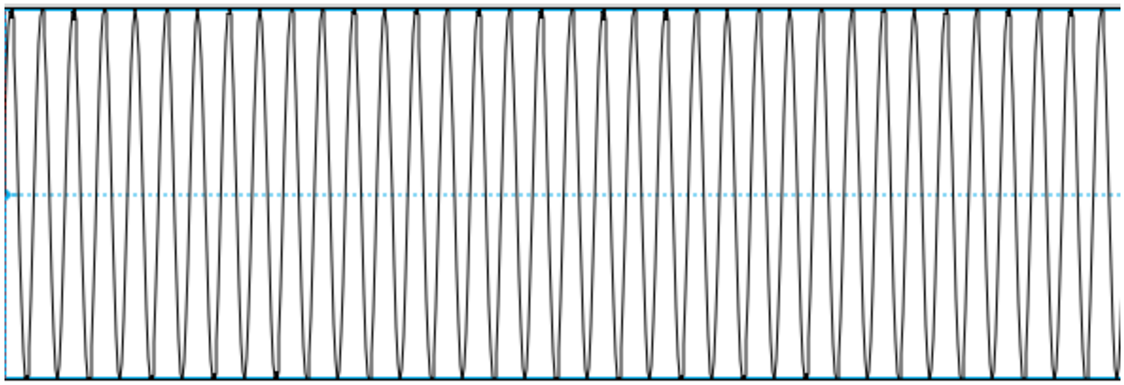
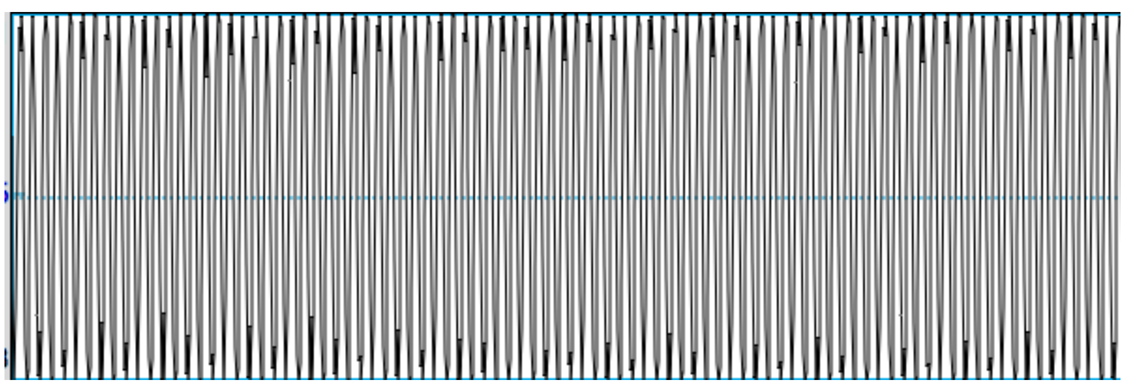
Chapter 9

9.1 Tone b has a higher pitch than tone a. Tone b should therefore have a higher frequency.

9.2 Tone b has a waveform that repeats more often. The frequency of tone b is more than double that of tone a. The images that you came up with in *Praat* should look like those below.



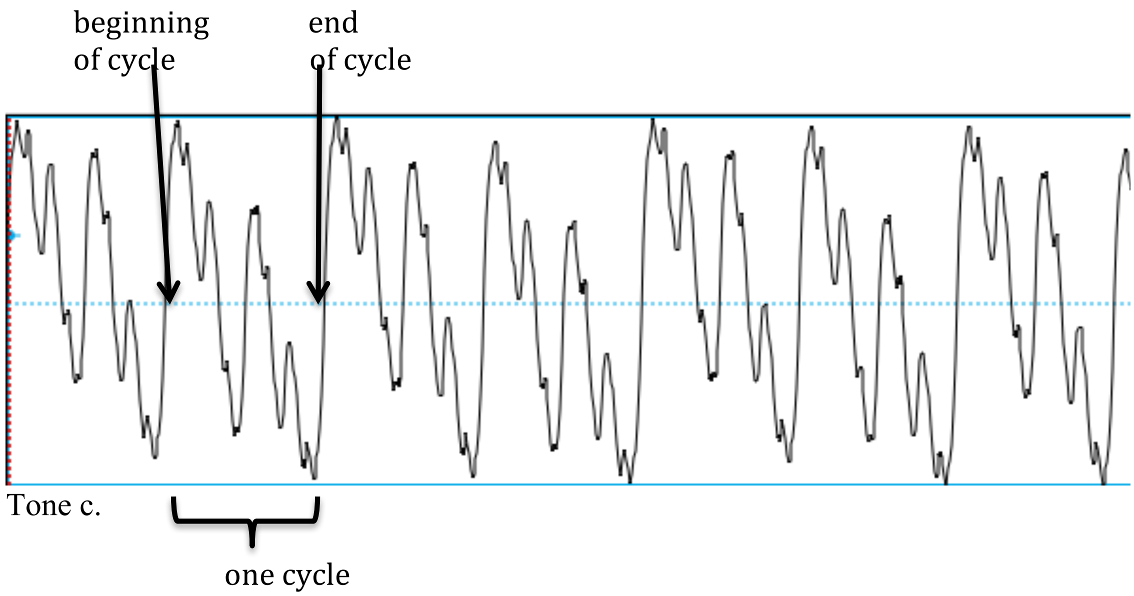
Tone a.



Tone b.

> You are not expected to be able to compute the differences in frequency, but it might be interesting for you to know that tone a has a frequency of 400 Hz, and tone b has a frequency of 1000 Hz.

9.3. The Shepard tone is not a pure tone. Instead, it sounds more complex. It is made up of a set of tones at frequencies that are always an octave apart and that increase (or decrease) slowly in frequency. (You will note an auditory illusion of the pitch of this Shepard tone seeming to ascend as it is played.) The overall frequency of tone c is lower than that of both tones a and b. You can tell this by looking at the beginning and end of one cycle, that is, one complete repetition of the waveform. There are fewer cycles per unit of time than with tones a and b. One cycle has been highlighted below. When you zoom in on the tone, you end up with something like what you see below. In this figure you can see the complexity in the tone in the jagged nature of the waveform.



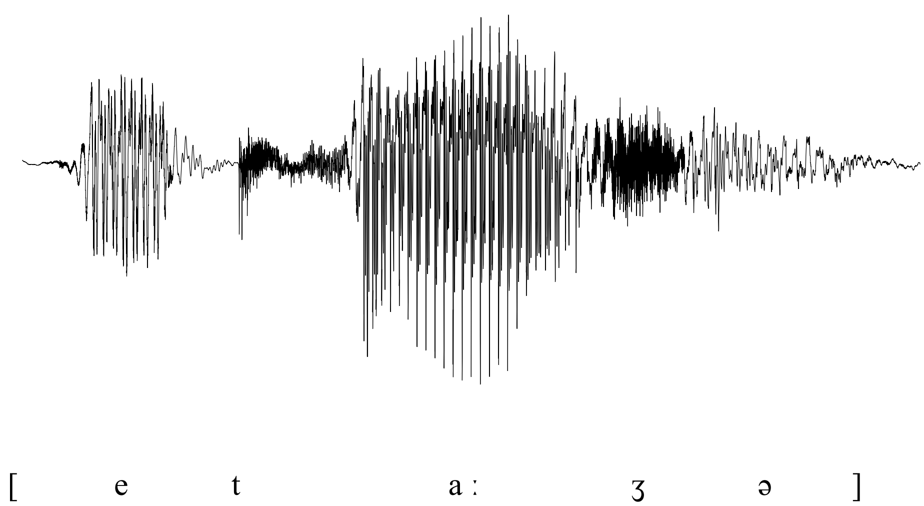
Tone c.

9.4. [etaːʒə]: [t] is a plosive, [ʒ] is a fricative

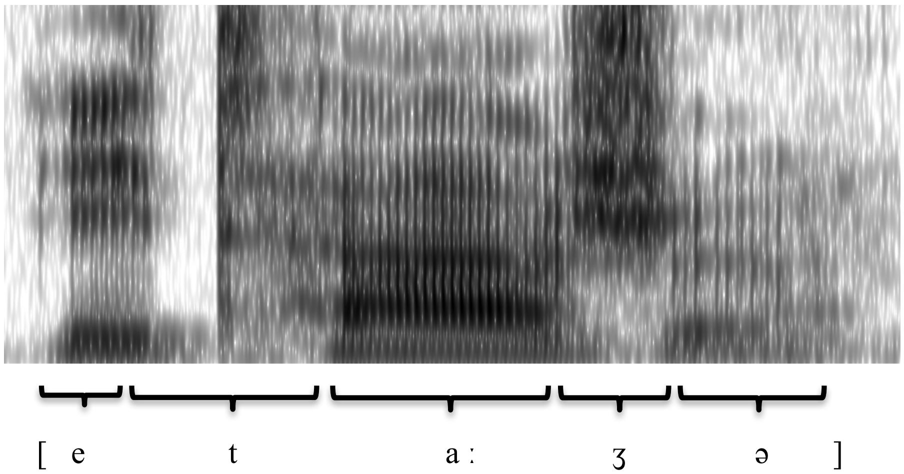
Based on what we know about theses consonants and the vowels, we can expect the following:

- the presence of waves: we expect to see waves everywhere except on the stop portion of the plosive [t]. This is followed by a stop burst.
- the regularity of the waves: the wave cycles should repeat more or less regularly for the vowels. For the fricative [ʒ], we can expect to see waveforms that vary a great deal across the duration of the consonant. We might expect to see a release burst in the [t], but otherwise we should expect to see very little in terms of waveform movement in the stop portion of the [t].
- the amplitude of the waves: the amplitude is highest for the vowel [aː], as this is the loudest sound. The amplitude for the vowels [e] and [ə] are also relatively high (although [ə] is not a very loud vowel) and regular. There are irregular, noisy waves for the fricative [ʒ].

You can see all of this in the waveform below.



9.5.
Below you will find the spectrogram. Each of the segments is labeled. You will note that the time matches up with that of the waveform in 9.4.



If you are having difficulty measuring the formant values, make sure to click on *Formant* → *Show formants* in *Praat.*

9.6. The approximate F_1 values are provided in table 9.1.
The low vowel [aː] has the highest F_1 values of all of the vowels. This indicates that it is produced lowest in the mouth for both the male and the female speaker.
The male's formant values are lower. This is due to the typically longer length of a male's vocal tract and heavier vocal folds, to name just two reasons.

9.7. The approximate F_2 values are provided in table 9.1.
The back vowels [uː] and [oː] have the lowest F_2 values. The values for [aː] are in between those of the front and the back vowels, and the F_2 values for the front vowels are highest. Once again, the male's F_2 values are lower.

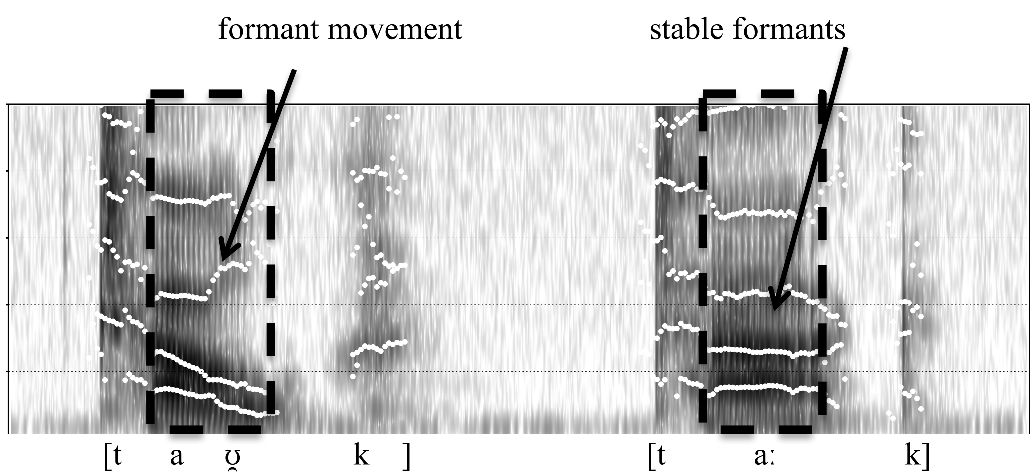
9.8. If we compare the F_2 values for [iː] and [yː] we see that they are lower for the front, rounded vowel [yː]. The same generalization holds true when we compare the F_2 values for [eː] and [øː]. They are lower for the front, rounded vowel [øː] than they are for its unrounded counterpart [eː].

vowel	formant	female	male
[aː]	F_1	950 Hz	680 Hz
[baːtə]	F_2	1500 Hz	1250 Hz
[eː]	F_1	400 Hz	300 Hz
[beːtə]	F_2	2500 Hz	2225 Hz
[øː]	F_1	415 Hz	325 Hz
[bøːtə]	F_2	1850 Hz	1450 Hz
[iː]	F_1	275 Hz	250 Hz
[biːtə]	F_2	2750 Hz	2200 Hz
[yː]	F_1	310 Hz	250 Hz
[byːtə]	F_2	1800 Hz	1625 Hz
[uː]	F_1	370 Hz	275 Hz
[buːtə]	F_2	850 Hz	640 Hz
[oː]	F_1	375 Hz	320 Hz
[boːtə]	F_2	800 Hz	700 Hz

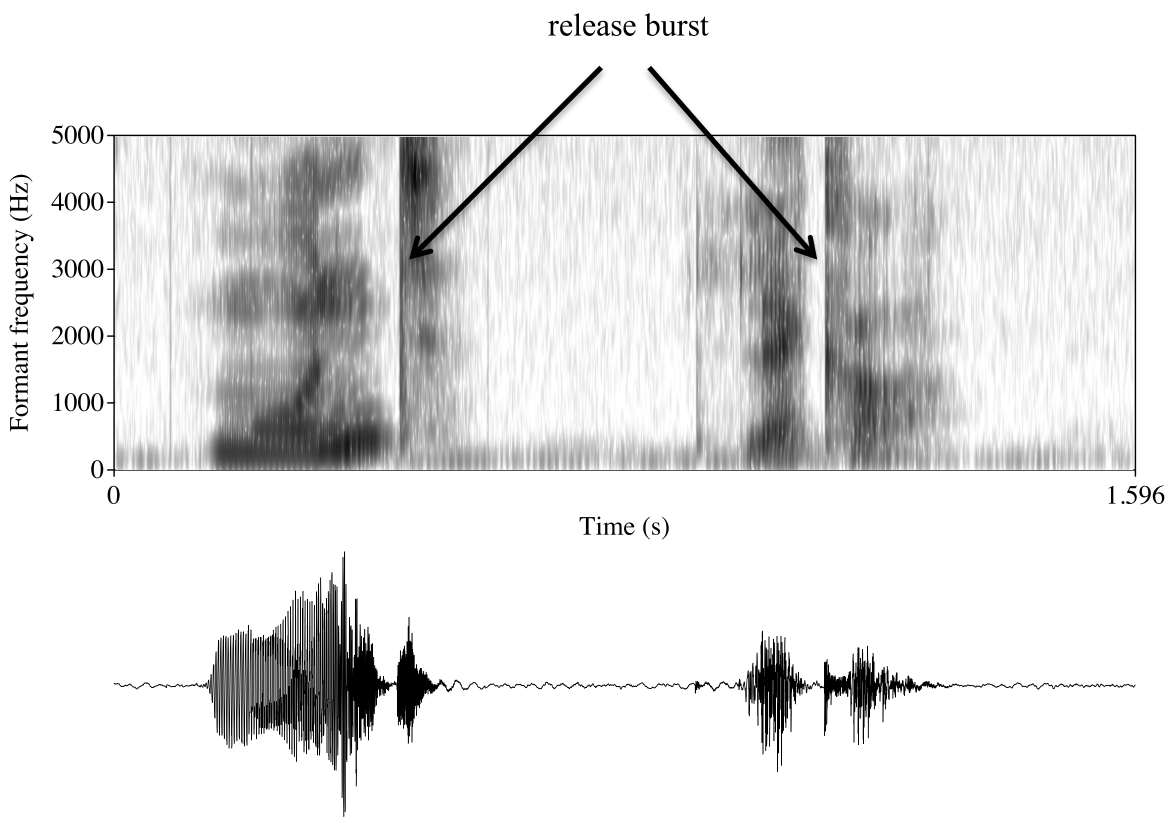
Table 9.1 German vowel formant values.

9.9.

Simply by viewing the spectrogram, we can determine that the first word contains a diphthong, and the second word contains a monophthong. If you are unsure about this, zoom in to the vowel in both words. These have been highlighted via the boxes in the spectrogram below. The white dots highlight the formants. You can see formant movement within the vowel in the first word and relative stability in the formant structure in the second word.

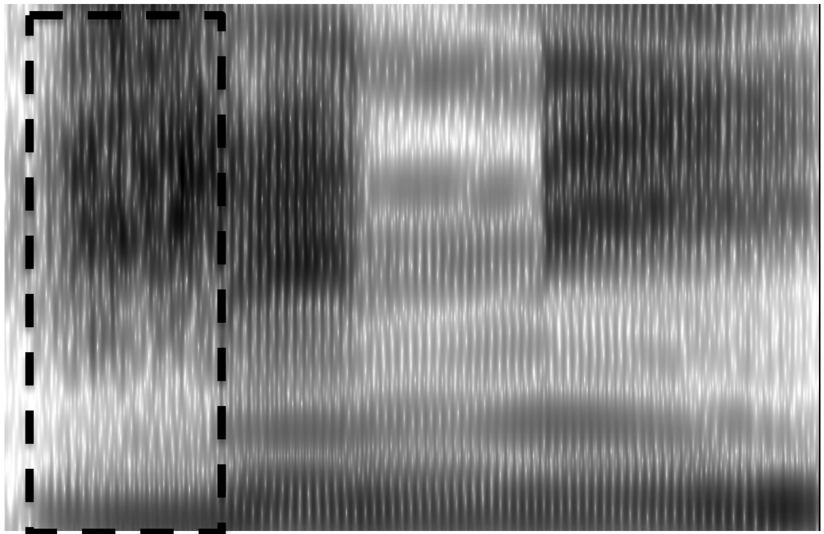


9.10. The waveform and spectrogram for both words, <Mund> [mʊnt] and <lecker> [lɛkɐ], are provided below. The release burst is marked for you in the spectrograms, where it is clearest.

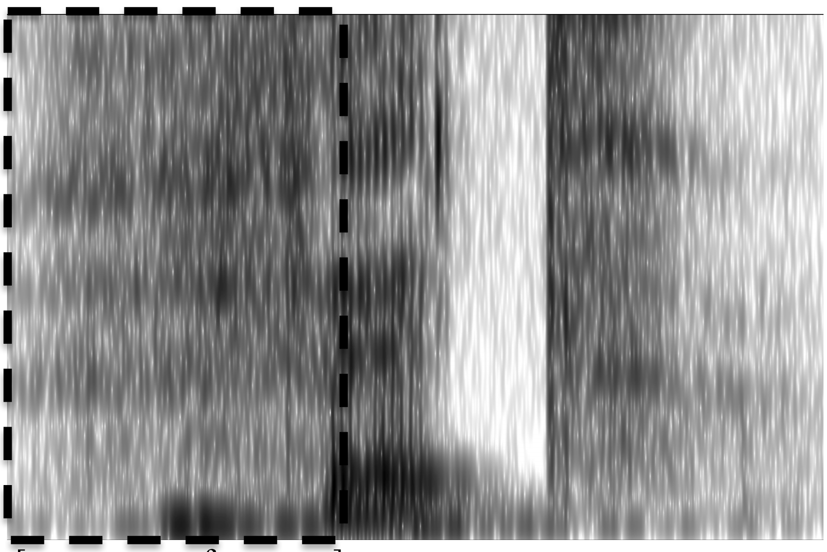


9.11. The speech sample contains the following words:

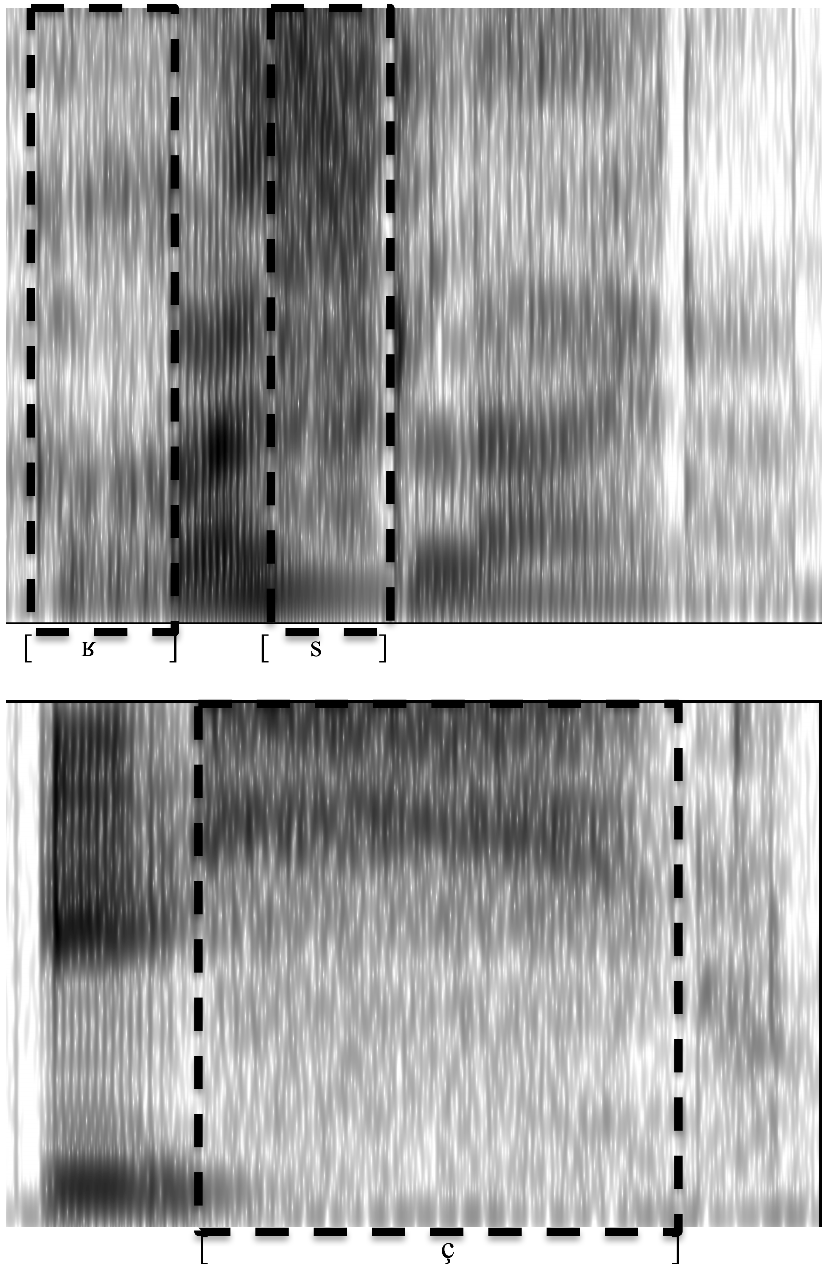
orthography	phonetic transcription	fricative
<Genie>	[ʒeniː]	[ʒ]
<Fett>	[fɛt]	[f]
<Rösslein>	[ʁœslai̯n]	[ʁ], [s]
<ich>	[ɪç]	[ç]
<Schule>	[ʃuːlə]	[ʃ]

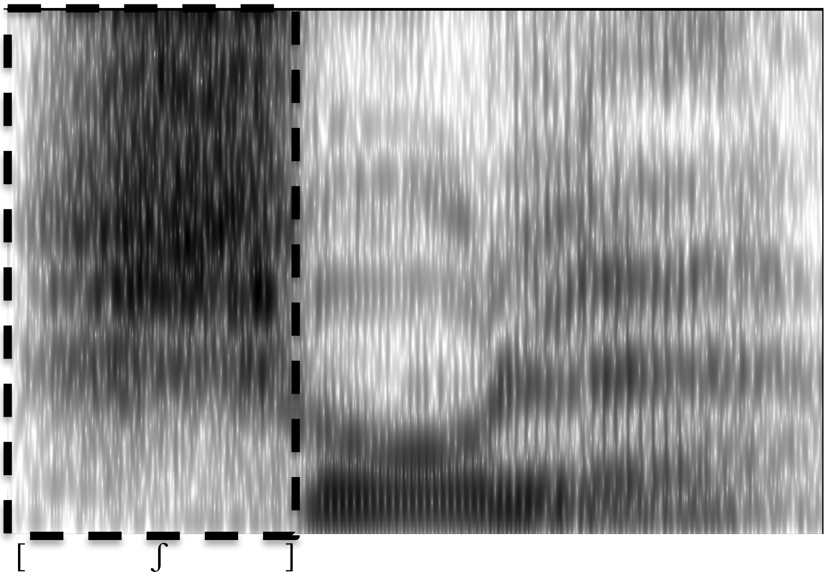


[ʒ]



[f]


[ʁ]
[s]
[ç]



9.12. The pairs are as follows:
<dick> [dɪk] <dich> [dɪç]
<back> [bak] <Bach> [bax]

The first word in both pairs ends with the plosive [k]. We can see evidence of this in the release burst that is present. The second word in both pairs contains a fricative, and we see evidence of this in the fricative noise in both.