

PEPPER GUIDE 5:

ACOUSTIC ANALYSES

Overview

As discussed more fully in PEPPER Guide 7 (PG7), only perceptual data from phonetic transcription are required for many to most PEPPER outputs. However, outputs that describe and, notably, those that classify a speaker's motor speech status, also require both prosody-voice analyses and acoustic analyses of a conversational speech sample.

This guide includes information on the following 5 elements of acoustic analyses in PEPPER:

- **Hardware and Software Requirements**

PEPPER uses an Active X version of CSpeech (TF32), acoustic software developed and distributed by Paul Milenkovic, University of Wisconsin-Madison (Milenkovic, 2001). Dr. Milenkovic graciously made a version of TF32 available during the development of PEPPER. This section provides information on hardware and software requirements as well as how to obtain and install TF32.

- **Madison Speech Assessment Protocol (MSAP)**

Acoustic analyses can be completed on many Madison Speech Assessment Protocol (MSAP) tasks. A following section includes a table of the tasks, also called "sources," that can be used for PEPPER outputs that require acoustic data. (PEPPER outputs are generated from acoustic analyses performed on MSAP tasks only; PEPPER is not programmed to recognize non-MSAP tasks.)

- **File Preparation and Management**

This section provides instructions for file naming and formatting rules specific to PEPPER acoustic procedures.

- **General Procedures**

This section includes information on opening PepFiles and sound files in PEPPER, playing sound files, and opening and navigating the TF32 dialog window.

- **Acoustic Procedures and Operations**

For each MSAP task, up to 9 acoustic operations may be performed. Utterances in a sound file must be "marked" (i.e., linked to their corresponding utterances in the PepFile) before acoustic analyses are completed. Acoustic stimuli and analyses procedures for each MSAP task/source are detailed in this section.

Before reading the present guide, it is useful to read PG7 to become familiar with the outputs available in PepAssess and PepClass. PG7 includes a table that lists all PEPPER outputs that require acoustic data, as well as, for each output, the MSAP sources from which data can be collected and acoustically analyzed. Once you have determined which outputs you would like to run, complete the following steps:

1. Determine which PepAssess and/or PepClass outputs of interest require acoustic data ([PG7](#)).
2. Determine which MSAP task(s) is/are required ([PG7](#), [MSAP](#)).
3. Administer and record (preferably in .wav format) the conversational speech sample (CS) and/or responses to additional MSAP task(s) ([MSAP](#), [PG1](#)).
4. If using a CS, gloss, transcribe, and **complete PVSP coding** ([PG2](#), [PVSP](#)).
5. Transcribe other MSAP tasks as needed ([MSAP](#), [PG2](#)).
6. Enter each transcript into PEPPER as a PepFile, enter PepStore variables, and enter PVSP data for the CS ([PG3](#), [PG4](#)).
7. Complete acoustic analyses (this guide).
8. Create PepFile list(s) and run selected PepAnalyses ([PG6](#)).
9. Interpret selected outputs ([PG7](#)).

This guide includes information specific to Step 7. For information on completing the other steps, click on the corresponding links above.

Hardware and Software Requirements for Acoustic Analyses

Hardware requirements

- A computer*
- A keyboard
- A mouse or touchpad
- External speakers (optional)
- A foot pedal from P. I. Engineering (optional, for hands-free playback of sound files)

*Most laptop screen sizes are not large enough to display the full TF32 dialog window. If using a laptop with an insufficient screen size, connecting a larger external monitor may be required.

Software Requirements

PEPPER

Instructions for freely downloading and installing PEPPER are provided in the PEPPER tab on the Phonology Project website.

TF32 (CSpeech)

Purchase Arrangements

PEPPER uses TF32 (formerly CSPEECH) for all acoustic analyses. Specifically, PEPPER uses the commercial products TF32Ax.ocx and TF32Voice.dll. If these two files are not installed on your computer, the TF32 dialog in PEPPER does not open. Even if PEPPER is run from a network drive, these files must be installed on each computer by running the **regsvr32 program** in a command window.

The price of the TF32 Active X Library, which includes the TF32Ax.ocx and TF32Voice.dll files, is \$195, payable by check through a U.S. bank. The purchaser is responsible for any applicable taxes, or import duties outside United States.

To order the TF32 Active X Library, send a check or a purchase order to:

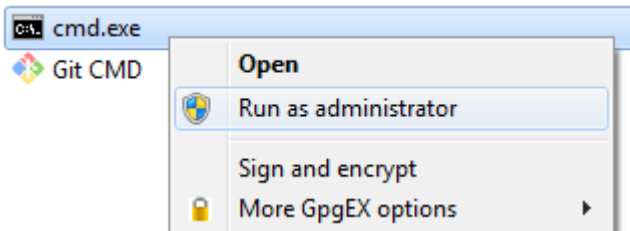
Paul Milenkovic
118 Shiloh Dr.
Madison, WI 53705-2433 U.S.A.
608 833 7956 (weekdays between 7 and 9 AM Central Time)
cspeech@chorus.net

Payment of \$195 grants a software license to one named person, either an individual or one using the software at a named organization. That person may install the TF32Ax ActiveX Library on as many computers as needed for use by the named person, use by persons assisting the named person on projects conducted at the named organization, which includes persons in a class or a laboratory taught or directed by the named person. This license may not be shared with any other persons at the named organization or any persons outside that organization or apart from the named person licensed as an individual.

The TF32Ax ActiveX Library is licensed "as is" and no warranties are offered regarding the suitability of the software for any purpose. The purchaser assumes all risks associated with installing executable software programs on computers and as well as assumes responsibility for making backups of this and any other software and/or data on those computers.

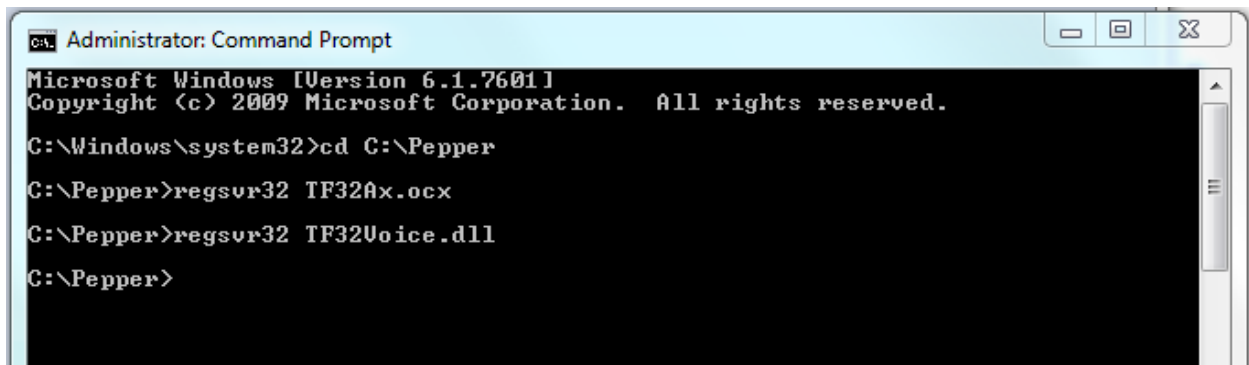
Installation

Save the TF32Ax.ocx and TF32Voice.dll files to the C:\Pepper directory. If a file name extension (ocx or dll) has been modified, rename the file(s) to correct the extension. Type cmd in the start menu. Right click on cmd.exe and select Run as Administrator.

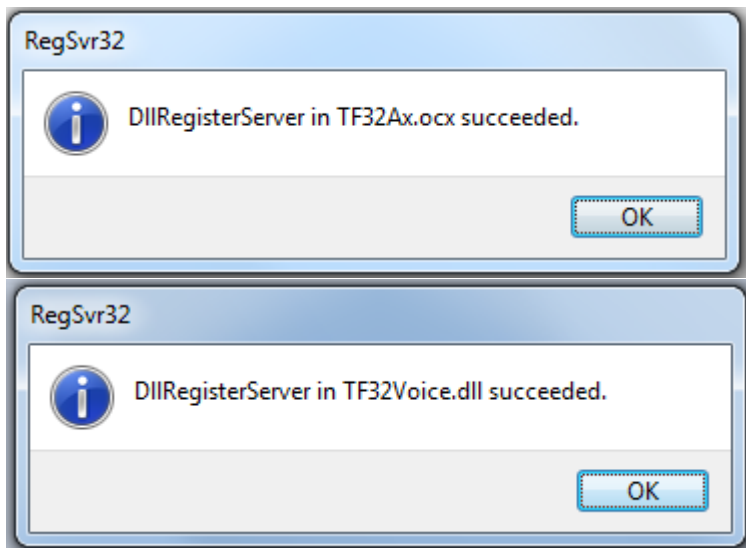


This opens a window for entering DOS-style commands. Enter the following commands:

```
cd C:\Pepper  
regsvr32 TF32Ax.ocx  
regsvr32 TF32Voice.dll
```



You should get the following response:



See the TF32 homepage at <http://userpages.chorus.net/cspeech/> for more information.

Madison Speech Assessment Protocol (MSAP)

Sources Used for Acoustic Procedures

The following table includes a list of Madison Speech Assessment Protocol (MSAP) tasks (Shriberg et al., 2010a, 2010b; see the table beginning on p. 8 for a key to these task abbreviations). The 10 tasks/sources are ordered from those that yield the most acoustic data to those that yield the least, along with a general overview of the types of acoustic data that each source provides. These speech tasks include the conversational sample (CS), articulation test (AT; Goldman & Fristoe, 2000), single-word vowel imitation tasks (VT1, VT2), single-word vowel and consonant imitation tasks (RST, MWT1/MWT2), stress tasks (CWT, LST, EST), and a sustained vowel task (SVT). The instructions for the procedures included in this guide are specific to the MSAP tasks. As mentioned previously, PEPPER is not programmed to recognize or utilize stimuli or responses from non-MSAP sources or acoustic data generated from analyses software other than TF32.

Of all MSAP sources, the conversational speech sample (CS) yields the most acoustic data. Thirty-seven of the 39 PepAnalyses profiles that are generated in whole or in part using acoustic data use the CS as their primary source. (Only the Lexical Stress and Emphatic Stress profiles do not.) **The CS must be glossed and transcribed phonetically following transcription and formatting guidelines for PEPPER ([PG2](#)), coded for prosody-voice (Shriberg et al., 1990; [PVSP](#)), and entered into PEPPER (entering PepFiles-[PG3](#), entering PVSP data and variables-[PG4](#)) before acoustic operations can be performed.** Other tasks from the MSAP that have been administered and recorded can also be used to provide supplemental or additional acoustic data. These tasks must be transcribed and entered in PEPPER before acoustic procedures are performed; unlike the CS, prosody-voice coding for these other tasks is not required.

PEPPER Outputs

Tabular information in PG7 provides, for each selected PepAnalyses (PepAssess, PepClass) output, the acoustic data that must be obtained and the MSAP task(s)/source(s) that can be acoustically analyzed to obtain those data. As shown in the study examples in PG7, Section II, data from MSAP tasks other than the CS are used to provide required supplemental information for motor speech classifications, to provide additional support for speech and motor speech classifications, and to guide treatment planning.

For each source and its associated operations in the following section "Acoustic Procedures and Operations," a list of corresponding PepAssess outputs is provided. Although acoustic operations are described for each MSAP source, it might not be

necessary to complete each operation if the resulting data do not contribute to the PepAnalyses output(s) of interest. For example, if outputs related to laryngeal voice quality are not of interest, it would not be useful to complete Operation 3 (set jitter, shimmer, and harmonics-to-noise ratio).

MSAP SOURCES/TASKS AND THE LINGUISTIC DOMAINS ON WHICH THEY PROVIDE
SEGMENTAL AND SUPRASEGMENTAL ACOUSTIC DATA

Source	Segmental Data			Suprasegmental Data							
	Vowels & Diphthongs	Consonants	Vowels & Consonants	Phrasing	Pauses	Rate	Stress	Loudness	Pitch	Laryngeal Quality	Resonance Quality
CS	X	X	X	X	X	X	X ^a	X	X	X	X
VT1	X							X	X	X	X
VT2	X							X	X	X	X
AT		X		X				X			
RST	X	X									
LST							X ^b	X			
SVT									X	X	
MWT		X		X							
CWT							X ^b				
EST							X ^c				

^aSentential Stress; ^bLexical Stress; ^cEmphatic Stress

File Preparation and Management

File Formatting and Naming Requirements

Files used for acoustic analyses include PepFiles (.*pep*) and sound files (.*wav*). PepFiles must be entered in PEPPER using the formatting conventions described in PEPPER Guide 3 (PG3). Sound files must be in uncompressed .*wav* format.

The PepFile and corresponding sound file must be saved under the same name and in the same directory. Although not a requirement, a copy of the original PepFile can be saved specifically for acoustic analyses (possibly in a separate folder with the corresponding sound file) so that no changes are made (either accidentally or purposely) to the original PepFile that contains the perceptual data only.

It is necessary to follow specific naming conventions for MSAP tasks when acoustic analyses will be performed. The following table provides the PepFile naming conventions for MSAP tasks that are entered and saved as PepFiles in PEPPER. (Some tasks -- VT3, SRT, NRT, SPT, DDK, and SCT -- included in the table do not contribute acoustic data to PEPPER outputs; it is recommended, but not mandatory, that the PepFile naming conventions for these tasks be followed.) The bolded portion of the PepFile name examples in the rightmost column represents how and where the string of characters must be present in the PepFile name, because PEPPER identifies the MSAP task/source based on that string. The characters can be upper or lower case. Characters preceding and following the required bolded string are for illustrative purposes only and can be modified as needed, following the naming guidelines described in PG3. As some of the examples in the table demonstrate, characters that follow the required character string begin with an underbar (_).

MSAP Task/Source	Acronym	Required Characters	Pepfile Name Example
Conversational Sample	CS	-C# (where the # can be 1, 2, 3, etc.)	abc2- c1 . <i>pep</i>
Goldman-Fristoe Test of Articulation-2 (Goldman & Fristoe, 2000)	AT	-GF	1234- gf _id. <i>pep</i>
Lexical Stress Task	LST	-LST	smile- LST . <i>pep</i>
Challenging Words Task	CWT	-CWT	Spch- CWT . <i>pep</i>
Vowel Task 1	VT1	-VT1	R2D2- vt1 . <i>pep</i>
Vowel Task 2	VT2	-VT2	HB2U- VT2 . <i>pep</i>
Vowel Task 3	VT3	-VT3	EIPre- VT3 _1. <i>pep</i>
Syllable Repetition Task	SRT	-SRT	2good- SRT . <i>pep</i>
Nonword Repetition Task (Dollaghan & Campbell, 1998)	NRT	-NRT	CDTC- NRT . <i>pep</i>

Emphatic Stress Task	EST	-EST	Bob- EST . <i>pep</i>
Rhotics and Sibilants Task	RST	-RST	RandS- RST _glp. <i>pep</i>
Multisyllabic Words Task 1 (Catts, 1986)	MWT1	-MWT1	child- MWT1 . <i>pep</i>
Multisyllabic Words Task 2 (Catts, 1986)	MWT2	-MWT2	Adult- MWT2 . <i>pep</i>
Speech Phrases Task (Catts, 1986)	SPT	-SPT	100KID- SPT _2a. <i>pep</i>
Diadochokinesis Task	DDK	-DDK	pataka- ddk . <i>pep</i>
Sustained Vowel Task	SVT	-SVT	aaaa- SVT . <i>pep</i>
Sustained Consonant Task	SCT	-SCT	FFFF- SCT . <i>pep</i>

General Procedures

Opening PepFiles and Sound Files

Before beginning acoustic analyses, a PepFile transcript and its corresponding sound file must be opened in PEPPER. To open an existing PepFile, open PEPPER and type Ctrl+O or go to the File menu and select “Open...” from the drop-down menu. A window will open wherein the PepFile can be selected and opened. (Make sure the file type is *.*pep*.) Select the file of interest and click on the Open button.

To open the corresponding sound (*.wav) file, go to the File menu and select “Open *.wav Sound File....” A window will open wherein the sound file can be selected. After clicking “Open,” a display of the sound file's waveform appears at the bottom of the PEPPER screen, below the open PepFile transcript. The sound file window displays 30 seconds of the recording's waveform at a time. Left click the mouse in the waveform display to set the playback cursor.

Playing Sound Files

A new or existing PepFile must be open in order to open and listen to a sound file (*.wav) in PEPPER. If you want to play a sound file in PEPPER but don't have a corresponding PepFile transcript that has been entered and saved, open a new PepFile window by typing Ctrl+N or going to the File menu and selecting "New" from the drop-down menu. Once the PepFile window is open, a sound file can then be opened.

There are several ways to play sound files in PEPPER. One way is to select a portion of the waveform and click the “Play Selection” button to the right of the waveform. To

select the portion of interest, use the mouse to move the cursor to the beginning of the portion of the waveform to be played, hold down the left mouse button, drag the mouse to the end of the portion, and then release the left mouse button. The selection will be highlighted in blue.

If your computer keyboard has a numeric keypad, 4 of its keys can be used to control the playback of the sound file (Num Lock can be on or off):

- 1 Rewind
- 2 Play
- 3 Fast Forward
- 0 Stop

For keyboards without numeric keypads, turn on the Num Lock feature to produce the numeric keypad codes. (The J, K, and L keys typically correspond to 1, 2, and 3, respectively, and a key one row down, likely M, will correspond to the 0.) Even with the Num Lock feature activated, it may be necessary to press and hold a function key (labeled 'Fn' on some keyboards) to produce the numeric keypad codes to control sound file playback.

A foot pedal from P. I. Engineering (<http://xkeys.com/XkeysFootPedals/index.php>) can be programmed to mimic numeric keypad codes 1, 2 and 3 for the left, middle and right pedals, respectively, and a numeric keypad code 0 when any pedal is released. This allows for hands-free playback, which is especially useful and efficient when using PEPPER to play a sound file while glossing, transcribing, and/or coding a sample for prosody and voice.

Once an utterance has been "marked" for acoustic analyses (instructions on marking utterances are provided below), it can be played by clicking the "Play Utt." button in the waveform display window. Before clicking the "Play Utt." button, use the mouse to place the cursor anywhere within the marked utterance. When the "Play Utt." button is clicked, PEPPER will automatically reset the cursor in the waveform to the beginning of the selected utterance and will play the whole marked utterance.

Opening the TF32 Dialog Display

An utterance must be "marked" before opening the TF32 dialog display. (See "File Preparation" instructions beginning on p. 15 for instructions on how to mark utterances.) To open the TF32 display, click on the "Expand Utt." button in the waveform display window. The TF32 display is used to complete acoustic procedures described in this guide. If utterances have already been marked, double clicking on an utterance in the waveform will also open the TF32 display.

The TF32 dialog shows an expanded view of an utterance within a sound file. This display can be used to mark the start, end, and characteristic point of the phonemes in the utterance and the location of pauses and disruptions.

Navigating the TF32 Dialog Display

The TF32 dialog has 5 display windows:

1. The top window shows the LPC analysis for the part of the waveform between the cursors. If the cursors are far apart, the 50ms following the left cursor are used.
2. The next window shows the amplitude but in volts rather than dB.
3. The next window shows the fundamental frequency (F0).
4. The next window shows the spectrogram.
5. The final window shows the waveform.

Right click on any of the windows (other than the LPC analysis and amplitude windows) to change scaling or to set other options. For information about these other options, see the TF32 manual at <http://userpages.chorus.net/cspeech/>. Scaling can also be changed using the up or down arrows to the left of all the windows except the spectrogram. The spectrogram initially displays 0 to 9,000 Hz. If you click the Expand button to the left of the spectrogram, 0 to 16,000 Hz is displayed.

Between the spectrogram and waveform windows there is a bar showing the boundaries of the various parts of the utterance. Pause sections as well as any silence before or after the utterance are shown as gray. Black sections are speech. If phoneme boundaries have been set, phonemes are shown in red with the characteristic point shown in green. A pause with a specified location is light blue. A disruption (sound addition) with a specified location is light magenta.

Following is a list of functions as they relate to the TF32 dialog display.

- *Set and adjust cursors*

Click in the waveform window. Drag a cursor (click, hold and move the mouse to the right) to adjust its location. The control that starts out with "Select cursor --->" near the lower left shows the time in milliseconds from the start of the utterance to the cursor. All other times on the display are in seconds from the start of the sound file. There are buttons to select the left or right cursor and arrows to nudge the selected cursor left or right.

- *Play the part of the utterance between the cursors*

Select the Play button to play the part of the utterance between the cursors. Select the "Play to End" button to play from the left cursor to the end of the utterance.

- *Change how much of the utterance is shown*

Use the control that starts out with "t=time ms" near the lower left. The up arrow shows more of the utterance (less expansion); the down arrow shows the part of the utterance between cursors (more expansion). There is a scroll bar under the waveform window that lets you see the rest of the utterance. Under the scroll bar is the beginning and ending times of the displayed section. If there are two cursors in the waveform, this control shows both the time in milliseconds between the cursors and the reciprocal of that time in Hz. This is labeled F0 because if the cursors are placed at successive glottal pulses, it is the fundamental frequency.

- *Make F0 corrections*

Two types of corrections can be made in the F0 window:

1. To interpolate, place the cursors at the two points in the F0 window you want to interpolate between. Right click in the F0 window and select "Pitch Trace." If the button and drop-down list say "One cycle," change the drop-down list to "Interpolate." Then click the "Interpolate" button.
2. To set a new F0 (make the other kind of correction), first expand the waveform enough so that the individual glottal pulses can be seen. Set the cursors on successive glottal pulses. Bring up the "Pitch Trace" dialog, set the drop-down box to "One cycle" if necessary, and click the "One cycle" button. This can be used to give you a place to interpolate with.

At times it may be necessary to redo the F0 fixes. This is because the pitch trace algorithm is sensitive to any changes in the start time that has been set for the utterance. In fact, if the "Set Utterance" button is used to change the start time of the utterance, do an "Accept & Close" and then reopen the utterance before making any F0 corrections. If the F0 corrections do not need to be redone, there is a "Clear F0 corrections" button that lets you start over.

The "Pitch Trace" dialog has lots of other buttons, none of which work with PEPPER. "Interpolate" and "One cycle" are all that can be used. The others appear to work, but the changes are not saved.

- *Set jitter, shimmer, and harmonics-to-noise ratio*

To set jitter, shimmer and harmonics-to-noise ratio (HNR) for one of /i, u, æ, a, ʌ/, first set the cursors around the part of the vowel where the pitch trace is reasonable. Click the "Set Jitter, etc." button at the upper left to save these values for that vowel. Then the jitter, shimmer, and HNR values should display near the upper right.

- *Set an utterance and set or delete a pause*

Set the start and end of an utterance by setting the corresponding cursors and clicking "Set Utterance." To manually adjust a pause or add a new pause, set the cursors to the start and end of the pause and click "Set Pause." Delete a pause by clicking inside the pause and then clicking "Delete Pause."

- *Locate a pause*

To specify where the pause occurs within the utterance, click the "Locate Pause" button. Once the resulting dialog is completed, the pause turns from gray to light blue (or light magenta if you called it a disruption).

- *Set phonemes*

There are four radio buttons that allow you to set the family of phonemes of interest: vowels, rhotics, fricatives, or all phonemes. To set the beginning and end of a phoneme of interest, set the left and right cursors and click the corresponding phoneme button. There are 4 phoneme buttons labeled "Set *t n x*" where *t* is the type (vowel, rhotic, fricative, phoneme), *n* is the number, and *x* is a special coding for the phoneme:

i=i	I=I	e=e	E=ε	ae=æ	3=ɜ	3^=ɝ	4=ə
4^=ə	^=ʌ	a=a	u=u	U=ʊ	o=o	c=ɔ	D=ɒ
@=ɑ	@I=ɑ̄I	@U=ɑ̄U	eI=ēI	oU=ōU	cI=ɔ̄I		
m=m	b=b	j=j	n=n	w=w	d=d	p=p	h=h
t=t	ng=ŋ	k=k	g=g	f=f	v=v	tsh=tʃ	dzh=dʒ
sh=ʃ	th=θ	s=s	z=z	dh=ð	l=l	r=r	zh=ʒ

If there are fewer than 4 phonemes of interest, the extra buttons are dropped. If there are more than 4 phonemes, there's a scroll bar next to the phoneme buttons that lets you move through all the phonemes of interest.

By default, the characteristic point (shown in green within the red area for the phoneme) of the phoneme is set at the middle of the phoneme. To adjust a phoneme, set the left and right cursors and click that phoneme button again. To adjust the characteristic point, place either cursor at the desired point and click

"Set Char." To delete a phoneme, place either cursor within the phoneme and click "Delete Phoneme."

- *Set formants 1, 2, 3*

After you set the limits of a phoneme or reset the characteristic point, the cursors are set at a 20-ms interval surrounding the characteristic point. TF32's best guess for F1, F2, and F3 are displayed at the lower left. Typical F1, F2, and F3 values, if available, are displayed above the F1, F2, and F3 boxes for the vowel. F1, F2, and F3 values can be set directly or by using the LPC curve plotted at the top of the display. Set the cursor at the frequency (the window goes from 0 Hz to 10,000 Hz) and click "Set F1," "Set F2," or "Set F3." If you click the BIG button to the left of the LPC plot, the window expands showing, to the right of the window, some controls that can be used to control the LPC calculation.

PEPPER allows separate analyses (in particular, setting F1, F2, and F3) for the two vowels in a phonemic diphthong ($\overline{a}i$, $\overline{a}u$, $\overline{o}i$) in a VT2 transcript. There are two additional lines in the table of phoneme settings at the bottom of the TF32 dialog. The line before the phonemic diphthong (labeled either @ or c) is for the first vowel of the diphthong; the line after (labeled I or U) is for the second vowel. Clicking one of these buttons sets the cursors to a 20ms interval around the characteristic point (normally at 20% or 80% of the full diphthong).

If the two parts of the diphthong are of unequal length, the characteristic point of the full diphthong can be set to the middle of the transition and the characteristic points of the two vowels will be automatically adjusted. For example, if the characteristic point of the diphthong is set at 60%, the characteristic points of the two vowels move to 24% and 84%.

- *Additional Functions*

Click "Not Measurable" to the left of the spectrogram if the utterance can't be measured. If needed, a comment can be entered in the comment box at the top of the TF32 dialog window.

Once you are done processing the utterance, click the "Accept & Close" button near the upper left. To discard your changes, click the red X at the upper right instead.

If you've clicked "Accept & Close," then when you try to close the PepFile window, PEPPER first asks if you want to save changes. This is because the acoustic values are stored in the same file as the transcript. This does not interfere with other uses of the PepFile transcript.

Once you are done marking all the phonemes and/or pauses for a transcript, you can look at the results by viewing the acoustic-related PepAssess and PepClass outputs on the PepAnalyses menu.

Acoustic Procedures and Operations

Overview

Up to 9 acoustic analysis operations (single- and multi-step) can be completed using the TF32 dialog in PEPPER:

1. Set vowel (including correcting the characteristic F0 as needed)
2. Set formants 1-3
3. Set jitter, shimmer, and harmonics-to-noise ratio (HNR)
4. Set consonant
5. Set consonant, set pause, set addition, set consonant
6. Set consonant, set vowel
7. Set pause and/or addition
8. Locate pause and/or addition
9. Identify pause as appropriate or inappropriate

All 9 operations can be completed on the CS. Acoustic analyses on other MSAP sources include fewer operations. In this guide, we provide, by source, instructions for each operation. The following table provides an overview of the operations that are typically completed for each source.

Operation	CS	VT1	VT2	AT	RST	LST	SVT	MWT	CWT	EST
1	X	X	X	X	X	X	X		X	X
2	X	X	X		X		X			
3	X	X	X							
4	X	X	X	X	X	X		X	X	
5	X			X				X		
6	X									
7	X									
8	X									
9	X									

Note that, for each operation, the instructions are basically the same regardless of the source; however, the stimuli (i.e., the phonemes or pauses/additions) that are analyzed are different, depending on the source.

File Preparation

Before acoustic procedures can be completed, the CS must be glossed and phonetically transcribed following PEPPER formatting procedures ([PG2](#)); coded for prosody and voice using the *Prosody-Voice Screening Profile* ([PVSP](#)) (Shriberg et al.,

1990); and the transcript, PVSP data, and any required PepStore variables must be entered in PEPPER ([PG3](#), [PG4](#)). For all other MSAP tasks/sources, the participant's responses must be phonetically transcribed and entered into PEPPER along with required PepStore variables. Protocol PepFiles are available for the PowerPoint MSAP tasks. These protocol files can be used to generate pepforms and to enter PepFiles more efficiently. Go to "MSAP" in the PEPPER Help Index for more instructions as well as links to the protocol files.

Utterances that will be analyzed acoustically must first be "marked" in the sound file. Marking an utterance in the sound file links it to the corresponding utterance in the PepFile. For the CS, acoustic analyses are typically completed on the first 12 utterances that have been PVSP coded; additional PVSP-coded utterances can be marked if sufficient acoustic data cannot be obtained in the first 12 coded utterances, or if more acoustic data is desired. For other tasks, some or all utterances can be marked for acoustic analysis, depending upon clinical, academic, or research goals.

Marking Utterances

1. Open an existing PepFile by going to File>Open (or type Ctrl+O) in PEPPER and selecting the PepFile.
2. For the CS, go to the PepFunctions menu, click PepTools, and select "Show PVSP, Y Line Colors, Pauses." PVSP codes are displayed in contrasting colors to the right of the lines that precede the X lines for each of the utterances. This step isn't necessary for other MSAP tasks.
3. Open the corresponding sound file by going to the File menu and selecting "Open *.wav Sound File...."
4. In the PepFile transcript, find the first/next utterance to be marked for acoustic analyses. (For the CS, this will be the first/next *PVSP coded* utterance.)
5. In the sound file, find and play the section of the waveform that corresponds to the first/next utterance to be marked for acoustic analyses, using the playback instructions on pp. 9-10 of this guide.
6. Highlight/select the utterance in the waveform by placing the cursor at the beginning of the utterance and dragging the cursor over the waveform to the end of the utterance. (Click the "Play Selection" button to listen and confirm that the complete utterance is selected. Make adjustments to the start and/or end point until you are satisfied with the selected portion of the waveform.)
7. In the PepFile transcript, left click anywhere in the utterance that corresponds to the highlighted portion of the waveform.
8. To mark the utterance for acoustic analyses, click the "Set Utt." button (found on the upper right side of the sound file window). This "marks" the utterance for acoustic analyses. The selected portion of the waveform will change color and the corresponding utterance number from the PepFile will appear nearby. (NOTE: For the CS, the number displayed is the sequential utterance number, *not* the PVSP-coded utterance number.) PEPPER adjusts the "Set Utt." # for each subsequent utterance that is marked.

9. Press the "Expand Utt." button to open the TF32 dialog box. It may be necessary to mark the utterance as "not measureable" if there are significant sound quality problems or other problems that make the entire utterance unusable (see the following section). If this is the case, mark the "not measurable" box. If parts of the utterance are usable, do not check this box. If needed, adjust the beginning and ending points of the utterance using the left and right cursors, then click the "Set Utterance" button. Click the "Accept & Close" button to save your work.
10. Continue marking subsequent utterances following steps 4 through 9 until all utterances to be acoustically analyzed have been marked.
11. When all utterances needed for acoustic analyses have been marked/set, save the entire PepFile before closing it, or when prompted to do so.
12. When saving and/or attempting to exit a PepFile, a window will pop up with the following prompt: "Is acoustic data gathering finished?" Enter yes or no. (At this stage, if you've marked/set the utterances but have not yet completed acoustic operations, enter "no.") A % symbol will be added to the end of the file name if "no" is selected. If "yes" is selected, a \$ sign is added to the end of the file name.

Click here for video tutorial on [marking an utterance](#) ("Swim" video).

NOTE: We recommend downloading and saving all video tutorials for best quality viewing.

Additional Notes on Marking Utterances

In some cases, when identifying utterances in the sound file, a spectrogram display may be helpful. Default settings for Time-Frequency analysis are

- 300 Hz bandwidth
- Pre-emphasis checked
- 4.004 KHz frequency range (may be extended with the "expand" button on the display)
- -72 Floor (dB)
- 48 Dynamic range (dB)
- LPC tracking checked

Sometimes it may be helpful to adjust the bandwidth to 400 or 500 Hz or to change the Floor settings for an especially quiet signal.

There are several sound quality problems that might make certain utterances, or possibly entire .wav files, unusable for acoustic analyses. These problems include

1. Lack of vowel amplitude energy above F2 (approximately 2000 Hz)
2. Examiner over talk or other background noise(s) that occurs during the target speech signal

3. Background noise that significantly obscures the speech signal, especially for low energy fricatives

Other situations that could make an utterance ineligible for acoustic analyses include

1. Deletion of the target speech signal
2. Behavioral issues that influence the speech signal, such as excessive prolongation of a vowel, laughing, use of a register (character register, narrative register, etc.), or significant movement noise

It is not necessary to mark all eligible utterances in a sound file before beginning acoustic analyses. For example, it's acceptable to mark an utterance and complete acoustic measurements on it before marking the next utterance in the sample.

The Conversational Sample (CS)

Operations/Procedures

All of the acoustic analyses operations to be described are completed in the TF32 dialog (see pp. 10-15 in this guide). In the PepFile transcript for the conversational speech sample, provided that "Show PVSP, Y Line Colors, Pauses" is checked (PepFunctions>PepTools), all phonemes needed for acoustic analyses are automatically identified and color-coded by PEPPER in the Y line:

- Corner vowels: *green*
- Sibilants: *orange*
- Rhotic vowels: *magenta*
- Stop-fricative and fricative-stop pairs/clusters: *aqua*
- Intensity pairs: *gray*
- Needed vowels beyond the first 12 coded utterances: *red*

PEPPER identifies and color codes phonemes in the CS only; phonemes in all other MSAP tasks are not color coded and must be identified by the acoustic analyst. In the TF32 dialog box below the spectrographic display, select the "All" view for acoustic analysis. Screen shots included at the end of this guide provide examples of some of the operations described below.

Operation 1: Set vowel.

Source: CS

Related PepAssess outputs: Vowel Duration profile, Vowel Duration Z Scores (C), Pairwise Variability Index (B, D), Vowel Stability Z Scores (I, J, K), Sentential Stress, Stress Stability Analyses (C)

Stimuli: All vowels in the first 12 PVSP coded utterances. At least 5 tokens of each vowel, including diphthongs and rhotic vowels, must be segmented. If a sufficient number of tokens are not available in the first 12 coded utterances, it is necessary to segment additional tokens of needed vowels that occur beyond the twelfth coded utterance. These additional vowel tokens are marked in *red* in the PepFile transcript. For phoneme analysis, only words that are not questionable in both the X and Y lines are used. Questionable words that are enclosed by angle brackets (e.g., <play>, <in>, <Daddy>) in the X line are ignored.

Procedure: Identify and segment each vowel. Identify vowels by strong vertical glottal pulsing in the presence of formant structure through the region of F2. The middle 20 ms are automatically marked off by TF32. Note that any unmarked segment longer than 20 ms will be identified as a pause that needs location or as an addition. Confirm that contiguous vowels are fully segmented. Correct the characteristic F0 as needed for all segmented vowels. Instructions for correcting F0 are on p. 12 of this guide.

Operation 2: Set formants 1-3.

Source: CS

Related PepAssess outputs: Vowel Space Quadrilateral (C), Vowel Space Dispersion (A, B), Pairwise (A), Corner Vowel Formant Analysis, Vowel Profile 9 Z Scores (A, B, D), Pairwise Variability Index (C), Vowel Stability Z Scores (A-H, M), Fundamental Frequency Index, Fundamental Frequency Analyses, Pitch Stability Analyses, Resonance Quality Competence-Precision, Resonance Quality Precision, Resonance Quality Stability Analyses. Also Rhotics Analyses (see stimuli requirements below*).

Stimuli: The first 3 tokens of each corner vowel / i, æ, u, ɑ / and central vowel / ʌ /.

*For the Rhotics Analyses output: The first 10-12 occurrences of / ɜ / (the main symbol in the Y and Z lines must match).

Procedure: Segment the vowels. If Operation 1 has been completed, these vowels should already be segmented with the possible exception of a sufficient number of tokens of / ɜ / for the Rhotics Analyses. If needed, segment additional tokens of / ɜ / following the instructions in Operation 1. The middle 20 ms will automatically be marked off by PEPPER. Click once on the “little” button at the top left of the TF32 display; the LPC and FFT traces will be displayed in a larger format.

Identify characteristic frequencies for F1, F2, and F3 using a combination of the Fast Fourier Transform (FFT) amplitude and the Linear Predictive Coding (LPC) peak, with

visual confirmation of this point in the middle of the formant band. Press the Set F1, F2, and F3 buttons.

Check and correct, if necessary, the F0 track for the entire vowel.

*Additional instructions for setting formants 1-3 on /ɜ/ (Rhotics Analyses):

1. Identify F3 first by locating the area where F2 and F3 are closest, termed the *constriction interval*. Identify the flat portion of the constriction on a spectrogram using a 400 or 500 Hz bandwidth to set both F2 and F3.
2. If there is no flat portion (e.g., in /r/ cluster contexts in which the formants might rise immediately after the burst release of the stop), set the point in time where F3 is lowest and set the 3 formants at that point.
3. Identify the frequencies by first isolating the center 20 ms of the flat portion (or for cluster contexts, a 20 ms window centered at the low point of F3).
4. Obtain an LPC spectrum and identify the peak of the trace, visually confirmed to be at the middle of the formant band.

Click here for video tutorial on [segmenting vowels and setting formants](#) ("Underwater" video).

Operation 3: Set jitter, shimmer, and harmonics-to-noise ratio (HNR).

Source: CS

Related PepAssess Outputs: Voice Laryngeal Quality Competence, Laryngeal Quality Analysis, Laryngeal Quality Stability Analyses

Stimuli: The first 3 tokens of each corner vowel /i, æ, u, ɑ/ and central vowel /ʌ/.

Procedure: Complete the procedure described for Operation 1 (Set Vowel). Relocate the cursor to the vowel boundary. Press the jitter/shimmer button. Data are automatically recorded.

Operation 4: Set consonant (fricative singletons).

Source: CS

Related PepAssess Outputs: Sibilant Analyses, Consonant Acoustic Z Scores (A, B, C, D), Moments profile

Stimuli: The first 10-12 occurrences of any of the following sibilants: word initial /s/, word final /s/, and word final /z/. These should be color coded as orange in the PepFile transcript. The stimuli must also meet the following criteria:

- The sibilant does not occur in a /ʌ/ (schwa vowel) context.
- The sibilant does not occur in a consonant cluster.
- The main character/symbol in the Z line must match the symbol in the Y line.
- There can be no more than 3 tokens/occurrences of the same word included in this analysis.

For phoneme analysis, only words that are not questionable in both the X and Z lines are used. Questionable words that are enclosed by angle brackets (e.g., <play>, <in>, <Daddy>) in the X line are ignored.

Procedure: Segment the sibilant by identifying the onset to offset of strong noise energy. Use close listening to confirm. "Noisy" vowels may be contiguous with the sibilant(s). This noise should be considered part of the vowel, not the sibilant.

Operation 5: Set consonant, set pause, set addition, set consonant (stop-fricative and fricative-stop clusters).

Source: CS

Related PepAssess Outputs: Consonant Acoustic Z Scores (E - L)

Stimuli: First occurrences of up to 5 stop-fricative pairs and up to 5 fricative-stop pairs. The main symbols in the Y and Z lines must match. These pairs are color coded as aqua in the PepFile transcript. The 5 stop-fricative and 5 fricative-stop pairs are identified by PEPPER using the following hierarchy of priorities, listed from most desirable to least:

- 5 word types with one token pair each
- 2 word types with 2 token pairs each, plus one additional word type with one token pair
- 1 word type with 5 token pairs

For phoneme analysis, only words that are not questionable in both the X and Z lines are used. Questionable words that are enclosed by angle brackets (e.g., <play>, <in>, <Daddy>) in the X line are ignored.

Procedure: Segment word-initial stops by burst, aspiration noise to the onset of glottal pulsing for the following sound. Segment word-medial stops by stop gap, burst, and aspiration noise. Segment word-final stops by end of periodic glottal pulsing through the region of F2 for the preceding vowel or major energy for the preceding speech sound.

Segment sibilants by identifying the onset to offset of strong noise energy. Use close listening to confirm. "Noisy" vowels may be contiguous with the sibilant(s). This noise should be considered part of the vowel, not the sibilant.

Any unmarked segment longer than 20 ms will be identified as a pause that needs location or as an addition. Confirm that all segments in the consonant pairs are fully marked and identified, and that any pause or addition is marked and located. (See Operations 7 and 8.)

Click here for video tutorial on [marking a fricative /s/ and a cluster /sk/](#) ("SundaySch" video).

Operation 6: Set consonant, set vowel.

Source: CS

Related PepAssess Outputs: Vowel Duration, Pairwise Variability Index, Consonant Acoustic Z Scores, Sentential Stress, Stress Stability Analyses (C), Speech Intensity Index, Speech Intensity Analysis, Loudness Stability Analysis, Fundamental Frequency Index, Fundamental Frequency Analyses, Pitch Stability Analyses

Stimuli: The first 10 consonants (stop, fricative, or affricate) and the first 10 "mid-level" vowels (i.e., all vowels other than the corner vowels /i, æ, u, ɔ/ and central vowel /ʌ, ə/) in any non-questionable words in which they first occur (i.e., up to 20 total phonemes). These are color-coded gray in the PepFile transcript.

For phoneme analysis, only words that are not questionable in both the X and Z lines are used. Questionable words that are enclosed by angle brackets (e.g., <play>, <in>, <Daddy>) in the X line are ignored.

Procedure: Segment word-initial stops by burst, aspiration noise to the onset of glottal pulsing for the following sound. Segment word-initial affricates by the burst, affrication noise, and following frication noise. Segment fricatives by identifying the onset to offset of strong noise energy. Use close listening to confirm. "Noisy" vowels may be contiguous with the fricative(s). This noise should be considered part of the vowel, not the fricative.

Segment the vowels (see Operation 1). Identify vowels by strong glottal pulsing in the presence of formant structure through the region of F2. Fundamental frequency information is calculated and recorded automatically.

Operation 7: Set pause and/or addition.

Source: CS

Related PepAssess Outputs: CS24 Syllable Segregation Pauses, Prosody Phrasing, Phrasing Analysis, Prosody Rate Stability, Speech Rate Analyses, Speech Rate Z Score Analyses, Mean Syllable Duration, Speech Rate Stability Analyses

Stimuli: All pauses in the first 12 PVSP-coded utterances.

Procedure: In the first 12 PVSP coded utterances, segment all pauses (i.e., any portion(s) of each utterance where the participant is not speaking) by positioning the cursors directly after the final glottal pulse or measurable speech energy and directly in front of the next glottal pulse or measurable speech energy. Segment additions [any additional speech sound tagged onto a word that creates an unacceptable form of the word (i.e., an onglide, offglide, or addition, represented by a synchronic tie symbol in the Z line)] using procedures described previously for setting phonemes. Click the "Set Pause/Add" button.

Click here for video tutorial on [setting and locating a pause](#) ("Nope" video).

Operation 8: Locate pause and/or addition.

Source: CS

Related PepAssess Outputs: Between/Within Word Syllable Segregation

Stimuli: All set pauses in the first 12 PVSP-coded utterances.

Procedure: After setting the pause(s) and/or addition(s) (Operation 7), position the right cursor within the boundary of each pause/addition and click the "Locate Ps/Add" button. In the "Location of Pause or Addition" window that pops up, click the radio button to choose "pause" (or "addition"), and then mark the location of the pause (or addition)--between words and/or within words--by clicking the corresponding radio button(s) to the left of the list of words that make up the utterance. (The "appropriate" box will automatically be checked when the radio button(s) is clicked). Click "OK" to save.

Click here for video tutorial on [setting and locating a pause](#) ("Nope" video).

Operation 9: Identify pause as appropriate or inappropriate.

Source: CS

Related PepAssess Outputs: Percentage of Inappropriate Pauses, Inappropriate Pauses Z Scores

Stimuli: All set pauses in the first 12 PVSP-coded utterances.

Procedure: As mentioned in the instructions for Operation 8, the default setting for a pause that has been located is "appropriate." In the "Location of Pause or Addition" window, the "appropriate" box must be unchecked if the pause is judged to be inappropriate. Once this box is unchecked, pausing typologies become highlighted for selection. Choose only one selection among types 1-3 (the pause location). If "2" is chosen, any choices numbered 4-10 (pause descriptors) are optional. If "3" is chosen, at

least one choice among pause descriptors 4-10 is required. More than one pause descriptor can be chosen.

Inappropriate pause subtype descriptors:

1. Within word
2. “Alone” – a linguistically incorrect location with no other identifiable characteristic present
3. Linguistically correct location with at least one identifiable characteristic among subtype descriptors 4 through 10
4. A sound addition that immediately precedes or follows an inappropriate pause
5. “Change” - A significant amplitude, frequency, or rate change that immediately precedes or follows an inappropriate pause
6. “Sharp” - a sharp offset or onset that immediately precedes or follows an inappropriate pause. Sharp offset is defined as a sudden “cut off” of energy in the segment immediately before the inappropriate pause. Sharp offsets are found predominantly in vowel segments. Sharp onset is defined as a sudden strong onset of energy immediately following the inappropriate pause. Sharp onsets occur most often on vowels, but can occur in all manners of articulation.
7. A significant repetition or revision that immediately precedes or follows the inappropriate pause and contributes significantly to the percept of “inappropriate.” This subtype is characterized by a choppy, dysfluent quality vs. an “easy” repetition or revision.
8. A very long pause (750 ms or more) that is perceptually too long for the linguistic context
9. “Gesture” - A gesture during the inappropriate pause that results in some visible acoustic energy in the spectrogram (often lip or voicing sounds)
10. A breath that is misplaced and not due to excitement or in the context of an especially long utterance

See [Technical Report 22](#) for more detailed information on inappropriate pause subtypes. As mentioned previously, screen shots at the end of this guide provide TF32 displays of some of the pause subtypes described above.

Vowel Task 1 (VT1)

Operation 1: Set vowel.

Source: VT1

Related PepAssess outputs: Vowel Space Quadrilateral (B, C), Vowel Space Dispersion (partial), Pairwise (B--partial), Z Scores (C), Vowel Stability Z Scores (F-K), Speech Intensity Index (A, B), Loudness Stability Analyses (A, B)

Stimuli: All vowels, including substitutions, in VT1

Procedure: Identify and segment each vowel. Identify vowels by strong vertical glottal pulsing in the presence of formant structure through the region of F2. The middle 20 ms are automatically marked off by TF32. Correct the characteristic F0 as needed for all segmented vowels. Instructions for correcting F0 are on p. 12 of this guide.

Operation 2: Set formants 1-3.

Source: VT1

Related PepAssess outputs: Corner Vowel Z Scores (A, B), Vowel Stability Z Scores (A-D), Fundamental Frequency Index, Pitch Stability Analyses, Resonance Quality Precision, Resonance Quality Stability Analyses.

Stimuli: All vowels, including substitutions, in VT1

Procedure: Segment the vowels. If Operation 1 has been completed, these vowels should already be segmented. The middle 20 ms will automatically be marked off by TF32. Click once on the “little” button at the top left of the TF32 display; the LPC and FFT traces will be displayed in a larger format.

Identify characteristic frequencies for F1, F2, and F3 using a combination of the Fast Fourier Transform (FFT) amplitude and the Linear Predictive Coding (LPC) peak, with visual confirmation of this point in the middle of the formant band. Press the Set F1, F2, and F3 buttons.

Check and correct, if necessary, the F0 track for the entire vowel.

Click here for video tutorial on [segmenting vowels and setting formants](#) ("Underwater" video).

Operation 3: Set jitter, shimmer, and harmonics-to-noise ratio (HNR).

Source: VT1

Related PepAssess Outputs: Voice Laryngeal Quality Competence

Stimuli: All vowels, including substitutions, in VT1

Procedure: Complete the procedure described for Operation 1 (Set vowel). Relocate the cursor to the vowel boundary. Press the jitter/shimmer button. Data are automatically recorded.

Operation 4: Set consonant (stop singletons).

Source: VT1

Related PepAssess Outputs: Speech Intensity Index (partial), Loudness Stability Analyses (partial)

Stimuli: All word-initial stops (no substitutions; Y and Z lines must match)

Procedure: Segment word-initial stops by burst, aspiration noise to the onset of glottal pulsing for the following sound.

Vowel Task 2 (VT2)

Operation 1: Set vowel.

Source: VT2

Related PepAssess outputs: Vowel Space Dispersion (C, D--partial), Pairwise (B--partial), Z Scores (C, D), Vowel Z Scores (D), Speech Intensity Index (A, B--partial), Loudness Stability Analyses (A, B--partial)

Stimuli: All vowels, including substitutions, in VT2 (44 words)

Procedure: Identify and segment each vowel. Identify vowels by strong vertical glottal pulsing in the presence of formant structure through the region of F2. The middle 20 ms are automatically marked off by TF32 when the vowel is segmented. Correct the characteristic F0 as needed for all segmented vowels. Instructions for correcting F0 are on p. 12 of this guide.

Operation 2: Set formants 1-3.

Source: VT2

Related PepAssess outputs: Z Scores (D), Vowel Stability Z Scores (M), Fundamental Frequency Index, Pitch Stability Analyses, Resonance Quality Precision, Resonance Quality Stability Analyses.

Stimuli: All vowels, including substitutions, in VT2 (44 words)

Procedure: Segment the vowels. If Operation 1 has been completed, these vowels should already be segmented. The middle 20 ms will automatically be marked off by TF32. TF32 allows separate analyses for the 2 vowels in the phonemic diphthongs / $\overline{a}i$, $\overline{a}u$, $\overline{o}i$ / in the VT2 transcript. *For the 3 phonemic diphthongs, 5 formant measures are made: at 20 ms from the onset, 20%, 50% (temporal midpoint), 80%, and 20 ms*

from the offset. The 5 measurement portions are identified automatically when the vowel is segmented.

Click once on the “little” button at the top left of the TF32 display; the LPC and FFT traces will be displayed in a larger format.

Identify characteristic frequencies for F1, F2, and F3 using a combination of the Fast Fourier Transform (FFT) amplitude and the Linear Predictive Coding (LPC) peak, with visual confirmation of this point in the middle of the formant band. Press the Set F1, F2, and F3 buttons.

Check and correct, if necessary, the F0 track for the entire vowel.

Click here for video tutorial on [segmenting vowels and setting formants](#) ("Underwater" video).

Operation 3: Set jitter, shimmer, and harmonics-to-noise ratio (HNR).

Source: VT2

Related PepAssess Outputs: Voice Laryngeal Quality Competence

Stimuli: All vowels, including substitutions, in VT2 (44 words)

Procedure: Complete the procedure described for Operation 1 (Set Vowel). Relocate the cursor to the vowel boundary. Press the jitter/shimmer button. Data are automatically recorded. Check and correct, if necessary, the F0 track for the entire vowel.

Operation 4: Set consonant (stop singletons).

Source: VT2

Related PepAssess Outputs: Speech Intensity Index (A, B--partial), Loudness Stability Analyses (A, B--partial)

Stimuli: All word-initial stops (no substitutions; Y and Z lines must match)

Procedure: Segment word-initial stops by burst, aspiration noise to the onset of glottal pulsing for the following sound.

Articulation Test (AT)

The stimuli for the acoustic analyses operations in this section are taken from some of the words that are administered as part of the *Goldman-Fristoe Test of Articulation 2* (Goldman & Fristoe, 2000). Included are Operations 1, 4, and 5.

Operation 1: Set vowel.

Source: AT

Related PepAssess outputs: Speech Intensity Index (partial), Loudness Stability Analyses (partial)

Stimuli: /ʌ/ in *cup*, /ʌ/ in *shovel*, /ɪ/ in *zipper*, /ɪ/ in *scissors*, /ʌ/ in *duck*

Procedure: Identify and segment each vowel. Identify vowels by strong vertical glottal pulsing in the presence of formant structure through the region of F2. The middle 20 ms are automatically marked off by TF32 when the vowel is segmented. Correct the characteristic F0 as needed for all segmented vowels. Instructions for correcting F0 are on p. 12 of this guide.

Operation 4: Set consonant (fricatives and stops).

Source: AT

Related PepAssess Outputs: Consonant Acoustic Z Scores (A, B, C, D), Moments profile, Speech Intensity Index (partial), Loudness Stability Analyses (partial)

Stimuli: /s/ in *house*, /s/ in *spoon*, /s/ in *scissors*, /s/ in *this*, /s/ in *stars*, /k/ in *cup*, /ʃ/ in *shovel*, /z/ in *zipper*, /d/ in *duck*. The main symbols in the Y and Z lines must match.

Procedure: Segment the sibilants by identifying the onset to offset of strong noise energy. Use close listening to confirm. "Noisy" vowels may be contiguous with the sibilant(s). This noise should be considered part of the vowel, not the sibilant.

Segment word-initial stops by burst, aspiration noise to the onset of glottal pulsing for the following sound.

Operation 5: Set consonant, set pause, set addition, set consonant.

Source: AT

Related PepAssess Outputs: Consonant Acoustics Z Scores (E - L), Between/Within Word Syllable Segregation

Stimuli: The adjacent consonants specified in the following list (the main symbols in the Y and Z lines must match):

- /k j/ in *vacuum*
- /p l/ in *plane*
- /b/ in *blue*
- /θ t/ in *bathtub*
- /f l/ in *flowers*
- /br/ in *brush*
- /fr/ in *frog*
- /s l/ in *slide*

Procedure: Segment word-initial stops by burst, aspiration noise to the onset of glottal pulsing for the following sound. Segment word-medial stops by stop gap, burst, and aspiration noise.

Segment fricatives by identifying the onset to offset of strong noise energy. Use close listening to confirm. "Noisy" vowels may be contiguous with the fricative(s). This noise should be considered part of the vowel, not the fricative.

Identify pauses and/or additions, if present. Any unmarked segment longer than 20 ms is identified as a pause that needs location or as an addition. Confirm that all segments in the consonant pairs are fully marked and identified and that any pause(s) and/or addition(s) is marked and located. See instructions for marking and locating pauses/additions on pp. 22-23, Operations 7 and 8.)

Following are instructions specific to each consonant pair:

/k j/ in *vacuum*

1. Following the periodic glottal pulsing of the preceding vowel, segment the stop gap, burst, and aspiration noise for /k/.
2. Mark and locate any pause(s) and/or addition(s), if present.
3. Segment the weaker periodic energy of /j/, using the waveform, presence of antiformants, and close listening to assist.

/p l/ in *plane*

1. Segment the stop gap, burst, and aspiration noise for /p/.
2. Mark and locate any pause(s) and/or addition(s), if present.
3. Segment the relatively weaker energy (as compared to a vowel) for the /l/ using the waveform and presence of antiformants, along with close listening as a guide.

/b/ in *blue*

1. Segment the stop gap, burst, and aspiration noise for /b/.
2. Mark and locate any pause(s) and/or addition(s), if present.

3. Segment the relatively weaker energy (as compared to a vowel) for the /l/ using the waveform and presence of antiformants, along with close listening as a guide.

/θt/ in *bathtub*

1. Following the strong energy of the preceding vowel, segment the onset of strong frication noise in /θ/ to the offset of the strong frication noise.
2. Mark and locate any pause(s) and/or addition(s), if present.
3. Segment the stop gap, burst, and aspiration noise for /t/.

/f/ in *flowers*

1. Segment /f/ by identifying the frication noise onset and offset.
2. Mark and locate any pause(s) and/or addition(s), if present.
3. Segment the relatively weaker energy (as compared to a vowel) for /l/ using the waveform and presence of antiformants, along with close listening as a guide.

/br/ in *brush*

1. Segment the stop burst and aspiration noise for /b/.
2. Mark and locate any pause(s) and/or addition(s), if present.
3. To identify and segment /r/, look for the point at which F2 and F3 are close together, using the waveform and presence of antiformants, along with close listening.

/fr/ in *frog*

1. Segment /f/ by identifying the frication noise onset and offset.
2. Mark and locate any pause(s) and/or addition(s), if present.
3. To identify and segment /r/, look for the point at which F2 and F3 are close together, using the waveform and presence of antiformants, along with close listening.

/s/ in *slide*

1. Segment /s/ by identifying the frication noise onset and offset.
2. Mark and locate any pause(s) and/or addition(s), if present.
3. Segment the relatively weaker energy (as compared to a vowel) for /l/ using the waveform and presence of antiformants, along with close listening as a guide.

Click here for video tutorial on [marking a fricative /s/ and a cluster /sk/](#) ("SundaySch" video).

Rhotics and Sibilants Test (RST)

Operation 1: Set vowel.

Source: RST

Related PepAssess outputs: Vowel Z Scores (D)

Stimuli: The first 3 tokens of /ɜ/ in each of 3 word types (*burr*, *bird*, *burg*--typically in the first 30 words/stimuli of the task). The main symbols in the Y and Z lines must match.

Procedure: Identify and segment each token of /ɜ/, characterized by lowered F3 and reduced energy in the waveform. The middle 20 ms of the segmented /ɜ/ are automatically cursored off by TF32.

Operation 2: Set formants 1-3.

Source: RST

Related PepAssess outputs: Vowel Z Scores (D), Vowel Stability Z Scores (M)

Stimuli: The first 3 tokens of /ɜ/ in each of 3 word types (*burr*, *bird*, *burg*--typically in the first 30 words/stimuli of the task). The main symbol in the Y and Z lines must match.

Procedure: After all tokens have been segmented, click once on the "little" button at the top left of the TF32 display; the LPC and FFT traces will be displayed in a larger format.

Identify characteristic frequencies for F1, F2, and F3 using a combination of the Fast Fourier Transform (FFT) amplitude and the Linear Predictive Coding (LPC) peak, with visual confirmation of this point in the middle of the formant band. Press the Set F1, F2, and F3 buttons.

Check and correct, if necessary, the F0 track for the entire vowel. Instructions for correcting F0 are on p. 12 of this guide.

Click here for video tutorial on [segmenting vowels and setting formants](#) ("Underwater" video).

Operation 4: Set consonant (sibilants).

Source: RST

Related PepAssess Outputs: Consonant Acoustic Z Scores (A, B, C, D), Moments profile

Stimuli: The first 3 tokens of /s/ in each of 5 word types (*sin, soon, skin, kiss, spoon*). The main symbol in the Y and Z lines must match.

Procedure: Segment the sibilants by identifying the onset to offset of strong noise energy. Use close listening to confirm. "Noisy" vowels may be contiguous with the sibilant(s). This noise should be considered part of the vowel, not the sibilant.

Click here for video tutorial on [marking a fricative /s/ and a cluster /sk/](#) ("SundaySch" video).

Lexical Stress Task (LST)

Operation 1: Set vowel.

Source: LST

Related PepAssess outputs: Lexical Stress, Stress Stability Analyses (A), Speech Intensity Index (partial), Stress Stability Analysis (partial), Loudness Stability Analyses (partial)

Stimuli: The 2 vowels in *chicken, dishes, hammer, ladder, peanut, puppy, robot, window*; the first vowels in *giraffe, guitar*. The main vowel symbols in the Y and Z lines must match.

Procedure: Identify and segment each vowel. Identify vowels by strong vertical glottal pulsing in the presence of formant structure through the region of F2. The middle 20 ms are automatically marked off by TF32 when the vowel is segmented. Correct the characteristic F0 as needed for all segmented vowels. Instructions for correcting F0 are on p. 12 of this guide.

Click here for video tutorial on [segmenting vowels and setting formants](#). ("Underwater" video).

Operation 4: Set consonant.

Source: LST

Related PepAssess Outputs: Speech Intensity Index (partial), Loudness Stability Analyses (partial)

Stimuli: /tʃ/ in *chicken*, /d/ in *dishes*, /dʒ/ in *giraffe*, /g/ in *guitar*, /p/ in *puppy*. The main consonant symbols in the Y and Z lines must match.

Procedure: Segment word-initial stops by burst, aspiration noise to the onset of glottal pulsing for the following sound. Segment word-initial affricates by the burst, affrication noise, and following frication noise.

Sustained Vowel Task (SVT)

The SVT typically includes 3 attempts at producing /a/ for "as long as possible." If the SVT isn't included in the assessment protocol, or if the audio file for the task is not suitable for acoustic analyses, the tokens of sustained /a/ administered as part of the Orofacial Exam Task (OET) can also be acoustically analyzed using the following procedures if the OET was administered and recorded.

Operation 1: Set vowel.

Source: SVT/OET

Related PepAssess outputs: Pitch Stability Analyses

Stimulus: The middle 1 second of the first usable sustained /a/

Procedure: Identify the vowel by strong vertical glottal pulsing in the presence of formant structure through the region of F2. The middle 20 ms are automatically marked off by TF32. Use this center portion to locate the middle one second (1000 ms) of the vowel. Correct the characteristic F0 as needed for all segmented vowels. Instructions for correcting F0 are on p. 12 of this guide.

Operation 3: Set jitter, shimmer, and harmonics-to-noise ratio (HNR).

Source: SVT/OET

Related PepAssess Outputs: Voice Laryngeal Quality Competence, Laryngeal Quality Stability Analyses

Stimulus: The middle 1 second of the first usable sustained /a/

Procedure: Complete the procedure described for Operation 1 (Set Vowel). Relocate the cursor to the vowel boundary. Press the jitter/shimmer button. Data are automatically recorded.

Multisyllabic Words Task 1 (MWT1)

There are 2 versions of the Multisyllabic Words Task (MWT) (Catts, 1986) available as part of the Madison Speech Assessment Protocol (MSAP). The MWT1 is administered to preschool and school-age children from ages 3;0 to 11;11. The MWT2, which is covered in the next section, is administered to adolescent and adult participants age

12;0 and up. The operations for each task are the same; however, the stimuli are different.

Operation 4: Set consonant (fricatives).

Source: MWT1

Related PepAssess Outputs: Consonant Acoustic Z Scores (A, B, C, D), Moments profile (A)

Stimuli: /s/ in *symphony*, first /s/ in *suspicious*, /s/ in *skeptical*, first /s/ in *substantial*, first /s/ in *susceptible*, first /s/ in *specific*. The main symbols in the Y and Z lines must match.

Procedure: Segment the sibilants by identifying the onset to offset of strong noise energy. Use close listening to confirm. "Noisy" vowels may be contiguous with the sibilant(s). This noise should be considered part of the vowel, not the sibilant.

Operation 5: Set consonant, set pause, set addition, set consonant.

Source: MWT1

Related PepAssess Outputs: Consonant Acoustics Z Scores (E - L), Between/Within Word Syllable Segregation

Stimuli: The adjacent consonants specified in the following words (the main symbols in the Y and Z lines must match), plus any pauses/additions between the 2 consonants:

- /sf/ in *hemisphere*
- /st/ in *establish*
- /ns/ in *consequence*
- /mf/ in *symphony*
- /sp/ in *suspicious*
- /pt/ in *skeptical*
- /kl/ in *bicyclist*
- /rk/ in *orchestra*
- /bs/ in *substantial*
- /sp/ in *specific*

Procedure: Segment consonant pairs and identify pauses and/or additions, if present. As noted, the main symbols in the Y and Z lines must match.

Identify pauses and/or additions, if present. Any unmarked segment longer than 20 ms is identified as a pause that needs location or as an addition. Confirm that all segments in the consonant pairs are fully marked and identified and that any pause(s) and/or

addition(s) is marked and located. See instructions for marking and locating pauses/additions on pp. 22-23, Operations 7 and 8.)

Following are instructions specific to each consonant pair:

/sf/ in hemisphere

1. Following the strong energy of the preceding vowel, segment the onset to offset of the strong frication noise of the /s/.
2. Mark any pause(s) and/or addition(s), if present.
3. Segment /f/ from the onset of weaker frication noise to the offset of weaker frication noise preceding the onset of the following vowel.

/st/ in establish

1. Following the strong energy of the preceding vowel, segment the onset to offset of strong frication noise of the /s/.
2. Mark any pause(s) and/or addition(s), if present.
3. Segment the stop gap, burst, and aspiration noise for the /t/.

/ns/ in consequence

1. Following the strong glottal pulsing of the preceding vowel, look for the typical reduced energy of the /n/ and segment accordingly. Use the waveform to assist; antiformants and nasal murmur will likely be present.
2. Mark any pause(s) and/or addition(s), if present.
3. Following the weaker energy of the preceding sound, segment the /s/ using its typical onset of frication energy for identification.

/mf/ in symphony

1. Following the strong glottal pulsing of the preceding vowel, look for the typical reduced energy of the /m/ and segment accordingly. Use the waveform to assist; antiformants and nasal murmur will likely be present.
2. Mark any pause(s) and/or addition(s), if present.
3. Following the weaker energy of /m/, segment the /f/ using its typical onset of frication energy for identification.

/sp/ in suspicious

1. Following the strong energy of the preceding vowel, segment the onset to offset of strong frication noise of the /s/.
2. Mark any pause(s) and/or addition(s), if present.
3. Segment the stop gap, burst, and aspiration noise for the /p/.

/pt/ in *skeptical*

1. Following the periodic glottal pulsing of the preceding vowel, segment the stop gap, burst, and aspiration noise for the /p/.
2. Mark any pause(s) and/or addition(s), if present.
3. Segment the stop gap, burst, and aspiration noise for the /t/.

/k/ in *bicyclist*

1. Following the periodic glottal pulsing of the preceding vowel, segment the stop gap, burst, and aspiration noise of the /k/.
2. Mark any pause(s) and/or addition(s), if present.
3. Segment the relatively weaker energy (as compared to a vowel) of the /l/ using the waveform and presence of antiformants, along with close listening, as a guide.

/rk/ in *orchestra*

1. Following the strong energy of the preceding vowel, segment the /r/, using the point at which F2 and F3 are close together. Use the waveform, the presence of antiformants, and close listening for guidance and confirmation.
2. Mark any pause(s) and/or addition(s), if present.
3. Segment the stop gap, burst, and aspiration noise for the /k/.

/bs/ in *substantial*

1. Following the periodic glottal pulsing of the preceding vowel, segment the stop gap, burst, and aspiration noise of the /b/. The duration of this segment will likely be shorter than that of a voiceless stop.
2. Mark any pause(s) and/or addition(s), if present.
3. Segment the strong onset to offset of frication energy of the /s/.

/sp/ in *specific*

1. Segment the onset to offset of strong frication noise of the /s/.
2. Mark any pause(s) and/or addition(s), if present.
3. Segment the stop gap, burst, and aspiration noise for the /p/.

Multisyllabic Words Task 2 (MWT2)

As mentioned previously, there are 2 versions of the Multisyllabic Words Task (MWT) (Catts, 1986) available as part of the Madison Speech Assessment Protocol (MSAP). The MWT2 is administered to adolescent and adult participants age 12;0 and up.

Operation 4: Set consonant (fricatives).

Source: MWT2

Related PepAssess Outputs: Consonant Acoustic Z Scores (A, B, C, D), Moments profile (A)

Stimuli: /s/ in *sympathize*, first /s/ in *synthesis*, /s/ in *skeptical*, first /s/ in *suspicious*, first /s/ in *specific*, first /s/ in *statistics*, first /s/ in *statistician*. The main symbols in the Y and Z lines must match.

Procedure: Segment the sibilants by identifying the onset to offset of strong noise energy. Use close listening to confirm. "Noisy" vowels may be contiguous with the sibilant(s). This noise should be considered part of the vowel, not the sibilant.

Operation 5: Set consonant, set pause, set addition, set consonant.

Source: MWT2

Related PepAssess Outputs: Consonant Acoustics Z Scores (E - L), Between/Within Word Syllable Segregation

Stimuli: The adjacent consonants specified in the following words, (the main symbols in the Y and Z lines must match), plus any pauses/additions between the 2 consonants:

- /mf/ in *emphasis*
- /mp/ in *sympathize*
- /nθ/ in *synthesis*
- /sp/ in *especially*
- /pt/ in *skeptical*
- /nʃ/ in *consciousness*
- /sp/ in *suspicious*
- /rk/ in *orchestra*
- /st/ in *statistics*
- /ks/ in *extinguisher*

Procedure: Segment consonant pairs and identify pauses and/or additions, if present. As noted, the main symbols in the Y and Z lines must match.

Identify pauses and/or additions, if present. Any unmarked segment longer than 20 ms is identified as a pause that needs location or as an addition. Confirm that all segments in the consonant pairs are fully marked and identified and that any pause(s) and/or addition(s) is marked and located. See instructions for marking and locating pauses/additions on pp. 22-23, Operations 7 and 8.)

Following are instructions specific to each consonant pair:

/mf/ in *emphasis*

1. Following the strong glottal pulsing of the preceding vowel, look for the typical reduced energy of the /m/ and segment accordingly. Use the waveform to assist; antiformants and nasal murmur will likely be present.
2. Mark any pause(s) and/or addition(s), if present.
3. Following the weaker energy of the preceding sound, segment the /f/ using its typical onset of frication energy for identification.

/mp/ in *sympathize*

1. Following the strong periodic glottal pulsing of the preceding vowel, look for the typical reduced energy of the /m/ and segment accordingly. Use the waveform to assist; antiformants and nasal murmur will likely be present.
2. Mark any pause(s) and/or addition(s), if present.
3. Segment the stop gap, burst, and aspiration noise for the /p/.

/nθ/ in *synthesis*

1. Following the strong glottal pulsing of the preceding vowel, look for the typical reduced energy of the /n/ and segment accordingly. Use the waveform to assist; antiformants and nasal murmur will likely be present.
2. Mark any pause(s) and/or addition(s), if present.
3. Following the weaker energy of the preceding sound, segment the /θ/ using its typical onset of frication energy for identification.

/sp/ in *especially*

1. Following the strong energy of the preceding vowel, segment the onset to offset of strong frication noise of the /s/.
2. Mark any pause(s) and/or addition(s), if present.
3. Segment the stop gap, burst, and aspiration noise for the /p/.

/pt/ in *skeptical*

1. Following the periodic glottal pulsing of the preceding vowel, segment the stop gap, burst, and aspiration noise for the /p/.
2. Mark any pause(s) and/or addition(s), if present.
3. Segment the stop gap, burst, and aspiration noise for the /t/.

/n/ in *consciousness*

1. Following the strong glottal pulsing of the preceding vowel, look for the typical reduced energy of the /n/ and segment accordingly. Use the waveform to assist; antiformants and nasal murmur will likely be present.
2. Mark any pause(s) and/or addition(s), if present.
3. Following the weaker energy of the preceding sound, segment the /ŋ/ using its typical onset of frication energy for identification.

/rk/ in *orchestra*

1. Following the strong energy of the preceding vowel, segment the /r/, using the point at which F2 and F3 are close together. Use the waveform, the presence of antiformants, and close listening for guidance and confirmation.
2. Mark any pause(s) and/or addition(s), if present.
3. Segment the stop gap, burst, and aspiration noise for the /k/.

/st/ in *statistics*

1. Segment the onset to offset of strong frication noise of the /s/.
2. Mark any pause(s) and/or addition(s), if present.
3. Segment the stop gap, burst, and aspiration noise for the /t/.

/ks/ in *extinguisher*

1. Following the periodic glottal pulsing of the preceding vowel, segment the stop gap, burst, and aspiration noise of the /k/.
2. Mark any pause(s) and/or addition(s), if present.
3. Segment the strong frication noise of the /s/, distinguishing it from the aspiration noise for the preceding /k/ by the greater amount of energy present.

Challenging Words Task (CWT)

Operation 1: Set vowel.

Source: CWT

Related PepAssess outputs: Lexical Stress (A), Stress Stability Analysis (A)

Stimuli: The vowels in the first usable production of each of the 8 following target words: *helicopter*, *kangaroo*, *elephant*, *caterpillar*, *tomato*, *octopus*, *alligator*, *watermelon*. The main vowel symbol in the Y and Z lines must match.

Procedure: Identify and segment each vowel. Identify vowels by strong vertical glottal pulsing in the presence of formant structure through the region of F2. The middle 20 ms are automatically marked off by TF32 when the vowel is segmented. Correct the characteristic F0 as needed for all segmented vowels. Instructions for correcting F0 are on p. 12 of this guide.

Click here for video tutorial on [segmenting vowels and setting formants](#) ("Underwater" video).

Emphatic Stress Task (EST)

Operation 1: Set vowel.

Source: EST

Related PepAssess outputs: Emphatic Stress profile, Stress Stability Analysis (B)

Stimuli: The 4 vowels from each of the 8 utterances. Although the vowel/word responses (i.e., the Z lines) do not have to match the administered stimuli (i.e., the Y lines established in the protocol), each response can contain no fewer or no more than 4 vowels in order to be included in the acoustic analyses, and at least 4 usable utterances are necessary for inclusion as data that contribute to PepAnalyses outputs.

Procedure: Identify and segment each vowel. Identify vowels by strong vertical glottal pulsing in the presence of formant structure through the region of F2. The middle 20 ms are automatically marked off by TF32 when the vowel is segmented. Correct the characteristic F0 as needed for all segmented vowels. Instructions for correcting F0 are on p. 12 of this guide.

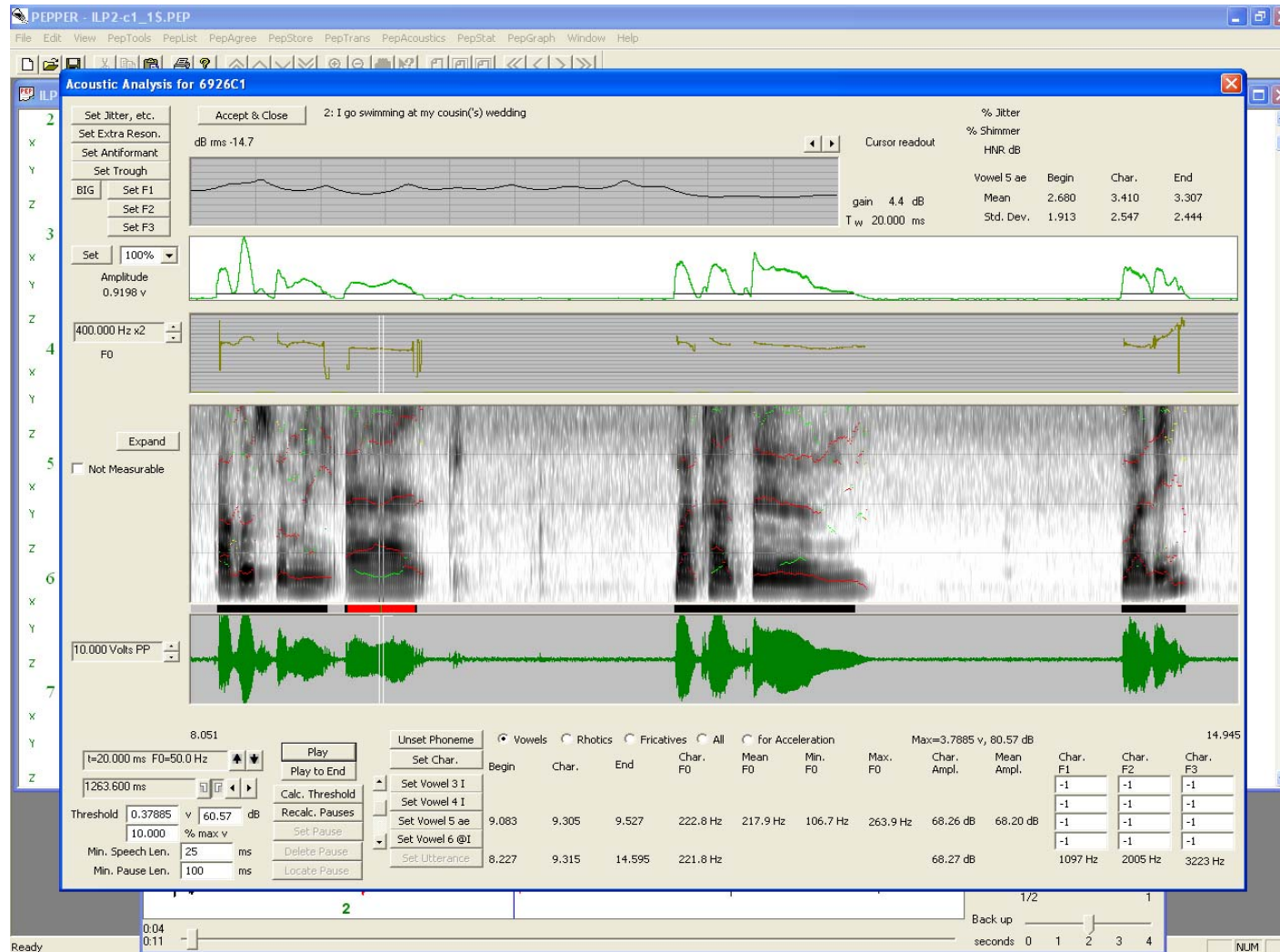
Click here for video tutorial on [segmenting vowels and setting formants](#) ("Underwater" video).

References

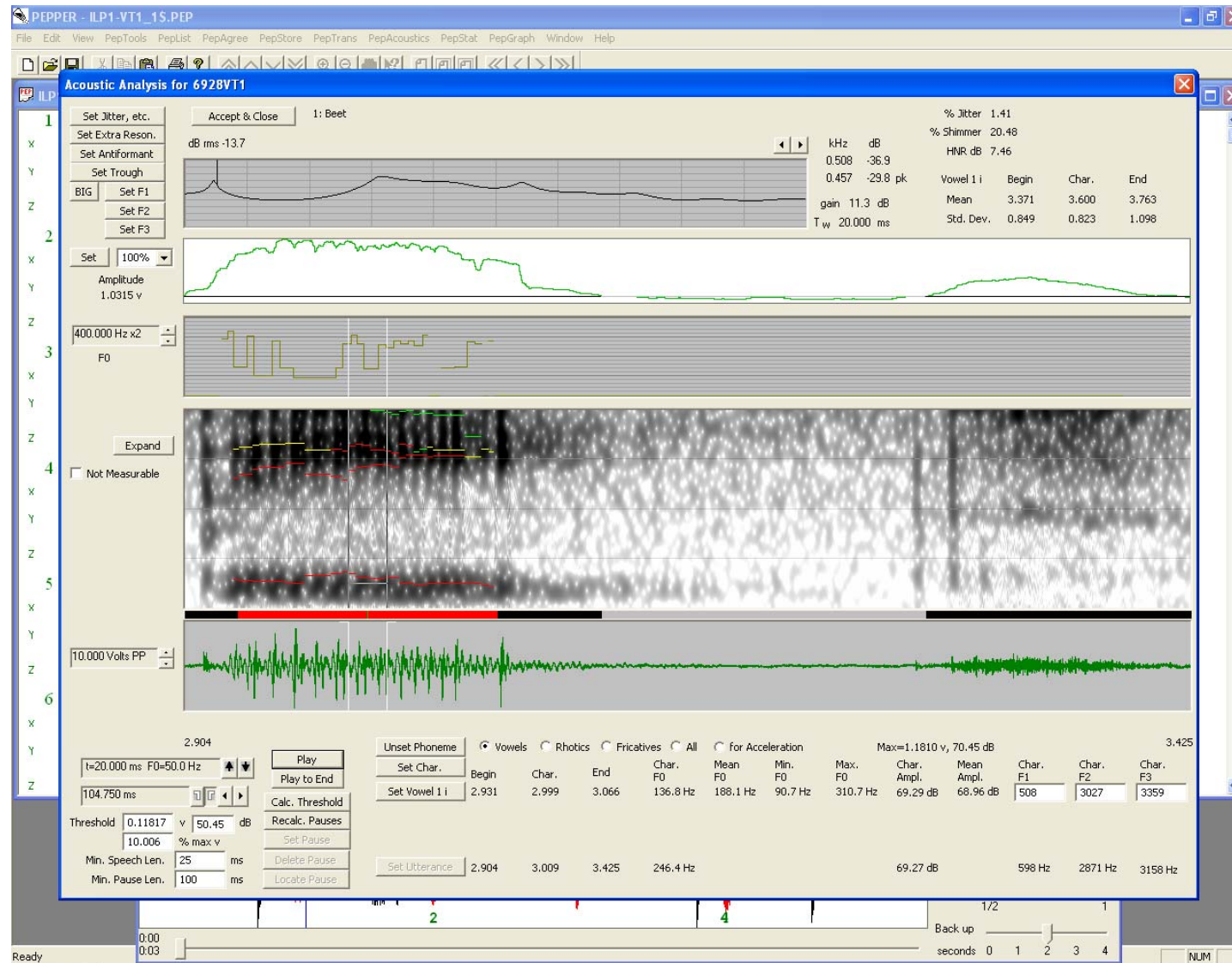
- Catts, H. (1986). Speech production/phonological deficits in reading disordered children. *Journal of Learning Disabilities, 19*, 504-508.
- Dollaghan, C., & Campbell, T. F. (1998). Nonword repetition and child language impairment. *Journal of Speech, Language and Hearing Research, 41*, 1136-1146.
- Goldman, R., & Fristoe, M. (2000). *Goldman Fristoe Test of Articulation - Second Edition*. Circle Pines, MN: American Guidance Service.
- Milenkovic, P. (2001). *TF32: Time-frequency analyses for 32-bit windows* [Computer software]. Wisconsin, Madison: Department of Electrical and Computer Engineering.
- Shriberg, L. D., Fourakis, M., Hall, S., Karlsson, H. B., Lohmeier, H. L., McSweeney, J., Potter, N. L., Scheer-Cohen, A. R., Strand, E. A., Tilkens, C. M., & Wilson, D. L. (2010). Extensions to the Speech Disorders Classification System (SDCS). *Clinical Linguistics & Phonetics, 24*, 795-824.
- Shriberg, L. D., Fourakis, M., Hall, S., Karlsson, H. B., Lohmeier, H. L., McSweeney, J., Potter, N. L., Scheer-Cohen, A. R., Strand, E. A., Tilkens, C. M., & Wilson, D. L. (2010). Perceptual and acoustic reliability estimates for the Speech Disorders Classification System (SDCS). *Clinical Linguistics & Phonetics, 24*, 825-846.
- Shriberg, L.D., Kwiatkowski, J., & Rasmussen, C. (1990). *The Prosody-Voice Screening Profile*. Originally published by Communication Skill Builders, Tucson, AZ; rights returned to The Phonology Project, University of Wisconsin-Madison, Madison, WI.
- Tilkens, C. M., Karlsson, H. B., Fourakis, M., Hall, S. D., Mabie, H. L., McSweeney, J. L., Wilson, D. L., & Shriberg, L. D. (2017). *A diagnostic marker to discriminate Childhood Apraxia of Speech (CAS) from Speech Delay (SD)*. (Tech. Rep. No. 22). Phonology Project, Waisman Center, University of Wisconsin-Madison.

Screen Shots

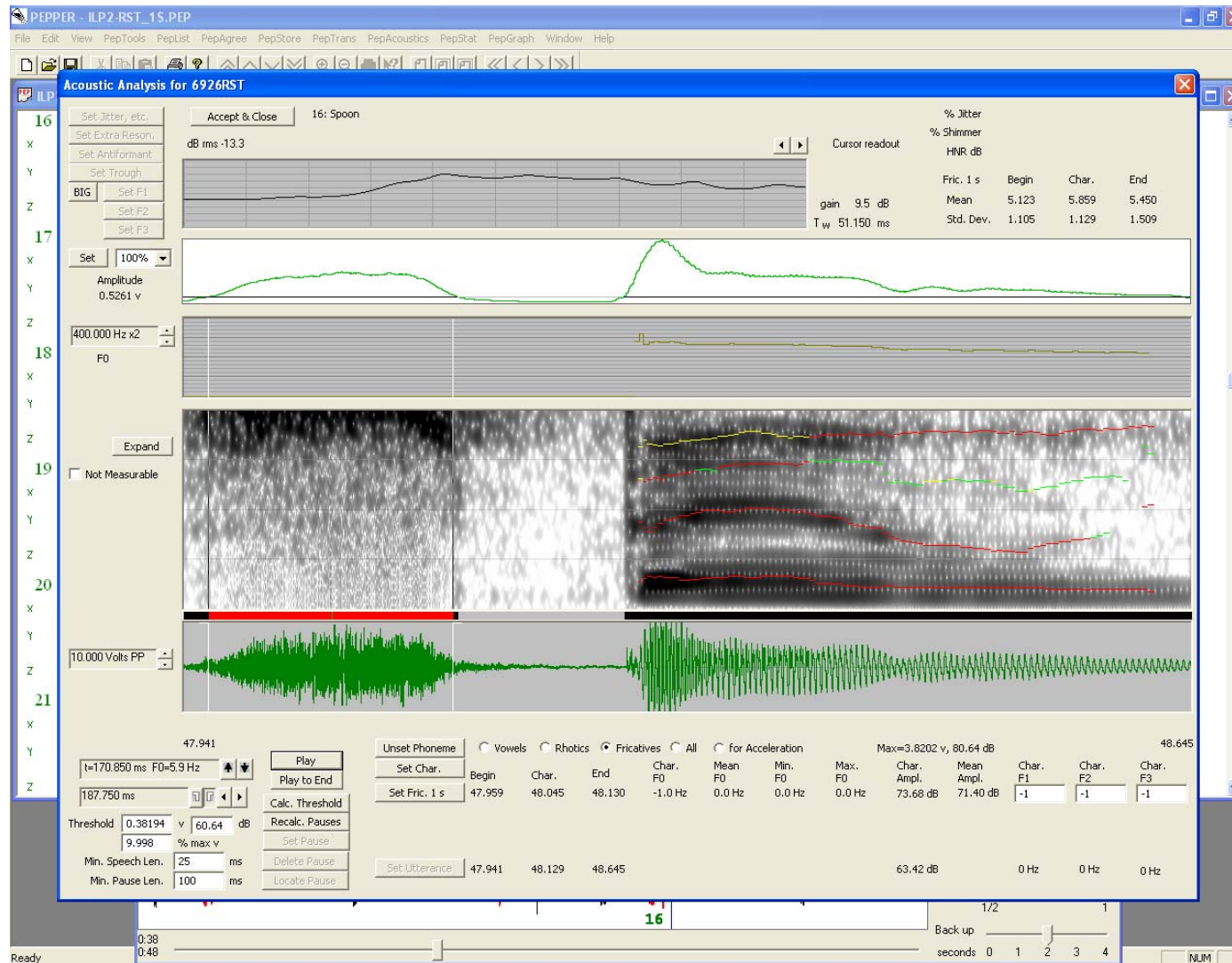
Set Vowel



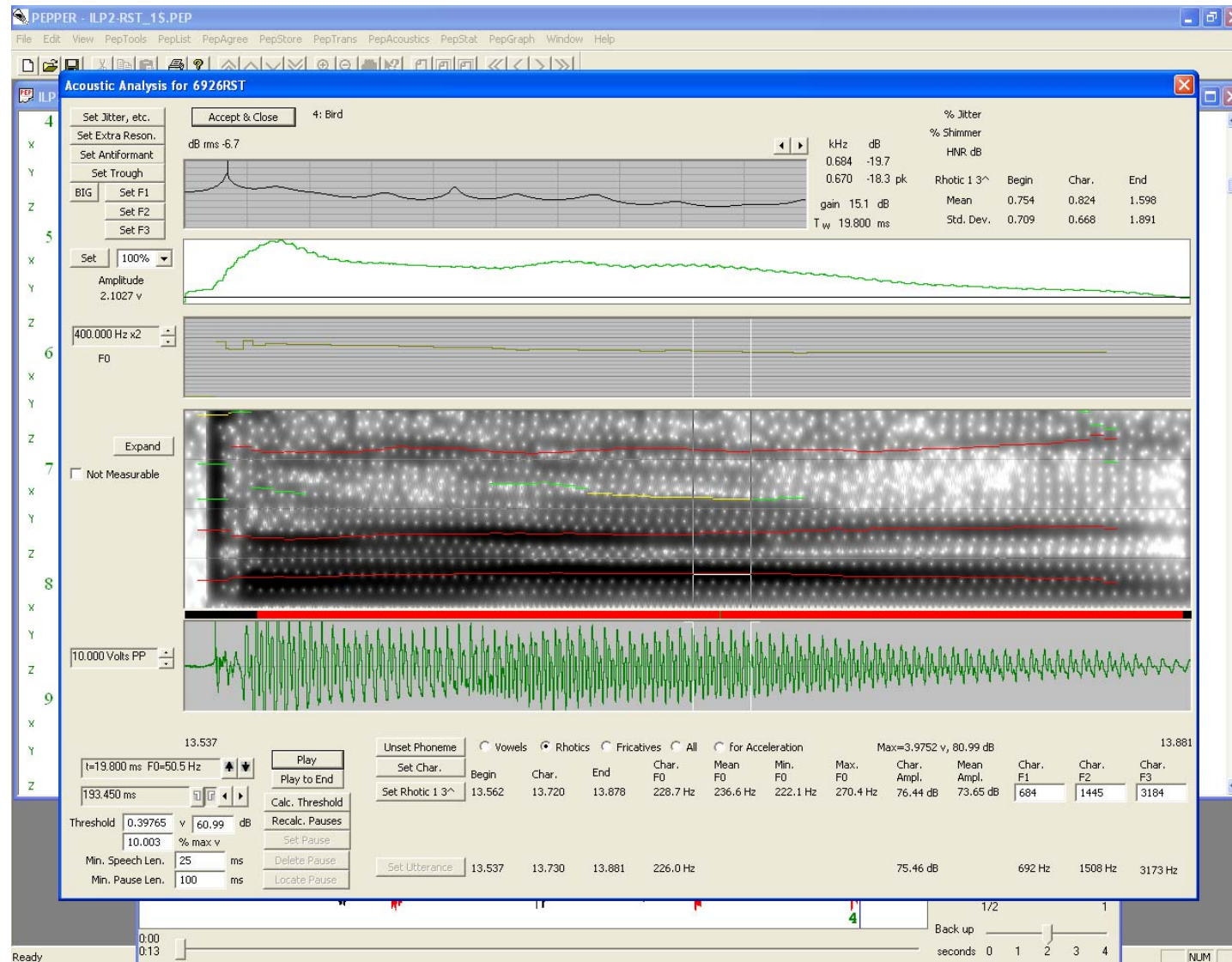
Set Formant (F1)



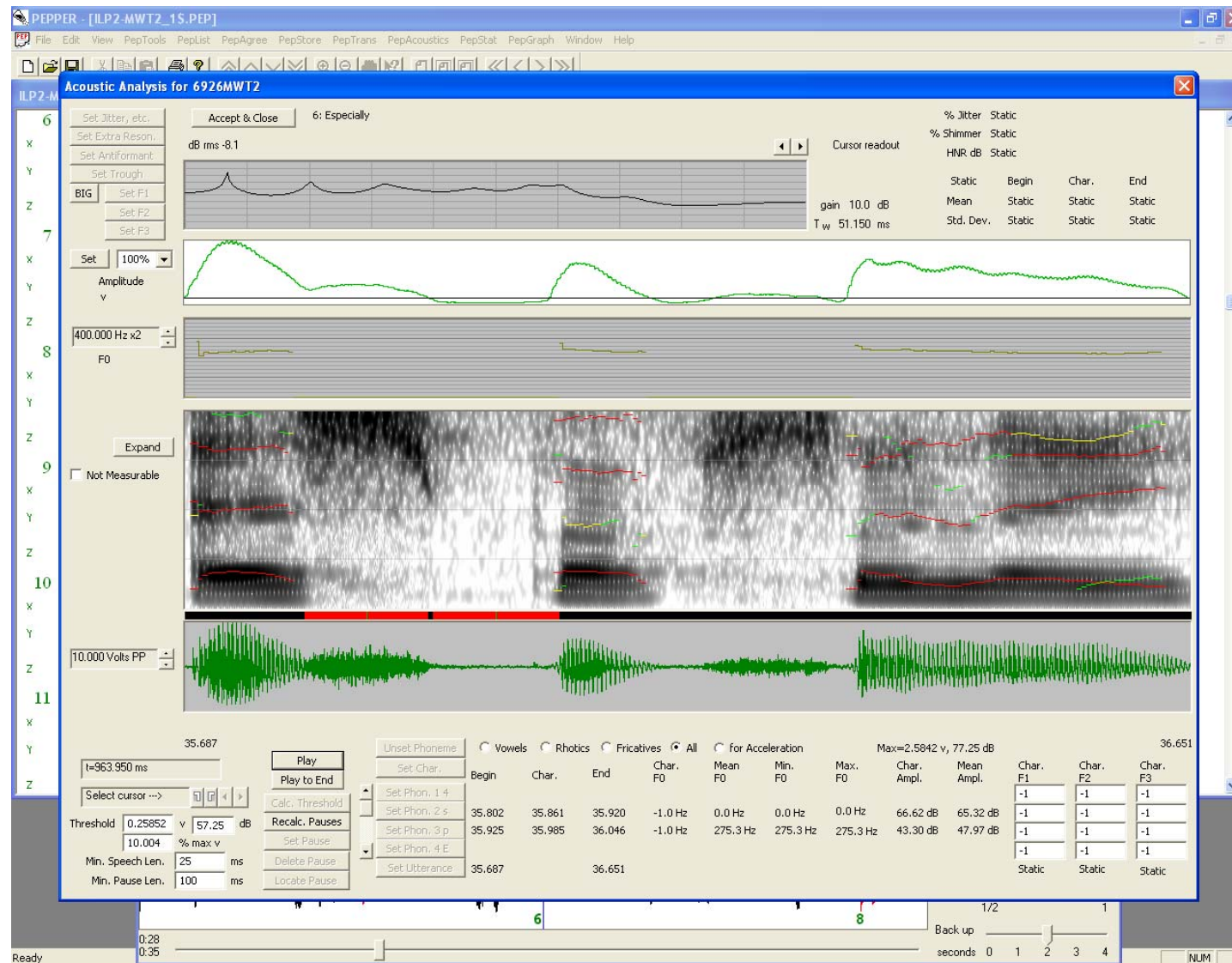
Set Phoneme - sibilant



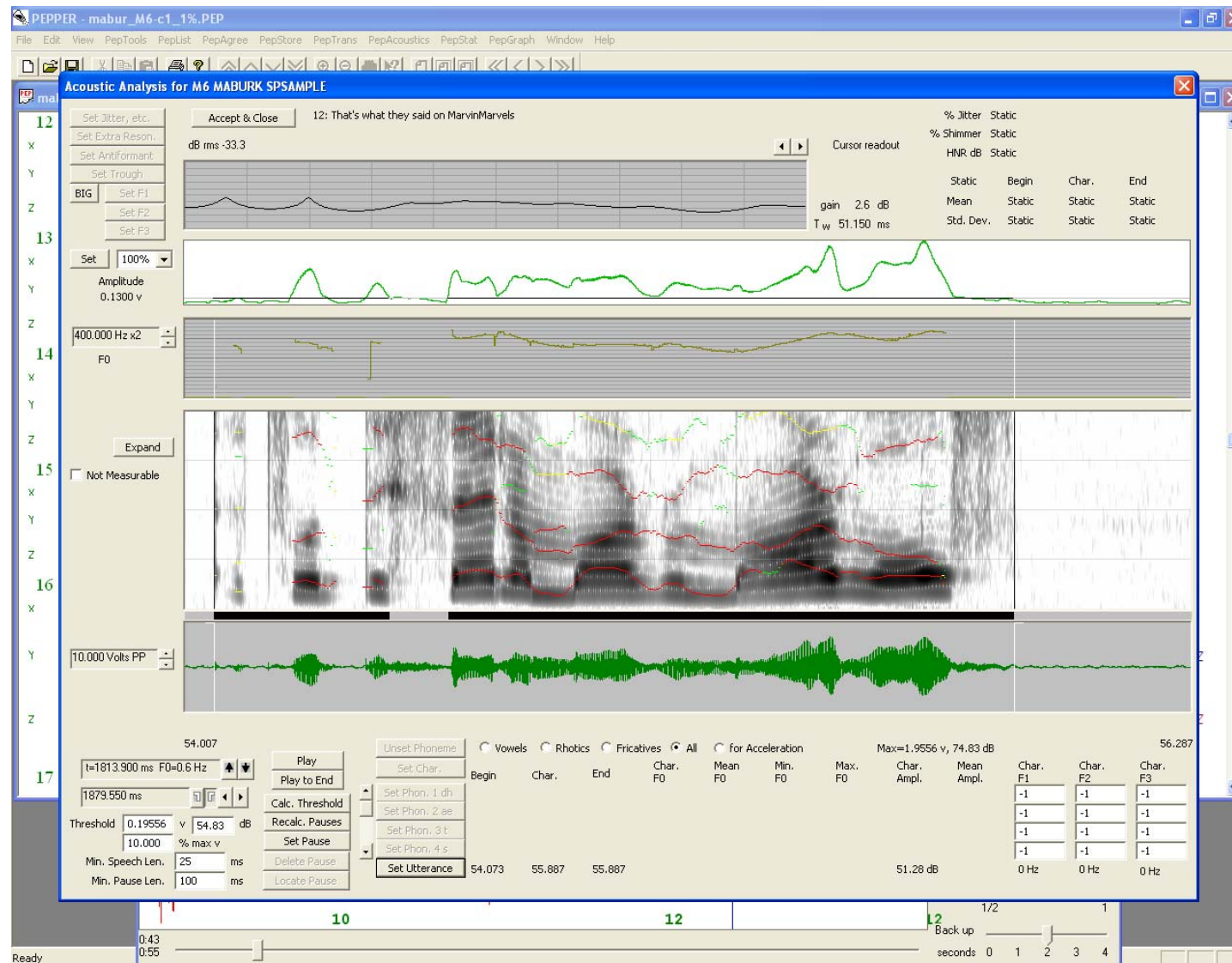
Set Phoneme – rhotic



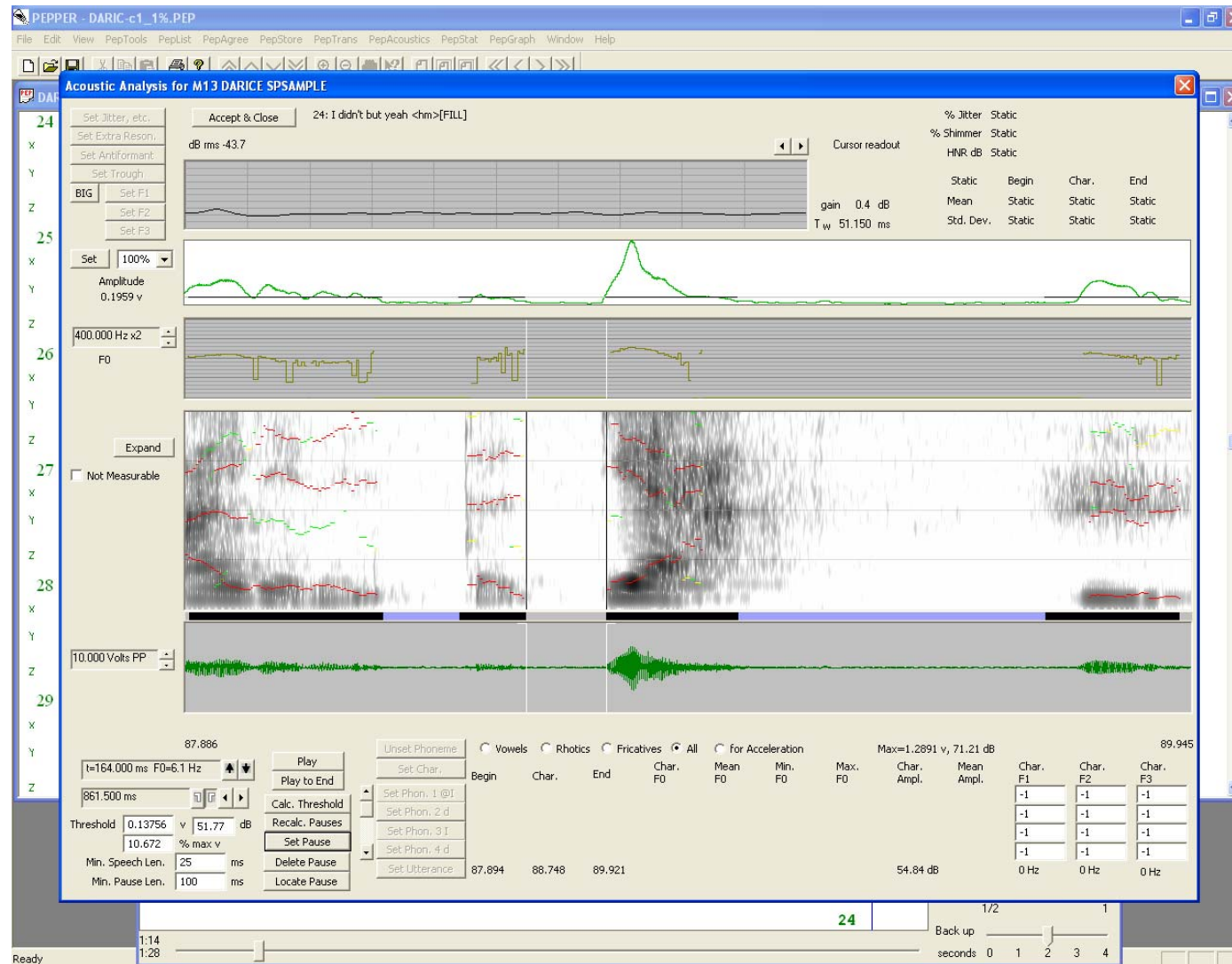
Set Phoneme Set Pause Set Phoneme



Set Utterance



Set Pause



Addition ("sing")

PEPPER - [MAYO_023-c1_1CTS.PEP]

File Edit View PepTools PepList PepAgree PepStore PepSDCS Obsolete PepStat PepGraph Window Help

MAYO_023-c1_1CTS.PEP

83 He he sing(s) alot
 Y hi: hi siŋ elat
 Z hi: hi siŋ^o elat
 84 <Um> C7
 Y Am
 Z Am
 85 His name is Stully 23 .15/SING
 Y hiz nēim iz salɪ
 Z hiz nēim iz salɪ
 86 A C7
 Y ēɪ:
 Z ēɪ:
 87 A bird C6
 Y ēɪ bɔd
 Z ēɪ bɔɪ
 88 Yellow [O] C5 C7
 Y jelo
 Z jelo
 89 With [O] orange C5 C6
 Y wɪθ: ɔrɪndʒ
 Z wɛθ: ɔrɪnɪʃ

Acoustic Analysis for MAYO_023-c1

Set Jitter, etc. Accept & Close Comment: 83: He he sing(s) alot

dB rms -34.1

gain 6.3 dB
 T_W 23.197 ms

% Jitter
 % Shimmer
 HNR dB

Begin Char. End

Mean Std. Dev.

Set 100%
 Amplitude 0.1221 v

400.000 Hz x2
 F0

Clear F0 corrections

Expand
☐ Not Measurable

10.000 Volts PP

580.498

Play
 Play to End

Calc. Threshold
 Recalc. Pauses
 Del Pause/Add
 Locate Ps/Add

Unset Phoneme
 Set Char.
 Set Vowel 1
 Set Vowel 2
 Set Vowel 3
 Set Vowel 4
 Set Utterance

For Acceleration

Char.	F0	Mean F0	Min. F0	Max. F0	Char. Ampl.	Mean Ampl.	Char. F1	Char. F2	Char. F3
255	255	255	254	254	-1	-1	467	2971	3462
254	254	254	254	254	-1	-1	467	2971	3462
254	254	254	254	254	-1	-1	590	2468	3377
228	228.9 Hz	209.6 Hz	239.2 Hz	68.34 dB	69.02 dB	-1	-1	-1	-1
580.498	580.498	580.498	580.498	50.73 dB	50.73 dB	0 Hz	0 Hz	0 Hz	0 Hz

Max=2.0357 v, 78.05 dB

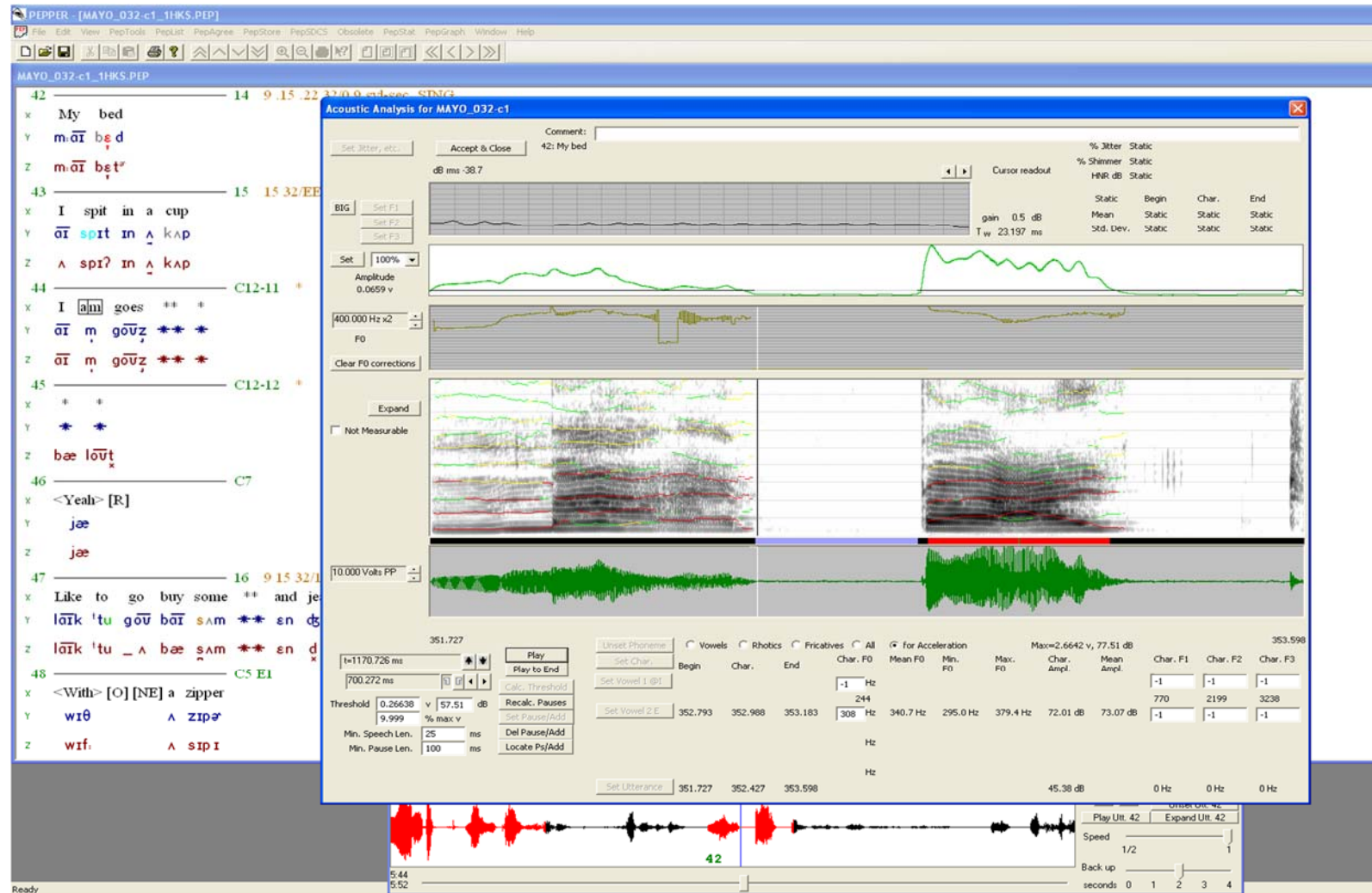
Play Ut. 83
 Expand Ut. 83

Speed 1/2

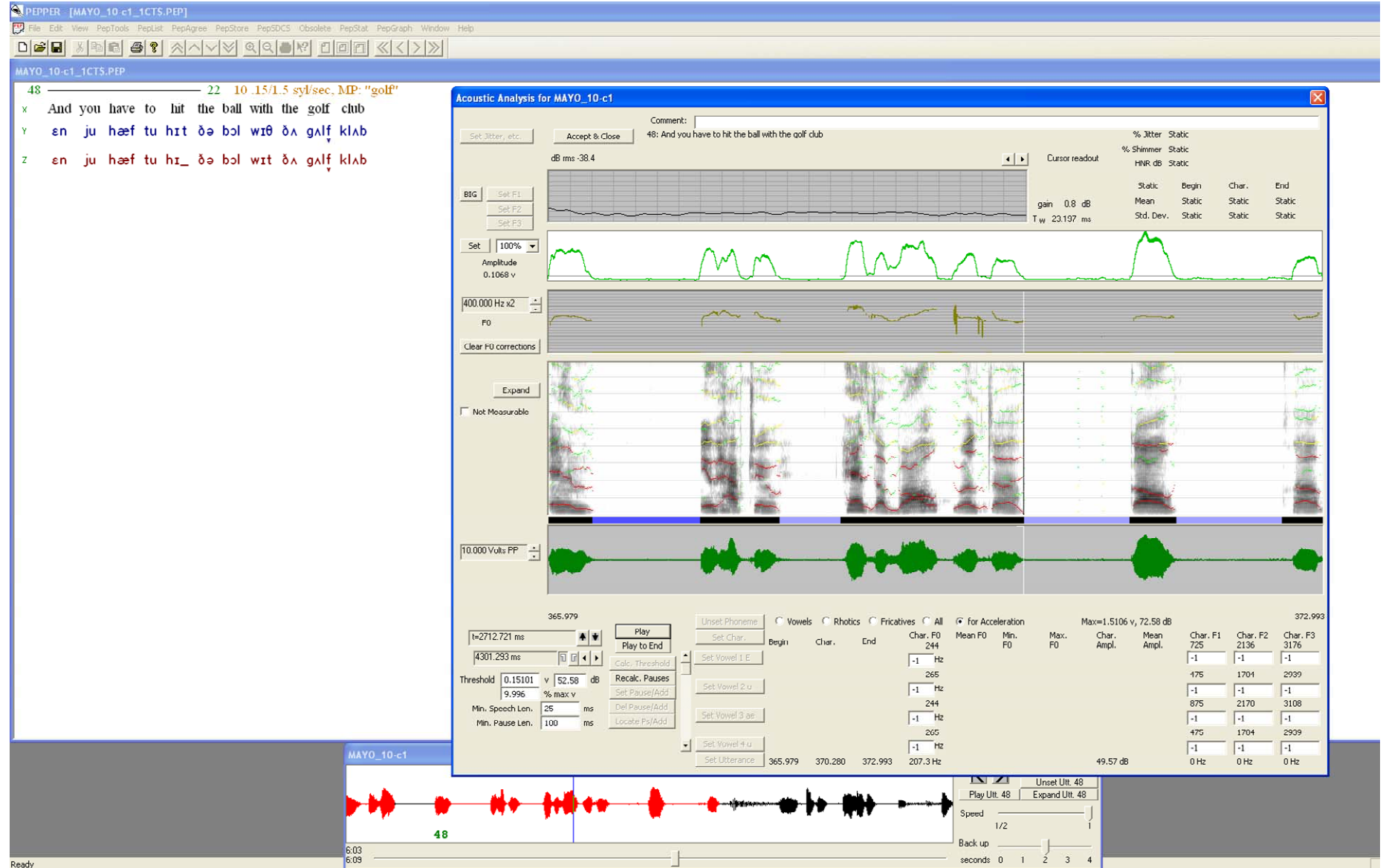
Back up seconds 0 1 2 3 4

Ready

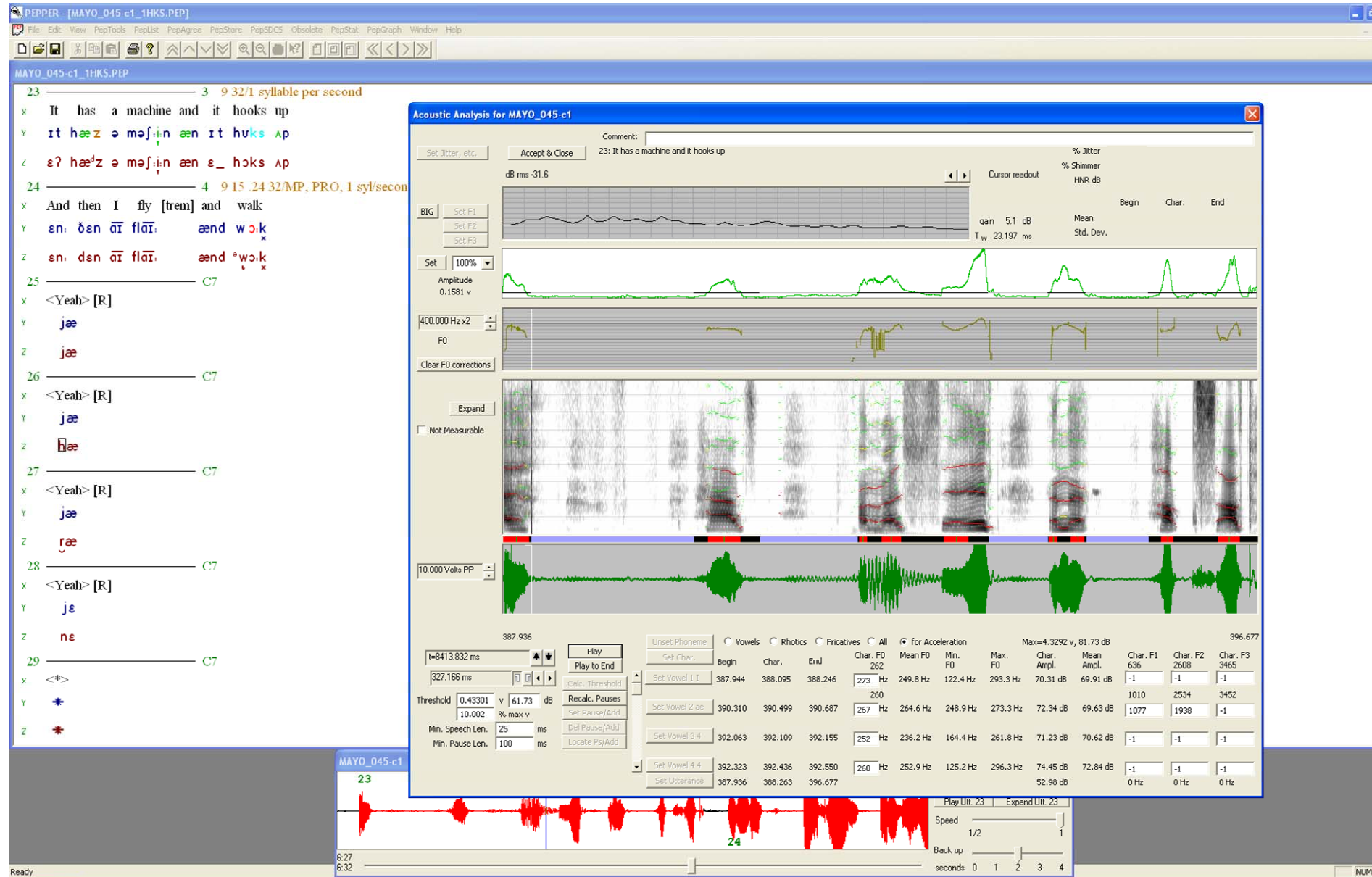
Inappropriate Pause: Alone ("bed")



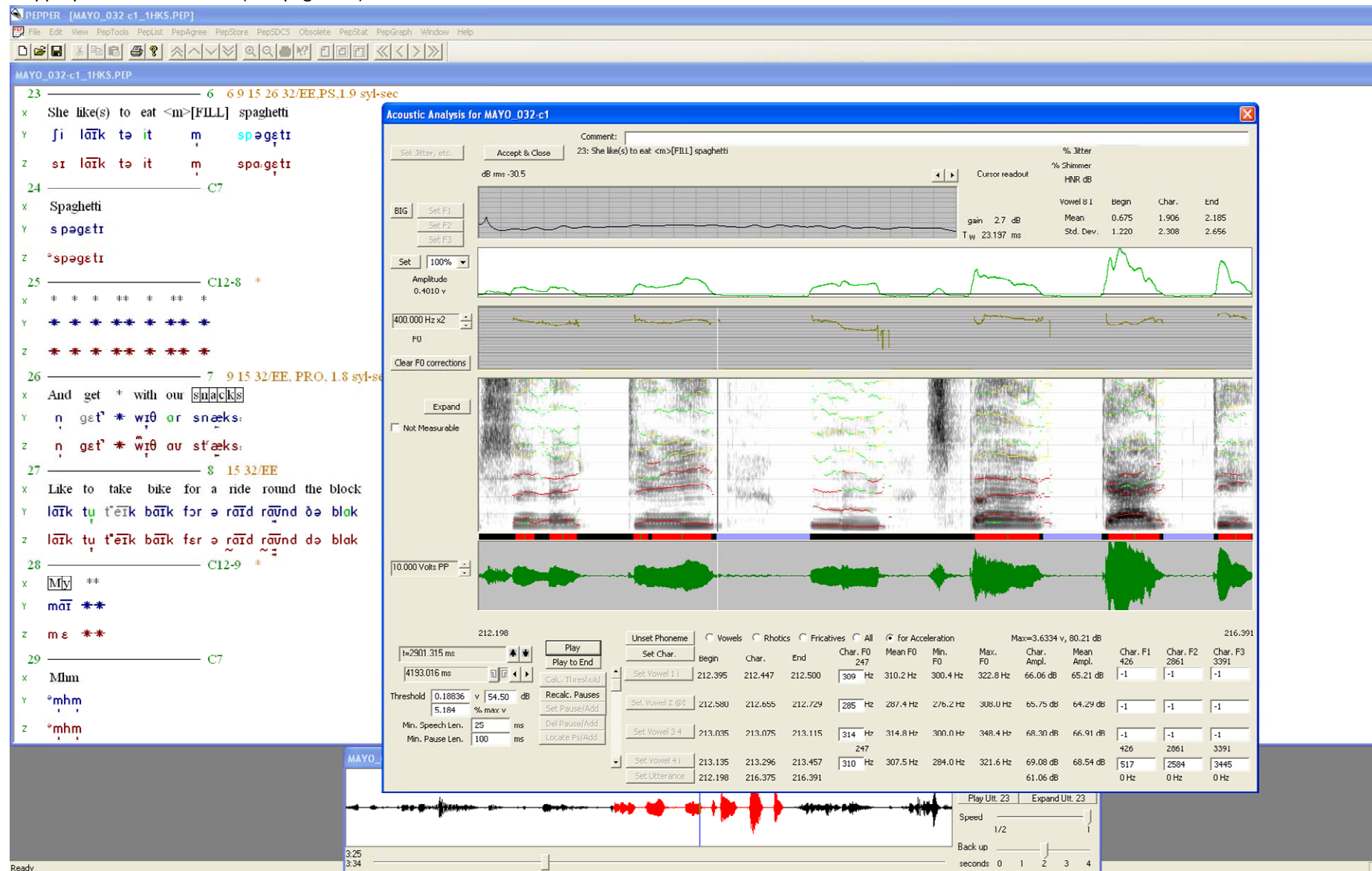
Inappropriate Pause: Alone ("golf," "club")



Inappropriate Pause: Alone ("has," "a machine," "and it")



Inappropriate Pause: Breath ("m spaghetti")



Breath (play)

