CST

for Windows

Version 1.0
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**Software to administer and score the
Connected Speech Test (CST)**

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The Connected Speech Test (CST)

The CST provides objective quantification of the intelligibility of connected speech. It is suited to the measurement of hearing aid benefit in that it has high content validity (conversationally produced connected speech), good sensitivity, and a large number of equivalent forms.

In the original video laser disc recording of the CST, the test passages were produced at a conversational rate, with natural timing between sentences. In addition, the original recording includes a video display of the passage topic word (before the passage is delivered) and shows the head and shoulders of the talker, if desired. In the audio compact disc, the audio portion has been dubbed from the video laser disc. During the dubbing process, brief silent intervals were inserted between sentences so that the test could be presented manually, if desired. A Supplemental Booklet in the form of a .pdf file is included with this software. It contains the complete script of the test, practice, and learning passages with scoring words highlighted. The Supplemental Booklet can be printed for use in manual scoring, if desired.

The talker (left CD channel) is a female who produces speech of average intelligibility (Cox, Alexander, and Gilmore, JASA, 1987). The multi-talker babble (right CD channel) can be adjusted to simulate the signal to babble ratio (SBR) encountered in everyday listening situations. Each test item is a passage of speech, 9 or 10 sentences in length, about a familiar topic. The listener should be informed of the passage topic prior to presentation. Each passage is played one sentence at a time. The passage score is based on the proportion of 25 scoring words correctly repeated. Scores typically are averaged across several test passages to produce a measure of intelligibility for a particular listening condition.

In early development of the CST, passages were determined to be equal in average intelligibility for normal hearers. Later research revealed that the passages were not equally intelligible for hearing-impaired listeners. Based on data, passages were grouped into 24 pairs which were essentially equivalent in intelligibility for a group of hearing-impaired subjects. However, to increase the sensitivity of the test, it is recommended that, for hearing-impaired listeners, at least two passage pairs be used per score. The user is encouraged to consult Cox, Alexander and Gilmore (1987) and Cox, Alexander, Gilmore and Pusakulich (1988, 1989) about the development and administration of the test and reliability of data from normal-hearing and hearing-impaired listeners.

Also, note that there is a period of rapid learning when listeners are first exposed to the CST task and whenever the SBR is changed. Hence, it is advisable to administer Practice passages before test data are collected. Also, reliability is improved if one of the four Practice pairs is presented each time test conditions are changed.

Please refer to these articles for further and more detailed information about the CST and its development:

- Cox RM, Alexander GC, and Gilmore C. "Development of the Connected Speech Test (CST)." *Ear and Hearing,* 8(suppl): 11 9S-1 26S (1987).
- Cox RM, Alexander GC, Gilmore C. and Pusakulich KM. "Use of the Connected Spech Test (CST) with Hearing-impaired Listeners". *Ear and Hearing, 9*(4), 1 8-207 (1988).
- Cox RM, Alexander GC, Gilmore C. and Pusakulich KM. "The Connected Speech Test Version 3: Audiovisual Administration". *Ear and Hearing, 10(l),* 29-32 (1989).

The SIR Test

Note that the Speech Intelligibility Rating (SIR) Test passages are included on the audio CD along with the CST. The SIR Test was created as a clinical tool for hearing aid comparisons. In this test, the listener provides subjective estimations of the proportion of words understood in order to quantify the intelligibility of continuous speech. A suitable rating scale is included in the Supplemental Booklet provided with the CD. More information about the development and administration of the test can be found in Cox and McDaniel (1989) and McDaniel and Cox (1992).

Also, note that this software does not support the administration of the SIR Test. However, the SIR Test is readily administered manually.

Note for research applications:

Track 81 on the CD contains several minutes of CST babble on both channels. Material on the left CD channel is uncorrelated with that on the right CD channel. Levels on both channels are the same as for the right CD channel on tracks 32-79. Excerpts from this track may be used (employing a second CD and CD player) if it is desired to present uncorrelated babble from additional loudspeakers as a competing message. However, this software does not support this set-up.

SYSTEM REQUIREMENTS AND INSTALLATION

The CST program is a 32-bit Microsoft Windows®[1] application that can run on most systems with Microsoft Windows® 95 or later. CST for Windows needs at least 1 MB of hard disk space for the program and associated files. To install the software, run SETUP.EXE from the disk or directory that contains the CST setup program.

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[1] Windows is a registered trademark of Microsoft Corporation.

The CST Program

The CST software program provides a way to administer and score the test by computer. The CST audio CD is played from the computer's CD-ROM drive via the computer's sound card. A clinical audiometer can be used as a mixer, routing the audio from the sound card into speakers or earphones, as desired. The audiometer can be used to set the talker channel (left CD channel) to one level, with the babble channel (right CD channel) independently adjusted to any level needed to present a desired signal-to-babble ratio (SBR).

It is advisable to check the frequency response of the sound card/earphone system.
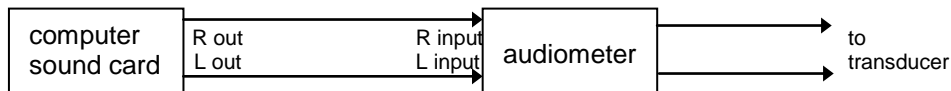
The materials for the CST are contained on tracks 32-81 of the CD. They comprise a speech-shaped noise for calibration, 48 test passages, 8 practice passages, 16 learning passages, and a track containing babble on both channels. Though the 48 test passages are equally intelligible, on average, for normal hearing listeners, they have not been found to be equivalent for hearing-impaired listeners. Thus, the test passages are arranged into 24 passage pairs and each pair is contained on a single track. The pairs have been found to be equivalent in average intelligibility for most hearing-impaired listeners. All tracks are accessed automatically by making selections while running the software.

CD CONTENT FOR CST

Track #	Right CD channel	Left CD channel	Remarks
#32-55	babble	Test passages	2 paired passages per track
#56-63	babble	Practice passages	not paired on CD, paired on software
#64-79	babble	Learning passages	not paired on CD or software
#80	babble-shaped noise	talker-shaped noise	for calibration
#81	babble	babble	uncorrelated babble

RUNNING THE PROGRAM

NOTE: **The CST audio CD should be in the CD-ROM drive <u>before</u> opening the CST program. If a CD or media player program opens automatically when the CD is inserted, <u>close</u> the player program <u>before</u> opening the CST program. Otherwise, there will be a conflict in controlling the CD and the CST program will not work.**

The CST program opens displaying a blank Client Information screen. At the top of the screen is the Main Menu bar. "File" and "Help" are pull-down menus of program options. To select a menu item click on it with the mouse.

<u>FILE menu</u>: From this menu, the user can load an existing file, start a new file, save files, and exit and close the program

> <u>New</u>: When the program is first opened, it is ready to take edits for a new file. This menu option is primarily used when you are finished with an already loaded file and you wish to create a new file.

> <u>Load</u>: Selecting this option opens a window to allow the user to load a previously stored data file. Use the window to access the appropriate subdirectory (folder) and select a file to open.

> <u>Save</u>: This option saves the current file and any edits without exiting the program. When the user selects the "Save" option of the program, a data entry window opens where the filename must be typed in. The filename is <u>not</u> read from the identification field on the Client Information screen.

> Data files are automatically given an .CS8 extension. Only one set of data can be stored in a file. Therefore, if there is more than one administration of the CST for the same patient, the filenames must be different.

> Please note that as CST passages are tested, the program automatically stores the scoring. The user does <u>not</u> need to save the file repeatedly as passages are tested. However, at the end of the test session, the file <u>will</u> need to be saved, as it has been modified.

> <u>Save as</u>: This option is used to save a copy of a data file under a different name. There will then be two copies of the data file under two different filenames. Type in the new filename and then select "OK".

> <u>Exit</u>:   Select this or type <Alt + X> to exit the SADL program.
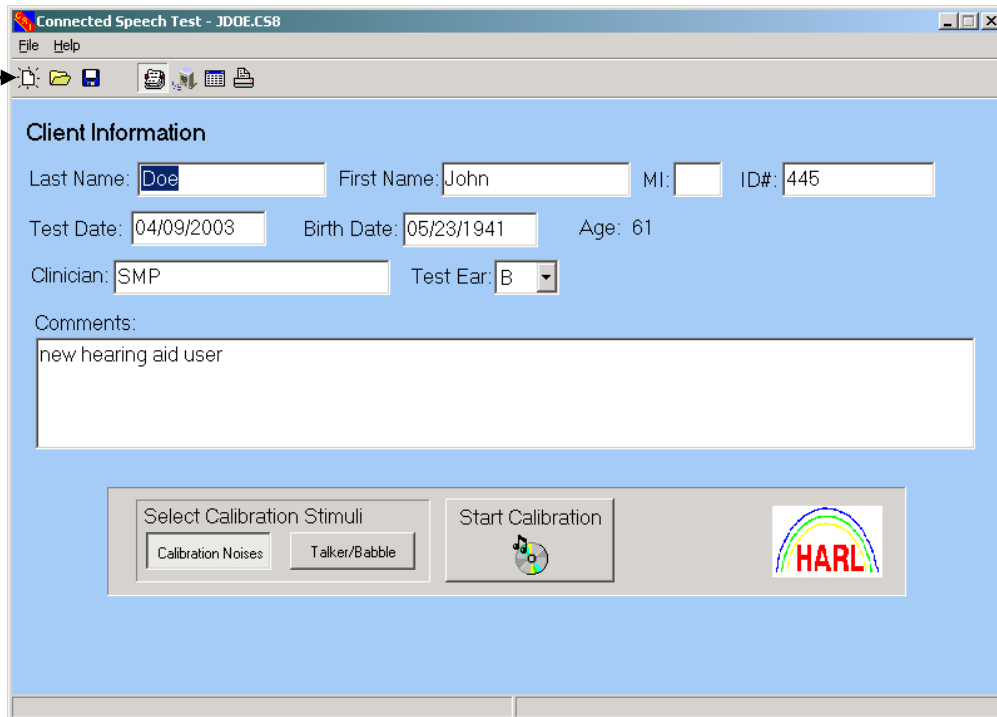
Below the Main Menu bar is an icon toolbar for quick access to program functions. These include the file function icons common to most software:

- ➢ Create a new file
- ➢ Open an existing file
- ➢ Save the current file

The remaining icons pertain to CST administration:

- ➢ Client information
- ➢ Select a passage to present
- ➢ Display passage scores
- ➢ Print CST scores

On any data entry screen, moving around the various fields is done with the mouse or with the Tab key. Moving within a field is done with the mouse or the cursor keys. Pressing a button is done by clicking on it with the mouse.

CLIENT INFORMATION

To move around the Client Information screen use the <tab> key or the mouse. <Tab> moves from field to field and <Shift+Tab> moves backwards through the edit fields. There are edit fields available for the client's name, an identification number or name, the client's date of birth (entered in the format xx/xx/xxxx), the test date, the clinician's name, test ear (R, L, or B), and comments field. The Comments field provides space for recording details of interest about the test situation. When the birth date is entered and the user moves to another field, the age is calculated from the test date and displayed. All these text fields are simply for the user to archive information, but none are required to run the program or to save a file. All the information, including Comments, will be included on the file's printout.

CALIBRATION: At the bottom of the screen are the calibration control buttons. On the left side are buttons to select the stimuli to use for calibration. The choices are "Calibration Noises" or "Talker/Babble."

Selecting "Calibration Noises" will access Track 80 on the CD. The calibration noises for the CD were created by filtering random noise so that the long-term level in each 1/3- octave band is essentially the same as that in the corresponding test materials. On the left channel, the calibration noise has the same 1/3-octave band spectrum and level as the talker (the RMS difference between talker and calibration noise from 200 Hz to 10 kHz is 0.66 dB). On the right channel, the calibration noise has the same 1/3-octave band spectrum and level as the multi-

talker babble (the RMS difference between babble and calibration noise from 200 Hz to 10 kHz is 0.53 dB). Note that this relationship between test materials and calibration noise was computed over the entire corpus of test materials. For any individual sentence or passage, there will probably be differences between the spectrum of the calibration noise and that of the test materials. If the calibration noises on track 80 are set so that the audiometer VU meter readings are -5 dB (left CD channel) and -4 dB (right CD channel), both the test passages and the babble will have peak meter excursions near 0 dB on the VU meter.

Selecting the "Talker/Babble" button accesses certain Learning passages in case the tester wants to use the actual talker and babble for a calibration signal. Another application for this signal could be as a sample of long-playing speech and babble while setting a hearing aid volume control. Please note that there are brief pauses between the passage sentences.

The button on the right side toggles the calibration signal on and off.

PRESENTATION & SCORING

INSTRUCTIONS
"You will be listening to a woman talking about different topics. Your task is to repeat each sentence. Before we start a new passage, you will be informed of the topic. There will be several other people talking in the background when the woman is talking. This may make it difficult to understand the sentences. The talker and background noise will stop after each sentence. After the sound stops, please repeat the sentence exactly as you heard it. If you don't hear every word, please repeat the words you did hear. You may guess if you are not sure. After you answer, we will proceed to the next sentence."

Use the icon "Select a passage to present" to access the test presentation and scoring functions of the program.
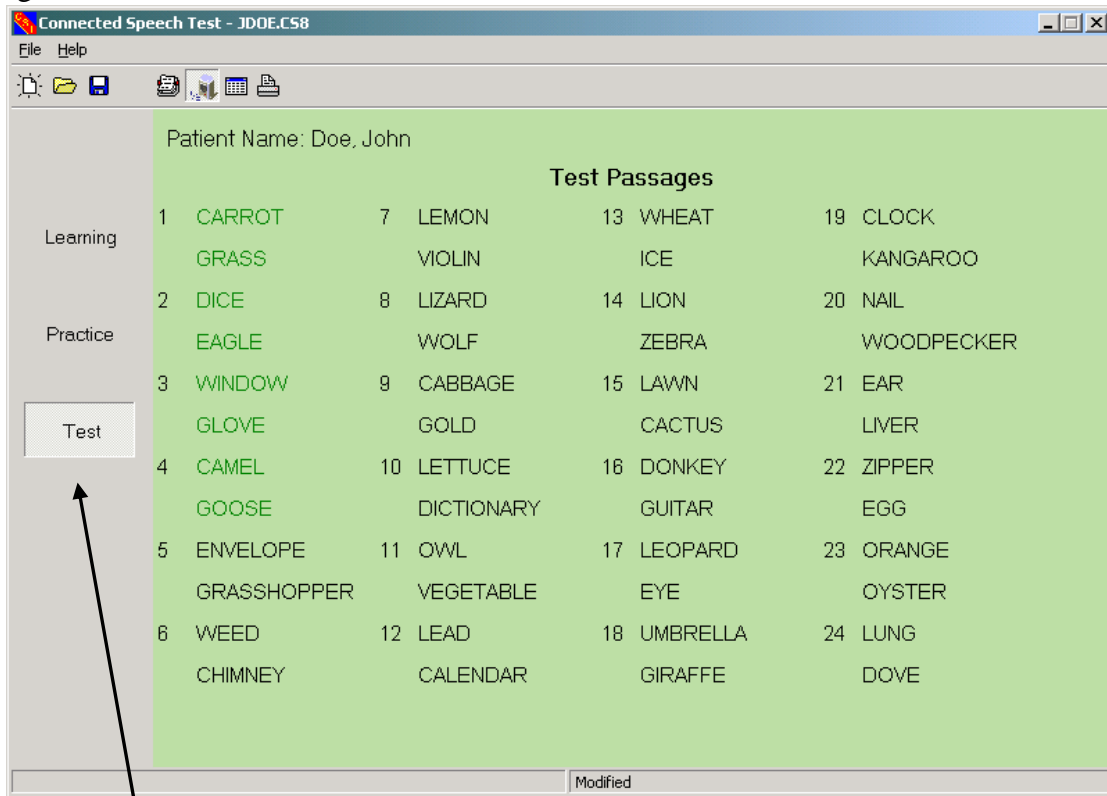
PASSAGE SELECTION:

On the left of the screen are buttons to access lists for Learning, Practice, or Testing passages. There are 16 Learning passages, 8 Practice passages, and 48 Test passages. Passage topics are shown on the right (green background) portion of the screen for whichever list is selected. In the example shown in the figure above, the Test passage list is selected on the left and the test passage topics are shown on the right.

All unused passage topics are displayed in black text. After testing is completed for an individual passage, (i.e. all sentences in the passage have been presented to the listener), the text color of the topic name changes to green. This enables the user to know at a glance which passages have been tested and which are still available for further testing. Note that the text color only changes to green after every sentence within that passage has been played. If any sentence has not been played, for instance if a sentence is skipped accidentally, the text color remains black.

Tracks 56 through 63 on the CD contain the eight Practice passages. The structure and content of the Practice passages are similar to that of the Test passages but scores have slightly poorer reliability for these passages. Scores on the Practice passages should be reasonably close to performance on the Test passages. They may be used to select an appropriate SBR for testing or to acclimate the listener to the task.

Tracks 64 through 79 on the CD include the 16 Learning passages. The Learning passages are also similar to the test passages in structure and content. However, the Learning passages are not equal in difficulty to the Test passages, and they have relatively poor reliability. However, they

can be used to familiarize the listener with the CST test and the characteristics of the talker. Note that the final sentence of the last learning passage ("kidney", track 79) was not recorded on the video laser disc due to space limitations and, therefore, does not appear on this CD.

 Tracks 32 through 55 on the CD comprise the 24 pairs of test passages. A new randomized order of passage pairs is created by the program for each new file. Each pair is contained on one track and each sentence is indexed. Note that "lung", "calendar", and "lizard" (tracks 34, 46, and 48) have only nine sentences. All of the other test passages have ten sentences. Also note that the first word of track 52, index 1 ("eye") is partly inaudible. This occurred in original mastering and is not a flaw on the CD.

PASSAGE PRESENTATION & SCORING:

To record the conditions used for testing a passage, right click with the mouse on a passage title and a small text entry box (pictured on the right) will open to give the user an opportunity to note the test condition used for the passage. It will accommodate a 20-character entry. The program does not require these notations. This feature could be used to make notations about hearing aid settings, SBR used, etc. The text notation applies to both passages in a pair. This information will be displayed on the Display Scores screen and on the printout of scores.
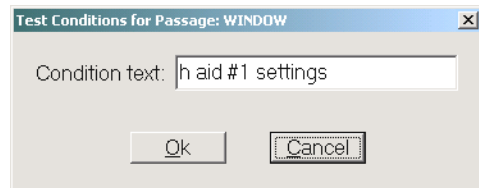
Left click on the passage title to open the screen for presenting and scoring the passage.

The listener should be informed of the topic <u>before</u> presenting the sentences. This can be done verbally by using the audiometer's talk forward mode, by using a printed topic list, or by whatever means the tester prefers.
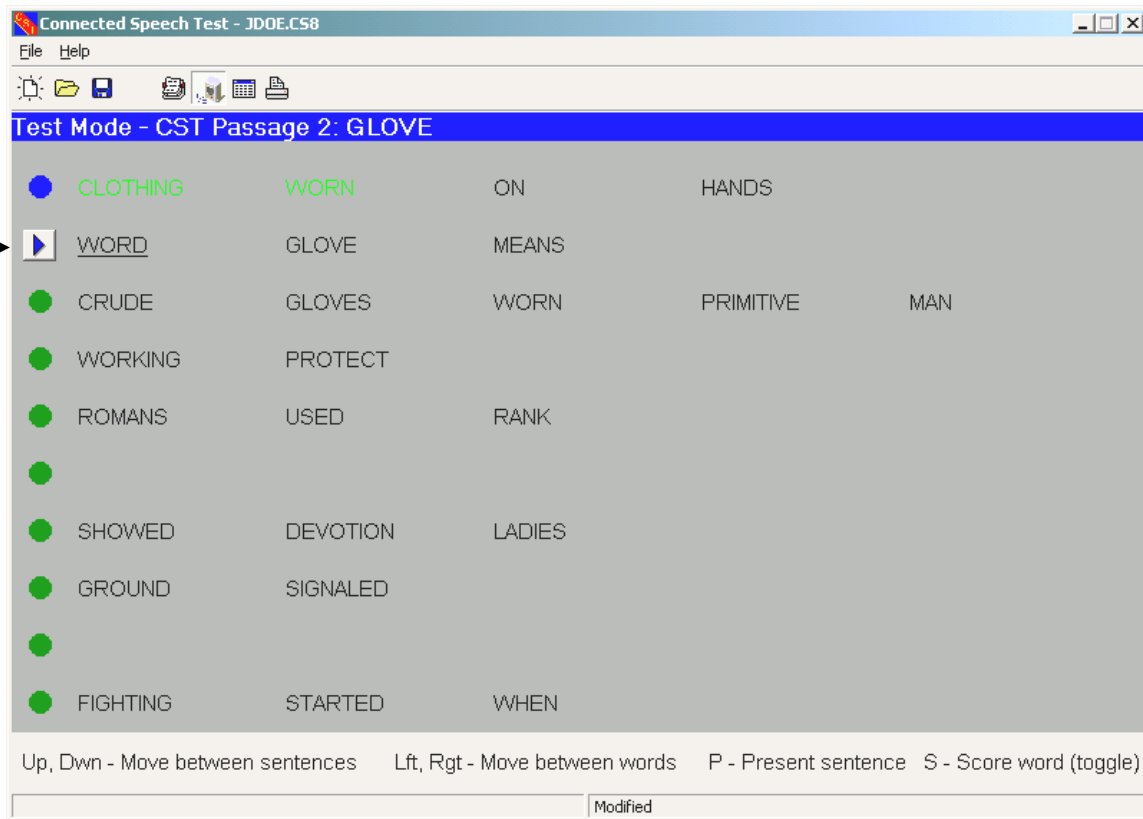
The screen displays all key/scoring words for each sentence in the passage. See figure above.

Sentences can be presented using either the mouse or keyboard controls.

<u>Using the mouse</u>: Left-clicking on the blue arrow/triangle on the left plays the sentence next to it. Left-clicking on each key word toggles scoring between correct and incorrect, and left-clicking on the green dot to the left of any sentence moves presentation to that sentence. After a sentence has been played, the dot will turn to blue, but it can still be replayed, if needed. However, note that scoring for the previous presentation will be lost.

<u>Using the keyboard</u>: Use the up/down cursor keys to move up and down the list of sentences for presentation. The <P> key plays the sentence next to the arrow, the <S> key toggles scoring for the underlined word, and the horizontal arrow keys move between the key words.

The current sentence for presentation is indicated by the blue arrow to the left of the sentence. Green circles to the left of the sentences indicate the ones which have not been played. After a sentence has been played, the color of the circle changes to blue. A sentence can be presented again, if necessary, but as stated above, the scoring for the previous presentation will be lost. Please note that <u>all</u> sentences, including those with no key words, must be played in order for the passage to be completed, scored, and recorded by the program.

When a passage is first loaded, all the key words are shown in black text, indicating an incorrect response. When a key word has been toggled to correct, the text changes to green. A key word

must be repeated exactly by the client in order to be scored as correct. In other words, the correct response for the key word "gloves" would be "gloves" but not "glove."

To abort testing a passage, click on one of the program icons at the top of the screen before finishing the passage. Note that any scoring on the passage will be lost.

When a passage is completed, click on the icon for "Select a passage to present" to select the next passage for testing, or on the "Display passage scores" icon to view the client's scores.
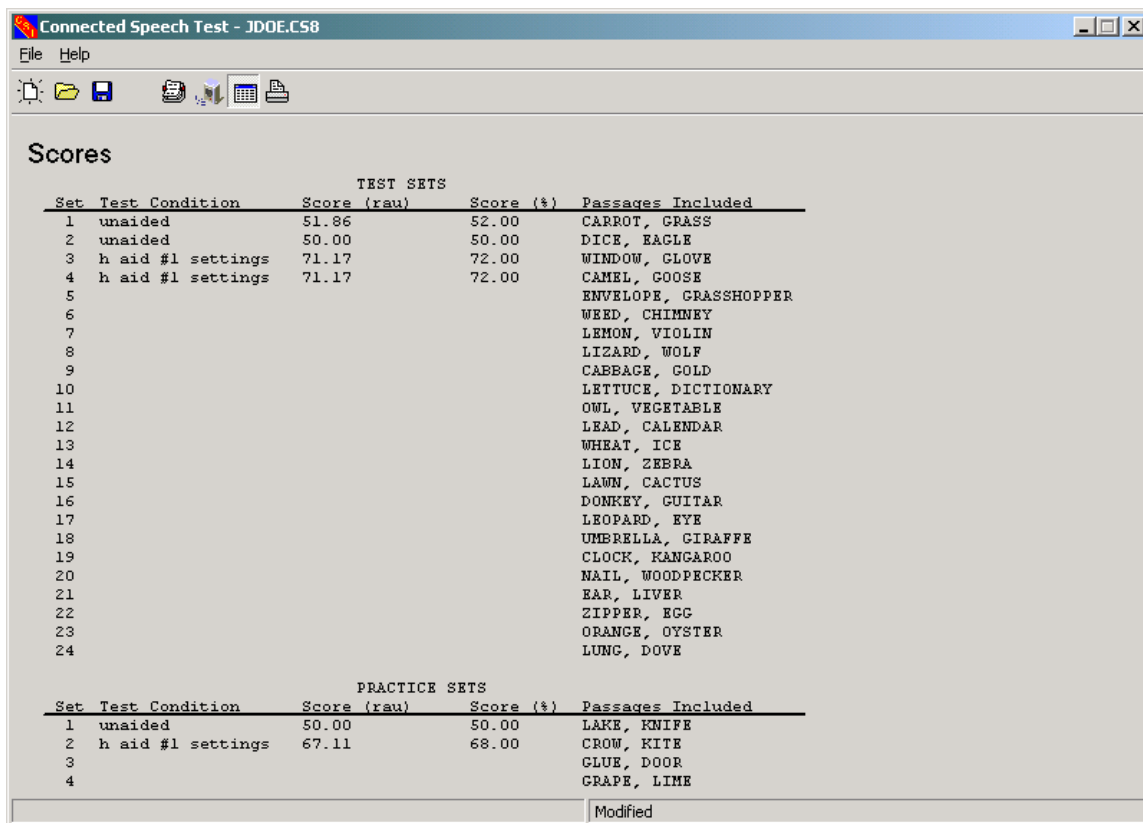
Pointers for test administration:

➢ Because of the learning effect, repeated presentation of a sentence is usually not advisable. A sentence can be replayed if something happens during the sentence presentation which would prevent the client from hearing the sentence. Some common examples of this would be if the client sneezes or coughs while the sentence plays, or the client starts talking as the sentence plays.

➢ Reliability of the test is improved if a practice passage is done each time the test conditions are changed. This would include changes in the SBR or presentation level, aided vs unaided conditions, and changes in hearing aid settings.

➢ A listener tends to remember test sentences. To minimize memory effects, allow 2-3 months to elapse before administering a test passage a second time.

DISPLAY SCORES

Scores for each completed practice and test passage are displayed on this screen in percent correct and in rau (rationalized arcsine units). The percent correct scores are transformed into rau to minimize the relationship between mean score and variance that is characteristic of percentage scores while providing a scoring unit similar to percentages and, therefore, readily interpreted. Please refer to Studebaker (1985) for a detailed explanation of this transform. Note that Learning passages are not scored. Any test condition notations the user has entered will appear on this screen.

If several pairs of passages are administered under the same test condition (this may be done to improve score reliability), the user will need to manually average the scores for the pairs comprising the set to obtain an overall score for that test condition.

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Connected Speech Test - JDOE.CS8                                      _ □ ×
File  Help

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Scores
                            TEST SETS
   Set  Test Condition      Score (rau)   Score (%)   Passages Included
    1   unaided             51.86         52.00       CARROT, GRASS
    2   unaided             50.00         50.00       DICE, EAGLE
    3   h aid #1 settings   71.17         72.00       WINDOW, GLOVE
    4   h aid #1 settings   71.17         72.00       CAMEL, GOOSE
    5                                                 ENVELOPE, GRASSHOPPER
    6                                                 WEED, CHIMNEY
    7                                                 LEMON, VIOLIN
    8                                                 LIZARD, WOLF
    9                                                 CABBAGE, GOLD
   10                                                 LETTUCE, DICTIONARY
   11                                                 OWL, VEGETABLE
   12                                                 LEAD, CALENDAR
   13                                                 WHEAT, ICE
   14                                                 LION, ZEBRA
   15                                                 LAWN, CACTUS
   16                                                 DONKEY, GUITAR
   17                                                 LEOPARD, EYE
   18                                                 UMBRELLA, GIRAFFE
   19                                                 CLOCK, KANGAROO
   20                                                 NAIL, WOODPECKER
   21                                                 EAR, LIVER
   22                                                 ZIPPER, EGG
   23                                                 ORANGE, OYSTER
   24                                                 LUNG, DOVE

                            PRACTICE SETS
   Set  Test Condition      Score (rau)   Score (%)   Passages Included
    1   unaided             50.00         50.00       LAKE, KNIFE
    2   h aid #1 settings   67.11         68.00       CROW, KITE
    3                                                 GLUE, DOOR
    4                                                 GRAPE, LIME
                                                  | Modified
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PRINT TEST SCORES

The printout of the test scores includes the screen display of the scores and also includes the information entries from the Client Information page.

References

Cox RM, Alexander GC, and Gilmore C. "Development of the Connected Speech Test (CST)." *Ear and Hearing,* 8(suppl): 11 9S-1 26S (1987).

Cox, R.M., Alexander, G.C. and Gilmore, C.A. "Intelligibility of average talkers in typical listening environments." *J. Acoust. Soc. Amer.,* 81: 1598-1608 (1987).

Cox RM, Alexander GC, Gilmore C. and Pusakulich KM. "The Connected Speech Test Version 3: Audiovisual Administration". *Ear and Hearing, 10(l),* 29-32 (1989).

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