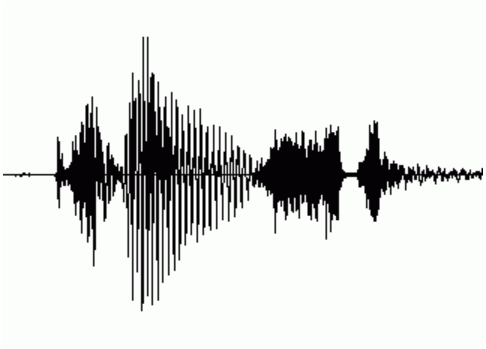
Speech Analyzer

Version 3.0

Student Manual

Contents

Introduction



Speech Analyzer is a computer program for acoustic analysis of speech sounds.

The goal of this training course is for you to be able to analyze audio data in Speech Analyzer quantitatively with accurate measurements and qualitatively using relevant graphs. In other words, the goal is competent use of Speech Analyzer as an instrument.

This course does not teach everything you can do in Speech Analyzer.

This course does not provide training in acoustic analysis. Training in acoustic phonetics, practice, and experience are essential to make the best use of graphs and measurements in Speech Analyzer. We encourage you to seek the assistance of an experienced linguist in interpreting pitch graphs, spectrograms, and spectra.

For information about acoustic phonetics in general, we recommend that you refer to:

Baart, Joan. 2001. *Acoustic Phonetics*. CD-ROM. In LinguaLinks 5.0. Dallas: SIL.

Johnson, Keith. 2003. *Acoustic and Auditory Phonetics*, 2nd edition. Cambridge, MA: Blackwell Publishing.

Ladefoged, Peter. 2001. *Vowels and Consonants*. Malden, MA: Blackwell Publishing.

Ladefoged, Peter. 2003. *Phonetic data analysis*. Malden, Massachusetts and Oxford, England: Blackwell Publishing.

How you will learn

You spend most of your time actually *practicing the skills* using realistic data—audio files that demonstrate common analysis tasks for field researchers.

Each training module teaches one or more learning objectives. The *learning objectives* are skills that most people need to be able to do. A brief introduction explains why the skills are important and when to use them. In each module, follow the numbered steps and check your work using the pictures and the tables of expected measurements. For more practice, do the exercises.

If you intend to teach the course or if you are a *self-paced* learner instead of a student in an instructor-lead course, first read about the course prerequisites and design in the Instructor Guide. Before you start each module in the Student Manual, read the module notes in the Instructor Guide.

To clean up your computer after you have finished the course, see page 65.

How the training course differs from analysis work

In the context of a training course, there are practical reasons for learning skills in a certain order. The way that you apply the skills when you analyze audio data might differ.

In the training course	When you analyze audio data
You will take measurements before you make visual comparisons.	You use quantitative or qualitative methods, or both, in the order that the situation requires.
You will invest most of your time taking measurements because that skill requires more practice to learn than displaying the graphs.	You might invest more time interpreting the graphs—applying knowledge and skill in acoustic phonetics.
You will take enough measurements to learn the skill.	You must take enough measurements to test a hypothesis, using statistical analysis if needed.

Opening course documents

The course includes this Student Manual and an Instructor Guide. To open a document (for example, this Student Manual), do either of the following:

On the **Help** menu of Speech Analyzer, point to **Training**, and then click **Student Manual**.

In Windows Explorer, double-click the SA Student Manual.doc file in the following folder*:

C:\Program Files\SIL\Speech Analyzer\Training

*By default, the SIL folder is installed in the Program Files folder on drive C.

Opening and saving audio files

You can open existing audio files (see page 7) or record utterances in Speech Analyzer, and then save them as audio files (see page 16).

The initial default folder in the **Open** and **Save As** dialog boxes is the Speech Analyzer folder.

On Windows 2000 and XP computers, it is in the My Documents folder.

On Windows Vista computers, it is in the Documents subfolder of your personal folder.

Therefore, each user on a computer initially has a personal folder for audio files.

If you store audio files on the hard disk of a computer for your individual use, we recommend that you organize the files in subfolders of the Speech Analyzer folder.

During the course, make sure to select the correct folder when you save or open a file:

If you do Module RS, you save audio files in the Speech Analyzer folder. In some exercises of other modules, you open the audio files that you recorded and saved.

In all of the other modules, you open audio files in the Samples subfolder of the Speech Analyzer folder.

Changes to audio files and folders in Speech Analyzer 3.0

Speech Analyzer now stores transcription and annotation data in a file with a .saxml extension in the same folder as the audio file.

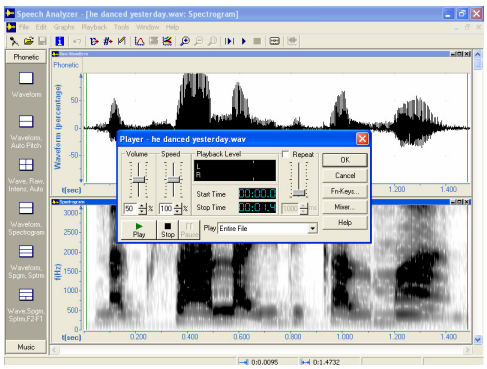
When you *install* Speech Analyzer, sample audio files are installed in the following folder:

> *C:\Program Files*\SIL\Speech Analyzer\Samples
>
> *By default, the SIL folder is installed in the Program Files folder on drive C.
>
> When you *start* Speech Analyzer the first time, the program creates a Speech Analyzer folder, and then copies the Samples folder into it.

We recommend that you do *not* open sample audio files in the Program Files folder.

We strongly recommend that you do *not* save audio files in the Program Files folder, especially on computers with Microsoft Windows Vista.

Module GS: Getting Started



Learning objectives:

Open an audio file.

Get information about an audio file.

Play, stop, pause, and resume playback of a file.

Mark a point in time or a portion of audio data.

Zoom in and out to see more or less detail in time-based graphs.

Play back a portion at different speeds.

Automatically repeat playback of a portion with a pause.

Audio file: he danced yesterday.wav

In this module, you will learn basic skills in Speech Analyzer. For example, skills you can use when you transcribe phonetic data and learn to say words through mimicry.

Starting Speech Analyzer

.1 To start Speech Analyzer, do one of the following:

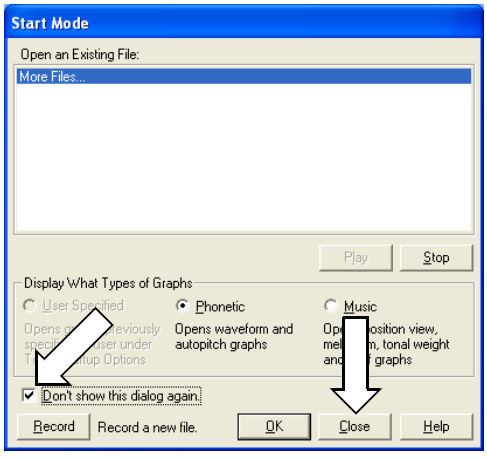
On the desktop, double-click the **Speech Analyzer** icon  .

On the taskbar, click the **Start** button, click **Programs** or **All Programs**, click **SIL Software**, click **Speech Analyzer**, and then click **Speech Analyzer**.

.2 If a **Speech Analyzer** dialog box appears, read the information, and then click **OK**.

A **Speech Analyzer** window opens.

.3 If the **Start Mode** dialog box appears:



.a Select the **Don't show this dialog again** check box.

.b Click **Close**.

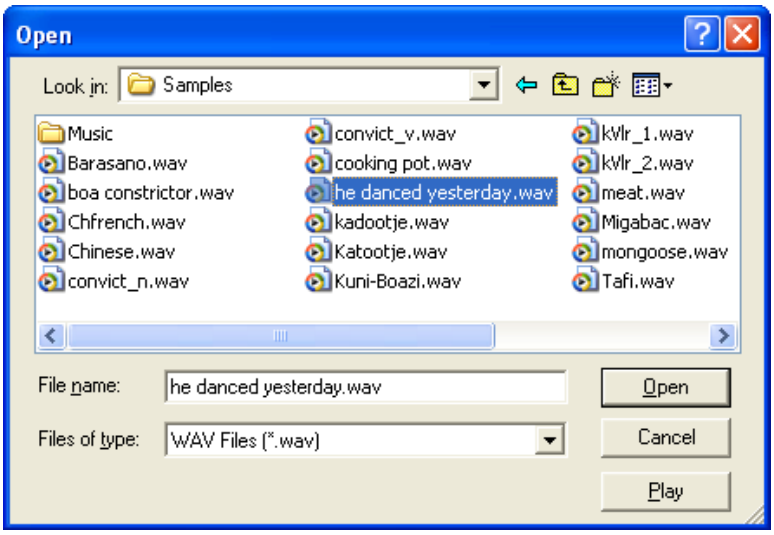
This dialog box displays a list of recently opened audio files. Because you might not have opened the sample files, you will not use the **Start Mode** dialog box during the training course.

.4 If the **Speech Analyzer** window does not fill all the available space on the screen, maximize the window.

Opening an audio file

.5 On the **File** menu, click **Open**.

The **Open** dialog box appears.



.6 In the **Look in** box, navigate to the folder that contains the audio file.

In this case, navigate to **Samples** folder.

For more information about folders, see page 5.

.7 In the list, select the audio file.

In this case, select **he danced yesterday.wav**.

.8 Click **Open**.

The audio file opens in a window within the Speech Analyzer window. The **Raw Waveform** graph is in the upper half. The **Auto Pitch** graph is in the lower half.

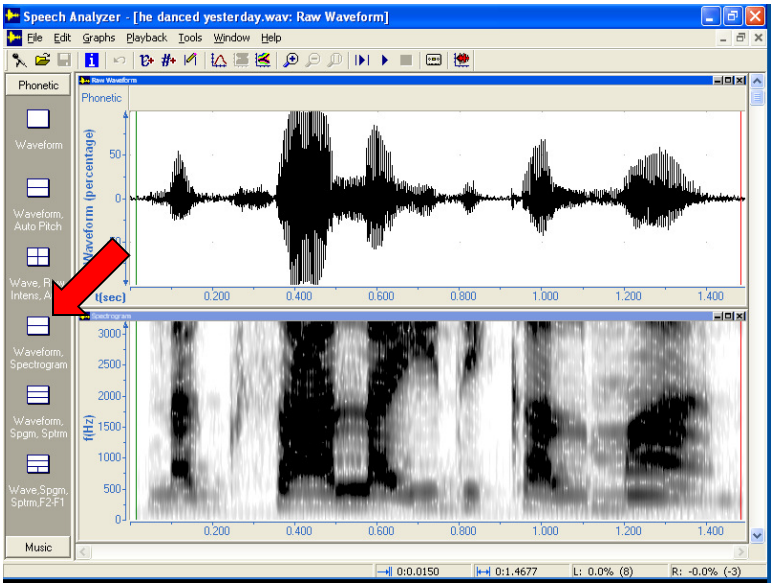
Selecting graph types

In Speech Analyzer, a *graph* is a window that displays a specific type of information about the active audio file. A graph includes the plot area and the horizontal and vertical axes. You can compare patterns that you see in the graphs with sounds that you hear. You can select different graph types for different types of speech analysis.

On the Speech Analyzer taskbar, click **Waveform, Spectrogram**.

The **Raw Waveform** graph is in the upper half.

The **Spectrogram** graph is in the lower half.



What you see on your computer screen might not exactly match the picture in the Student Manual.

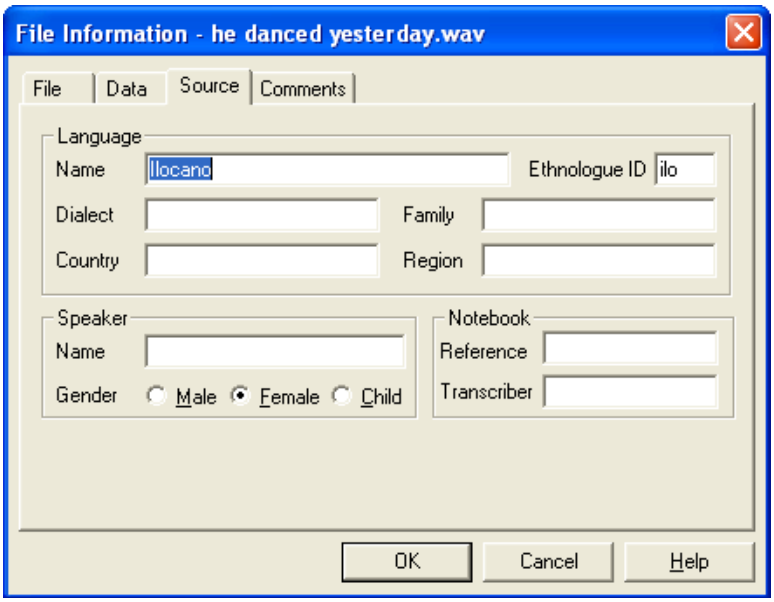
Getting information about an audio file

Information about an audio file might be useful to you. Speech Analyzer now stores transcription and annotation data in a file with a .saxml extension in the same folder as the audio file.

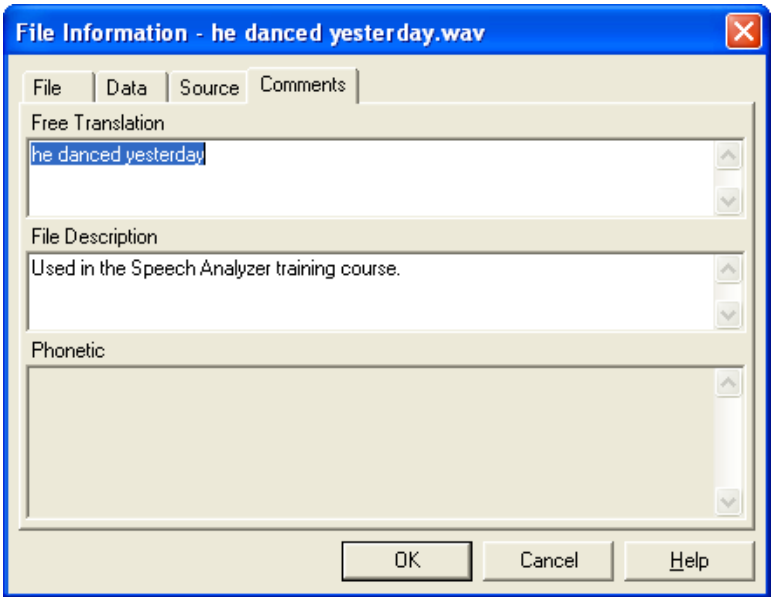
.9 On the **File** menu, click **Information**.

The **File Information** dialog box appears.

.10 Click the **Source** tab.



.11 Click the **Comments** tab.



.12 Click **OK**.

Playing an entire audio file

Do one of the following:

On the toolbar, click the **Play File** button.

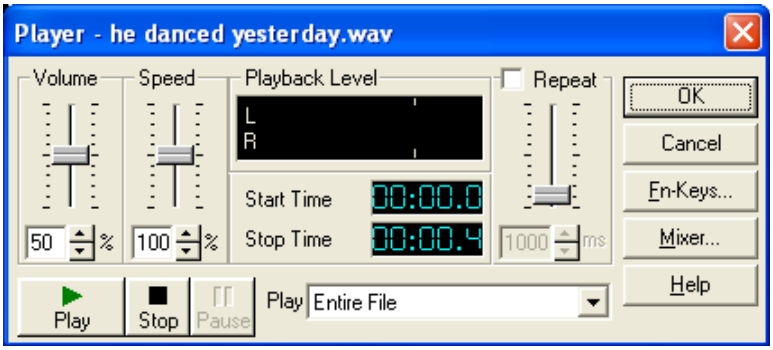
On the keyboard, press **F12**.

Stopping the playback of an audio file

In Speech Analyzer, you can stop the playback before the end.

.13 On the **Playback** menu, click **Player**.

The **Player** dialog box appears.



.14 Find the **Stop** button at the lower left.

.15 Click **Play**, and after the playback has started, click **Stop**.

The audio playback stops.

.16 Click **Play**.

Speech Analyzer plays from the beginning to the end.

.17 To close the **Player** dialog box, click **OK**.

.18 To start and stop playback on the toolbar:

.a Find the **Play File** and **Stop Playing** buttons.

.b Click , and then click .

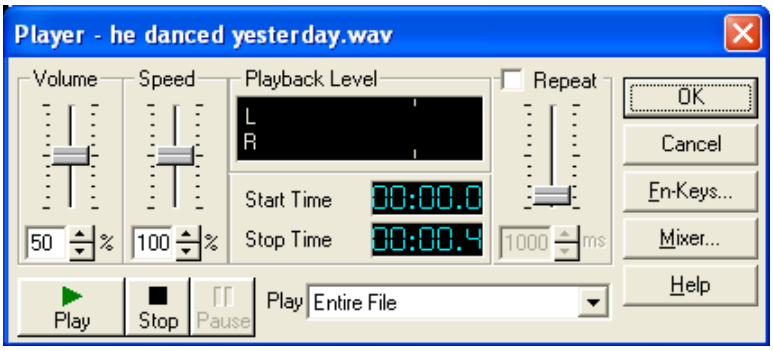
.19 To start and stop playback on the keyboard: Press **F12**, and then press **Esc**.

Pausing and then resuming the playback of an audio file

In Speech Analyzer, you can pause the playback, and then continue playing.

.20 On the toolbar, click the **Player** button.

The **Player** dialog box appears.



.21 Find the **Pause** button at the lower left.

.22 Click **Play**.

The **Play** button becomes steady green.

The **Pause** button becomes available.

.23 Click **Play**, and after the playback has started, click **Pause**.

The audio playback stops.

The **Play** button blinks green.

.24 Click **Play**.

Speech Analyzer plays from the point when you paused to the end.

The **Play** button becomes steady green.

.25 To close the **Player** dialog box, click **OK**.

Moving the cursors

When you transcribe an utterance, you might need to break down the utterance into portions.

Speech Analyzer provides a begin cursor and an end cursor to mark portions of audio data in time-based graphs (for example, Raw Waveform and Auto Pitch). The *begin cursor* is a vertical green line. It marks a point in time and the beginning of a portion. The *end cursor* is a vertical red line. It marks the end of a portion.

When an audio file opens, the begin cursor is at the left edge and the end cursor is at the right edge of the plot area. Cursors might be difficult to see at the edge of the graph.

If you display an audio file in multiple graphs, moving a cursor in one graph moves it to identical positions in other time-based graphs.

To move the cursors, you can click or drag using the mouse, or press keys on the keyboard.

By default, the cursor snaps to fragments when you click or drag and moves to fragment boundaries when you press arrow keys. In Speech Analyzer, a *fragment* is the smallest significant unit of audio information in a sound. Fragment boundaries are located at the beginning of large positive pulses, usually pitch pulses. In unvoiced sounds, fragment boundaries are often located at the beginning of major acoustic events like bursts.

Read the information in the following bullet lists, but do *not* click, drag, or press keys yet.

Moving the begin (green) cursor

Click at the point where you want the begin cursor to move.

For more precise movement using the mouse: Drag the green cursor left or right.

For more precise movement using the keyboard: Hold down the **Ctrl** key, and then press the **Left Arrow** or **Right Arrow** keys.

Moving the end (red) cursor

Hold down the **Shift key**, and then click at the point where you the end cursor to move.

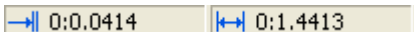
For more precise movement using the mouse: Drag the red cursor left or right.

For more precise movement using the keyboard: Hold down the **Shift** key, and then press the **Left Arrow** or **Right Arrow** keys.

Now do the following:

.26 Using a combination of **Ctrl+Right Arrow** and **Ctrl+Left Arrow**, move the begin cursor to **0.0414**.

At the lower right, the status bar displays four measurements for the *active* graph.



The first pane displays the time in minutes and seconds at the begin cursor.

The second pane displays the time difference between the cursors (that is, the duration of the portion of audio data).

The initial values before you move the cursors depend on the screen resolution. Therefore, the values on your computer might not exactly match the preceding picture of the status bar.

.27 To move the end cursor one fragment to the left, press **Shift+Left Arrow**.

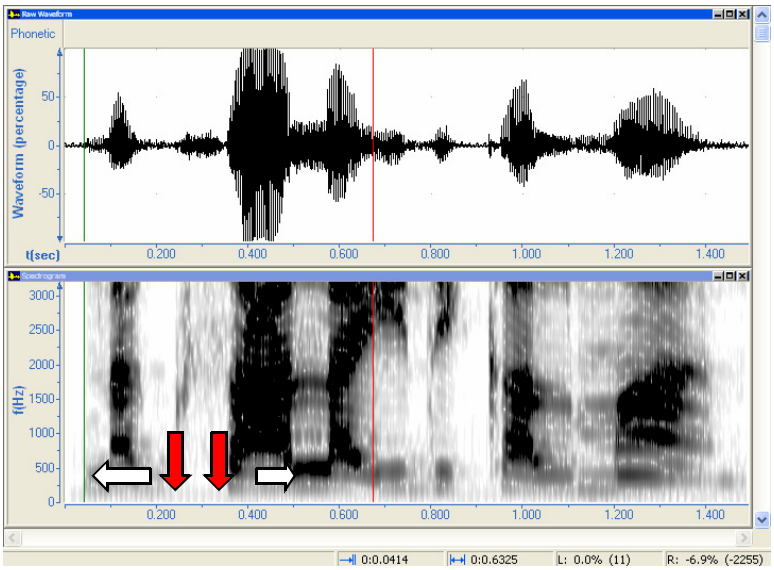
Because the duration of the portion decreases, the value in the second pane of the status bar decreases.

.28 To move the end cursor to 0.6739 seconds, press **Shift+Left Arrow**, until the second pane of the taskbar displays **0.6325**.

The duration is the difference in time between the cursors: 0.6325 = 0.6739 – 0.0414

.29 On the toolbar, click the **Play Between Cursors** button.

The audio file plays from the begin cursor to the end cursor.



.30 To move the begin cursor to about 0.25 seconds, click just above the horizontal axis around 0.25.

.31 To move the end cursor to about 0.35 seconds, hold down **Shift**, and then click just above the horizontal axis around 0.35.

.32 To play the portion, press **F8**.

.33 Drag the begin cursor to about 0.05 seconds.

.34 Drag the end cursor to about 0.5 seconds.

.35 On the toolbar, click the **Play Between Cursors** button.

Zooming in and out

Sometimes you need to zoom in to see more detail in a time-based graph (for example, to see phonetic segment boundaries).

.36 On the toolbar, click the **Zoom Step In** button three times.

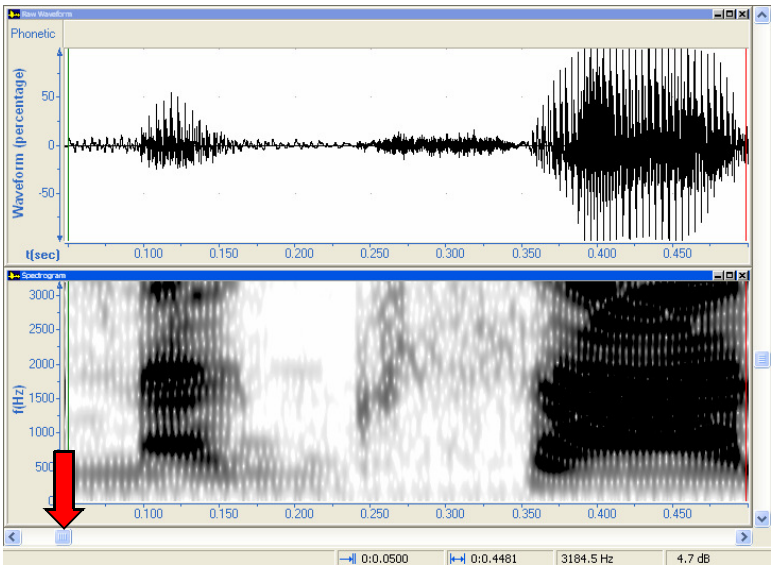
The horizontal scale of the time-based **Raw Waveform** and **Auto Pitch** graphs shows more detail.

.37 On the toolbar, click the **Zoom Step Out** button once.

The horizontal scale shows less detail.

.38 On the toolbar, click the **Zoom Cursors** button.

The horizontal scale displays the portion of audio data between the cursors.



.39 To see the data after the end cursor, you can drag the scroll box to the right on the horizontal scroll bar at the lower edge of the window.

.40 To see the portion of data between the cursors, click the **Zoom Cursors** button again.

.41 On the toolbar, click the **Play Between Cursors** button.

.42 On the **Graphs** menu, point to **View**, point to **Zoom**, and then click **Full**.

.43 For more information: On the **Help** menu, click **Graphs**.

The Help window opens.

.a In the first bullet point in **Graphs overview**, click the **graph types** hyperlink

.b At the upper left of the table of graph types, click the **Raw Waveform** hyperlink.

.c Read **Raw Waveform graph**.

.d Click the **Zoom** hyperlink, and then read the information.

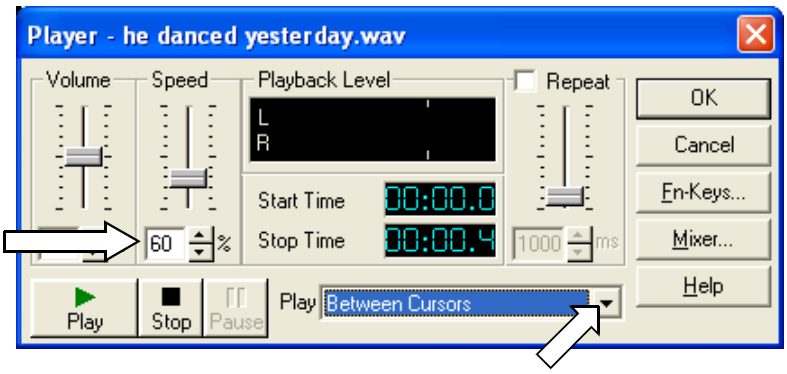
.e Close the Help window.

Reducing playback speed

To distinguish the phonetic segments, you can set options so Speech Analyzer plays slowly.

.44 On the toolbar, click the **Player** button.

The **Player** dialog box appears.



.45 To see the entire **Spectrogram** graph, drag the dialog box to the upper half of the window.

.46 Set the **Speed** value to **60%**. You can drag the slider. For more precise control, click the arrows or type in the box.

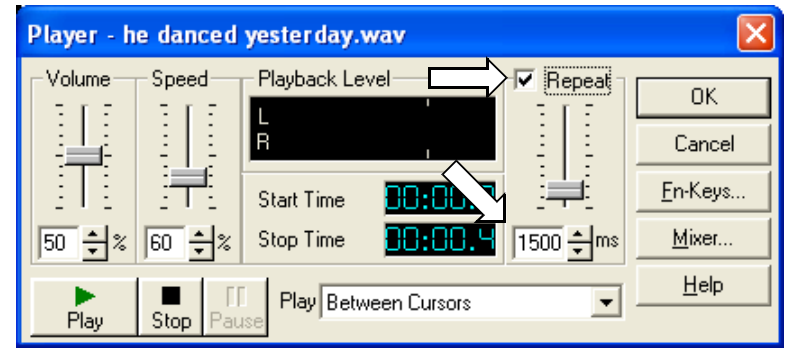
.47 If the **Play** box does not display **Between Cursors**, click the down arrow, and then select **Between Cursors**.

.48 Click **Play**.

Speech Analyzer plays the portion at a slower speed.

Repeating playback automatically

Instead of having to click **Play** repeatedly when you learn to say words through mimicry, you can set options so Speech Analyzer repeats the playback automatically with a delay.



.49 In the **Player** dialog box, select the **Repeat** check box.

.50 To specify the delay, set the **Repeat** value to **1500 ms** (that is, 1.5 seconds).

.51 Click **Play**.

Speech Analyzer plays the portion repeatedly at the slower speed.

After each repetition of the utterance, practice saying the utterance.

.52 Stop the playback. For more information, see page 9.

.53 To close the **Player** dialog box, click **OK**.

Exercise GS-1

To hear the final part of the utterance, do the following:

.54 Move the end cursor to about 1.42 seconds.

.55 Move the begin cursor to about 0.675 seconds.

Do the first and second panes of the status bar display the values that you expect?

.56 Play the portion back slowly with automatic repetition.

Exercise GS-2

To hear the middle part of the utterance, do the following:

.57 Move and the end cursor to about 0.820 seconds.

.58 Move the begin cursor to about 0.5 seconds.

Do the first and second panes of the status bar display the values that you expect?

.59 Zoom to display the portion of audio data between the cursors.

.60 Play the portion back slowly with automatic repetition.

.61 Exit Speech Analyzer.

Module RS: Recording and Saving Audio Files

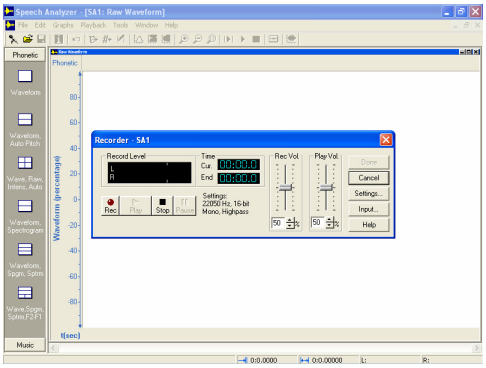
Learning objectives:

Set the recording level.

Record an utterance using Speech Analyzer.

Enter information about an audio file.

Save an entire recording or a selected portion as a new audio file.



Audio files that you will record and save:
color_collar.wav, color.wav, and collar.wav

In Speech Analyzer, you can record data in two ways:

Record spoken utterances directly from microphone input to the computer.

Record spoken utterances on an external recording device (for example, a MiniDisc recorder), and then record the playback from line input to the computer.

In this module, you will record data from a microphone. The course assumes that you can make a good recording.

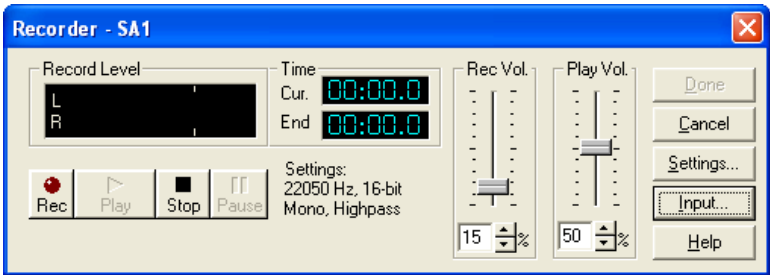
Setting the recording level

.62 Make sure that the microphone is connected to the computer.

.63 Start Speech Analyzer. For more information, see page 6.

.64 On the **File** menu, click **Record New**.

The **Recorder** dialog box appears.



To adjust the settings of your input device, click **Input**, and then see page 67.

.65 For information about recording audio, click **Help**.

The Help window opens.

.a Read **Record New**.

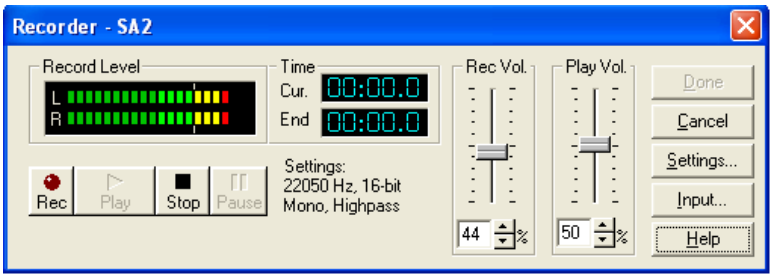
.b Scroll to the beginning of the Help topic, and then click the **audio input** hyperlink.

.c Read **Audio input devices**.

.d Minimize the Help window.

.66 To test the recording level, speak in a normal voice with your mouth a few inches away from the microphone.

.67 Drag the **Rec Vol.** slider up or down until the bars in the **Record Level** area stay primarily in the green zone and do not go beyond yellow into the red zone.



.68 If you hear feedback while you speak into the microphone:

.a Switch to the Help window.

.b Click the **Troubleshooting overview** hyperlink, click the **Feedback during recording** hyperlink, and then read the information.

.c Minimize the Help window.

Recording an utterance

.69 When you have finished setting the **Rec Vol.** level, click **Rec**.

The **Rec** button becomes red and Speech Analyzer begins recording.

The **Cur** box displays the running elapsed time of the recording.

.70 Speak the following sentences into the microphone:

The color of the dog is brown. The collar of the dog is brown.

.71 Click **Stop**.

Speech Analyzer stops recording. The **End** box displays the duration of the recording in minutes and seconds.

.72 Click **Play**.

The recording plays from beginning to end, allowing you to make a judgment of its quality.

.73 If the recording is unsatisfactory, repeat steps 1 through 4.

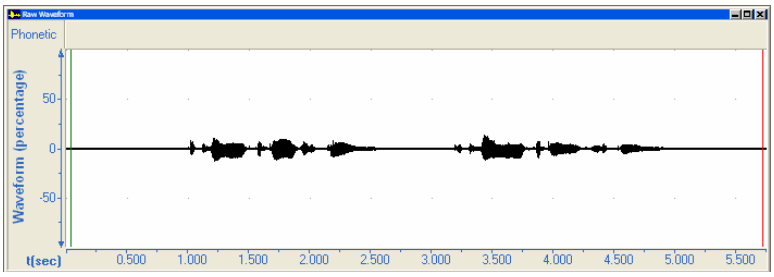
.74 When you are satisfied with the recording quality, click **Done**.

The **Recorder** dialog box disappears. The **Raw Waveform** graph appears in the upper half of the Speech Analyzer window and the **Auto Pitch** graph appears in the lower half.

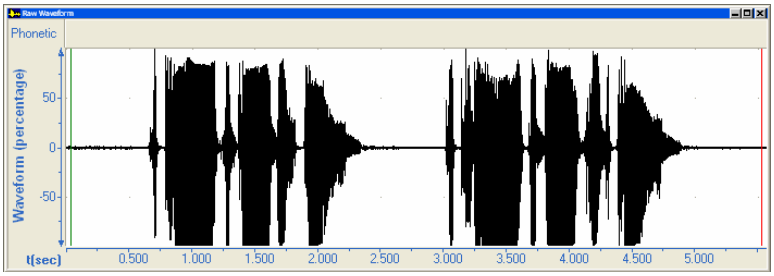
Verifying the quality of the recording

Before you save a recording as a new audio file, verify that the **Raw Waveform** graph of the recording appears to be satisfactory. Here are some examples.

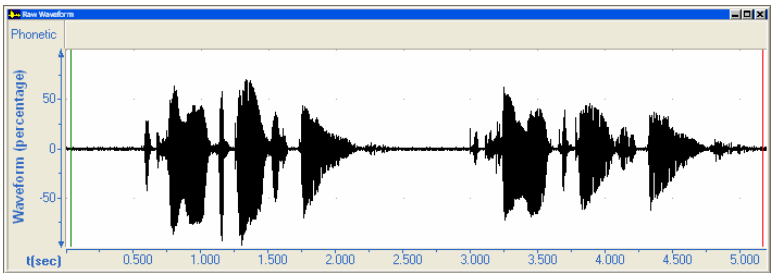
Unsatisfactory
Recording level is too low:



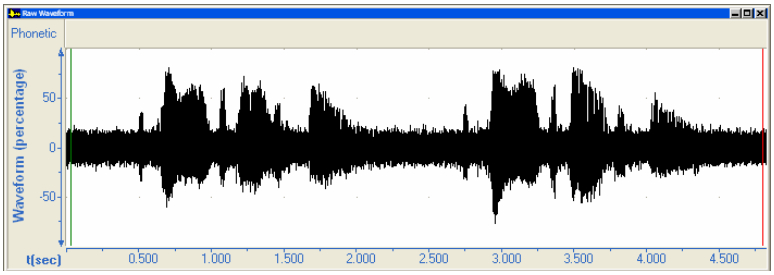
Unsatisfactory
Recording level is too high:



Satisfactory
Recording level is good:



Unsatisfactory
Recording contains noise:



If you decide that a recording is unsatisfactory, do the following:

.75 On the **File** menu, click **Close**.

A **Speech Analyzer** dialog box appears.

.76 To confirm that you do not need to save changes, click **No**.

.77 Repeat the preceding procedures starting at step 3 on page 16.

Entering information about an audio file

.78 On the **File** menu, click **Information**.

The **File Information** dialog box appears.

.79 Click the **Source** tab.

.80 In the **Language** area, do the following:

In the **Language** box, type the name of the language.

In this case, type **English**.

In the **Ethnologue ID** box, type the Ethnologue or ISO-639-3 code that identifies the language, if you know it.

In this case, type **eng**.

.81 In the **Speaker** area, do the following:

In the **Name** box, type the name of the language speaker.

In this case, type your name.

At the right of **Gender**, select **Male**, **Female**, or **Child**.

.82 Click the **Comments** tab.

.83 In the **Free Translation** box, you can type the meaning of the utterance in a researcher's language (for example, English, French, Spanish, or Portuguese).

In this case, type **The color of the dog is brown. The collar of the dog is brown.**

.84 In the File Description box, type **Recorded and saved for Module RS of the Speech Analyzer training course.**

.85 Click **OK**.

Saving an audio file

In the course, you save audio files in the Speech Analyzer folder. In your work, we recommend that you save the files in *subfolders* of the Speech Analyzer folder.

.86 On the **File** menu, click **Save As**.

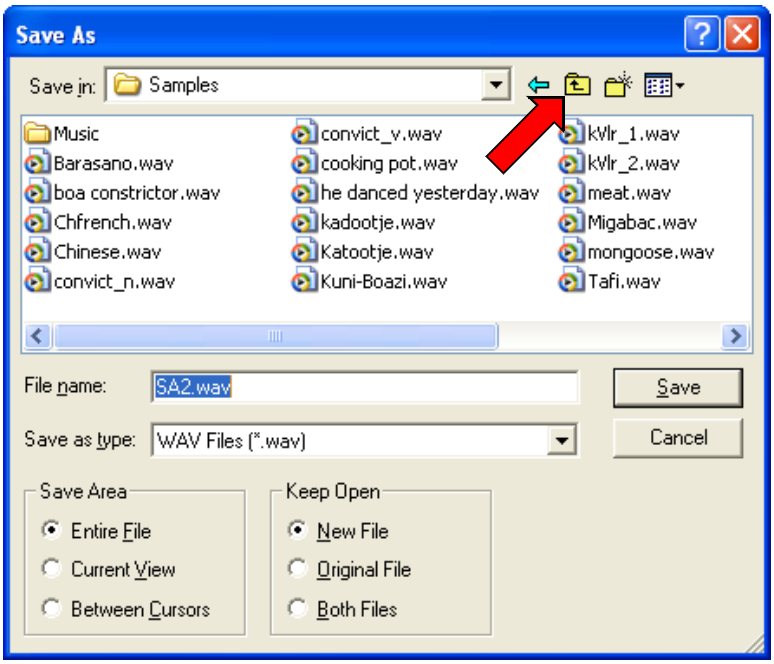
The **Save As** dialog box appears.

.87 Navigate to the folder in which you save new audio files.

In this case, navigate to the **Speech Analyzer** folder.

If the **Save in** box displays **Samples**, click the **Up One Level** button.

For more information about folders, see page 5.

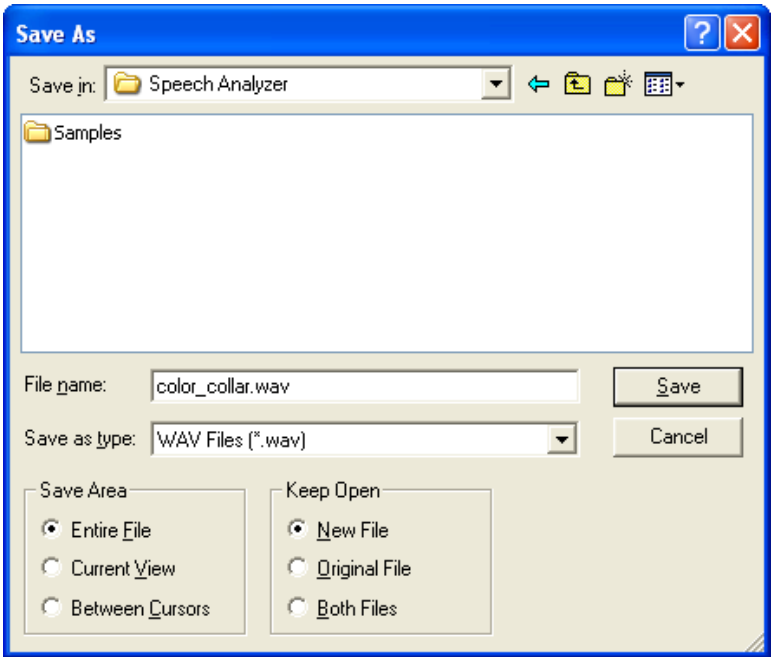


.88 In the **File Name** box, type a file name.

In this case, type **color_collar.wav**.

.89 Click **Save**.

The **Save As** dialog box disappears and the file is saved with the specified name.



Saving portions of an audio file

You might record several utterances in one recording session. After the recording session, you can save each utterance as a separate file.

.90 On the Speech Analyzer taskbar, click **Waveform, Spectrogram**.

.91 Move the begin (green) cursor to the beginning of the first sentence:

.92 Move the end (red) cursor to the end of the first sentence.

.93 To make sure that you have marked the first sentence, "The color of the dog is brown," click the **Play Between Cursors** button on the toolbar.

.94 On the **Edit** menu, click **Select Waveform**.

Selecting a portion of an audio file is analogous to selecting text in a word processing program.

.95 On the **Edit** menu, click **Copy**.

.96 On the **Edit** menu, click **Paste as New File**.

.97 A new file window opens in the Speech Analyzer window. It displays just the portion that you copied.

.98 Enter information about the first sentence (for more information, see page 19)

.99 On the **File** menu, click **Save As**.

The **Save As** dialog box appears.

.100 In the **File Name** box, type **color.wav**.

.101 Click **Save**.

The **Save As** dialog box disappears and the file is saved with the specified name.

.102 On the **File** menu, click **Close**.

The **color.wav** window disappears. The **color_collar.wav** window appears again.

.103 Move the begin (green) cursor to the beginning of the second sentence:

.104 Move the end (red) cursor to the end of the second sentence.

.105 To make sure that you have marked the second sentence, "The collar of the dog is brown," click the **Play Between Cursors** button on the toolbar.

.106 Repeat steps 5 through 13 to create a **collar.wav** file.

.107 To exit Speech Analyzer: On the **File** menu, click **Exit**.

Comparing audio files

You can now compare the two related audio files.

.108 Start Speech Analyzer.

.109 On the **File** menu, click **Open**.

The **Open** dialog box appears.

.110 In the **Look in** box, navigate to the folder.

In this case, navigate to the **Speech Analyzer** folder.

.111 In the list, select the audio file.

In this case, select **color.wav**.

.112 Click **Open**.

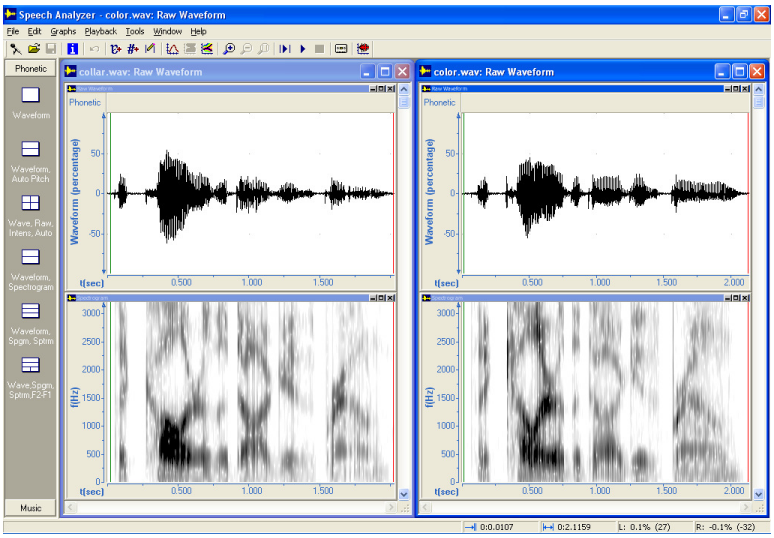
The audio file opens.

.113 On the Speech Analyzer taskbar, click **Waveform, Spectrogram**.

.114 To open the **collar.wav** file, repeat steps 2 through 6.

.115 On the **Window** menu, click **Tile Vertical**.

Speech Analyzer tiles the **collar.wav** and the **color.wav** windows side by side.



Compare the utterances.

.116 To make sure the next window you open will be maximized, maximize one of the file windows.

.117 Exit Speech Analyzer.

Exercise RS

Record some common greetings in a language you know, and then save each utterance as a separate file.

Important: Make sure to select the correct folder when you open or save a file.

In all of the other modules, you open audio files in the Samples subfolder of the Speech Analyzer folder. In some of the exercises, you open the collar.wav and color.wav files that you saved in the Speech Analyzer folder.

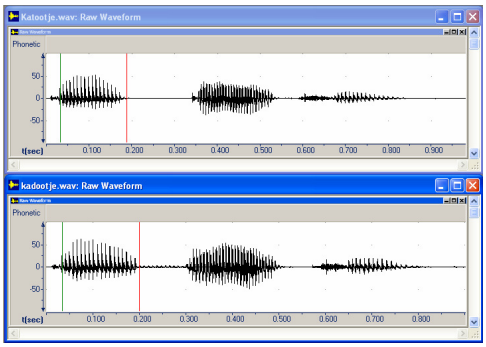
Module DR: Measuring Duration

Learning objectives:

Measure the duration of a portion in a time-based graph.

Get the length of an audio file.

Audio files: kadootje.wav and Katootje.wav



Measuring duration of events in a speech signal can be useful in any of the following types of linguistic analysis:

duration of pauses between clauses—discourse studies

duration of vowels—contrastive vowel length

time between the release of a plosive and the beginning of voicing (voice onset time)—distinguishing unaspirated, aspirated and voiced stops

duration of the closure phase—distinguishing voiced and voiceless stops

In this module, you will do a qualitative visual comparison and precise quantitative measurements of duration. For more information about when and how to use duration graphs in linguistic analyses, see chapter 4 of Baart. 2001. *Acoustic Phonetics*.

Duration measurements

In Module DR, you measure the voiced and voiceless stops [d] and [t] in the Raw Waveform graph. You also get the length of the audio files.

As you do the steps in this module, you will write measurements in the following table.

Round values to *three* decimal places in the following table.

To verify your measurements when you have finished the module, see page 28.

File	**Duration (seconds)**	
	stop [d] or [t]	**audio file**
kadootje.wav		
Katootje.wav		

Measuring duration of a portion

.118 Start Speech Analyzer. For more information, see page 6.

.119 Open the **kadootje.wav** file in the **Samples** folder. For more information, see page 7.

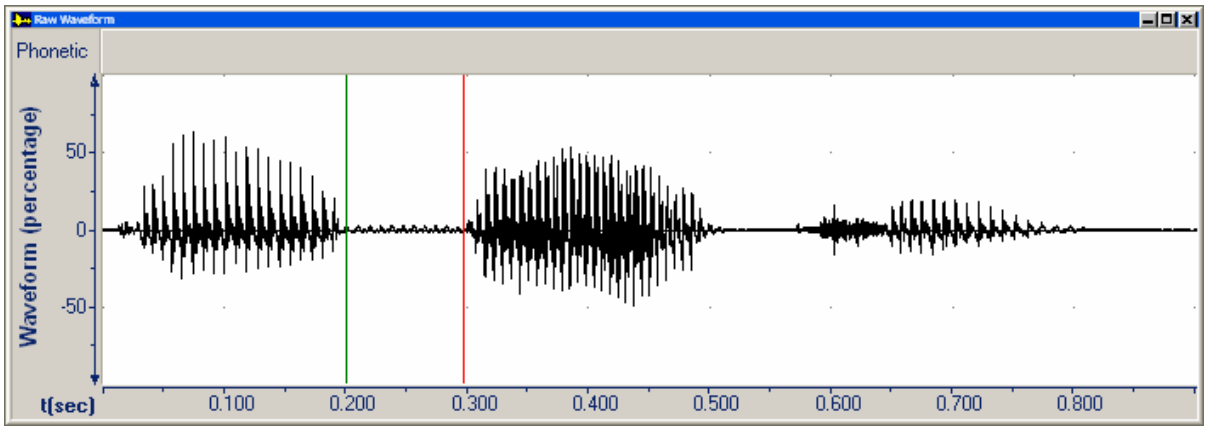
.120 On the toolbar, click the **Play File** button.

.121 Move the begin (green) cursor to the beginning of the closure phase of [d].

See the following picture.

For more information about moving cursors, see page 11.

.122 Move the end (red) cursor to the end of the closure phase of [d].



.123 Click the title bar of the **Raw Waveform** graph.

At the lower right, the status bar displays measurements for the *active* graph.

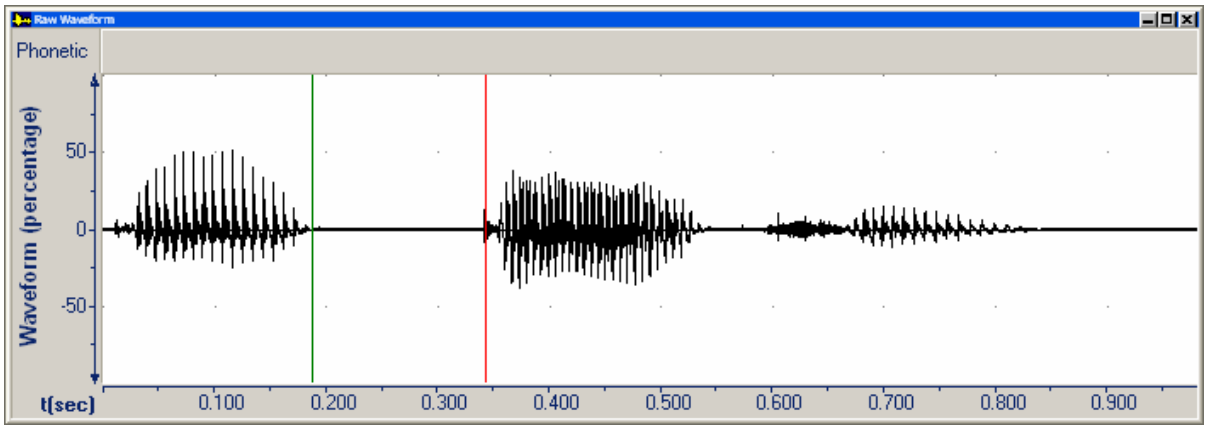
The first pane displays the time in minutes and seconds at the begin cursor.

The second pane displays the time difference between the cursors (that is, the duration of the portion of audio data).

.124 Write the duration measurement in the table on page 23.

.125 Open the **Katootje.wav** file in the **Samples** folder.

.126 Repeat steps 3 through 7 for the closure phase of [t].



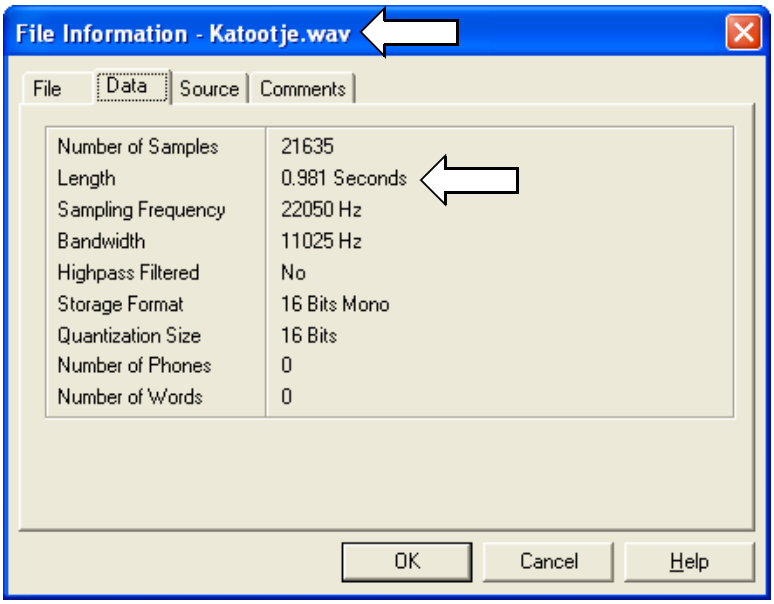
Getting the length of an audio file

.127 On the **File** menu, click **Information**.

The **File Information** dialog box appears for the active file.

.128 Click the **Data** tab.

.129 Write the length of the active file in the table on page 23.



.130 Click **Cancel**.

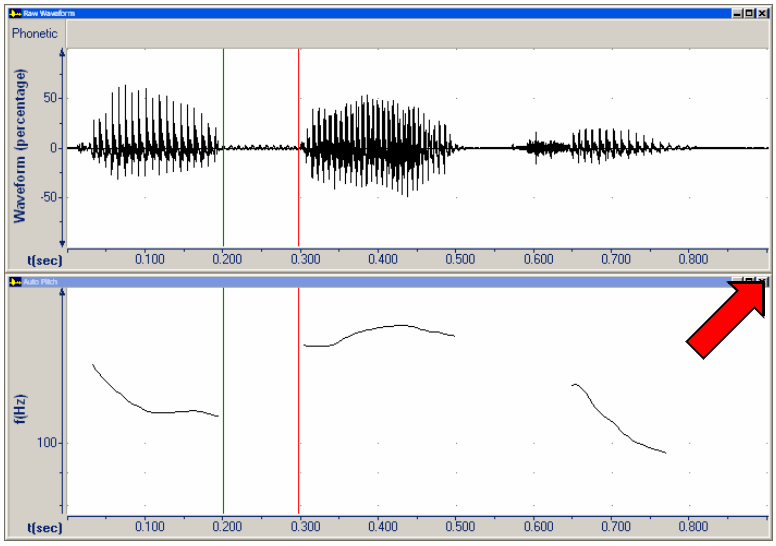
.131 To switch the active file: On the **Window** menu, click **kadootje.wav**.

.132 Repeat steps 1 through 4.

Comparing duration

In addition to quantitative comparisons, you can make qualitative comparisons visually.

.133 To close the **Auto Pitch** graph in the lower half of the file window, click the **Close** button.



.134 To switch the active file: On the **Window** menu, click **Katootje.wav**.

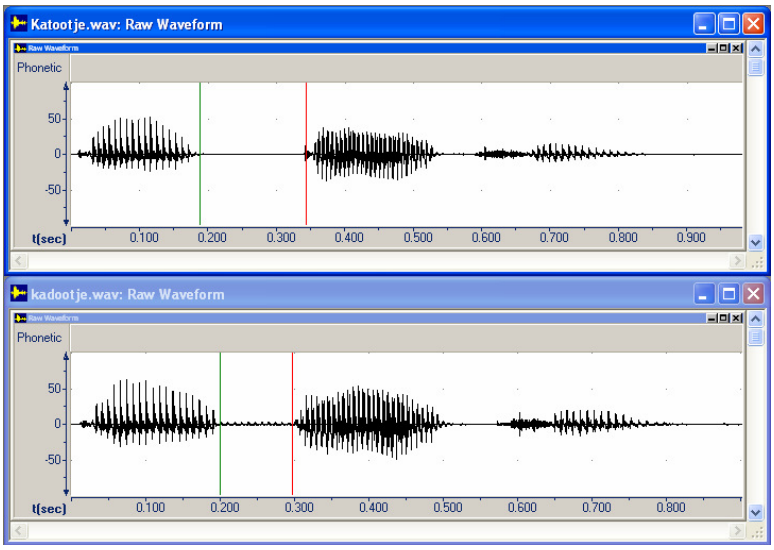
.135 Close the **Auto Pitch** graph in the lower half of the file window.

.136 On the **Window** menu, click **Tile Horizontal**.

Speech Analyzer displays the active file at the top.

The title bar of the active window and graph has a brighter color. In this case, **Katootje.wav** is active.

If the title bar of a window or graph is dimmed, it is not active. In this case, **kadootje.wav** is not active.

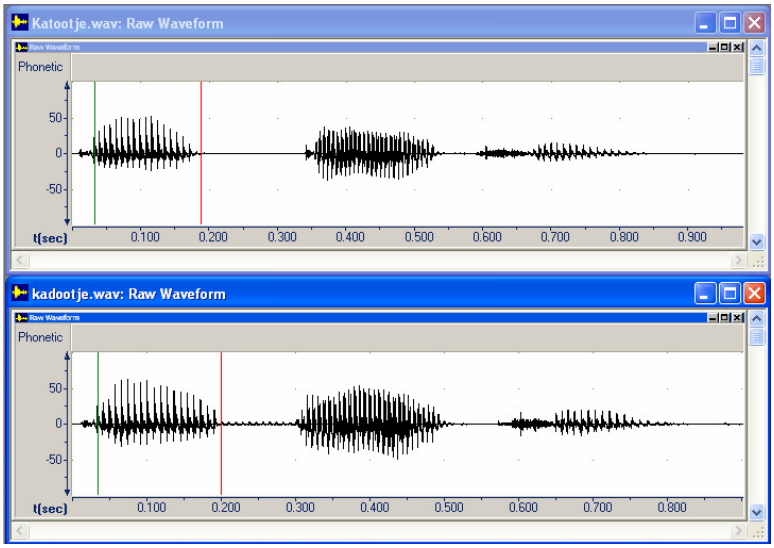


.137 Notice that the closure phase of [t] has a longer duration than the closure phase of [d].

Exercise DR-1

.138 In the **kadootje.wav** and **Katootje.wav** files, measure the duration of the vowel [a] preceding the stops [d] and [t].

Write the measurements rounded to *three* decimal places in the following table.



.139 Maximize one of the file windows.

.140 Exit Speech Analyzer.

File	Duration vowel [a]
kadootje.wav	
Katootje.wav	

Exercise DR-2

If you did Module RS, do the following:

.141 Start Speech Analyzer.

.142 Open the **collar.wav** and **color.wav** files in the **Speech Analyzer** folder.

.143 Measure the duration of the vowel in the first syllable of *collar* and *color* and the length of the entire audio file. Write the measurements in the following table:

File	Duration (seconds)	
	vowel	audio file
collar.wav		
color.wav		

.144 Exit Speech Analyzer.

Expected duration measurements for Module DR

To check your measurements, compare the table on page 23 with the following data:

File	Duration (seconds)	
	stop [d] or [t]	audio file
kadootje.wav	0.098	0.902
Katootje.wav	0.150	0.981

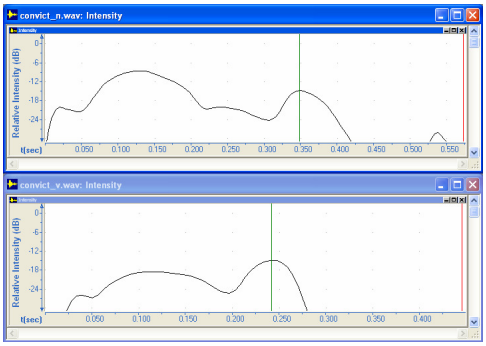
Expected duration measurements for Exercise DR-1

To check your measurements, compare the table on the preceding page with the following data:

File	Duration
	vowel [a]
kadootje.wav	0.166
Katootje.wav	0.156

Measurements for Exercise DR-2 will vary, because the audio data was recorded by the student.

Module IN: Measuring Intensity



Learning objective: Measure the intensity at a point in an Intensity graph.

Audio files: convict_n.wav and convict_v.wav

Measuring intensity can be useful when analyzing intonation, stress, and accent.

Intensity is the acoustic correlate of (psychoacoustic) loudness. Intensity is not necessarily a direct correlate of stress or accent.

In this module, you will do a qualitative visual comparison and precise quantitative measurements of intensity. For more information about when and how to use intensity graphs in linguistic analyses, see pages 92–104 of Baart. 2001. *Acoustic Phonetics*.

Intensity measurements

In Module IN, you measure the maximum intensity of syllables in *convict* as a noun and a verb.

As you do the steps in this module, you will write measurements in the following table.

To verify your measurements when you have finished the module, see page 36.

File	Relative intensity (dB)	
	first syllable	second syllable
convict_n.wav		
convict_v.wav		

.145 Start Speech Analyzer. For more information, see page 6.

.146 Open the **convict_n.wav** file in the **Samples** folder. For more information, see page 7.

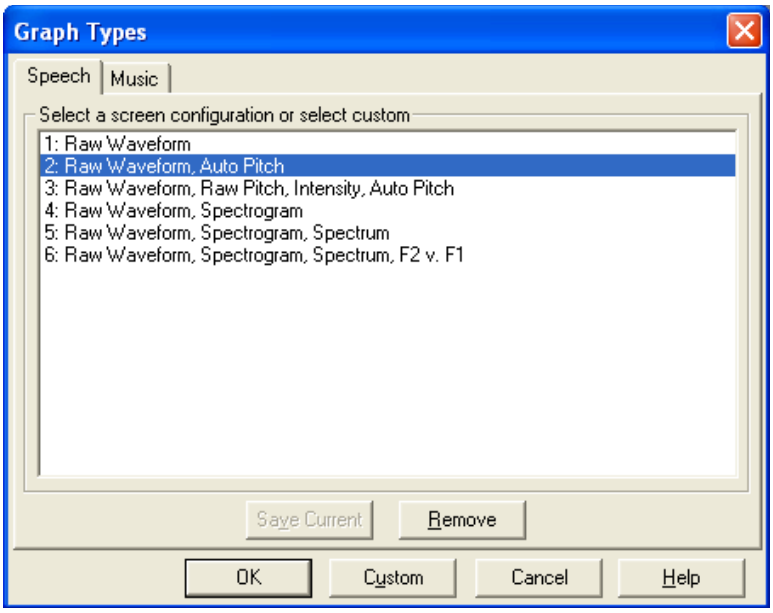
Selecting custom graph types

By default, the **Raw Waveform** graph is in the upper half of the Speech Analyzer window and the **Auto Pitch** graph is in the lower half.

You can select sets of graphs that do not appear on the Speech Analyzer taskbar.

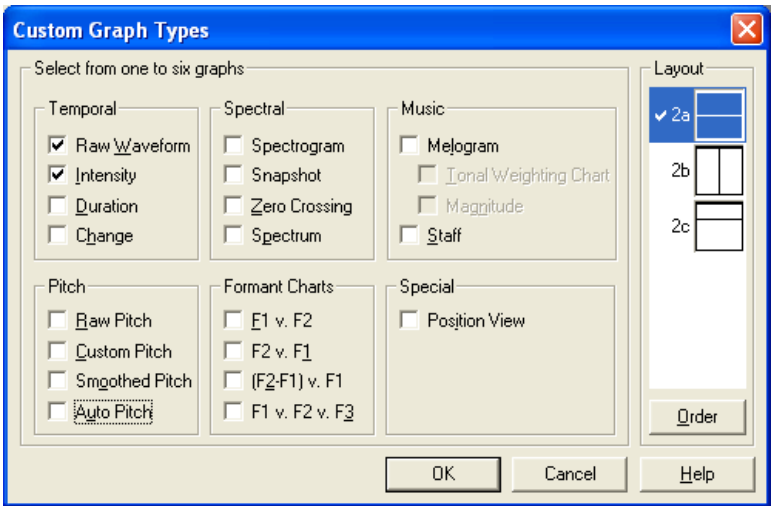
.147 On the **Graphs** menu, click **Types**.

The **Graph Types** dialog box appears.



.148 Click **Custom**.

The **Custom Graph Types** dialog box appears.



.149 Select the **Intensity** check box.

.150 Clear the **Auto Pitch** check box.

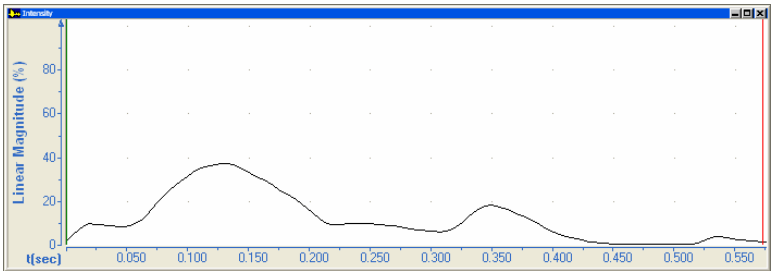
.151 Click **OK**.

The **Raw Waveform** graph remains in the upper half of the Speech Analyzer window.

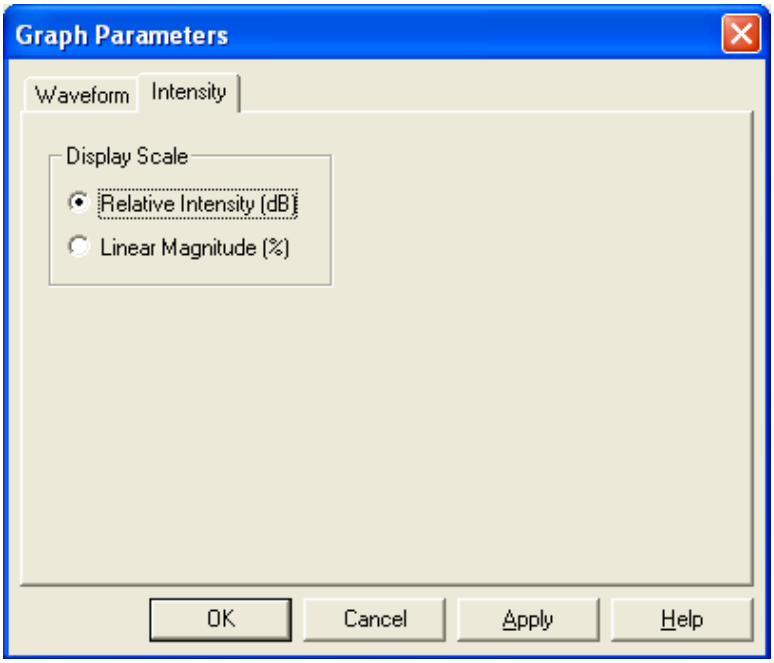
The **Intensity** graph replaces the **Auto Pitch** graph in the lower half.

Changing the display scale

.152 Right-click in the plot area of the **Intensity** graph, and then click **Parameters**.



The **Graph Parameters** dialog box appears with the **Intensity** tab visible.



.153 In the **Display Scale** area, select **Relative Intensity (dB)**.

.154 For more information, click **Help**.

The Help window opens.

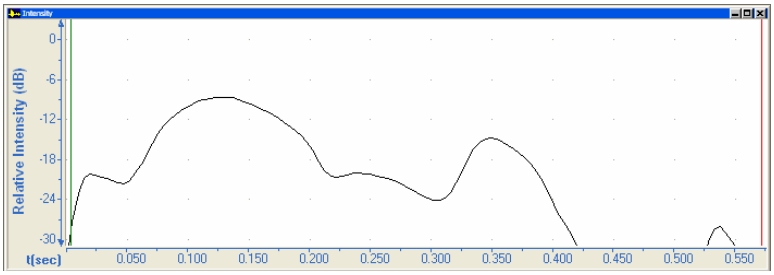
.a Read **Intensity tab, Graph Parameters**.

.b If necessary, scroll up, click the **Intensity graph** hyperlink, and then read the Help topic.

.c Close the Help window.

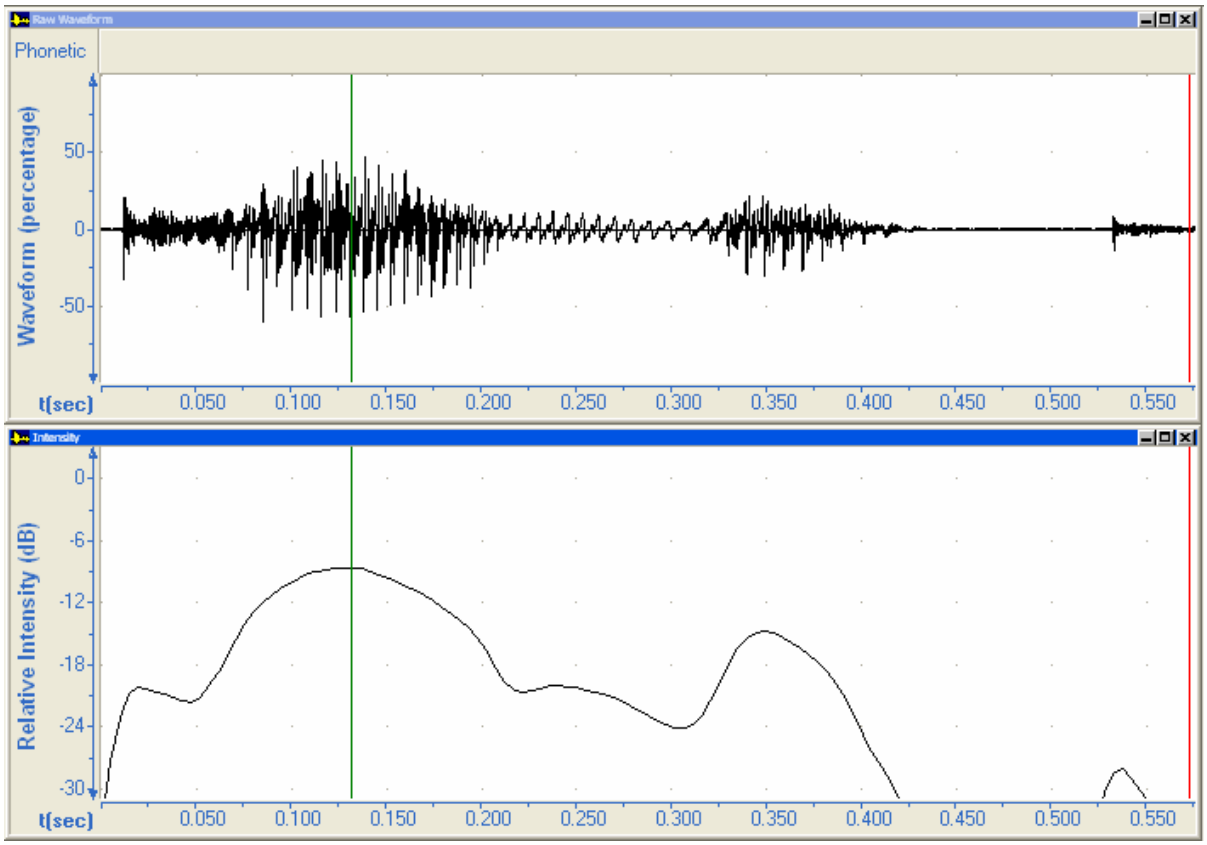
.155 Click **OK**.

Because relative intensity is a logarithmic scale, the shape of the line changes in the plot area of the **Intensity** graph.



Measuring intensity

.156 Move the begin cursor to the top of the peak in the first syllable at about 0.13 seconds. For more information, see page 11.



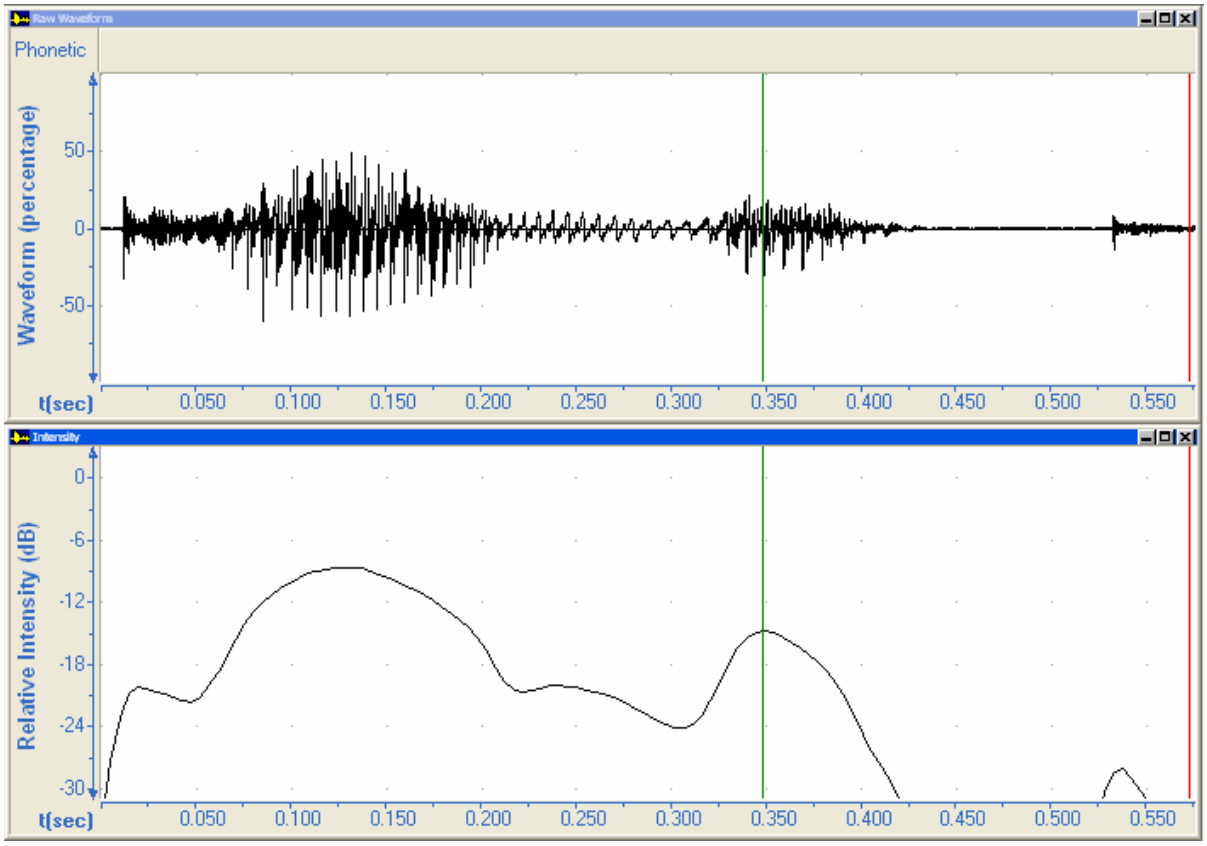
.157 Click the title bar of the **Intensity** graph.

At the lower right, the status bar displays measurements for the *active* graph.

The third pane of the status bar displays the relative intensity at the begin cursor.

.158 Write the relative intensity measurement in the table on page 29.

.159 Move the begin cursor to the top of the peak in the second syllable at about 0.34 seconds.



.160 Write the relative intensity measurement in the table on page 29.

.161 Open the **convict_v.wav** file in the **Samples** folder.

.162 Select the **Raw Waveform** and **Intensity** graphs. For more information, see page 30.

.163 Repeat steps 1 through 5.

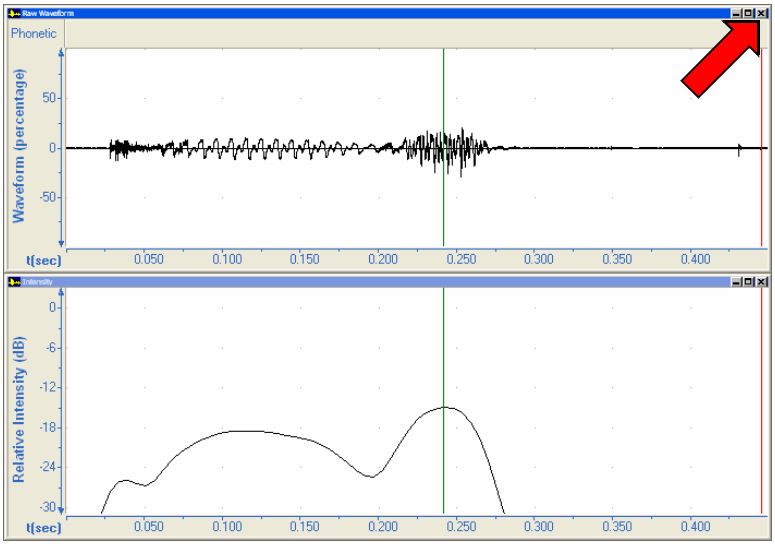
The top of the peak in the first syllable is at about 0.11 seconds.

The top of the peak in the second syllable is at about 0.24 seconds.

Comparing intensity

In addition to quantitative comparisons, you can make qualitative comparisons visually.

.164 To close the **Raw Waveform** graph in the upper half of the file window, click the **Close** button.



.165 To switch the active file: On the **Window** menu, click **convict_n.wav**.

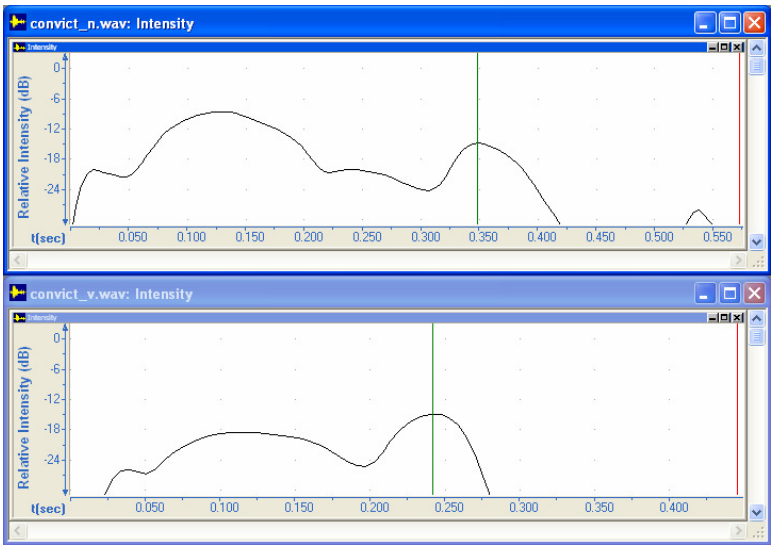
.166 Close the **Raw Waveform** graph in the upper half of the file window.

.167 On the **Window** menu, click **Tile Horizontal**.

Speech Analyzer displays the active file at the top.

The title bar of the active window and graph has a brighter color. In this case, **convict_n.wav** is active.

If the title bar of a window or graph is dimmed, it is not active. In this case, **convict_v.wav** is not active.



.168 Notice that the intensity of the first syllable of *convict* (noun) is greater than *convict* (verb).

.169 To make sure the next window you open will be maximized, maximize one of the file windows.

.170 Exit Speech Analyzer.

Exercise IN-1

.171 Start Speech Analyzer.

.172 Open the **kadootje.wav** and **Katootje.wav** files in the **Samples** folder.

.173 Measure the intensity of the first two syllables of each utterance.

File	**Relative intensity (dB)**	
	first syllable	**second syllable**
kadootje.wav		
Katootje.wav		

.174 Exit Speech Analyzer.

Exercise IN-2

If you did Module RS, do the following:

.175 Start Speech Analyzer.

.176 Open the **collar.wav** and **color.wav** files in the **Speech Analyzer** folder.

.177 Measure the intensity of the syllables of the words *collar* and *color*.

File	**Relative intensity (dB)**	
	first syllable	**second syllable**
collar.wav		
color.wav		

.178 Exit Speech Analyzer.

Expected intensity measurements for Module IN

To check your measurements, compare the table on page 29 with the following data:

File	Relative intensity (dB)	
	first syllable	second syllable
convict_n.wav	-8.6	-14.9
convict_v.wav	-18.5	-14.9

Expected intensity measurements for Exercise IN-1

To check your measurements, compare the table on the preceding page with the following data:

File	Relative intensity (dB)	
	first syllable	second syllable
kadootje.wav	-12.7	-7.2
Katootje.wav	-14.0	-9.6

Measurements for Exercise IN-2 will vary, because the audio data was recorded by the student.

Module F0: Measuring Fundamental Frequency

Learning objectives:

Measure the fundamental frequency in a Pitch graph.

Copy measurements to a spreadsheet or word processing program.

Audio files: cooking pot.wav and mongoose.wav

Measuring fundamental frequency can be useful when analyzing intonation, tone, and stress.

In Speech Analyzer, the so-called Pitch graphs display fundamental frequency. The *fundamental frequency* (or f_0) of a periodic signal is the inverse of the period length. The *period* is the smallest repeating unit of a signal.

Fundamental frequency is the acoustic correlate of (psychoacoustic) *pitch*. Do *not* assume the shapes of contours that you see in Speech Analyzer represent pitch and tone as perceived by vernacular language speakers.

Factors that influence the perception of pitch include:

vowel quality

adjacent phonetic segments

the suprasegmental environment—what are the surrounding tones, is there stress, and so on.

location within a phrase or clause

In this module, you will view pitch contours and take precise measurements of fundamental frequencies at various points in utterance files. For more information about when and how to use pitch graphs in linguistic analyses, see:

Chapter 5 of Baart. 2001. *Acoustic Phonetics*.

Snider, Keith. 1998. Phonetic realisation of downstep in Bimoba, *Phonology* 15.1, 77-101.

For more information about tone analysis, see:

Snider, Keith. 1999. *The Geometry and Features of Tone*. Dallas: The Summer Institute of Linguistics and the University of Texas at Arlington.

Fundamental frequency measurements

In Module F0, you measure the fundamental frequency at the beginning and middle of Ejagham words meaning *cooking pot* and *mongoose* recorded in a sentence frame: "here is a _____."

As you do the steps in this module, you will write measurements in the following table.

Round semitone values to the nearest *tenth* and hertz values to the nearest *whole number*.

To verify your measurements when you have finished the module, see page 47.

File	**Fundamental frequency (st)**		**Fundamental frequency (Hz)**	
	beginning	**middle**	**beginning**	**middle**
cooking pot.wav				
mongoose.wav				

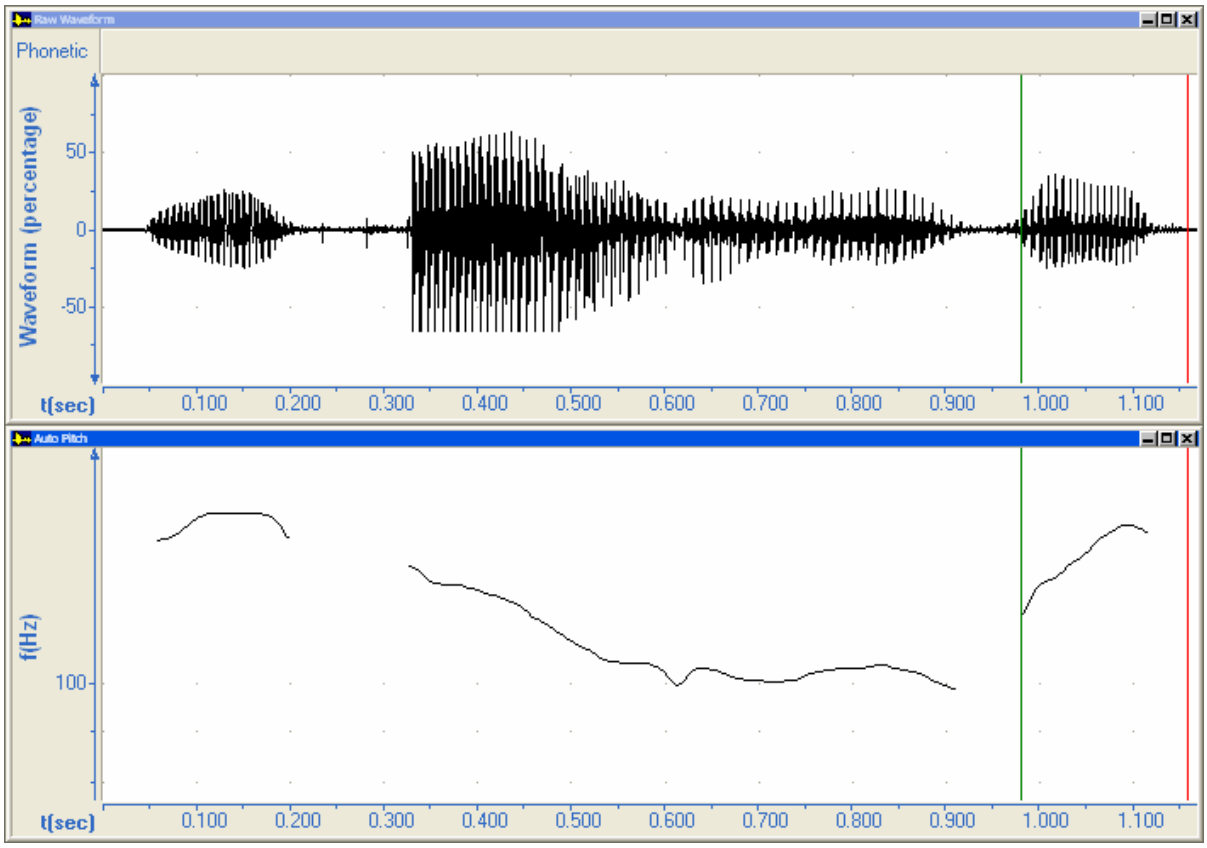
.179 Start Speech Analyzer. For more information, see page 6.

.180 Open the **cooking pot.wav** file in the **Samples** folder. For more information, see page 7.

.181 To hear the tone and compare to the graph, play the file. For more information, see page 9.

Measuring fundamental frequency

.182 Move the begin cursor to the beginning of the last word at about 0.98 seconds. For more information, see page 11.



.183 Click the title bar of the **Auto Pitch** graph.

At the lower right, the status bar displays measurements for the *active* graph.

The third and fourth panes of the status bar display the fundamental frequency at the begin cursor in semitones (st) and hertz (Hz).

.184 If the panes do not display frequencies, drag the begin cursor slightly to the right.

.185 Write the measurements in the first and third columns of the table on page 38.

.186 Move the begin cursor to the middle of the word at about 1.05 seconds.

.187 Write the measurements in the second and fourth columns of the table on page 38.

.188 Open the **mongoose.wav** file in the **Samples** folder.

.189 Repeat steps 1 through 6.

The beginning of the last word is at about 1.06 seconds.

The middle of the last word is at about 1.12 seconds.

Copying measurements

If there is a spreadsheet or word processing program on the computer, you can copy a set of measurements from Speech Analyzer.

.190 On the **Edit** menu, click **Copy Measurements**.

Speech Analyzer copies the measurements to the Clipboard in tab-delimited format.

.191 To paste the measurements, do one or both of the following:

Start a spreadsheet program (for example, Microsoft Excel), and then press **Ctrl+V**.

The first row consists of column headings.

The second row consists of data values.

	A	B	C	D	E	F	G	H	I	J	K	L
1	Filename	Speaker	Gender	Start (sec)	Duration (s	f0 (Hz)	f0 (st)	Intensity (c	F1 (Hz)	F2 (Hz)	F3 (Hz)	F4 (Hz)
2	mongoose.wav		Male	1.1177		103.9	44	-12.49	402.9	1978.4	2420.2	3337

Start a word processing program (for example, Microsoft Word), and then press **Ctrl+V**.

The first paragraph consists of column headings.

The second paragraph consists of data values.

```
Filename → Speaker → Gender Start·(sec) → Duration·(sec) f0·(Hz) f0·(st)
→ Intensity·(dB) F1·(Hz) → F2·(Hz) → F3·(Hz) → F4·(Hz)¶
mongoose.wav → → Male 1.1177 → 103.9 44.0 → -12.49 402.9 1978.4
→ 2420.2 3337.4¶
```

You can delete columns that are not relevant to your task.

.192 In the pasted data, find the time value at the begin cursor and the f_0 values in Hz and st.

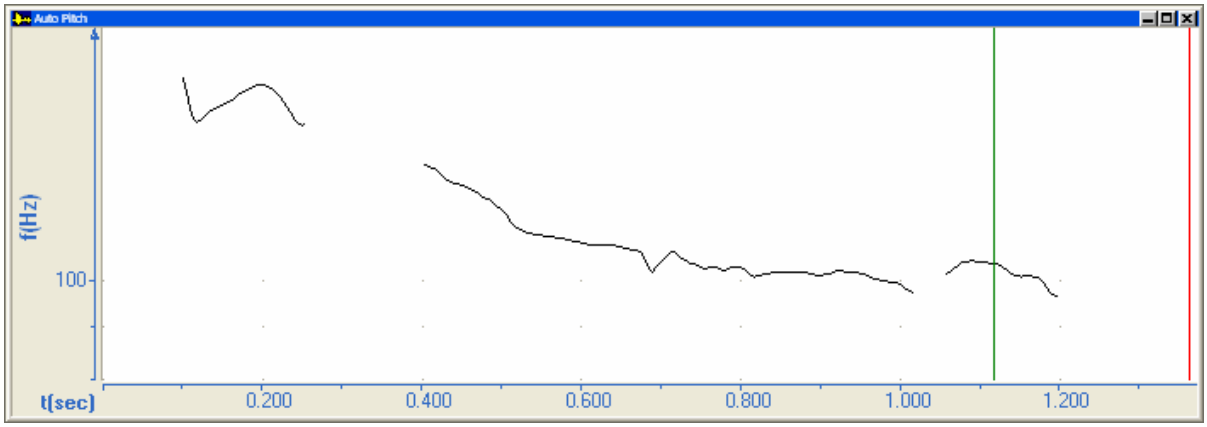
.193 Close the spreadsheet or word processing program.

You do not need to save the changes to the new spreadsheet or document.

Changing the display scale

The status bar displays precise values of the fundamental frequency at the begin cursor. You might also want to quickly estimate approximate values on the vertical axis.

.194 In the **Auto Pitch** graph for the **mongoose.wav** file, attempt to estimate the frequency at the begin cursor visually using the scale on vertical axis without using the status bar.



.195 Right-click in the plot area of the Pitch graph, and then click **Parameters**.

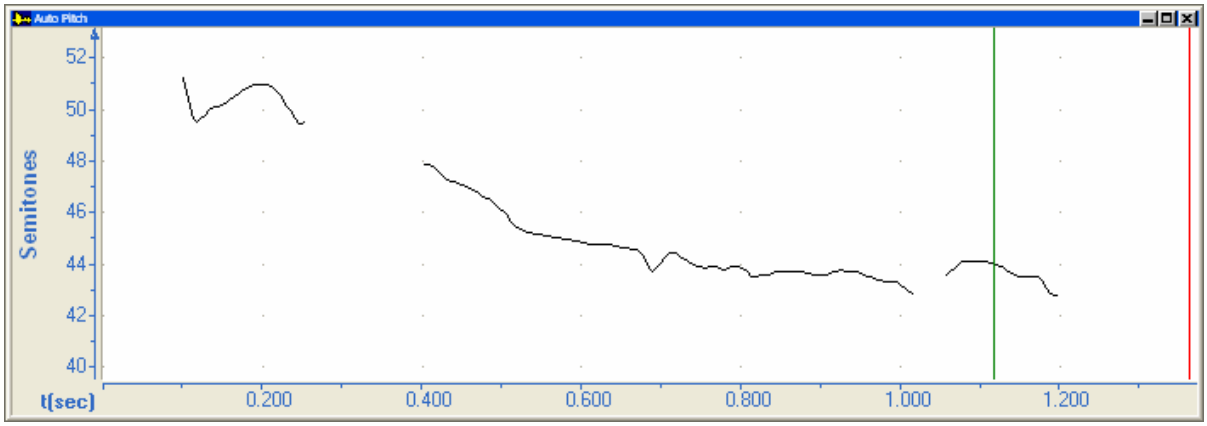
The **Graph Parameters** dialog box appears with the **Pitch** tab visible.

.196 In the **Scaling** list, select **Semitones**.

.197 Click **OK**.

A *semitone* represents a half step on a musical scale. The scale on the vertical axis displays more values.

.198 Estimate the frequency at the begin cursor again using the scale on the vertical axis



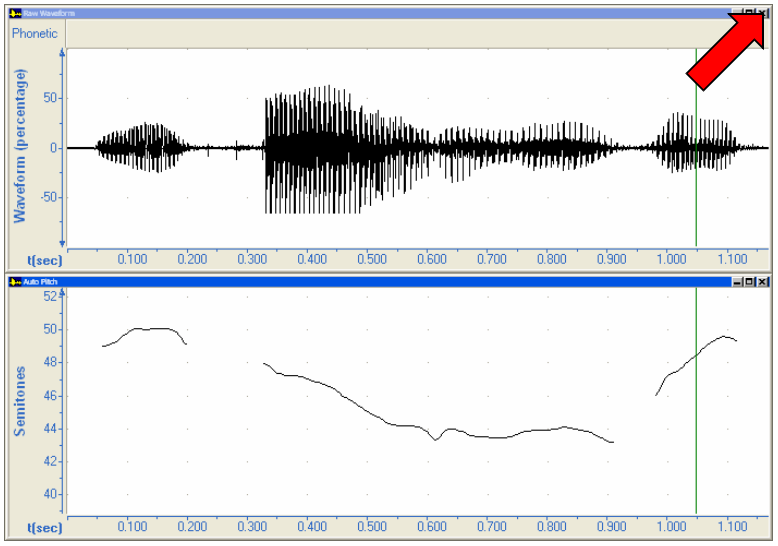
.199 To switch the active file: On the **Window** menu, click **cooking pot.wav**.

.200 Repeat steps 2 through 5.

Comparing fundamental frequency

In addition to quantitative comparisons, you can make qualitative comparisons visually.

.201 To close the **Raw Waveform** graph in the upper half of the file window, click the **Close** button.



.202 To switch the active file: On the **Window** menu, click **mongoose.wav**.

.203 Close the **Raw Waveform** graph in the upper half of the file window.

.204 On the **Window** menu, click **Tile Horizontal**.

Speech Analyzer displays the active file at the top.

The title bar of the active window and graph has a brighter color. In this case, **mongoose.wav** is active.

If the title bar of a window or graph is dimmed, it is not active. In this case, **cooking pot.wav** is not active.

.205 Play the files. For more information, see page 9.

How would you describe the differences in pitch?

.206 In the **Auto Pitch** graphs, notice that the contour of the *here is a* frame is similar, but the contour of *mongoose* and *cooking pot* is different.

The *visual* appearance of the fundamental frequency contour of *cooking pot* is rising. Does this mean that there is a rising tone in Ejagham? No—do *not* assume the shapes of contours that you see in Speech Analyzer represent pitch and tone as perceived by vernacular language speakers.

Selecting graph types and setting graph parameters

The Auto Pitch graph displays continuous lines when the individual data points are close enough. You can use the lines to confirm what you hear. If you hear pitch or tone in an utterance that differs substantially from the computed fundamental frequencies and plotted lines, do not assume the Pitch graph to be correct.

The Auto Pitch graph might not display data where you expect it, due to any of the following:

background noise

minimal voicing

very high or very low fundamental frequency

rapid change from one frequency to another

To analyze and interpret data, you might need to change the graph type and adjust parameters.

.207 For more information: On the **Help** menu, click **Graphs**.

The Help window opens.

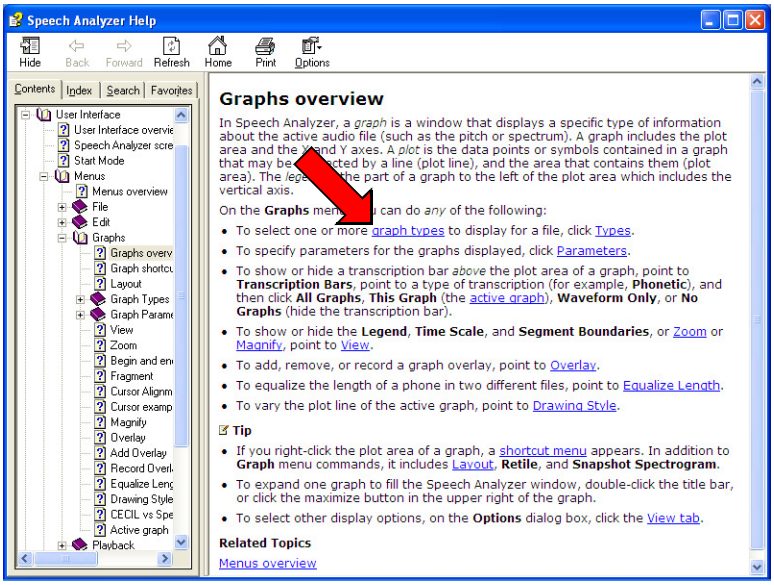
.a In the first bullet point in **Graphs overview**, click the **graph types** hyperlink

.b At the lower left of the table of graph types, click the **Pitch** hyperlink.

.c Read **Pitch graphs**.

.d Click the **Auto Pitch graph** hyperlink, read the topic, and then click **Back** on the toolbar.

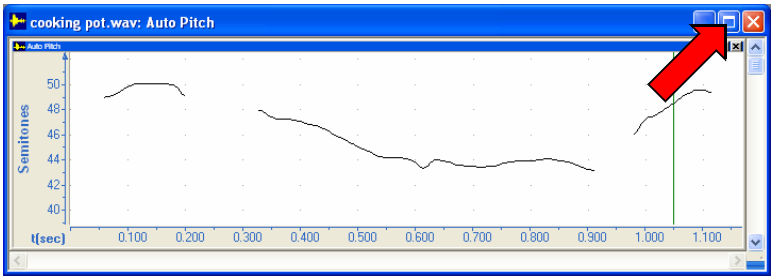
.e Close the Help window.



.208 To compare Pitch graphs, do the following:

.a Minimize the **mongoose.wav** window.

.b Maximize the **cooking pot.wav** window.



.c On the **Graphs** menu, click **Types**.

The **Graph Types** dialog box appears.

.d Click **Custom**.

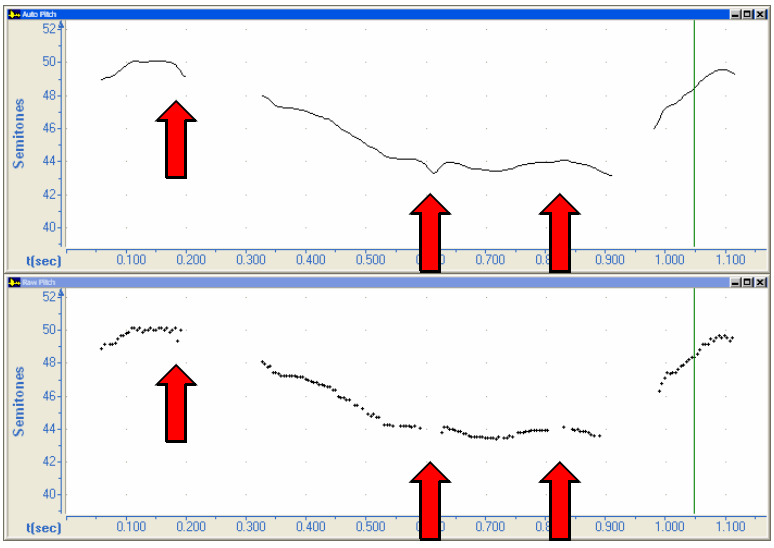
The **Custom Graph Types** dialog box appears.

.e Select the **Raw Pitch** check box.

.f Click **OK**.

The **Auto Pitch** graph is in the upper half of the window.

The **Raw Pitch** graph is in the lower half.



Compare the line in the upper half to the data points in the lower half.

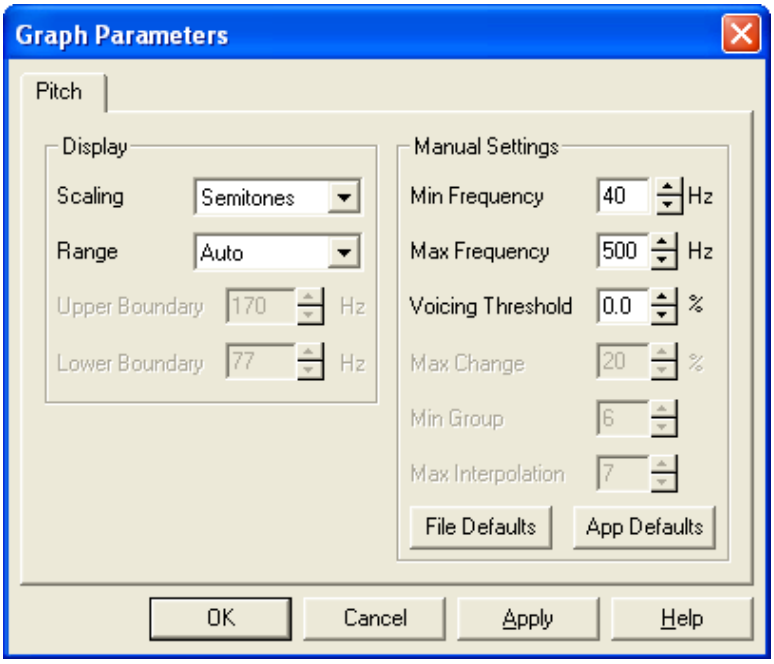
Speech Analyzer extrapolated data from the available points in at least three places.

In this case, the extrapolated data is in the frame, not the word for *cooking pot*.

.209 To see additional data points that Speech Analyzer filtered out, do the following:

.a Right-click in the plot area of the **Raw Pitch** graph, and then click **Parameters**.

The **Graph Parameters** dialog box appears with the **Pitch** tab visible.



.b For more information, click **Help**.

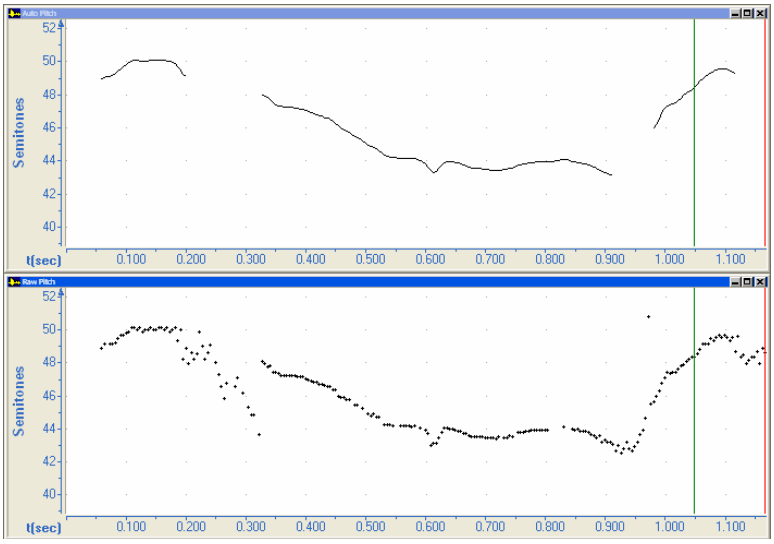
The Help window opens.

.c Read **Pitch tab, Graph Parameters**.

.d Close the Help window.

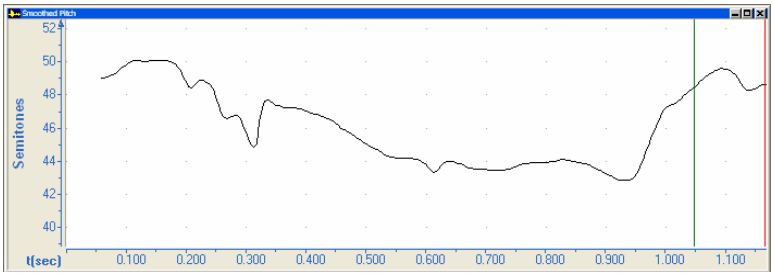
.e In the **Graph Parameters** dialog box, change the value in the **Voicing Threshold** box to **0.0%**.

.f Click **OK**.



In this case, the additional points are suspect, because they appear where there is minimal voicing.

.210 To see a smoothed line corresponding to these parameters, right-click in the plot area of the **Raw Pitch** graph, point to **Types**, and then click **Smoothed Pitch**.



.211 To change the display scale back to the default, do the following:

.a Right-click in the plot area of the **Auto Pitch** graph, and then click **Parameters**.

The **Graph Parameters** dialog box appears with the **Pitch** tab visible.

.b In the **Scaling** list, select **Logarithmic**.

.c Click **OK**.

.212 Exit Speech Analyzer.

.213 If a **Speech Analyzer** dialog box appears, click **No**. You do not need to save the change to the voicing threshold for the **cooking pot.wav** file.

Exercise F0-1

.214 Start Speech Analyzer.

.215 Open the **Chinese.wav** file in the **Samples** folder.

.216 Measure the fundamental frequency at the beginning and end of the first and fifth occurrence of the vowel [a].

Measure the first [a] at 0.1888 and 0.2291 seconds.

Measure the fifth [a] at 1.4818 and 1.5960 seconds.

Round semitone values to the nearest *tenth* and hertz values to the nearest *whole number*.

Write the four sets of measurements in the following table:

Vowel	**Fundamental frequency (st)**		**Fundamental frequency (Hz)**	
	beginning	**end**	**beginning**	**end**
first [a]				
fifth [a]				

.217 Exit Speech Analyzer.

Exercise F0-2

If you did Module RS, do the following:

.218 Start Speech Analyzer.

.219 Open the **collar.wav** and **color.wav** files in the **Speech Analyzer** folder.

.220 Measure the fundamental frequency in the two syllables of *collar* and *color*.

Round semitone values to the nearest *tenth* and hertz values to the nearest *whole number*.

File	Fundamental frequency (st)		Fundamental frequency (Hz)	
	first syllable	second syllable	first syllable	second syllable
collar.wav				
color.wav				

.221 Exit Speech Analyzer.

Expected fundamental frequency measurements for Module F0

To check your measurements, compare the table on page 38 with the following data:

File	Fundamental frequency (st)		Fundamental frequency (Hz)	
	beginning	middle	beginning	middle
cooking pot.wav	46.0	48.5	117	134
mongoose.wav	43.4	44.0	101	104

Expected fundamental frequency measurements for Exercise F0-1

To check your measurements, compare the table on the preceding page with the following data:

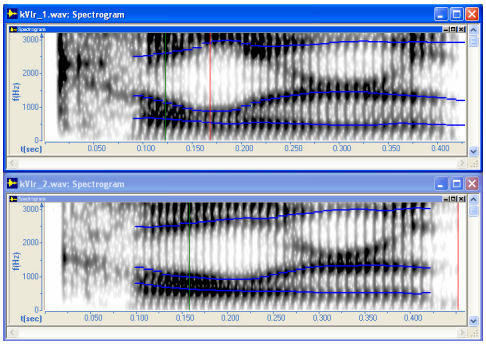
Vowel	Fundamental frequency (st)		Fundamental frequency (Hz)	
	beginning	end	beginning	end
first [a]	60.6	60.7	271	272
fifth [a]	60.9	55.2	276	198

Measurements for Exercise F0-2 will vary, because the audio data was recorded by the student.

Module SG: Measuring Formant Frequencies in a Spectrogram

Learning objective: Measure formant frequencies in a Spectrogram graph.

Audio files: kVlr_1.wav and kVlr_2.wav



A *spectrogram* is a three-dimensional plot of the intensity of the frequency content of a signal as it changes over time. Usually the vertical axis indicates frequency, the horizontal axis indicates time, and the color or gray scale indicates intensity.

You can use a spectrogram to measure formants, especially vowel formants. *Formants* (or formant frequencies) are the resonant frequencies of the vocal tract. Individual formants are numbered in order of ascending frequency (as in F1, F2, F3, and so on). Formants appear as dark bands in a spectrogram.

You can also use a spectrogram to analyze voiced and unvoiced sounds, periodic and aperiodic sounds, glottal pulses, and fundamental frequency overtones.

In this module, you will do a qualitative visual comparison between spectrograms, along with displaying and measuring formants frequencies. For more information about interpreting spectrograms for linguistic analyses, see chapter 3 of Baart. 2001. *Acoustic Phonetics*.

Formant frequency measurements

In Module SG, you measure formant frequencies of vowels in two similar utterances to determine if there is any significant difference.

To minimize context effects on the vowels, both words were originally recorded in a frame.

As you do the steps in this module, you will write measurements in the following table.

Round the values to the nearest *whole number*.

To verify your measurements when you have finished the module, see page 56.

File	Formant frequencies of vowel		
	F1	F2	F3
kVlr_1.wav			
kVlr_2.wav			

Selecting graph types

.222 Start Speech Analyzer. For more information, see page 6.

.223 Open the **kVlr_1.wav** file in the **Samples** folder. For more information, see page 7.

The **Raw Waveform** graph is in the upper half of the Speech Analyzer window.

The **Auto Pitch** graph is in the lower half.

.224 On the Speech Analyzer taskbar, click **Waveform, Spectrogram**.

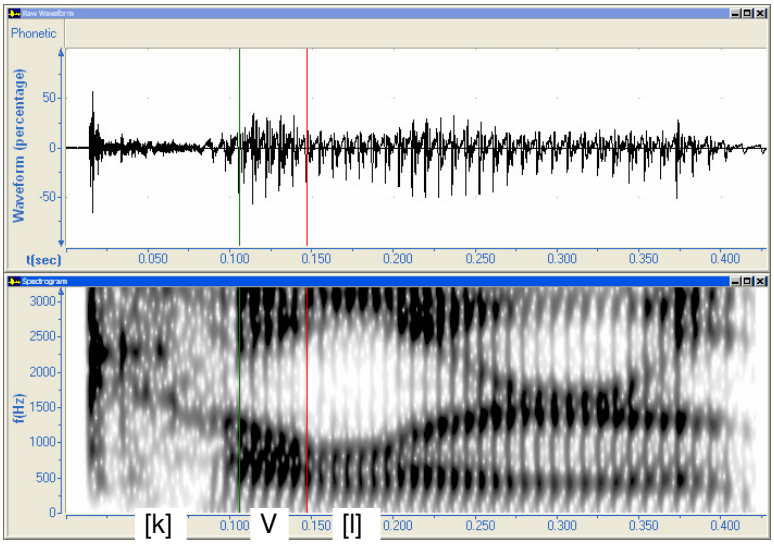
The **Spectrogram** graph replaces the **Auto Pitch** graph in the lower half.

.225 Play the file. For more information, see page 9.

.226 Move the begin cursor to the beginning of the vowel just past 0.10 seconds. For more information, see page 11.

.227 Move the end cursor to the end of the vowel at about 0.15 seconds.

.228 Notice the visual changes in intensity and shape of the formants in the vowel as it transitions from the preceding consonant [k] to the following consonant [l].



Identifying and measuring formant frequencies visually

In the **Spectrogram** graph, identify the formants of the vowel between the cursors. The formant slope shows that the vowel is in transition from the [k] to the [l].

.229 Click the title bar of the **Spectrogram** graph.

.230 Point at the lowest formant band (F1) in the area between the begin and end cursors.

When you move the mouse pointer into the plot area of a **Spectrogram** graph, it becomes a pointing hand .

At the lower right, the status bar displays measurements for the *active* graph.

The first pane displays the time at the begin cursor.

The second pane displays the time difference between the cursors (that is, the duration of the portion of audio data).

The third pane displays the frequency at the mouse pointer. It corresponds to the scale on the vertical axis.

The fourth pane displays the intensity for the frequency at the mouse pointer.

.231 Write the measurement of the F1 frequency in the following table.

File	**Formant frequencies of vowel**		
	F1	**F2**	**F3**
kVlr_1.wav			

.232 Point at the second formant band (F2) in the area between the begin and end cursors.

.233 Write the measurement of the F2 frequency in the table.

.234 Point at the third formant band (F3) in the area between the begin and end cursors.

.235 Write the measurement of the F3 frequency in the table.

.236 For more information: On the **Help** menu, click **Graphs**.

The Help window opens.

.a In the first bullet point in **Graphs overview**, click the **graph types** hyperlink

.b In the table of graph types, click the **Spectrogram** hyperlink.

.c Read **Spectrogram graph**.

.d Close the Help window.

Displaying formant tracks

Speech Analyzer can compute and display formant tracks (lines) representing the center frequency of each formant at each point in time.

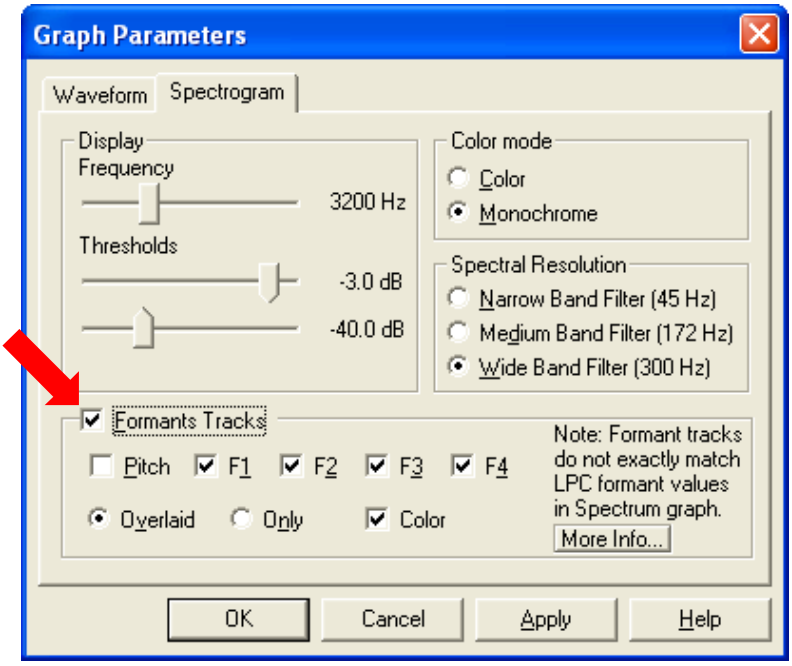
You can use the formant tracks to confirm what you identify visually. If you identify formants in a spectrogram that differ substantially from the computed formant tracks, do not assume the formant tracks to be correct.

.237 Move the begin cursor to the middle of the first vowel at 0.1225 seconds.

.238 Right-click in the plot area of the **Spectrogram** graph, and then click **Parameters**.

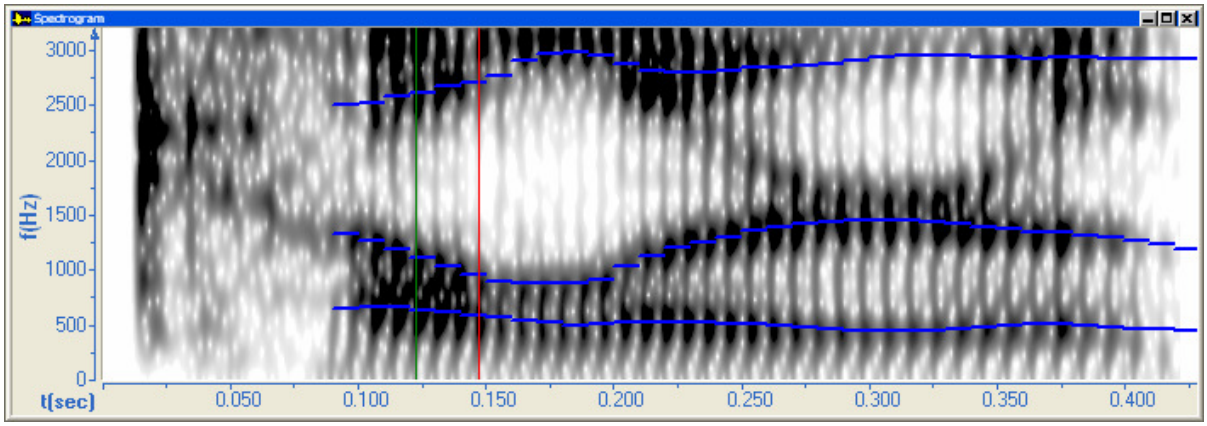
The **Graph Parameters** dialog box appears with the **Spectrogram** tab visible.

.239 Select the **Formant Tracks** check box.



.240 Click **OK**.

The default color of formant tracks is blue.



At the lower right, the status bar displays measurements for the *active* graph.

The four panes display the values of F1, F2, F3, and F4 at the begin cursor. That is, the frequencies at the intersection of the begin cursor and the formant tracks.

Measuring formant frequencies

When the **Spectrogram** graph displays formant tracks, the values in the status bar depend on the begin cursor, *not* the mouse pointer.

.241 Write the measurements of F1, F2, and F3 in the table on page 48.

.242 Open the **kVlr_2.wav** file in the **Samples** folder.

.243 On the Speech Analyzer taskbar, click **Waveform, Spectrogram**.

.244 Move the begin cursor to the middle of the vowel at 0.1576 seconds.

.245 Click the title bar of the **Spectrogram** graph.

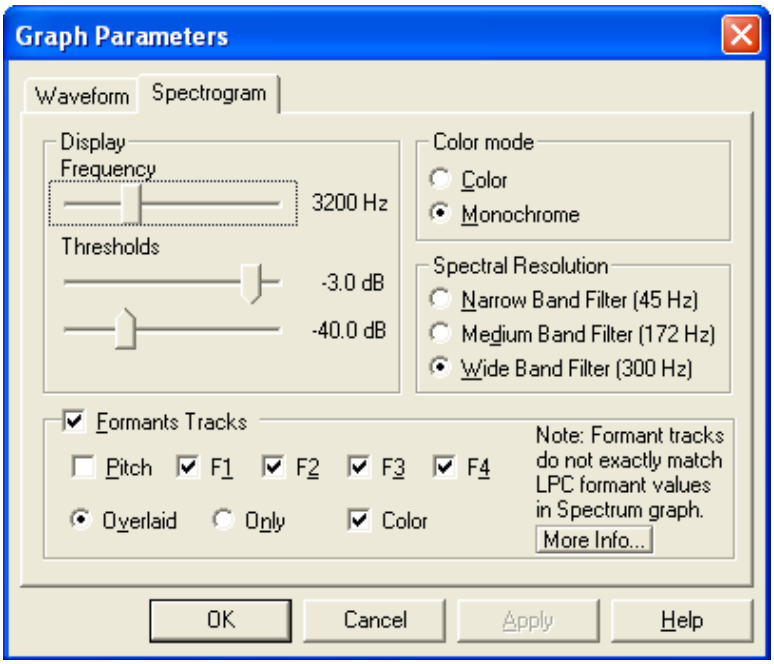
If you do not see the measurements that you expect in the status bar, make sure that the correct file window and graph is active.

.246 Write the measurements of F1, F2, and F3 in the table on page 48.

Changing display parameters

.247 Right-click in the plot area of the **Spectrogram** graph, and then click **Parameters**.

The **Graph Parameters** dialog box appears with the **Spectrogram** tab visible.



.248 To see the entire **Spectrogram** graph, drag the dialog box to the upper half of the window.

.249 In some cases, the **Threshold** sliders can help you see formants more clearly. As you do the following, observe the effect on the formants in the **Spectrogram** graph.

Drag the upper **Threshold** slider all the way to the left, and then to the right.

Drag the lower **Threshold** slider all the way to the left, and then to the right.

.250 For more information, click **Help**.

The Help window opens.

.a Read **Spectrogram tab, Graph Parameters**.

.b Click the **formant** hyperlink. Read the topic.

.c Close the Help window.

.251 To reset the parameters, do the following in the **Display** area:

Drag the upper **Threshold** slider until **-3.0 dB** appears again.

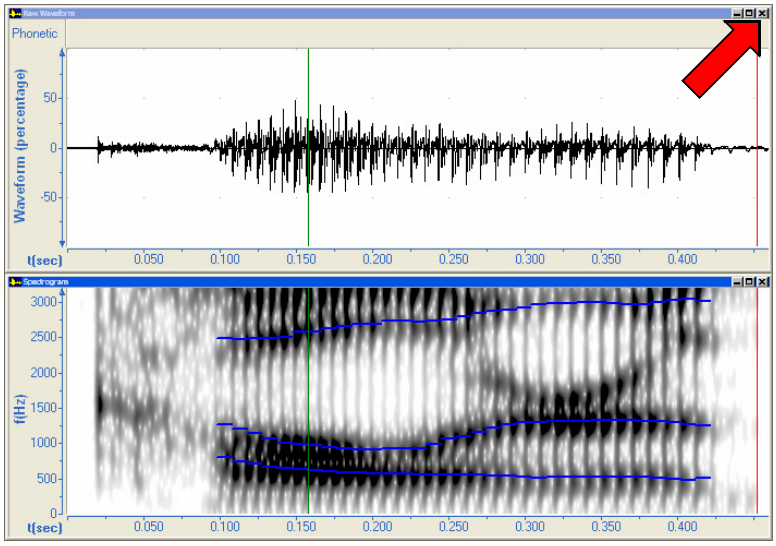
Drag the lower **Threshold** slider until **-40.0 dB** appears again.

.252 Click **Cancel**.

Comparing spectrograms

In addition to quantitative comparisons, you can make qualitative comparisons visually.

.253 To close the **Raw Waveform** graph in the upper half of the file window, click the **Close** button.



.254 To switch the active file: On the **Window** menu, click **kVlr_1.wav**.

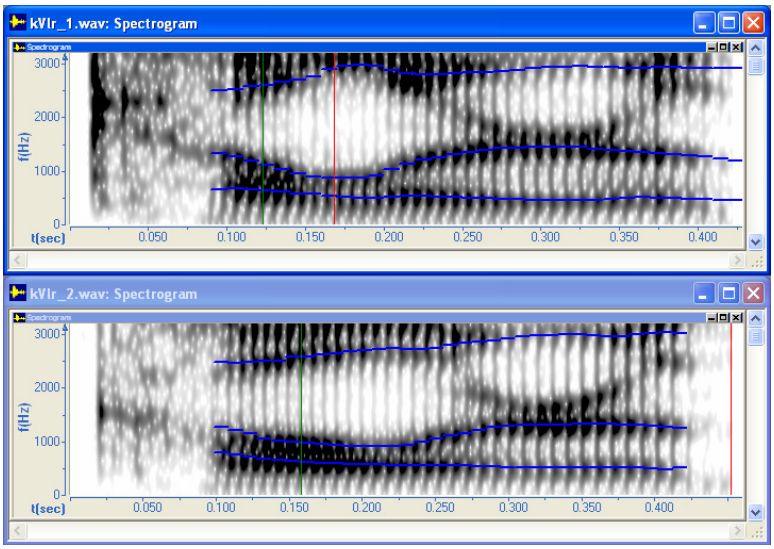
.255 Close the **Raw Waveform** graph in the upper half of the file window.

.256 On the **Window** menu, click **Tile Horizontal**.

Speech Analyzer displays the active file in the upper half.

The title bar of the active window and graph has a brighter color. In this case, **kVlr_1.wav** is active.

If the title bar of a window or graph is dimmed, it is not active. In this case, **kVlr_2.wav** is not active.



.257 Play the files. For more information, see page 9.

How would you describe the differences in the utterances?

.258 In the **Spectrogram** graphs, compare the shape of the formants. In the table on page 48, compare the formant measurements.

What similarities and differences do you notice between the two spectrograms?

.259 To make sure the next window you open will be maximized, maximize one of the file windows.

.260 Exit Speech Analyzer.

Exercise SG-1

.261 Start Speech Analyzer.

.262 Open the **boa constrictor.wav** and **meat.wav** files in the **Speech Analyzer** folder.

.263 Measure formant frequencies of the first vowel.

In the **boa constrictor.wav** file, measure at 0.1343 seconds.

In the **meat.wav** file, measure at 0.1544 seconds.

File	**Formant frequencies of vowel**		
	F1	**F2**	**F3**
boa constrictor.wav			
meat.wav			

.264 Exit Speech Analyzer.

Exercise SG-2

If you did Module RS, do the following:

.265 Start Speech Analyzer.

.266 Open the **collar.wav** and **color.wav** files in the **Speech Analyzer** folder.

.267 Measure formant frequencies of the vowels in the words *collar* and *color*.

File	**Formant frequencies of vowel**		
	F1	**F2**	**F3**
collar.wav			
color.wav			

.268 Exit Speech Analyzer.

Expected formant frequency measurements for Module SG

To check your measurements, compare the table on page 48 with the following data:

File	Formant frequencies of vowel		
	F1	F2	F3
kVlr_1.wav	638	1116	2613
kVlr_2.wav	616	968	2589

Expected formant frequency measurements for Exercise SG-1

To check your measurements, compare the table on the preceding page with the following data:

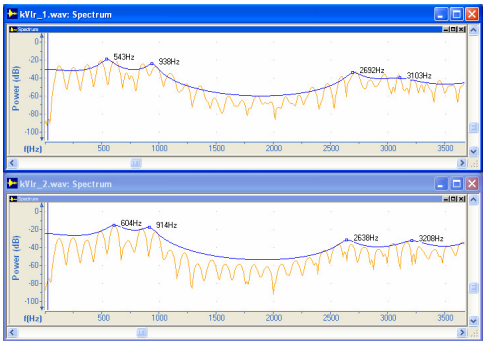
File	Formant frequencies of vowel		
	F1	F2	F3
boa constrictor.wav	452	891	2209
meat.wav	458	1620	2245

Measurements for Exercise SG-2 will vary, because the audio data was recorded by the student.

Module SM: Measuring Formant Frequencies in a Spectrum

Learning objective: Measure formant frequencies in a Spectrum graph.

Audio files: kVlr_1.wav and kVlr_2.wav



A *spectrum* is a two-dimensional plot of the intensity of the frequency content of a signal.

In a spectrum, the horizontal axis indicates frequency and the vertical axis indicates intensity. In a spectrogram, the horizontal axis indicates time, the vertical axis indicates frequency, and the color or gray scale indicates intensity. You can think of a spectrum as a slice of a spectrogram at a point in time. The peaks and valleys in a spectrum correspond to the darker and lighter gray scale in a spectrogram.

In Speech Analyzer, the Spectrum graph displays the energy levels at each frequency in the portion of audio data between the begin and end cursors.

A spectrum can be useful when determining whether or not two similar sounds are the same or different by comparing formant frequencies. *Formants* (or formant frequencies) are the resonant frequencies of the vocal tract. The term is also used to refer to the peaks in the spectrum caused by these resonances. Individual formants are numbered in order of ascending frequency (as in F1, F2, F3, and so on).

Spectra, as compared to spectrograms, provide a view that is more conducive to taking precise measurements of formant frequencies.

For more information about knowing when to use a spectrum or spectrogram, and how to interpret these graphs, see chapter 3 of Baart. 2001. *Acoustic Phonetics*.

Formant frequency measurements

In Module SM, you measure formant frequencies of vowels in two similar utterances, and then compare the measurements to Module SG.

To minimize context effects on the vowels, both words were originally recorded in a frame.

As you do the steps in this module, you will write measurements in the following table.

To verify your measurements when you have finished the module, see page 64.

File	**Formant frequencies of vowel**		
	F1	**F2**	**F3**
kVlr_1.wav			
kVlr_2.wav			

.269 Start Speech Analyzer. For more information, see page 6.

.270 Open the **kVlr_1.wav** file in the **Samples** folder. For more information, see page 7.

Selecting graph types

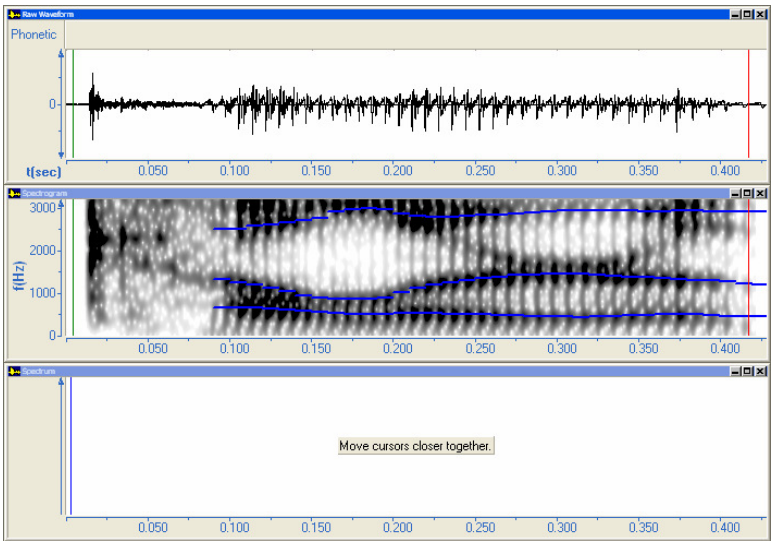
.271 On the Speech Analyzer taskbar, click **Waveform, Spgm, Sptrm**.

The **Raw Waveform** is in the upper third of the Speech Analyzer window.

The **Spectrogram** graph is in the middle third.

The **Spectrum** graph is in the lower third.

The plot area of the **Spectrum** graph displays **Move cursors closer together**. Do not do it now.



.272 For more information: On the **Help** menu, click **Graphs**.

The Help window opens.

.a In the first bullet point in **Graphs overview**, click the **graph types** hyperlink

.b In the table of graph types, click the **Spectrum** hyperlink.

.c Read **Spectrum graph**.

.d Close the Help window.

Measuring formant frequencies

.273 Move the begin cursor to about 0.095 seconds.

.274 Move the end cursor to about 0.155 seconds.

.275 On the toolbar, click **Zoom Cursors**.

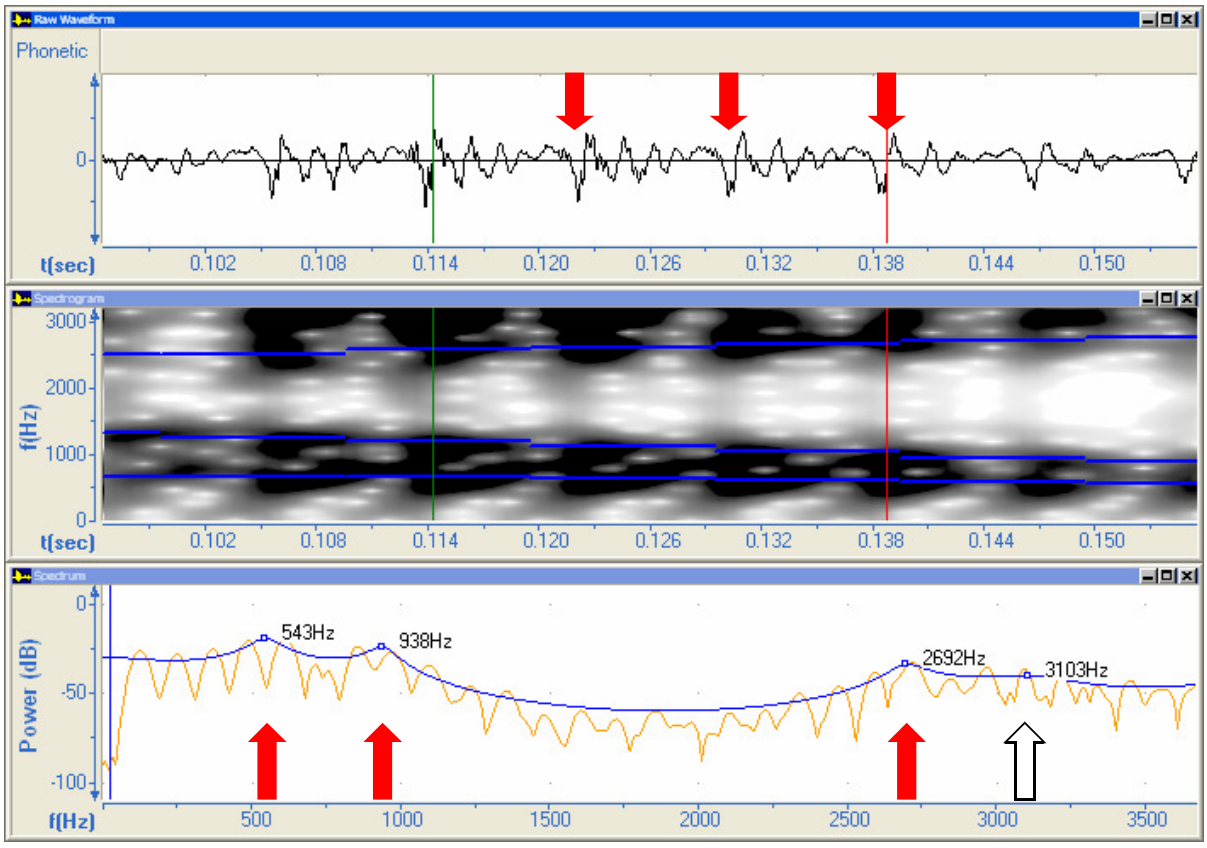
The horizontal scale of the time-based **Raw Waveform** and **Spectrogram** graphs displays the portion of audio data.

.276 To move the begin cursor into the vowel, press **Ctrl+Right Arrow** a few times until **0.1143** appears in the first pane of the status bar.

.277 To move the end cursor, press **Shift+Left Arrow** a few times until **0.0244** appears in the second pane of the status bar.

The portion of audio data consists of three fragments of the vowel.

In Speech Analyzer, a *fragment* is the smallest significant unit of audio information in a sound. Fragment boundaries are located at the beginning of large positive pulses, usually pitch pulses. In unvoiced sounds, fragment boundaries are often located at the beginning of major acoustic events like bursts.



The **Spectrum** graph displays the spectrum for the portion of audio data between the begin and end cursors. Speech Analyzer computes F1, F2, F3, and F4 using an LPC model.

.278 Write the measurements of F1, F2, and F3 in the table on page 58.

.279 Open the **kVlr_2.wav** file in the **Samples** folder.

.280 On the Speech Analyzer taskbar, click **Waveform, Spgm, Sptrm**.

.281 Move the begin cursor to about 0.098 seconds.

.282 Move the end cursor to about 0.2 seconds.

.283 On the toolbar, click **Zoom Cursors**.

The horizontal scale of the time-based **Raw Waveform** and **Spectrogram** graphs displays the portion of audio data.

.284 To be able to make smaller adjustments to the cursors, do the following:

.a On the **Tools** menu, click **Options**.

The **Options** dialog box appears.

.b In the **Cursor** area, click **Zero Crossing**

A *zero crossing* is a point where an audio waveform crosses the zero-line from negative to positive.

In this case, you need to override the end of the fragment that Speech Analyzer identifies.

.c Click **OK**.

.285 To move the begin cursor into the vowel press **Ctrl+Right Arrow** several times until **0.1414** appears in the first pane of the status bar.

.286 To move the end cursor, press **Shift+Left Arrow** several times until **0.0244** appears in the second pane of the status bar.

The portion of audio data consists of three fragments of the vowel.

.287 Write the measurements of F1, F2, and F3 in the table on page 58.

.288 To compare F1, F2, and F3, click the title bar of the **Spectrogram** graph.

The four panes display the values of F1, F2, F3, and F4 at the begin cursor. That is, the frequencies at the intersection of the begin cursor and the formant tracks.

If you do not see the measurements that you expect in the status bar, make sure that the correct file window and graph is active.

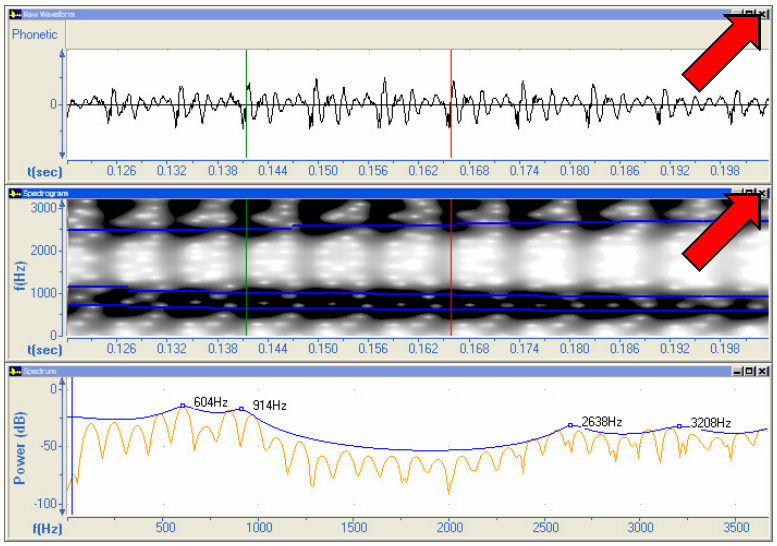
.289 Compare the measurements in the tables on pages 48 and 58.

Speech Analyzer computes formant values on **Spectrogram** and **Spectrum** graphs in slightly different ways.

Comparing spectra

In addition to quantitative comparisons, you can make qualitative comparisons visually.

.290 To close the **Raw Waveform** and **Spectrogram** graphs, click the **Close** buttons.



.291 To switch the active file: On the **Window** menu, click **kVlr_1.wav**.

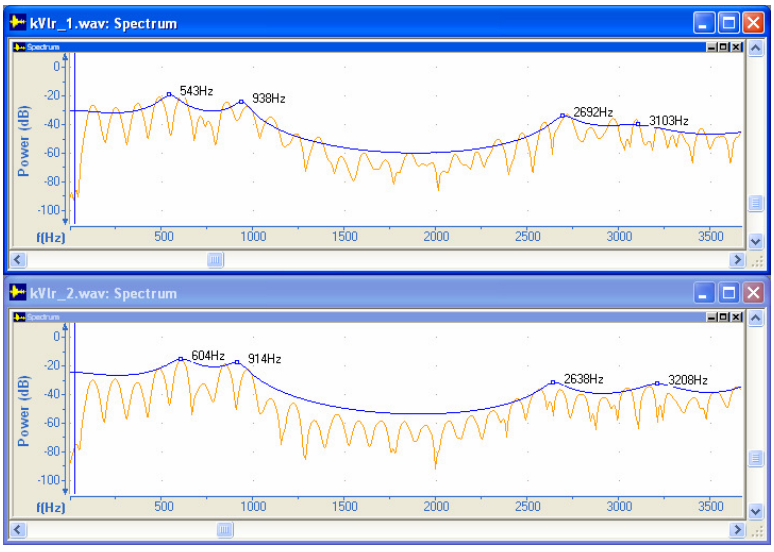
.292 Close the **Raw Waveform** and **Spectrogram** graphs

.293 On the **Window** menu, click **Tile Horizontal**.

Speech Analyzer displays the active file in the upper half.

The title bar of the active window and graph has a brighter color. In this case, **kVlr_1.wav** is active.

If the title bar of a window or graph is dimmed, it is not active. In this case, **kVlr_2.wav** is not active.



.294 In the **Spectrum** graphs, compare the shapes of the lines.

What similarities and differences do you notice in the vowels?

For example, note that F1 and F2 are farther apart in **kVlr_1.wav** than in **kVlr_2.wav**.

.295 To make sure the next window you open will be maximized, maximize one of the file windows.

.296 Exit Speech Analyzer.

Exercise SM-1

.297 Start Speech Analyzer.

.298 Open the **boa constrictor wav** and **meat.wav** files in the **Speech Analyzer** folder.

.299 Measure formant frequencies of the first vowel.

In the **boa constrictor.wav** file, move the begin and end cursor to about 0.10 and 0.20 seconds, click **Zoom Cursors**, and then move the cursors until **0.1343** and **0.0200** appear in the first and second pane of the status bar.

In the **meat.wav** file, move the begin and end cursor to about 0.10 and 0.20 seconds, click **Zoom Cursors**, and then move the cursors until **0.1544** and **0.0228** appear in the first and second pane of the status bar.

File	**Formant frequencies of vowel**		
	F1	**F2**	**F3**
boa constrictor.wav			
meat.wav			

.300 Exit Speech Analyzer.

Exercise SM-2

If you did Module RS, do the following:

.301 Start Speech Analyzer.

.302 Open the **collar.wav** and **color.wav** files in the **Speech Analyzer** folder.

.303 Measure formant frequencies of the vowels of the words *collar* and *color*.

File	**Formant frequencies of vowel**		
	F1	**F2**	**F3**
collar.wav			
color.wav			

.304 Exit Speech Analyzer.

Expected formant frequency measurements for Module SM

To check your measurements, compare the table on page 58 with the following data:

File	Formant frequencies of vowel		
	F1	F2	F3
kVlr_1.wav	543	938	2692
kVlr_2.wav	604	914	2638

Expected formant frequency measurements for Exercise SM-1

To check your measurements, compare the table on the preceding page with the following data:

File	Formant frequencies of vowel		
	F1	F2	F3
boa constrictor.wav	411	892	2223
meat.wav	478	1640	2843

Measurements for Exercise SM-2 will vary, because the audio data was recorded by the student.

Appendix CU: Cleaning Up Your Computer

The procedures in some modules of the training course included resetting options that you changed. After you have finished the course, do any of the following to clean up your computer.

Module GS

The **Start Mode** dialog box displays a list of recently opened audio files. During the course, you did not use the **Start Mode** dialog box (see page 6). To use it in your work, do the following:

.305 On the **File** menu, click **Open Startup**.

The **Start Mode** dialog box appears.

.306 Do any of the following:

Select an existing file, and then click **OK**.

Click **Record**.

Click **Close**.

Module RS

If you did Module RS, you saved a recording and two selected portions (see page 20).

.307 In Windows Explorer, navigate to the **Speech Analyzer** folder.

.308 Delete the collar.wav, color.wav, and color_collar.wav files.

.309 If you did Exercise RS, delete any other audio files that you saved (see page 22).

Module IN

.310 Right-click in the plot area of an **Intensity** graph, and then click **Parameters**.

The **Graph Parameters** dialog box appears with the **Intensity** tab visible.

.311 In the **Display Scale** area, select **Linear Magnitude (%)**.

.312 Click **OK**.

Module SG and SM

.313 Right-click in the plot area of a **Spectrogram** graph, and then click **Parameters**.

The **Graph Parameters** dialog box appears with the **Spectrogram** tab visible.

.314 Clear the **Formant Tracks** check box.

.315 Click **OK**.

Module SM

.316 On the **Tools** menu, click **Options**.

The **Options** dialog box appears.

.317 In the **Cursor** area, click **Fragment**.

.318 Click **OK**.

Appendix ID: Adjusting Settings for Audio Input Devices

The following procedures are for a microphone. The settings for other audio input devices are similar. The procedure for Microsoft Windows Vista is on the next page.

For more information about setting the recording level, see page 16.

Windows XP

.1 In the **Recording Control** dialog box: If you are using a microphone, make sure that its check box is selected.

.2 On the **Options** menu, do one of the following:

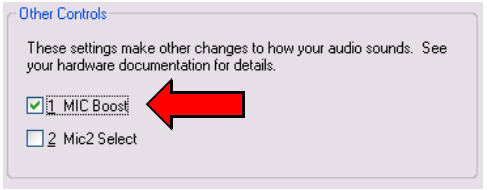
If there is *already* a check mark at the left of **Advanced Controls**, press **Esc**.

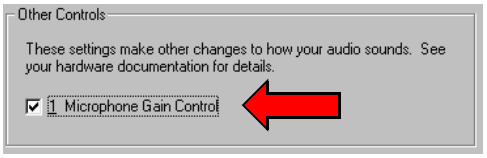
Otherwise, click **Advanced Controls**.

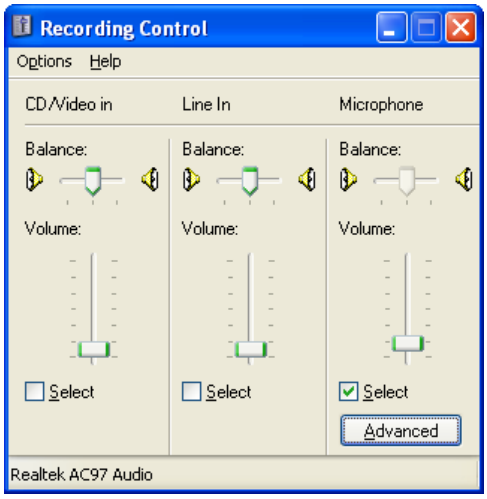
.3 Under **Microphone**, click **Advanced**.

Depending on the sound capabilities of your computer, an **Advanced Controls for Microphone** dialog box or other similar dialog box appears.

.4 Select the **Mic Boost**, **MIC Boost**, or **Microphone gain control** check box.







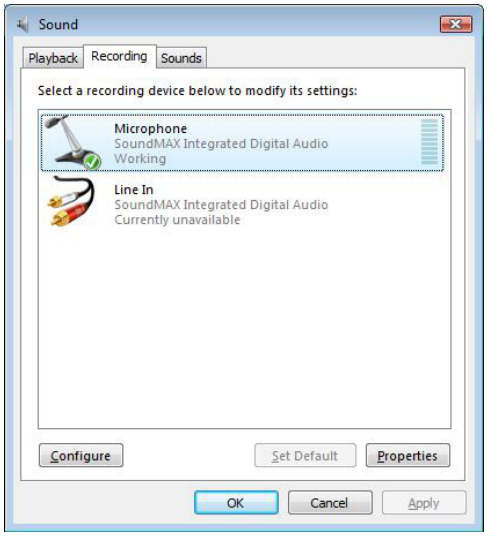
.5 Close the **Advanced Controls for Microphone** and **Recording Control** dialog boxes.

The **Recorder** dialog box reappears.

To continue the procedure to set the recording level, see page 17.

Windows Vista

.1 If you are using a microphone, make sure it is listed. If it is *not* listed, do the following:

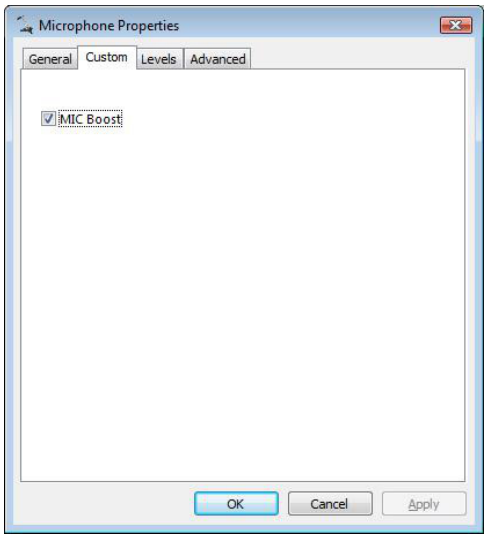


.a Right-click in the list, and then click **Show Disabled Devices**.

.b Right-click the microphone item, and then click **Enable**.

.2 Double-click **Microphone**.

The **Microphone Properties** dialog box appears.



.3 Click the **Custom** tab.

.4 Select the **MIC Boost** check box.

.5 Click **OK**.

.6 To close the **Sound** dialog box, click **OK**.

The **Recorder** dialog box reappears.

To continue the procedure to set the recording level, see page 17.

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