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ACOUSTIC DIFFERENCES BETWEEN THE
PORTUGUESE VOWELS OF NATIVE AND NON-NATIVE SPEAKERS

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The purpose of this study is to see what problems a native speaker of English might have in producing portuguese vowels. More specifically it is to compare the open and closed vowels of non-native speakers of Portuguese with those of native speakers. A brief review of the vowel sounds in Portuguese and in English may help to introduce this study.

Portuguese has seven vowel phonemes in tonic position. They are /i/, /e/, /ɛ/, /a/, /ɔ/, /o/, and /u/. The schwa /ə/ is also found in atonic position. English has eleven vowel phonemes. They are /i/, /I/, /e/, /ɛ/, /a/, /æ/, /ə/, /ɔ/, /o/, /ʊ/, and /u/. Table 1 displays these vowels on a chart to make them easier to read.

Portuguese			English				
	Front	Central	Back		Front	Central	Back
High	i		u	High	i(Ii)		u(Uu)
Mid	e ɛ	ə	ɔ o	Mid	e(ei) ɛ	ə	ɔ o(ou)
Low		a		Low	æ	a	

Table 1

Notice that the English vowels /i/, /e/, /o/, and /u/ are accompanied by [Ii], [ei], [ou], and [Uu]. This is because tense vowels are usually pronounced as diphthongs. This study will compare the Portuguese open /ɛ/ with the closed /e/ and the open /ɔ/ with the closed /o/. All four of these vowel sounds are found in English. They are, however, a little different. In English the open /ɛ/ is like the vowel sound in the word "bet". The closed /e/ is usually diphthongized as in the word "pay". The open /ɔ/ in English is only found in certain dialects. Some English speakers say the word "caught" with an open /ɔ/. The closed /o/ is also usually produced as a diphthong as in the word "bout". I will refer to these different vowel sounds as open and closed, although some call them tense and lax.

In Portuguese the open /ɛ/ can be heard in words like "céu" (heaven) which is phonetically transcribed as [séu]. An example of the closed /e/ is "seu" (your), phonetically transcribed as [séu] and which is a minimal pair with "céu" (heaven). In Portuguese the open vowels are only found in tonic position. Generally Portuguese words have stress on the second to last syllable unless otherwise marked with an accent. Those words that do carry an accent mark, have a circumflex accent for a closed vowel and an acute accent for the open vowels. For example, the open /ɔ/ in the word for grandmother is written with an acute accent, "avó" phonetically written as [avó]. The word for grandpa is written with a circumflex accent because it is pronounced with a closed /o/,

"avo" or [avó]. Words that do not carry a written accent do not give any clue as to their pronunciation.

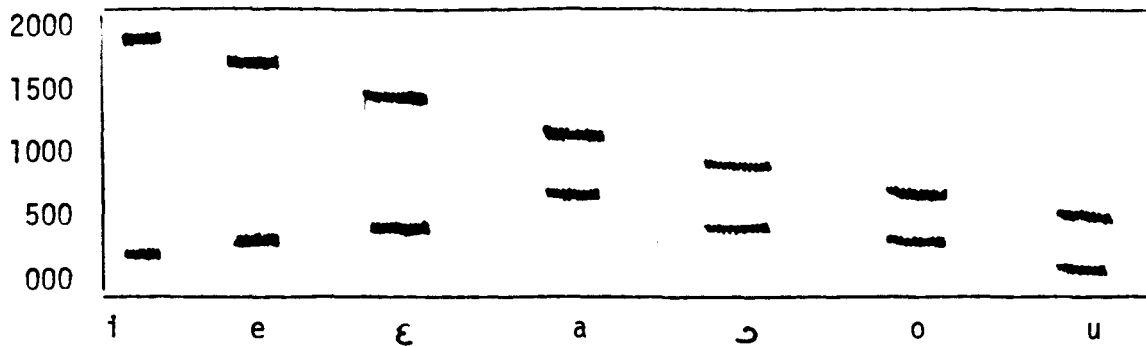
There are certain tendencies that might give a person an idea of how to pronounce a word. For example, "compra" (he buys): In this word the "o" is in the accented second to last syllable, but there is no accent mark to tell us if we should say /ɔ/ or /o/, however, because the "o" is followed by a nasal consonant the "o" will be closed, [komprɔ̃]. Another indication that sometimes helps is the spelling. Words that end in "osa" are almost always open. For example, the adjective "maravilhoso" (marvelous) has a closed /o/, phonetically [maraviʎózu]. The feminine form of marvelous, "maravilhosa" ends in "osa" and has an open /ɔ/, [maraviʎosa]. Of course there are exceptions to these tendencies. For example, "esposa" (wife) ends in "osa", but is pronounced with a closed /o/. Even though there are exceptions, by knowing about the written accent marks and the pronunciation tendencies a non-native speaker of Portuguese will be more prepared to open and close his vowels correctly.

To see if non-native speakers of Portuguese produce the same vowel sounds as do native speakers, an acoustic comparison was made with a sonagraph. A sonagraph is a machine that measures the frequencies and intensities of sounds and then graphically displays them on a piece of paper called a sonagram. On a sonagram at certain frequencies, darker areas are burned into the paper. These darker areas on the sonagram are called formants. These formants show the frequency or the pitch of the sound being measured with the sonagraph. Other formants appear on the sonagram also. The other formants are multiples of the main frequency and are called harmonics. Measuring the frequencies of the formants shows how open and closed the vowel is. For example, /i/ is a very high vowel and therefore, is very closed. /a/ is a low vowel and is, therefore, very open. On a sonagram the more closed a vowel is, the lower the frequency of the first formant. The first formant of /i/ will be lower than the first formant of /a/.

Second, measuring the frequency of the second formant shows a vowel's location front-back. For example, /i/ is a front vowel, and therefore, has a second formant with a high frequency. /u/ is a back vowel and has a second formant with a low frequency. Perhaps a diagram would help to show this distinction. Figure 1 shows what an ideal sonagram of the Portuguese vowels would look like. The numbers going up the left margin represent the frequencies of the formants.

In this study, sonagrams were made of ten native Brazilians who are students at Brigham Young University. Sonagrams were also made of thirteen Portuguese speaking Americans, also students at Brigham Young University. All of the Americans had lived in either Portugal or Brazil for at least fifteen months with an average stay of twenty months. All the Americans speak at what would be considered a level three of an F.S.I. test. All the native Brazilians had previously been taped, reading a list of nearly four hundred words for a study about vowel differences in tonic, pretonic and postonic position. This study was done by Willis Falls and Halvor Clegg of the Spanish and Portuguese Department at Brigham Young University. The non-native speakers of Portuguese in my study read a smaller version of the same list of words.

Fig. 1



Since the purpose of this study is to compare the open and closed "e" and "o", the following words were chosen for comparison. See Table 2:

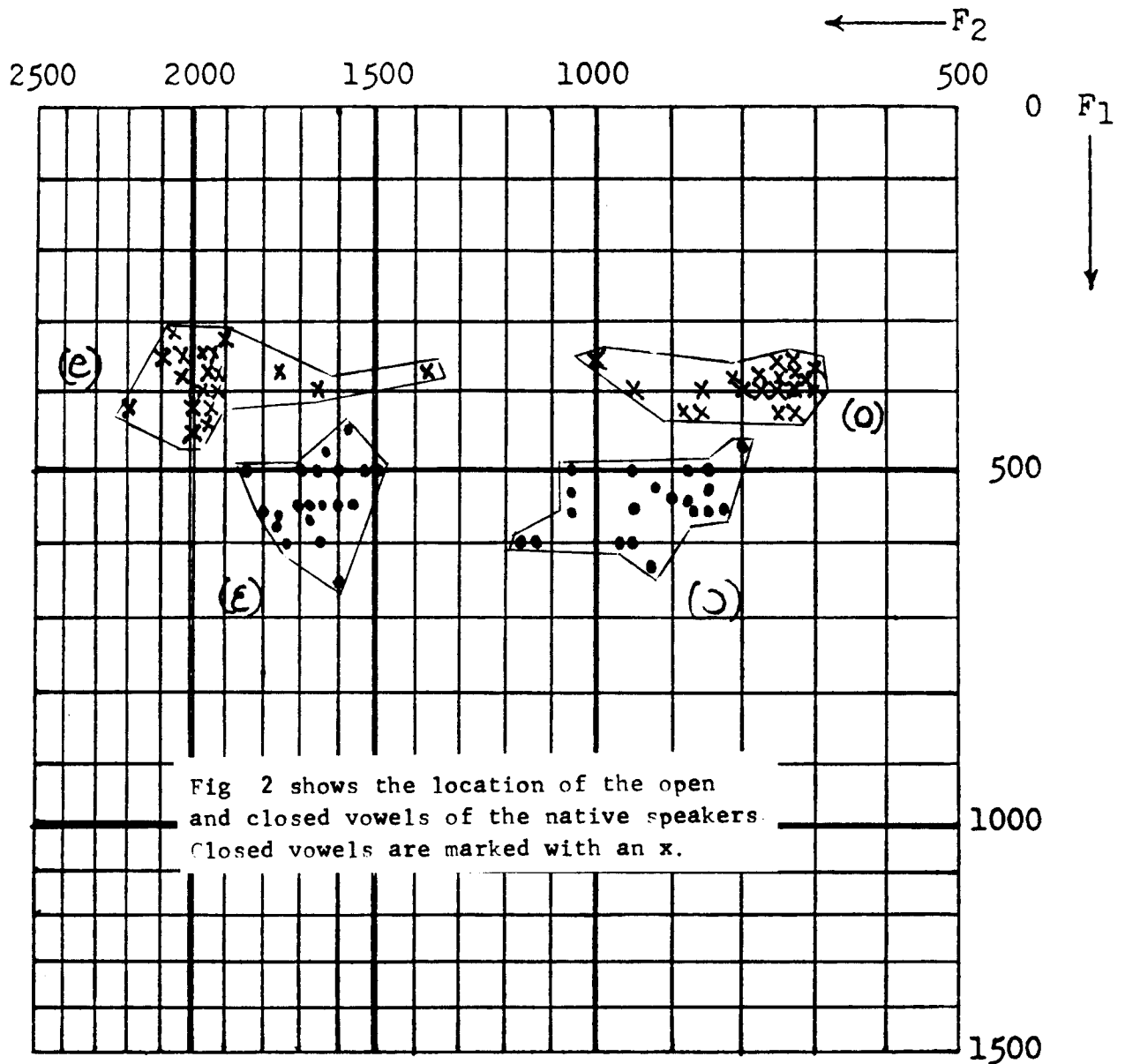
	open syll.	closed syll.
closed e	cedo (early)	deste (of this)
open e	breve (soon)	festa (party)
closed o	bobo (silly)	posto (put)
open o	pobre (poor)	costa (back)

Table 2

Each sound was represented in an open and in a closed syllable. The frequencies of the formants of the "e" in "cedo" (early) and "deste" (of this) were measured to give the location of the closed /e/. The formants of the "e" in "breve" (soon) and "festa" (party) were measured to show the place of articulation of the open /ε/. The first "o" of "bobo" (silly) and "posto" (put) was measured to locate the closed /o/. Finally the frequency of the "o" in "pobre" (poor) and "costa" (back) provided the location of the open /ɔ/. After the frequencies of these vowels were measured they were plotted on a Koenig-Scale on a scatter diagram. On a Koenig-Scale the first formant is plotted on the sheet top to bottom in order to show how open the vowel is and the second formant is plotted left to right to show how front or back the vowel is. Figure 2 shows the frequencies of the vowel formants of the native speakers of Portuguese. Both the open and closed syllables are plotted together because there really was not much of a difference. Notice the well defined areas of each vowel sound. Appendix 1, included at the end, gives the statistical information of all the formants of each of the words of the native speakers.

The frequencies of the vowel formants of the non-native speakers were also plotted on Koenig-Scale in a scatter diagram. Figure 3 shows the location of the vowels of the non-native speakers. The closed vowels are marked with x and the open vowels are marked by circles. With the non-native speakers we no longer see well defined areas of open and

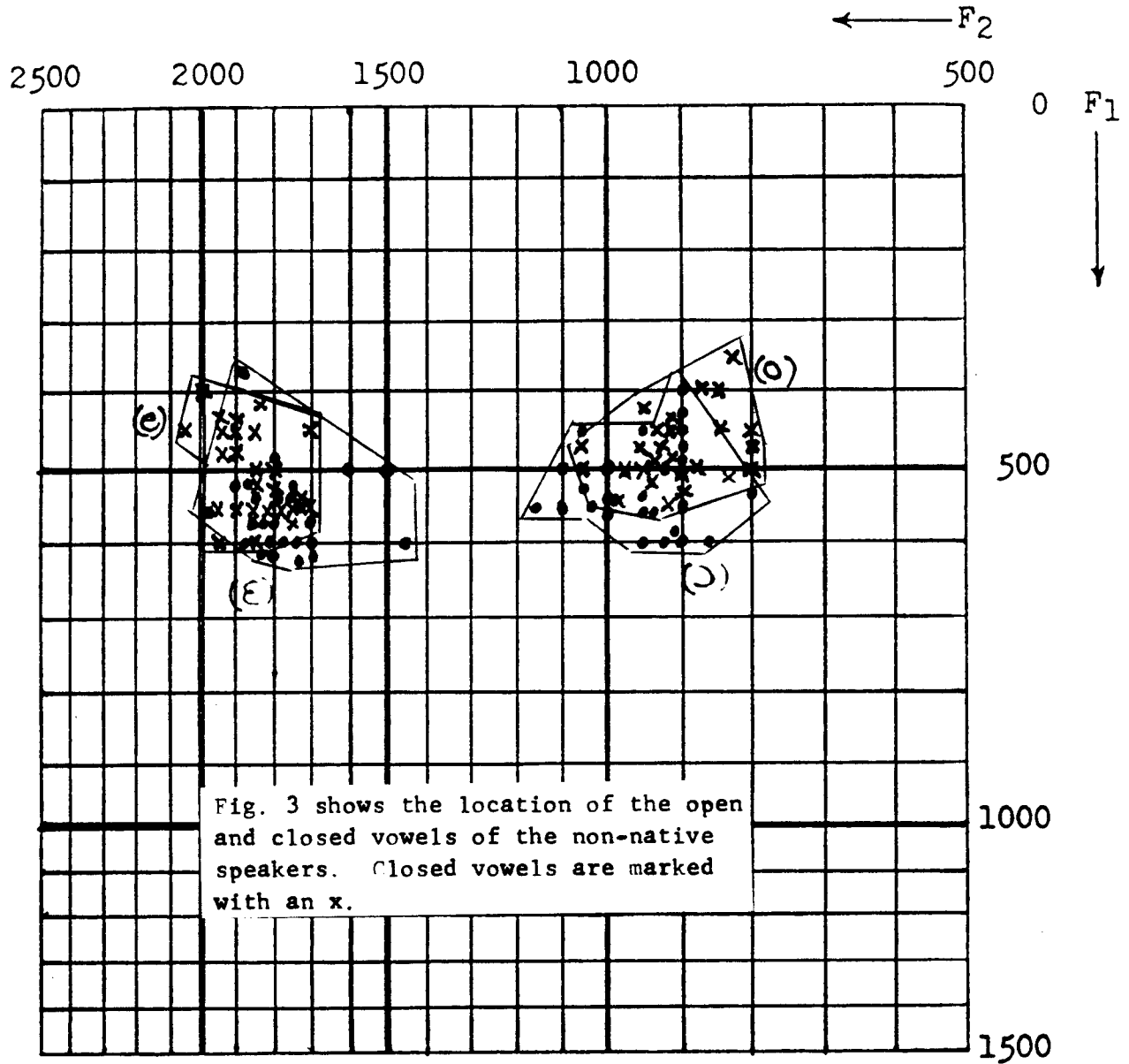
Fig. 2



closed vowels. Instead we see that the location of articulation has merged. What figure 3 shows us is that the non-native speakers are pronouncing the open and closed vowels in the same way. They are not distinguishing between the two. The non-native speakers pronounce the "e" in *cedo* and the "e" in *festa* the very same. Appendix 2, gives the statistical information for all of the formants of the non-native speakers.

After the scatter diagrams were made an average location of the vowel formant was determined. Table 3 gives the average frequencies for each

Fig. 3



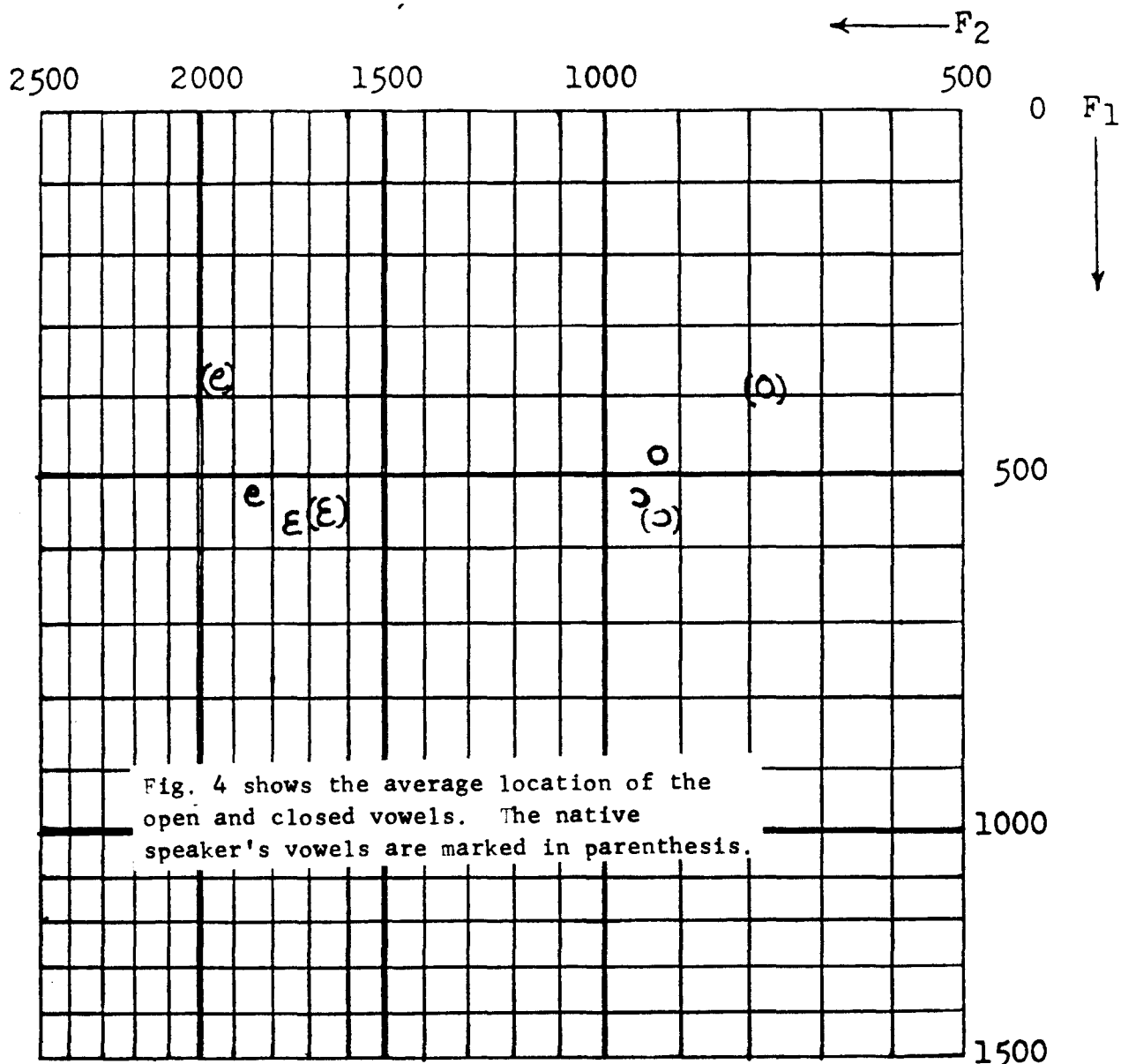
	1 st F.	2 nd F.		1 st F.	2 nd F.
non-native e	502	1854	non-native o	473	901
native e	383	1936	native o	399	780
non-native ɛ	554	1763	non-native ɔ	523	960
native ɛ	539	1659	native ɔ	545	939

Table 3

of the vowels.

The first formants of the open vowels for both the native speaker, as well as, the non-native speaker are pretty much the same. The first formants of the open vowels, however, show a major differences from native speaker to non-native speaker. With both the closed /e/ and the closed /o/ the native speaker produced a sound that is much more closed. The non-native speaker produced closed vowels that have first formants almost equal to those of the open vowels. What this all says is that the non-native speaker produces the closed vowels like open ones. Graphically this distinction is easily seen in Figure 4. The vowels of the native speakers are found in parenthesis. Notice the distance between the open and closed vowels of the native speaker as compared to how close the open and closed vowels of the non-native speakers are.

Fig. 4



Considering that all the non-native speakers are at least at a level three F.S.I. proficiency in Portuguese, the data presented is significant. The subjects were not beginning first semester language students. If these subjects have difficulty in pronouncing the open and closed vowels, it is safe to predict that almost all non-native speakers of Portuguese will need to exert extra care in producing these vowel sounds. Besides showing the differences of the Portuguese vowels between native and non-native speakers, this study also shows the value of acoustic comparisons. The sonagram can easily show what is really being produced when just listening produces results that can not be measured.

References

Fails, Willis C. and Halvor Clegg. "Acoustic Overview of Portuguese Vowels." Paper presented at the Deseret Language and Linguistics 5th Annual Symposium. 1984.

Appendix 1
Statistical information of the native Portuguese speakers

Sub.	cedo	deste	breve	festa	pobre	costa	bobo	posto
1	350-1775	375-1350	550-1675	600-1725	525-900	625-925	400-725	400-775
2	375-1950	350-1975	550-1600	550-1675	500-850	550-850	425-725	375-700
3	350-1950	350-2025	500-1600	500-1525	550-825	550-950	400-800	400-700
4	400-1650	325-1900	550-1650	500-1650	550-880	550-875	400-700	400-800
5	425-1850	350-2100	500-1850	500-1650	525-850	500-875	400-700	400-750
6	425-2200	425-1950	475-1625	650-1600	475-800	600-950	425-725	400-725
7	----	375-2025	550-1700	550-1700	600-1175	500-950	400-775	375-750
8	450-2000	400-1975	500-1500	500-1700	500-1050	525-1025	425-850	425-875
9	425-1975	375-1925	450-1575	550-1575	525-925	550-1050	375-725	400-950
10	400-1950	325-2075	575-1750	575-1750	600-950	600-1150	400-850	350-1000
ave	400-1939	365-1933	520-1663	555-1655	535-918	555-960	405-758	393-803

Appendix 1 shows the first and second formants of each of the words tested. "Cedo" and "deste", as well as, "bobo" and "posto" are closed. "Festa" and "breve", as well as, "costa" and "pobre" are open.

Appendix 2
Statistical information of the native English speakers

Sub.	Brazil	Home	cedo	deste	breve	festa	pobre	costa	bobo	posto
1	14mths	8mths	400-2000	450-2080	500-1600	550-1850	600-900	525-800	500-900	450-800
2	22mths	2½yrs	500-1850	500-1850	550-1800	600-1775	525-950	550-1000	500-950	500-975
3	16mths	1mth	550-1750	550-1900	550-1650	600-1800	450-1050	500-1100	450-900	475-1050
4	15mths	10mths	500-1800	600-1950	600-1750	600-1850	450-900	450-950	475-800	475-950
5	18mths	5yrs	450-1900	450-1850	500-1850	350-1900	450-900	400-900	400-850	425-950
6	21mths	9mths	550-1750	500-1850	500-1800	625-1750	450-900	550-950	450-900	475-925
7	31mths	12mths	550-1775	600-1850	575-1800	550-1700	550-1100	525-1050	500-800	500-1050
8	23mths	15mths	475-1900	450-1900	600-1700	550-1850	600-875	600-950	450-850	450-925
9	25mths	18mths	550-1700	550-1800	600-1800	600-1800	550-950	550-1150	500-900	525-900
10	24mths	16mths	550-1725	550-1850	550-1750	600-1700	500-925	500-1000	475-950	550-925
11	22mths	15mths	450-1900	550-1950	525-1900	550-1975	600-900	600-925	500-850	500-800
12	22mths	16mths	450-1700	475-1925	525-1750	550-1800	475-900	550-1000	500-875	525-950
13	18mths	5yrs	450-1975	400-1800	500-1500	600-1450	550-900	550-1025	400-875	350-825
ave	20mths	14mths	494-1825	510-1883	544-1742	564-1785	519-935	527-985	469-876	476-925

Appendix 2 shows how long each subject was in Brazil or Portugal and how long it has been since he returned. The first and second formants of each of the vowels tested are also given. "Cedo" and "deste" have closed "e", "breve" and "festa" have open "e". "Pobre" and "costa" have open "o" and "bobo" and "posto" have closed "o".