

Using Consonant Confusion to Infer Hearing Status: Instructions for the VCVTest¹ Software with the Quick-VC stimuli

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Requirements

- This has been tested on MATLAB version 2021a and a Windows 11 PC.

Starting the Software

- In MATLAB, open and run *ConsonantTest.m* to start the consonant confusion test software that uses the Quick-VC stimulus.
- The main graphical user interface (GUI) below will appear after executing *ConsonantTest.m*.

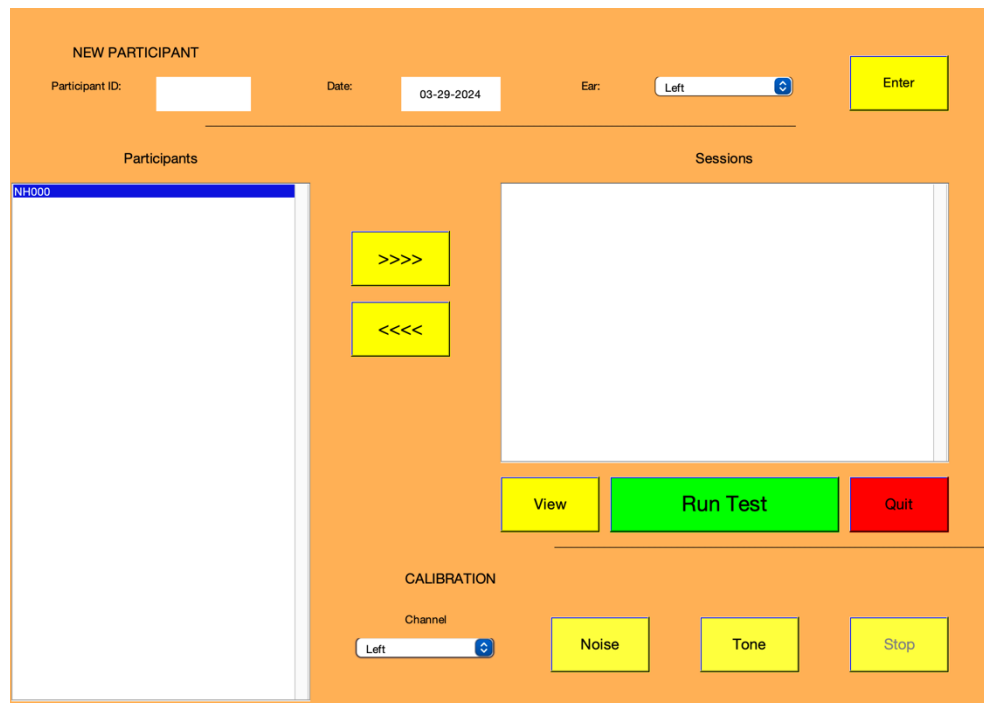


Figure 1. Main graphical user interface (GUI) of *ConsonantTest.m*.

Calibrate Stimulus Level (as needed)

The stimulus levels must be calibrated with your earphones or insert earphones. The level of the Quick-VC stimuli is designed to be presented at 65 dB SPL RMS. The calibration tone is programmed to play a 1000 Hz pure tone at 80 dB SPL.

- Under Calibration, select the output channel you wish to calibrate, Left (channel 1), Right (channel 2) or Both (channels 1 and 2) (see Figure 1).
- Couple your transducer to your calibration coupler which should be connected to a sound level meter.

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- Press the “Tone” button on the GUI and adjust output of the calibration tone with your hardware or digital audio workstation (DAW) so that the output level through the headphone measures 65 dB SPL.
- Press ‘Stop’ to stop the tone.

Adding a Subject ID

- Under ‘New Participant’ in the main GUI
 - Enter Subject ID, date, test ear and click ‘Enter’
 - Subject ID must have one of the following prefixes, ‘NH’, ‘HL’, ‘HA’, or ‘HP’ followed by three digits (the subject number) where,
 - NH=Normal Hearing,
 - HL=Hearing Loss,
 - HA=Hearing Aid (lab fitted hearing aid),
 - HP=Hearing Aid (personal hearing aid)

Note that the subject ID prefix is used by analysis scripts to parse the data into groups.

- Select Subject ID from list and click ‘>>>’ to move it into sessions if any exist
 - Any sessions already completed will display
 - Sessions cannot be repeated
 - You may also view the results of a session with the ‘View’ button after highlighting a session.

Running the Consonant Confusion test with the Quick-VC corpus

- With the subject you want to run highlighted on the ‘Participants’ list, click ‘Run Test’, then click ‘OK’
 - Trials start with Practice session in quiet, followed by Test sessions in noise
 - Test length is based on ID prefix where,
 - NH, or HL: long – Practice 20 trials, Test 4×50 trials, ~10 minutes
 - HA, or HP: short – Practice 10 trials, Test 1×100 trials, ~5 minutes
- Click ‘Continue’ to proceed to the next session, or first session in the case of a new participant where a practice session is given.
- Note, two GUI’s will pop up (see Figures 2 and 3) and the main GUI will close. The software is designed to be used with two monitors. The Response window (figure 2) should be placed on the participants monitor and the and the Test Progress on the clinician’s or researcher’s monitor.

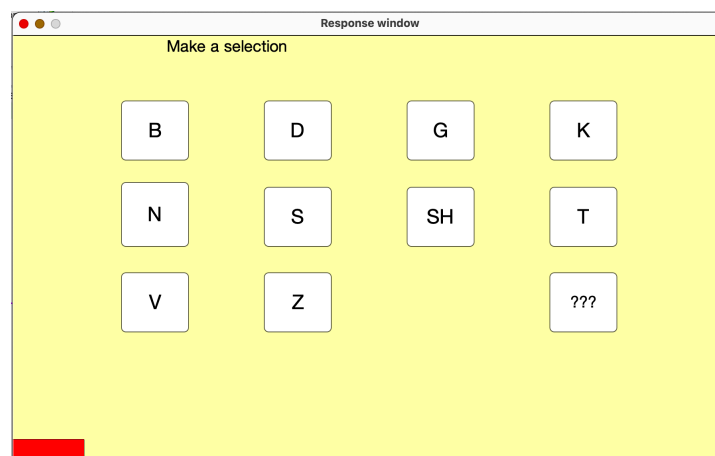


Figure 2. The participant response window.

The screenshot shows a window titled "Test Progress" with an orange background. It contains the following elements:

- Token: ada (yellow box)
- SNR: 60 (yellow box)
- Vowel: a (yellow box)
- Consonant: d (yellow box)
- Response: (red box)
- Quit button (red box)
- Continue button (green box)
- Progress bar (red bar) at the bottom left.
- 2/20 at the bottom right.

Figure 3. The researcher/clinician’s test progress window which displays the token presented, signal to noise ratio (SNR) of the token, vowel context, and consonant. The red bar at the bottom of the window displays the progress for each session.

- Give Practice Instructions to the participant:

“For this task, you’ll just be listening from one ear. You will hear what sound like “made-up words”; they don’t mean anything; they are just combinations of speech sounds. Each one has three sounds: a vowel, a consonant, and a vowel. The two vowels at the beginning and end are always the same, /a/, and your task is to identify the consonant sound that is in the middle. So, for example, you’ll hear something like “ABA”, and you would use the mouse to click on the ‘B’. Or for “AKA” and you would click on the ‘K’. You’ll make one choice after each one you hear. You cannot replay the sounds. Even if you’re not sure what the consonant sound was, try to make your best guess. You should only use the “???” box if you think you heard a consonant that isn’t an option on the screen. We’re going to start with a practice set in a quiet background, there won’t be any noise, so you get used to what they sound like. You will see feedback after your choices – if the box turns green you were correct and if it turns red you were incorrect. The practice takes about a minute. When you’re ready to begin, click ‘OK’. I’ll check back with you after this practice to see if you any questions.”

- Answer any questions and re-instruct if necessary
- Give Test Instructions:

“Now we’re going to add in some background noise and make things a bit more challenging. The noise sounds like static. The level of the noise will change. Sometimes it’s louder, sometimes it’s

softer. There will be times when you're not sure, and when that happens, try to make your best guess. You should only use the "???" box if you think you heard a consonant that isn't an option on the screen. You won't get any more feedback on your choices. Each session takes about 2-3 minutes. Once you start a session you should finish the whole thing but if you need to take a break in between sessions, please let me know."

Percent Correct is displayed after each session. Results (trial-by-trial consonant target/response) are automatically saved in an excel file to a subject subfolder under the 'Results' folder.

When all sessions are complete, hit the 'Quit' button on the Test Progress GUI to close the ConsonantTest GUI.

To view the predicted PTA (ppta) and percent correct for participant sessions, run ConsonantTest.m again, click on the Subject ID you want to view, and press '>>>' and hit 'View'.

Analysis

- Open .../VCVtest/Data/VCVtest_DATA.xlsx and add the demographics for each new subject using the same subject ID entered into the software.
 - NH000 is added as an example for a template
- Note, to run any of the analysis scripts all subject IDs should have completed all sessions.
 - For example, NH000 folder should be deleted or under the /Data or used as the first participant or the analysis scripts may throw an error.

For each subject, in VCVtest_DATA.xlsx, add audiogram data for the left and right ears, and what category of hearing loss according to table 2 in the manuscript. Also indicate the test ear and compute the PTA.

Run Combine_Data.m to combine data from all participants into one master file that is used for all subsequent analysis scripts.

Here is a brief description of the analysis scripts and what they do:

- Combine_Data.m - combines data from all participants into one data file that is used for all subsequent analysis scripts.
- Score_All.m – provides the scores for each participant and each of their sessions. Scores are reported as number of correct trials and uses the logistic regression model to predict the PTA from the scores (ppta).
- Residual_Loss.m - Uses a logistic regression model to provide a prediction of residual loss for all participants.
- Repeatability.m - This script computes the repeatability between sessions.
- Excess_Loss.m - This script is used to predict the participants that have excess loss.