phonologically, by finding a minimal pair for them in the lexicon. For the proof to them, word/non-word pairs are available (e.g. ??h?r vs. ??hr or ?æh), but at present word/word pairs have not been found. (minimal pairs are required for the newly established vowels only)

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APPENDIX

Phonetics

According to Ladefoged:

Phonetics is concerned with describing the speech sounds that occur in the languages of the world. What these sounds are, how they fall into patterns, how they change in different circumstances, and what aspects of sounds are necessary for conveying the meaning of what is being said.

Phonology

According to Ladefoged:

Phonology is the description of the systems and patterns of sounds that occur in a language. It involves studying a language to determine its distinctive sounds and to establish a set of rules that describe the set of changes that take place in these sounds hen they occur in different relationships with other sounds.

Phonemes

When two sounds can be used to differentiate words they are said to belong to different phonemes. There must be a phonetic difference if two words differ in only a single sound (Ladefoged, 1993).

Allophones

The variants of the phonemes that occur in detailed phonetic transcriptions are known as allophones. They are generated as a result of applying the phonological rules to the segments in the underlying forms of words (Ladefoged, 1993).

Vowel Spread

The following figures (A.1 to A.14) show the spread of the formant frequencies of the vowels for all the speakers.

The spread of the formant frequencies of the six rounded vowels range from around 280 to 800 for f_1 and from around 850 to 1250 for f_2. The spread of vowels ranges from 250 to 750 for f_1 and from 1650 to 3000 for f_2. The average values of these formant frequencies for males and females are shown in Table 3 and Table 4.

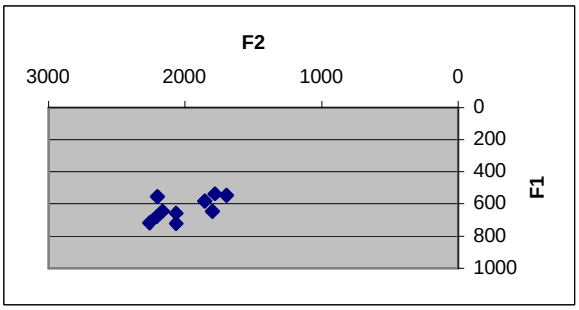

Figure A.1 Spread of the Formant Frequencies for æ

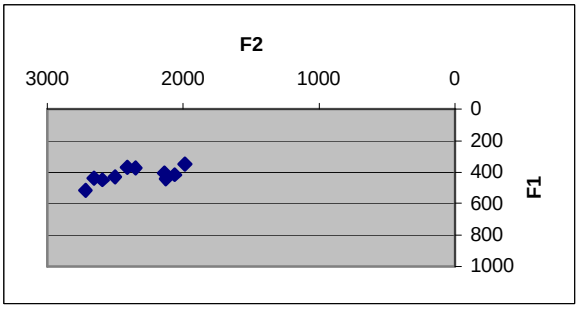

Figure A.2 Spread of the Formant Frequencies for e

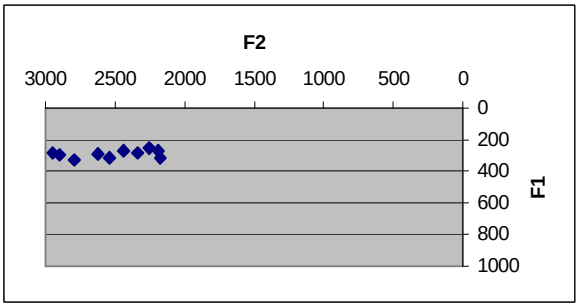

Figure A.3 Spread of the Formant Frequencies for i

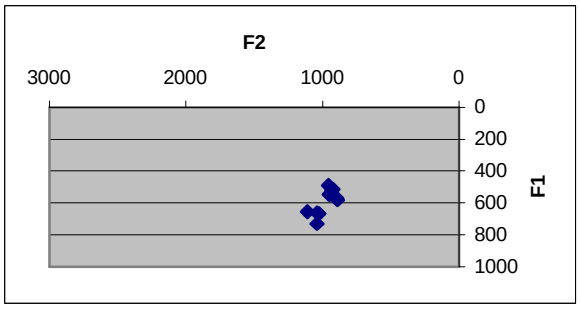

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Figure A.4 Spread of the Formant Frequencies for ?

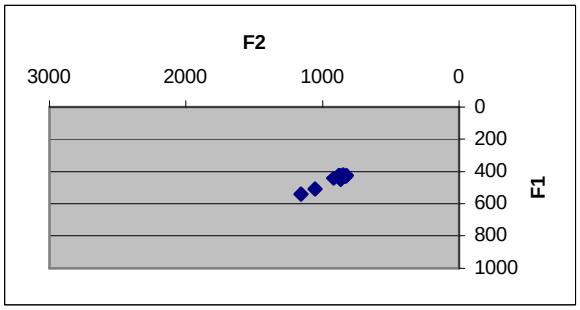

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Figure A.5 Spread of the Formant Frequencies for o

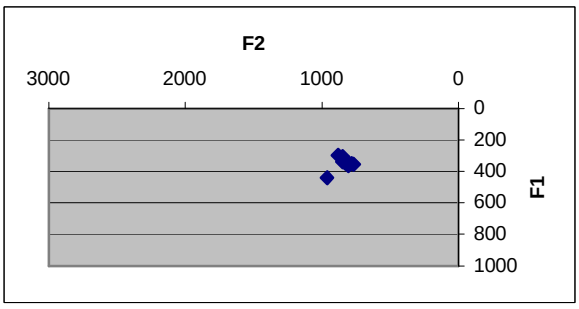

Figure A.6 Spread of the Formant Frequencies for u

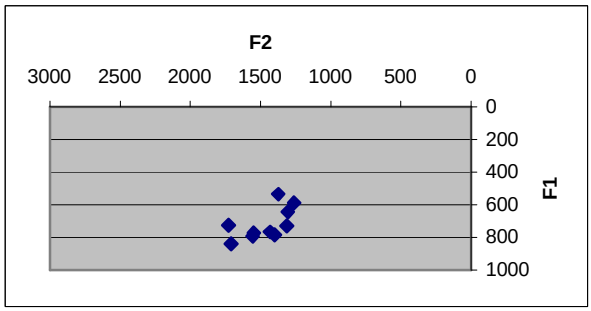

Figure A.7 Spread of the Formant Frequencies for ?

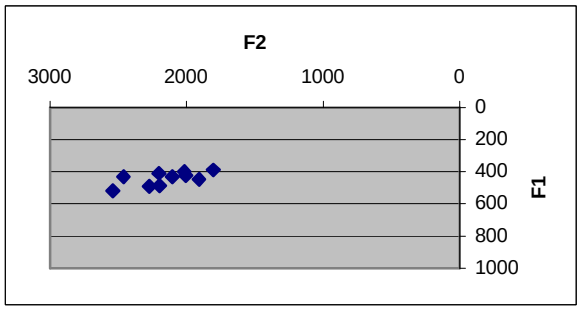

Figure A.8 Spread of the Formant Frequencies for ?

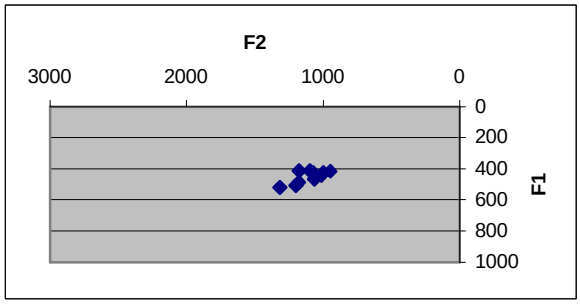

Figure A.9 Spread of the Formant Frequencies for ?

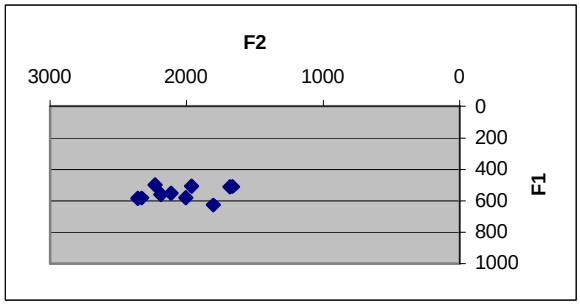

Figure A.10 Spread of the Formant Frequencies for ?

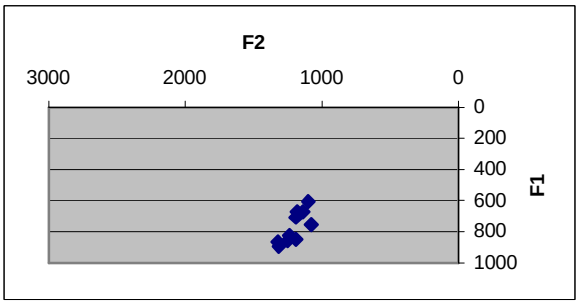

Figure A.11 Spread of the Formant Frequencies for a

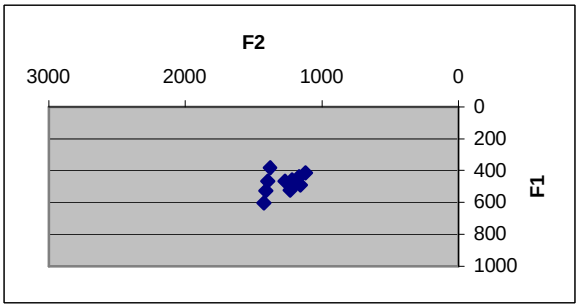

Figure A.12 Spread of the Formant Frequencies for ?ohr?t

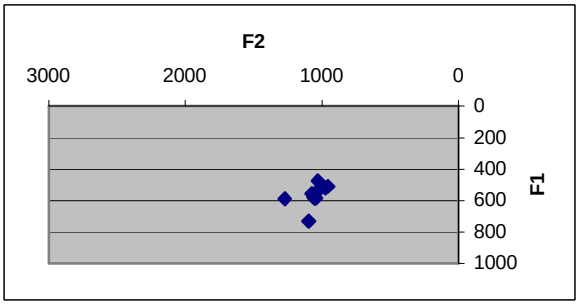

Figure A.13 Spread of the Formant Frequencies for b?h?t

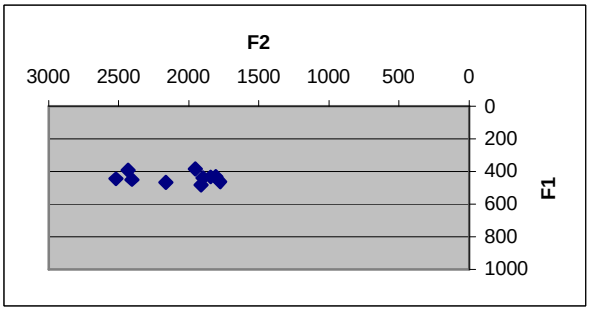

Figure A.14 Spread of the Formant Frequencies for beht?r