

**Lab Assignment #06****The phonetics of German vowels**

Due F Sept 23 at 3:00pm on Sakai ([Assignments](#))  
50 points total

**Purpose**

This assignment provides an opportunity to apply and develop:

**A. Phonetics knowledge**

- Use the multiple-tube model or perturbation theory to make predictions about vowel formants beyond [i a u]
- Relate vowel articulations to formant frequencies in a language with rounding contrasts

**B. Experiment and analysis skills**

- Propose hypotheses and test them with quantitative data
- Produce and interpret a data graphic
- Plot vowels in an F1 × F2 formant chart

**Task****A. Prepare to complete the lab assignment**

- **Download** the set of sound files in the folder “Lab #6--German words” (see the “[Lab assignments](#)” page for links) and save these sound files on your computer so that you can open them with Praat.
- Make concrete plans with your group partner(s) about how to divide up the work and about when and how to collaborate on the write-up.

**B. Write up your lab as a research report and upload it on Sakai**

- Follow the write-up format, and answer the questions, given below.
- Each partner group will submit **one** Lab #6 write-up on Sakai in [Assignments](#), “Lab 06 | The phonetics of German vowels.”
  - PDF files only (a single file is preferred, but the formant chart can be uploaded separately if necessary)
  - One submission per partner group
  - Resubmissions are allowed until the deadline
- *Collaboration and honor pledge:* You are welcome to discuss questions and ideas with anyone in the class, but lab **write-ups** must be done separately for each partner group. In your group’s write-up, please list the names of anyone outside your group that you have **collaborated** with.

## 1. How to approach this lab write-up

Treat your lab write-up as a (very small) research report. Write as though your audience is other linguists, not “your course instructor.” That is, don’t write for a reader who is looking at this assignment handout—make sure your write-up can be read and understood on its own.

In your write-up, include the following sections (1)–(3) (give them numbered section headings).

### 1. *Introduction and research questions*

- Start your write-up with a short paragraph of introduction. What is the purpose of the write-up — what research question(s) is it trying to answer, on the basis of what language?
  - Explain your research questions: What predictions does each model or factor make? Why?
  - Give a brief preview of your results or findings.
- Use this section to **set the stage** for what you’re actually going to discuss and report in your write-up. (Remember, your audience hasn’t read this handout!)

### 2. *Results*

- In this section, you will present your tables of vowel measurements and your formant chart (details below). You don’t need to include a lot of discussion here, but be sure to tell the reader what any tables of numbers or diagrams are from.
- When you give a table of measurements, pay attention to the **formatting** (is it easy to read? are there bad line breaks or bad page breaks?) and to how the information is **organized** (are you helping the reader see the important patterns by emphasizing key data and putting relevant items near each other?)

### 3. *Discussion*

- In this section, return to your research questions from section 1 of your write-up and evaluate them. Explain how the data you collected does — or does not! — answer each research question. Remember — while the formant chart is one good way to look at overall patterns, there may be information you have collected that is *not represented on the formant chart* but is also relevant to consider.
- Your discussion should include at least one **data graphic** (such as a bar chart or a scatterplot) as part of the discussion of **each** of your two research questions, allowing you to explicitly **compare and contrast relevant values** in making your argument.

## 2. What do to in this lab

German is a language with more vowel categories than the [i e a o u] you looked at in Lab #05. In this lab assignment, you will explore the phonetics of two aspects of the German vowel system: front vowels that contrast in **rounding**, and articulatorily similar vowels that contrast in **length**.

### 2.1. Research questions

**Research question #1:** German has both unrounded and round high front vowels. Choose one of the models of vowel formants that we discussed in class — the multiple-tubes model, or perturbation theory — and determine what predictions it makes about how the formants F1–F3 of a high front **round** vowel will differ from those of its **unrounded** counterpart. In section

1 of your write-up, **explain** what prediction the model makes and **why**. In section 3 of your write-up, use your measurement results to **evaluate** the predictions: is the model successful?

*Some hints for thinking about vowel articulation:*

- To translate the German vowel IPA symbols into articulatory descriptions, see the (modified) **IPA vowel chart** provided with the Lab #06 materials.
- A front round vowel has the **same** constriction(s) as the corresponding front unrounded vowel, plus an **additional constriction at the lips**.
- German has **two pairs** of high front vowels that differ in rounding; be sure to examine both.

*Some hints for thinking about the multiple-tube model:*

- *AAP*, p 131: “...there are a couple of articulations that alter the overall length of the vocal tract (lip protrusion [≈rounding — ʌs] and larynx lowering)...” — To consider: In a multiple-tube vowel system like that in *AAP* Fig. 6.3, which cavity or cavities would this lengthening affect?
- All high vowels have a Helmholtz resonator. *AAP*, p 135: “The natural resonant frequency of this Helmholtz resonator is determined by the relative volumes of air in the back cavity and in the constriction” — To consider: How would we expect the Helmholtz frequency to be affected by adding rounding to a high front vowel?

*Some hints for thinking about perturbation theory:*

- What vowel did we already examine that added rounding to another vowel constriction? What effect did rounding have in that case?

**Research question #2:** German has pairs of vowels with the same, or very similar, articulation that contrast in length: **long** (transcribed with the IPA length symbol [ː]) vs. **short**. How do long vowels differ phonetically from short vowels in German? In particular, **how much longer** is a long vowel than a short one, and is this pattern consistent across long/short vowel pairs? In section 1 of your write-up, include this research question. In section 3 of your write-up, use your actual measurement results to **answer** the question.

*Some hints for thinking about vowel length:*

- There is only one pair of vowels in the German data that contrasts *only* in length. However, there are multiple pairs of long and short vowels that differ in length and are *very similar* in their other properties. Include these pairs in your analysis.
- When comparing the length of two vowels, you can look at how much longer one is than the other by **subtracting** the durations. Or, you can compare the durations of the long and short vowels in terms of a **ratio or percentage**. Is either of these approaches more informative?

## 2.2. Investigating the phonetics of German vowels

The sound files used for this assignment are the words of German shown in the list below. In the chart, they are listed in alphabetical order by filename (because this is how you will find them on Sakai). However, in your write-up, you should **organize the words/vowels in a more linguistically relevant order**.

Here are the tables of measurements you should report in your write-up.

- *Table for individual word measurements*

Note that we are looking only at the **first vowel** in each word.

- (a) Give the **word** in question and its **vowel category** (=IPA symbol; see list below).
- (b) Give the **duration** of the vowel.
- (c) Use Praat's "List formants" function to get the **timepoint** and **F1, F2, F3** somewhere near the midpoint of the vowel on the spectrogram; report these values.

- *Table for vowel categories*

For each vowel **category** (=IPA symbol; see list below), report the average **duration** and average **F1, F2, F3** values for the words in that category. (There are usually two words per vowel category, although some vowels only have one word, in which case the "average" is the same as the individual value. Long ([V:]) and short ([V]) vowels are *different* categories.)

- *Formant chart*

Make an F1 by F2 plot using the average F1 and F2 values for each vowel **category**.

- If you make this plot **by hand** (or in a Paint program), download and use the [blank V&C vowel plotting chart](#) from the Lab assignments web page.
- If you make the chart in your spreadsheet software, remember to **put the low values in the top right corner**. You are also encouraged to plot F2 on a logarithmic scale, but if you can't make this work, a linear scale is acceptable.

Here is the list of German words by filename (continues on p 5):

<b>filename</b>	<b>word</b>	<b>gloss</b>	<b>vowel category</b>
<i>acht.wav</i>	acht	'eight'	[ a ]
<i>aehnlich.wav</i>	ähnlich	'similar'	[ ε: ]
<i>bruder.wav</i>	Bruder	'brother'	[ u: ]
<i>essen.wav</i>	essen	'to eat'	[ ε ]
<i>gaehnen.wav</i>	gähnen	'to yawn'	[ ε: ]
<i>hexe.wav</i>	Hexe	'witch'	[ ε ]
<i>igel.wav</i>	Igel	'hedgehog'	[ i: ]
<i>imbiss.wav</i>	Imbiss	'snack'	[ ɪ ]
<i>jeder.wav</i>	jeder	'each'	[ e: ]
<i>kuchen.wav</i>	Kuchen	'cake'	[ u: ]
<i>land.wav</i>	Land	'land'	[ a ]
<i>loewe.wav</i>	Löwe	'lion'	[ ø: ]

filename	word	gloss	vowel category
<i>muehle.wav</i>	Mühle	'mill'	[ y: ]
<i>mund.wav</i>	Mund	'mouth'	[ u ]
<i>muenze.wav</i>	Münze	'coin'	[ ʏ ]
<i>nicht.wav</i>	nicht	'not'	[ ɪ ]
<i>oder.wav</i>	oder	'or'	[ o: ]
<i>offen.wav</i>	offen	'open'	[ ɔ ]
<i>oesterreich.wav</i>	Österreich	'Austria'	[ œ ]
<i>ruecken.wav</i>	Rücken	'back' (n.)	[ ʏ ]
<i>schoen.wav</i>	schön	'pretty'	[ ø: ]
<i>sieben.wav</i>	sieben	'seven'	[ i: ]
<i>strasse.wav</i>	Straße	'street'	[ a: ]
<i>summen.wav</i>	summen	'to hum'	[ u ]
<i>ueber.wav</i>	über	'over'	[ y: ]
<i>vogel.wav</i>	Vogel	'bird'	[ o: ]

- Hint for working with these sound files in Praat: If you load all of them into the Praat 'Objects' window at once, you can highlight all, click `Combine > Concatenate recoverably`, and create a Sound with TextGrid that includes all the words at once. This may make it more convenient to get your measurements. (See Praat handout #4 on the course web site for more about TextGrids.)
- Note that a vowel that appears strangely placed on the formant chart may indicate a **formant-tracker error**. Have another look at the formants on the spectrogram, and use your ears to see if the placement of the vowel on the formant chart seems reasonable. If you have actually found a formant-tracker error, be sure to go back and adjust your table and your plotted chart with the corrected value.

### Criteria for success

This lab assignment is worth a total of 50 points. Grading criteria are provided in a separate grading rubric. All partners in the group will receive the same grade except in unusual circumstances.