

LIMBIC-CENC Prospective Longitudinal Study

Audiology Standard Operating Procedures

(SOP)

Version 5.2

LIMBIC-CENC Coordinating Center
Virginia Commonwealth University

Table of Contents

SECTION 1. PREPARATION FOR HEARING TESTING	4
Section 1.01. Introduction	4
Section 1.02. Creating an Adequate Test Environment	5
Section 1.03. Setting Up the GSI AudioStar Audiometer	7
Section 1.04. Monitoring Ambient Noise in the Test Environment	11
Section 1.05. Setting Up AMTAS Software for Automated Pure Tone Hearing Testing	12
Section 1.06. Setting Up the GSI AudioStar Audiometer for SCAN-3 Testing	19
Section 1.07. Verification of AudioStar Audiometer Operation	24
Section 1.08. Ambient Noise Check	25
Section 1.09. Pre-Test Biological Hearing Threshold Check	26
Section 1.10. Participant (Subject) Preparation	27
Section 1.11. Testing Participants Who Wear Hearing Aids	27
SECTION 2. PERFORMING AUTOMATED HEARING TESTING (AMTAS)	29
Section 2.01. Introduction	29
Section 2.02. Remote Ambient Noise Monitoring Software	29
Section 2.03. Instructions to Participant	29
Section 2.04. Placement of Bone Vibrator (Oscillator)	30
Section 2.05. Placement of Earphones	31
Section 2.06. Performing Automated Pure Tone Hearing Testing	34
Section 2.08. Participant Break from Testing (Between AMTAS and SCAN-3)	40
Section 2.09. Entry of Hearing Threshold Data on CRF	41
Section 2.10. Identifying and Reporting Audiogram Asymmetry	46
SECTION 3. PERFORMING SCAN-3 TESTS	49
Section 3.01. Introduction	49
Section 3.02. General Participant Instructions	51
Section 3.03. Verification of the AudioStar Set Up for SCAN-3	52

Section 3.04. Placement of Earphones	59
Section 3.05. Performing the SCAN-3 Tests	59
Section 3.06. Possible Problems during SCAN-3 Test Administration	65
Section 3.07. Scoring Participant Responses During SCAN-3 Testing	66
Section 3.08. Time Out Immediately After Completion of SCAN-3 Testing	71
Section 3.09. Entry of SCAN-3 Data on CRF	72
Section 3.10. Completion of Patient Reliability Data for SCAN-3	74
Section 3.11. Wrap Up with Participant	74
Section 3.12. General Clean Up	75
Section 3.13. Compilation of Data Documents	75
Section 3.14. Uploading AMTAS Audiometric Data to the SFTP Site	76
SECTION 4.0. CLEANING HEARING TEST EQUIPMENT AND TEST ENVIRONMENT	77
Section 4.01. Cleaning Test Equipment	77
Section 4.02. Cleaning Test Environment	78
SECTION 5.0. TROUBLE-SHOOTING GUIDE	79
SECTION 6.0. KEY REFERENCES	84
APPENDIX A: SCAN-3 Score Sheets	85
APPENDIX B: SCAN-3 Gap Detection Scoring Table	86
APPENDIX C: CRFs	89
APPENDIX D: Instructions for Participants	91
APPENDIX E: Clinical Referral Letter Example	94

SECTION 1. PREPARATION FOR HEARING TESTING

Section 1.01. Introduction

Veterans are at considerable risk for hearing loss and related auditory problems, such as bothersome tinnitus. You will find selected references on auditory assessment and auditory disorders in veterans at the end of this summary of procedures (SOP). Risks for auditory disorders in the veteran population include repeated exposure to high-intensity sounds, even a single exposure to a blast or explosion, and traumatic brain injury (TBI). In addition, age-related changes in auditory function are not uncommon in older veterans. Hearing problems in the veteran population may be related to damage or dysfunction throughout the auditory system including the middle ear (eardrum and small bones connecting the eardrum to the inner ear), the inner ear, the auditory nerve leading from the inner ear to the brain, and auditory regions within the central nervous system from the brainstem to the highest levels of the brain. Importantly, deficits in auditory function (particularly auditory processing disorders) may be closely associated with impairment of cognitive functioning.

Hearing testing of participants in the Long-Term Impact of Military-Relevant Brain Injury Consortium (LIMBIC) Chronic Effects of Neurotrauma Consortium (CENC) Prospective Longitudinal Study focuses on two general categories of auditory dysfunction. Automated estimation of air- and bone conduction pure-tone hearing thresholds with AMTAS (Automated Method for Testing Auditory Sensitivity) software measures sensitivity to soft sounds at different frequencies. Results of AMTAS hearing testing will identify veterans who have middle ear and/or inner ear auditory dysfunction. The three SCAN-3 tests are designed to identify central auditory nervous system disorders. The acronym SCAN refers to **s**creening for **c**entral **a**uditory **n**ervous.

The Gap Detection Test assesses the participant's ability to rapidly process auditory information. The Auditory Figure Ground test assesses the participant's ability to perceive speech in background noise. The Competing Words Test assesses the participant's ability to quickly perceive words presented simultaneously to each ear. Persons with central auditory disorders, that is, hearing problems due to brain rather than ear dysfunction, often perform poorly on one or more of these three tests.

The SOP is organized into four sections. **SECTION 1** describes the steps that must be taken before you begin collecting auditory data. The topics include setting up the equipment, selecting proper software parameters, verifying an adequately quiet test environment, and preparing the participant for hearing testing. **SECTION 2** describes auditory hearing testing using the AMTAS software coupled to the Grason Stadler Incorporated (GSI) AudioStar audiometer. **SECTION 3** describes the steps you will take in assessing auditory processing with the SCAN-3 tests. **SECTION 4** importantly reviews the protocol for cleaning and sanitizing hearing test equipment and the entire test environment. Finally, **SECTION 5** is a troubleshooting guide that consists of suggestions for solving problems that might arise during data collection. Please take a moment to review the Appendices to this SOP, including **Appendix D: Instructions for Participants**.

A few more words about possible problems in data collection are warranted here. At different places in the SOP you will see highlighted big double check marks (√√) on the left-hand side of pages. The double check marks identify a particularly critical step or part of the testing process that will have a major impact on data collection. In some cases, an error at this step in the test process will result in the collection of invalid data or even no data at all. You are encouraged to confirm, or double-check, your work at these important junctures and to take special care to follow in detail the information in the SOP to assure accurate data collection. If you do encounter problems at these or any other steps in the hearing testing protocol, first consult the troubleshooting guide (Section 5.0). If the problem persists after re-reviewing the SOP, the troubleshooting guide, and the narrated PPT presentations, contact Dr. James W. Hall (jwhall3phd@gmail.com) directly.

Section 1.02. Creating an Adequate Test Environment

Hearing testing should be done in a quiet environment. In an audiology clinic, most hearing tests are performed with the participant seated in a specially-designed sound-treated room that meets national standards for low background (ambient) noise levels. You will collect auditory data in a room that is not sound treated. The sound level in a reasonably quiet (non-sound treated) room is about 40 dB SPL (see the Margolis references at the end of the SOP). For comparison purposes, the level of speech in a typical conversation is about 50 to 60 dB SPL.

Research and preliminary experience with data collection for this study confirm that valid

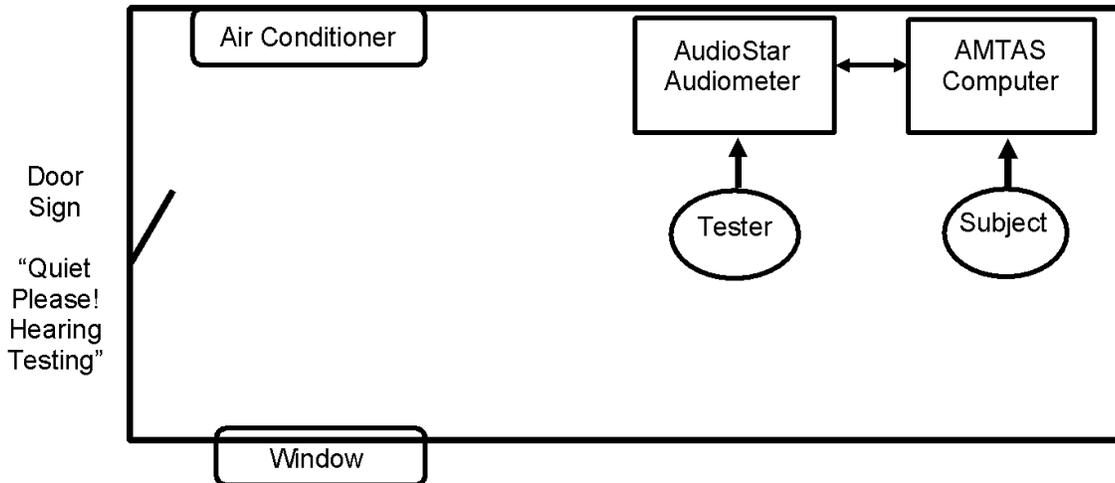
AMTAS pure tone audiometry can be conducted in a quiet (non-sound treated) room using the DD 450 earphones and the GSI AudioStar audiometer. Pure tone audiometry with the AMTAS software is conducted with pure tone sounds at very low-intensity levels, particularly for normal hearing participants. Therefore, ambient sound is more likely to interfere with the participant's ability to detect the pure tone sounds, especially low-frequency pure tone sounds. Concerns about ambient background noise interfering with hearing threshold measurements are less for participants with hearing loss because higher stimulus levels are required to estimate the participant's hearing levels at different test frequencies. The potential for problems in hearing testing due to ambient sound levels is greater for the AMTAS measurement of hearing thresholds than for the SCAN-3 tests. Since SCAN-3 tests are administered at an intensity level of 50 dB HL (hearing level), there is less chance that ambient sound will interfere with the participant's ability to hear the test materials (tones or words).



Several simple steps should be routinely taken to minimize ambient sound levels and the possibility that background noise might interfere with a participant's ability to detect soft pure tone stimuli. These steps will maximize the chances for the collection of valid data. Monitoring the test environment for ambient noise levels is discussed further in [Section 1.04](#).

- Prepare and place a sign (e.g., a sheet of paper with large font) on the outside of the door to the test room that indicates "Quiet Please! Hearing Testing in Progress."
- As shown in the diagram below, locate the audiometer and computer away from the door (s), windows, and any obvious sources of noise in the room (e.g., ventilation ducts) with participant chair furthest away from noise sources.
- If possible, turn off any equipment (e.g., computers) in the room that generates noise.
- Make sure all cell phones are in silent or vibrate mode, including the participant's cell phone.
- Separate the audiometer and the computer by the length of the cable that connects them, and the two power cords (see double arrow between audiometer and computer in diagram).
- Attempt to locate the participant so that he or she is not distracted by seeing anything on the wall (e.g., clock, window, written material) or in the room (including you) during hearing testing.

Example of Test Room



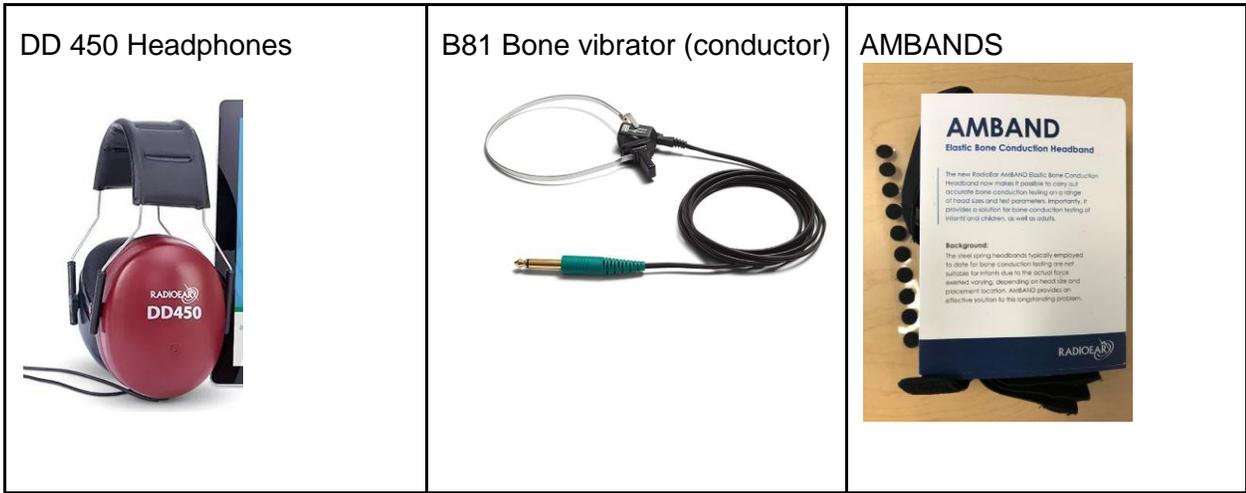
Section 1.03. Setting Up the GSI AudioStar Audiometer

Supplies

Supplies you will need from the box of supplies that came with the GSI AudioStar audiometer include:

- Power cables for audiometer and for computer (see photograph).
- USB A to B cord (for connecting computer to GSI AudioStar audiometer).
- DD 450 earphones
- Bone vibrator
- AMBANDS (Velcro strips for holding bone vibrator on forehead)





- Monitoring headset (shown below in a separate photograph)
- A microphone with a long cord for the participant (shown below in a separate photograph)



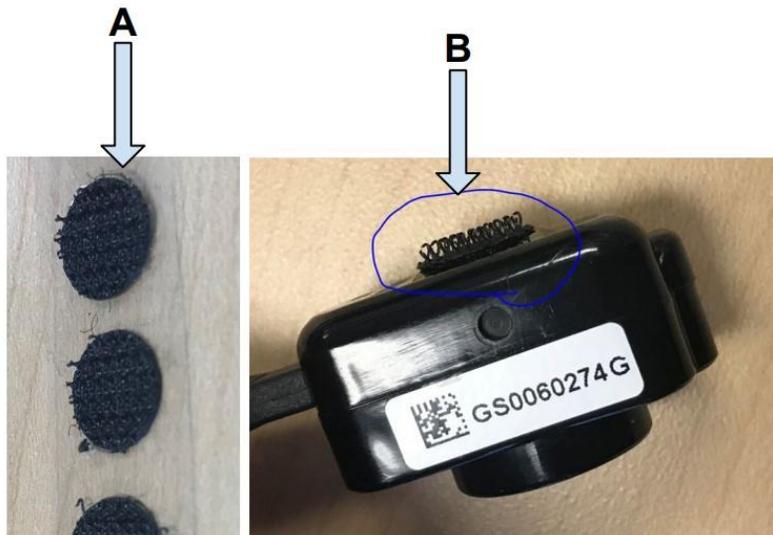
Steps in Setting Up the GSI AudioStar Audiometer

- Verify that Power Cable (**A** in figure below) is plugged into the Audiometer.
- Verify that the USB A to B cable connects the Audiometer (the square end or **B** in figure below) to the computer (USB end)
- Verify that the right (red) and left (blue) DD 450 headphone (earphone) inputs are plugged into the high frequency (HF) phone jacks in the back of the audiometer (**C** in the figure below).
- Verify that the Stereo Aux cable plugs into the EXT A/B in the back of the audiometer (**D**) and then into the earphone jack of the computer
- Verify that the bone conductor (vibrator) is plugged into the appropriate jack in the back of the audiometer (**E**).



Note: The figure above shows a close-up view of all of these cords and cables plugged into the back panel of the AudioStar audiometer (right side as viewed from the back).

- If you are using the bone vibrator (conductor) for the first time, remove the metal band from the body of the bone conductor. Take one of the small Velcro sticky tabs (A) found in the AMBAND bag and place it on the back of the bone conductor (B):



- Plug the monitoring headset into the AudioStar Audiometer as shown in the photograph below.



Note: The figure above shows the monitor cords and cables plugged into the side of the AudioStar audiometer (left side as viewed from the front).

- You should have packages with two sizes of AMBAND headbands that secure the bone conductor to the participant's head. One is the regular size and one is a larger size.
- The pack of smaller sized AMBAND headbands arrived in the original packaging with the audiometer and the pack of larger AMBAND headbands should have arrived from the device manufacturer more recently.
- Use the smallest AMBAND size that comfortably fits onto the participant's head. The headband and enclosed bone vibrator should be snug and secure on the participant's head so the bone vibrator makes consistent firm contact with the skin on the forehead.
- If your site does not have a sufficient supply of small or large AMBAND Headbands, please contact the Coordinating Center (cenc@vcu.edu).

Section 1.04. Monitoring Ambient Noise in the Test Environment

GSI has developed software to automatically document sound levels in the test setting. The new ambient noise software is scheduled for release in Spring of 2021. With the new software, sound levels for different frequencies will be measured in dB SPL using a special microphone that research assistants will place near the participant. The software will automatically confirm that sound levels are adequately low for valid pure-tone hearing threshold estimation. Once released, a description of the ambient noise monitoring software will be included in a later version of the SOP, under Section 2.0. Meanwhile, research assistants should adhere to the following guidelines to document noise level in the test environment.

Research assistants should download the **Decibel: dB sound level meter** app to an Apple device (e.g., iPad, iPhone, Mac computer). This audio noise spectrum analyzer app is identifiable by the logo presented here, and download is free. It permits reliable and accurate measurement of ambient noise levels with pre-calibrated profiles for 3 device-integrated mics. Before testing begins with a participant, research assistants should place the Apple device in the test room where the participant will sit during data collection, and measure sound levels using the **Decibel** app. The average dB level (AVG in upper right-hand portion of screen) should be recorded and documented (written down) prior to testing. If the measurement indicates a noise level in excess of 40 dB SPL, research



assistants should make every attempt to reduce noise levels in the room (see tips in [Section 1.02](#)). Checking for ambient noise is also described in [Section 1.08](#).

Section 1.05. Setting Up AMTAS Software for Automated Pure Tone Hearing Testing

- Verify that the AudioStar audiometer is connected to the touch-screen computer via the cable described already (USB connector in the back of the computer and square plug in left side of the back panel of the audiometer as viewed from the back near the power cord). Refer to the photogram of the back panel of the audiometer.
- Connect the appropriate keyboard to the computer (large monitor) using a USB cable from the keyboard to the USB port on the left side of the computer.
- Wirelessly connect the mouse to the AudioStar audiometer by inserting the dedicated flash drive into a USB port on the audiometer as identified with the arrow in the photograph below.





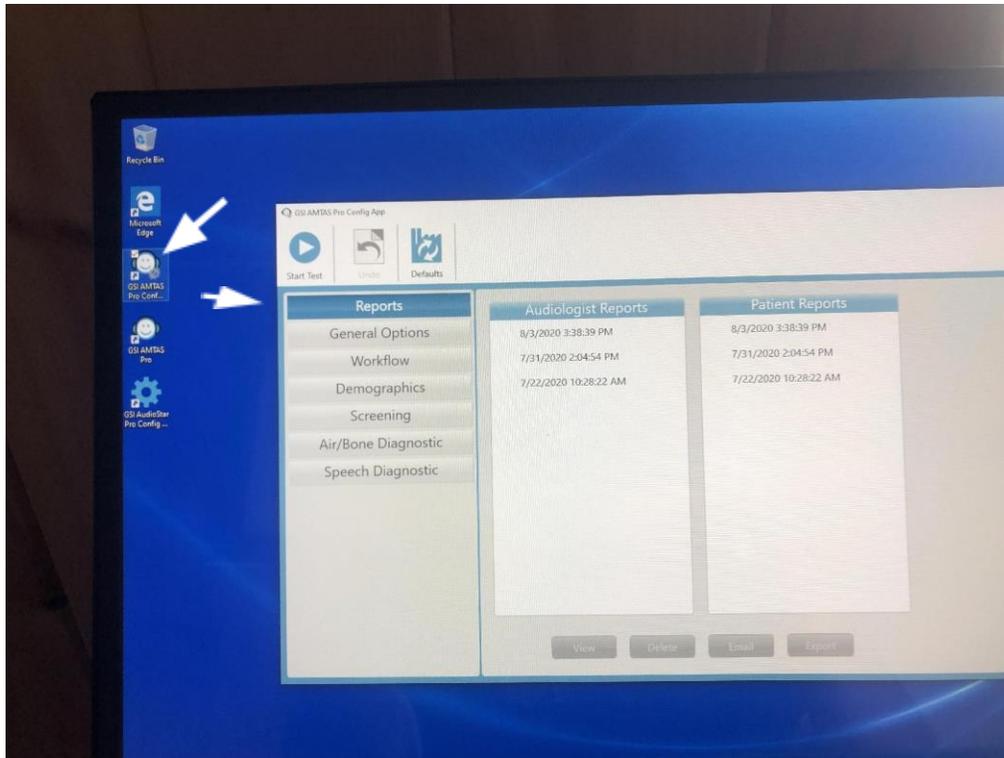
- **Before turning on the computer, first, turn on the GSI AudioStar audiometer using the power switch located on the back right side of the audiometer). Wait for the audiometer to boot up until the speech audiometry (SCAN-3) screen is displayed and the appropriate sequence of control buttons light up.**

Note: When you have finished all hearing testing with a participant (AMTAS and SCAN-3) and you have recorded all test results, power down the computer using the Shut Down option before leaving the test room. The computer will not communicate with the AudioStar audiometer unless it is powered on *after* the audiometer.

- If you are unable to perform the headset verification at the beginning of the AMTAS automated hearing test, power down both the computer and the AudioStar audiometer. Then turn the audiometer on and let it boot up before turning the computer on.

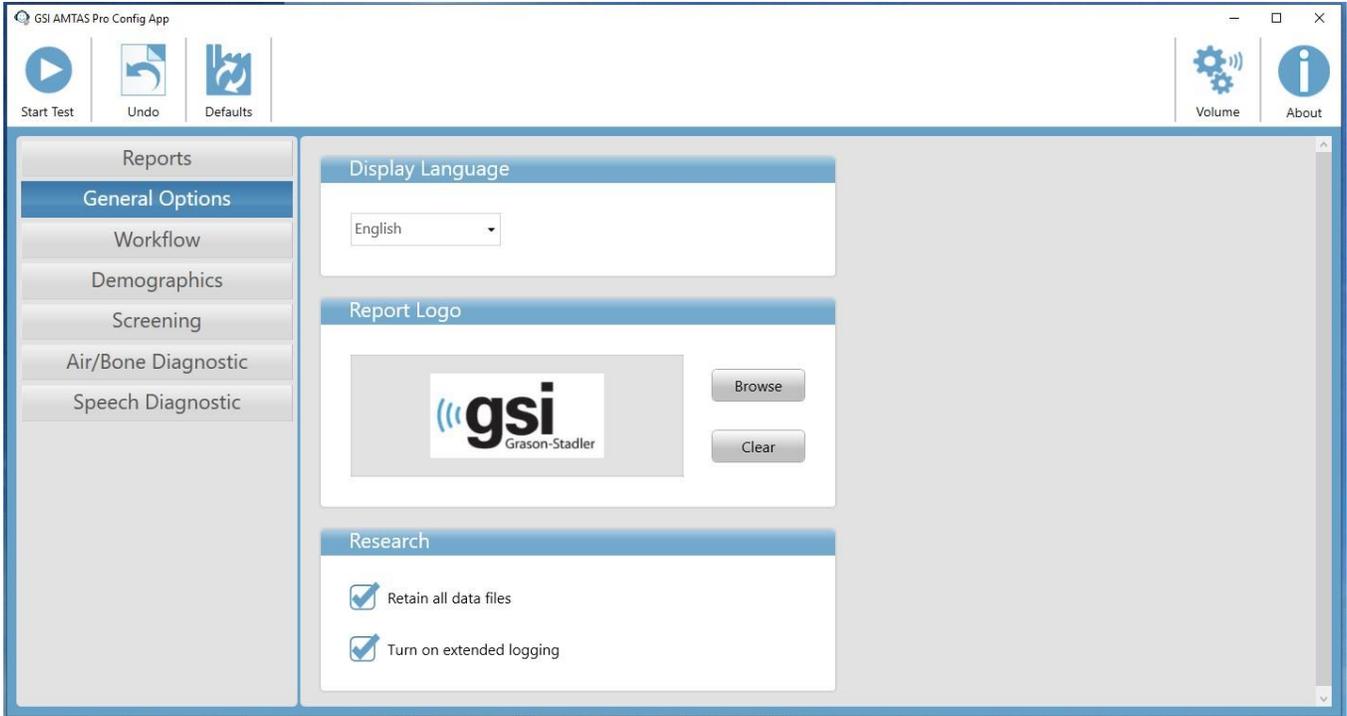


- **Turn on the touch screen computer using the round power switch in the lower right-hand front corner of the computer frame.**
- When the computer first powers on (with the photograph, date, and time), press **the Enter Key on the Computer** to get to a **User Sign In** message (below User and icon of a person).
- Double touch **Sign In** on the computer screen. You can navigate the computer by touching or double-touching the computer screen. You may need to double touch firmly to activate programs.
- The computer screen goes to sleep after a relatively short time. Repeat the above steps as needed to get the computer started again.
- Computer commands are initiated by firmly double-touching the appropriate place on the computer screen.
- Double click the **GSI AMTAS Pro Config** icon in the upper far left of the computer screen, as shown by an arrow in the photograph below.
- **Reports:** You do not need to access Reports in setting up the AMTAS Pro Configuration (also identified with an arrow in the photograph). You will access Reports after testing to view test results.



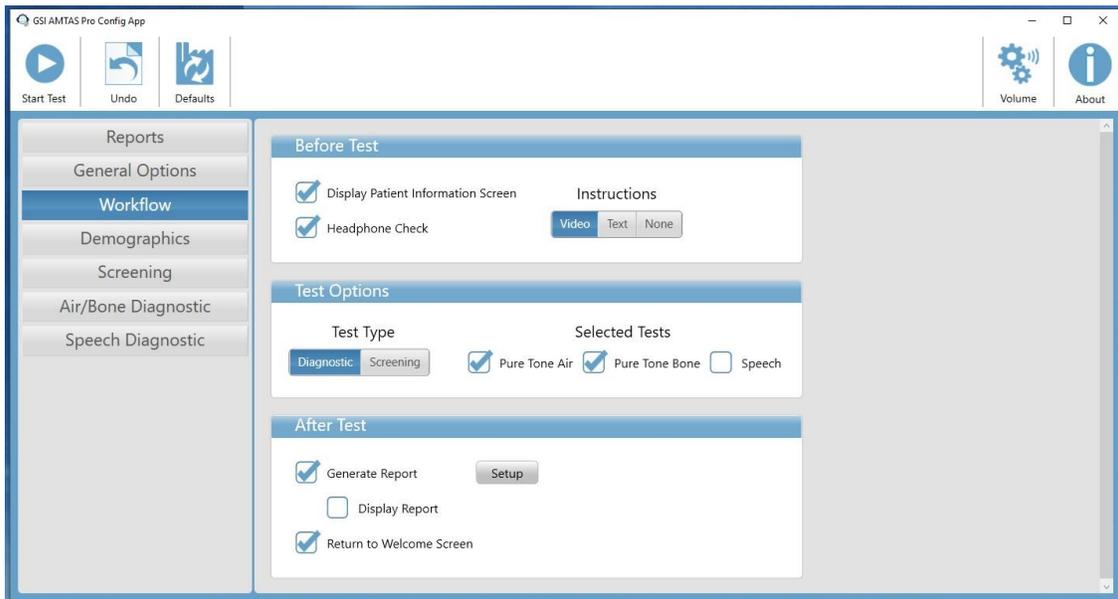
General Options:

- Verify language displayed is English
- Research: Check both boxes
- Retain all data files
- Turn on extended logging



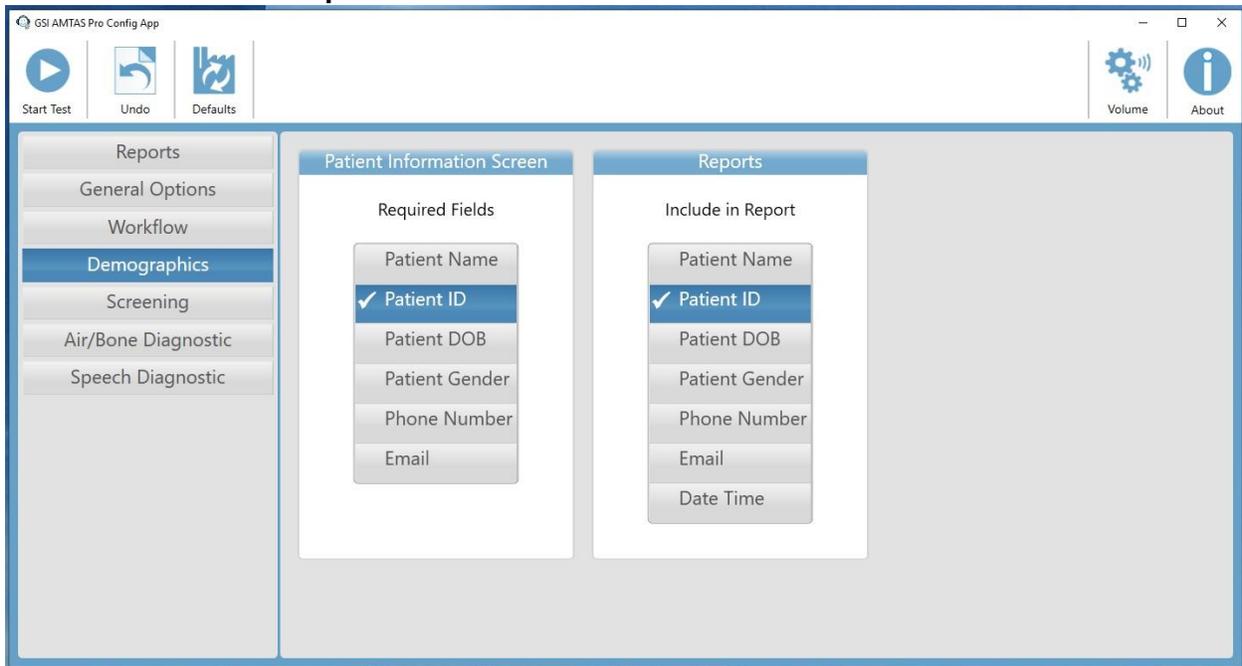
Select **Workflow** and then select

- o **Before Test** select
- o **Headphone Check** (see photograph below) High Frequency
- o **Display Patient Information Screen** (see photograph below)
- o **Instructions: Video**
- o **Test Options** select:
- o Test Type: Diagnostic
- o Selected Tests: Pure Tone Air and Pure Tone Bone ✓ **After Test** select:
- o Generate Report
- o Return to Welcome Screen

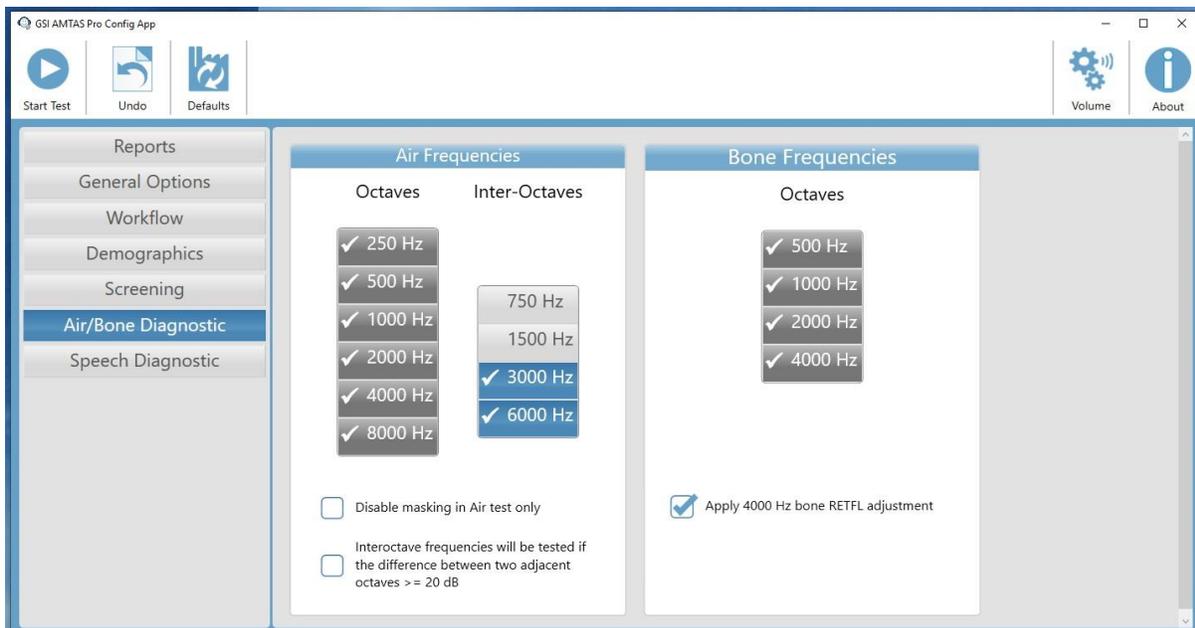


Select **Demographics** and then select:

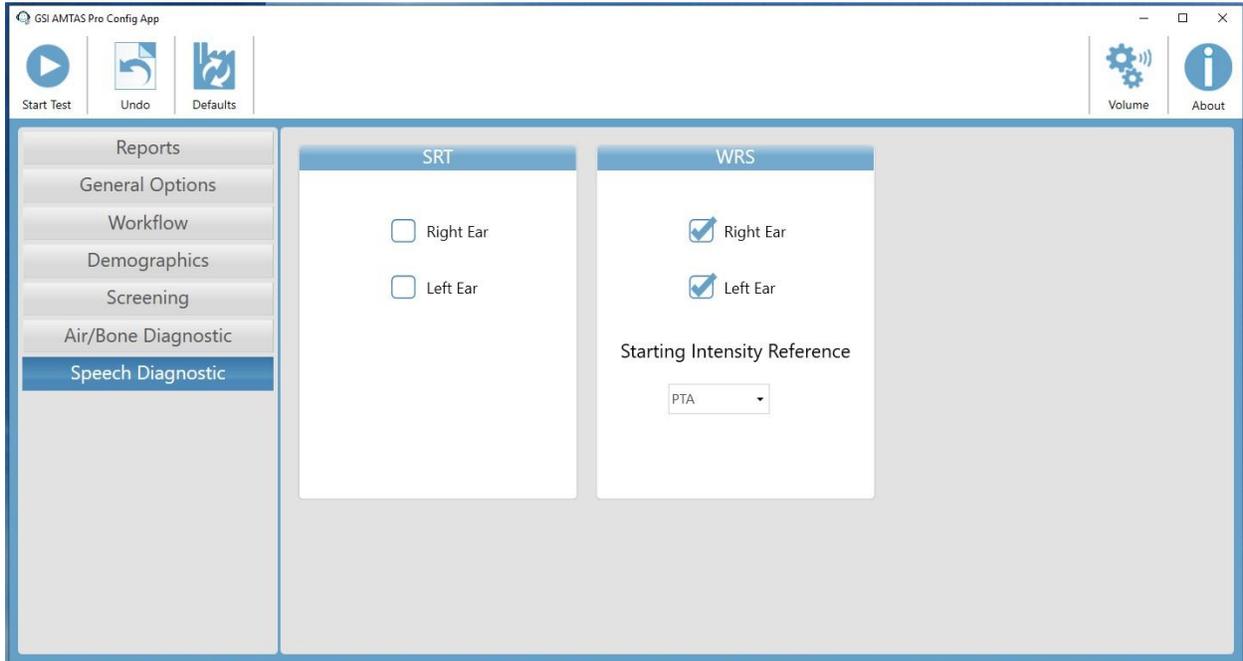
- o **Patient Information Screen:** Select Patient ID
- o **Reports:** Select Patient ID



- **Screening:** You do not need to access Screening in setting up the AMTAS Pro Configuration.
- Select **Air/Bone Diagnostic**
 - **Air Frequencies**
 - ✓ **Octaves:** Select 250 Hz, 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz, 8000 Hz
 - ✓ **Inter-octaves:** Select 3000 Hz and 6000 Hz
 - ✓ Do NOT select either option below
 - **Bone Frequencies**
 - ✓ **Octaves:** Select 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz
 - ✓ Select **“Apply 4000 Hz bone RETFL adjustment”**



- **Speech Diagnostics:** You do not need to access Speech Diagnostics in setting up the AMTAS Pro Configuration.



Section 1.06. Setting Up the GSI AudioStar Audiometer for SCAN-3 Testing

Installation of SCAN-3 Files on AudioStar Pro Audiometer

When the AudioStar Pro Audiometer is turned on, SCAN-3 files should be displayed in the lower portion of the screen, as illustrated in the photograph below.



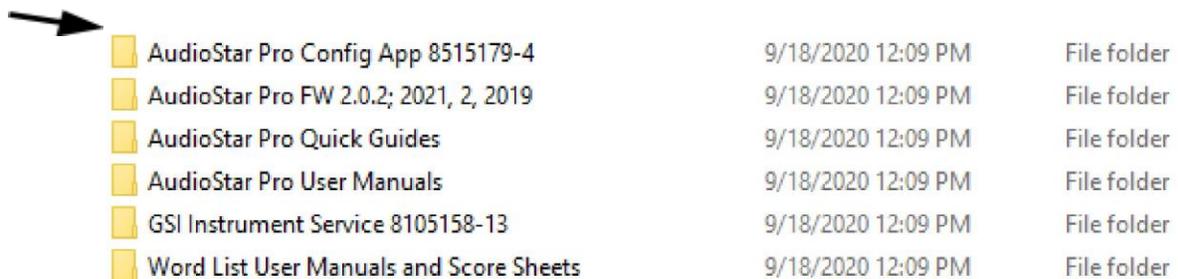
If these files do not appear on the screen of the AudioStar Pro Audiometer, they need to be installed before proceeding with setting up the audiometer for SCAN-3 testing.

- Locate the USB (flash drive) with the SCAN-3 files. It may be in a small plastic bag or metal tin. Contact Dr. Hall if you cannot locate the USB drive containing the SCAN-3 files.
 - To install the SCAN-3 from the USB, simply place it in any USB port on the AudioStar Pro audiometer
 - Press the “configure” button on the control panel of the audiometer.
 - There is an “update” option in the lower left hand corner of the configure screen.
 - Click on the “update” option and then click on “sound files”.
 - The audiometer will begin the update process.
 - Once the update process is complete, the device will automatically restart.
-
- Verify that the AudioStar audiometer is connected to the touch-screen computer via a cable (USB connector in the back of the computer and square plug in left side (of the back panel of the audiometer (viewed from the back) near the power cord. See the diagram of the back panel of the audiometer.
 - Connect the appropriate keyboard to the computer (large monitor) using a USB cable from the keyboard to the USB port on the left side of the computer
 - Turn on the computer (large screen) using the round power switch in the lower-right front corner of the computer frame
 - When the computer first powers on (with the photograph, date, and tie), press the **Enter Key on the Computer Keyboard** to get to a **User Sign In** message (below the icon of person)
 - Touch **Sign In** on the computer screen. You can navigate the computer by touching the computer screen. You may need to double touch to activate programs.
 - The computer screen goes to sleep after a relatively short time. Repeat the above steps as needed to get started again.
 - Double click the **GSI AudioStar Pro Config** icon in the upper-left corner of the computer screen.
-
-
- NOTE: If you do NOT see the **GSI AudioStar Pro Config** icon on the computer screen, you must first install the **AudioStar Pro Config app** as described below. If you do see

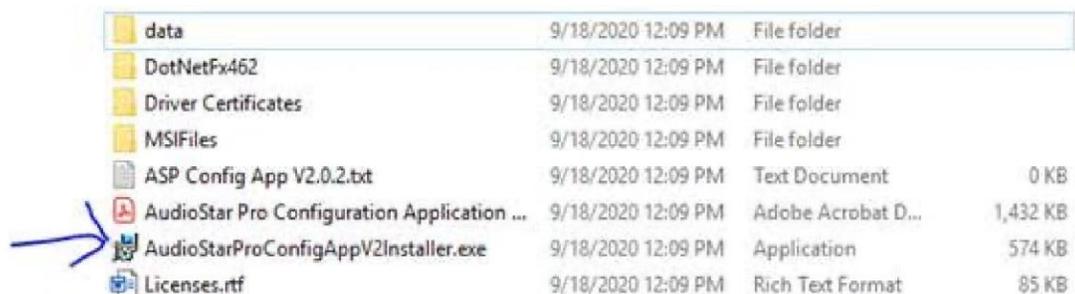
the **AudioStar Pro Config app** icon on the computer, click on the icon and proceed with **Setting Up the GSI AudioStar Audiometer for SCAN-3 Testing** as described below.

Installation of the **AudioStar Pro Config app** (only if the icon does not appear on your computer screen):

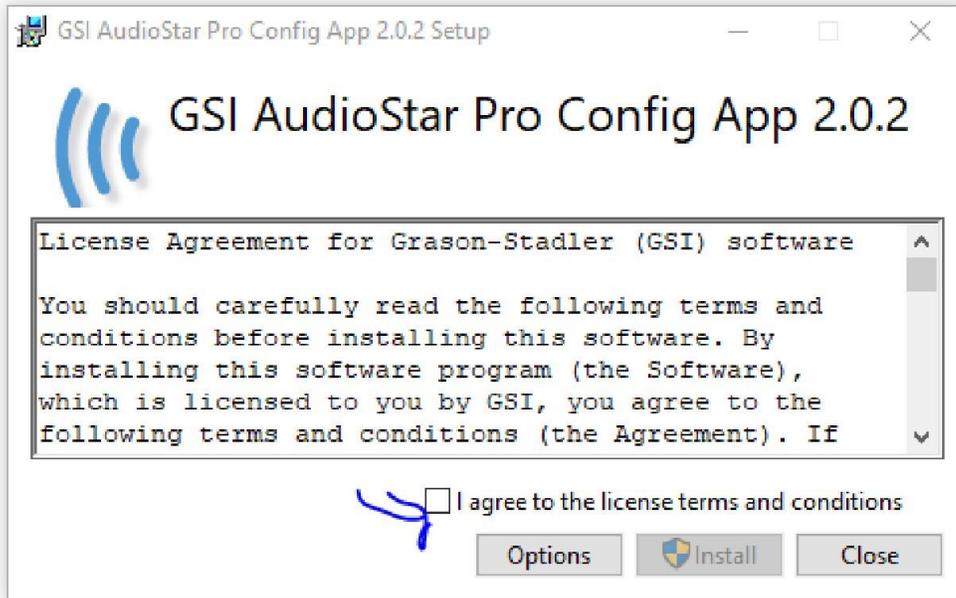
- Locate a little tin labeled (on the bottom) Software and Manuals
- Remove the flash drive (memory stick) and plug it into a USB port on the computer
- Open (click on) the Software and Manuals USB
- The display shown in the screenshot below will appear



- Click on the the AudioStar Pro Conf app (usually at the top of the list) as shown with an arrow in the screenshot
- On the screen that appears, double click on the AudioStarProConfigApp installer (ending with V2installer.exe as indicated with a hand-drawn arrow in second screenshot below



- A License Agreement message will appear as shown in the following screening shot



- Agree to the terms (click box) and then click Install
- Wait a few second until the installation process is complete
- Note that a lock icon appears on the screen of the AudioStar Pro audiometer. The computer has now configured the AudioStar Pro audiometer to default for SCAN-3 testing

You are now ready to move on to selecting the specific AudioStar Pro audiometer settings for SCAN-3 testing, as described next in the step-by-step process for **Setting Up the AudioStar**

Audiometer for SCAN-3

Setting Up the GSI AudioStar Audiometer for SCAN-3 Testing

- Click on the **AudioStar Pro Config app**
- Select **Upload** from command bar on the top left of the screen
- Select **General** on the **Audiometry** list (left side of the screen) ● Under **New Session**
 - ✓ **Initial Screen** select **Speech**
 - ✓ **Graph Orientation** select **Right/Left**
 - ✓ **Bone Setting** select **Mastoid**
 - ✓ **Channel 1 Transducer** select **High Freq. Phone**
 - ✓ **Channel 1 Routing** select **Left**
 - ✓ **Channel 1 Level (dB HL)** select **40 dB HL**
 - ✓ **Channel 2 Transducer** select **High Freq. Phone**
 - ✓ **Channel 2 Routing** select **Right**
 - ✓ **Channel 2 Level (dB HL)** select **40 dB HL**
- Under **Reliability** leave the selection as “Good”
- Under **Routing** select **Yes** ● Under **PTA**
 - ✓ **AC PTA Hz** select **500, 1K, 2K**
 - ✓ **BC PTA Hz** select **500, 1K, 2K**
- Select **Speech** on the **Audiometry** list (left side of screen)
 - ✓ **Speech Display** select **Table**
 - ✓ **AutoAdvance on Score** select **On**
 - ✓ **Word List Favorites** select **On**
 - ✓ **Stimulus Channel 1** select **IntA**
 - ✓ **Stimulus Channel 2** select **IntB**
 - ✓ **Filter Settings** select **Linear**
 - ✓ **dB STEP** select **5**
 - ✓ **Test Type** select **WRS**
 - ✓ **Internal Wavefile Auto-Play Mode** select **Wait for Score** (from the pull-down menu)
 - ✓ **Timeout (sec)** select **5**
 - ✓ **QuickSin & BKBSIN Scoring Method** select **Incorrect Button**
- Select **Word Lists** on the **Audiometry** list (left side of the screen)

- ✓ Clear List (lower-right)
- ✓ Select **Yes**
- ✓ Go to **downward arrow**, lower-left under “word list favorites” (v to show different test options)
- ✓ Scroll down to **SCAN-3 Custom (WRS)**
- ✓ Select **SCAN-3 Custom**. “Full Test” will display in the open box to the left.
- ✓ Highlight **FULL TEST** by clicking it
- ✓ Press **Add Favorite** button at bottom
- ✓ Confirm **FULL TEST** is in both boxes (no other tests should be listed)
- ✓ Press the **Download** command at the upper-left of the screen. **This is a critical step in Setting up the GSI AudioStar Audiometer for SCAN-3 Testing.**
- ✓ Press **OK**
- ✓ A confirmation will appear on the screen indicating that new settings have been saved to the audiometer device.
- ✓ New settings will become active when a new session is launched.
- ✓ **Restart the AudioStar Audiometer**

Section 1.07. Verification of AudioStar Audiometer Operation

The following steps should be completed on the day of data collection but preferably before the participant is present in the test room and especially if the equipment does not consistently remain in the test room:

- Double-check all plug-ins and connections as described earlier
- Review all default settings for the AudioStar audiometer and computer when each is first turned on (Remember to turn the AudioStar audiometer on first).
- Conduct a quick right versus left ear soundcheck via the AMTAS software. To conduct the soundcheck, place the earphones on your ears (red = right and blue = left) and begin the AMTAS automated pure-tone hearing test.
- You may abort the AMTAS test process as soon as you have heard the test sounds in the correct ear. To abort, do not respond to any commands or stimulus sounds. In less than one minute, you will have an opportunity to quit.

- Alternatively, if time permits you may continue with the AMTAS automated pure-tone hearing test as described below under “**Section 1.08. Pre-test Biological Hearing Threshold Check**”
- When you do continue with the pre-test biological hearing threshold check, compare your hearing thresholds to the thresholds for the baseline test when you first set up the computer and the AudioStar audiometer. Pay close attention to low-frequency hearing thresholds which are most likely to be affected by ambient noise in the test room.
- Immediately notify Dr. James Hall if the pre-test check shows a decrease of more than 10 dB in hearing thresholds for any test frequency.

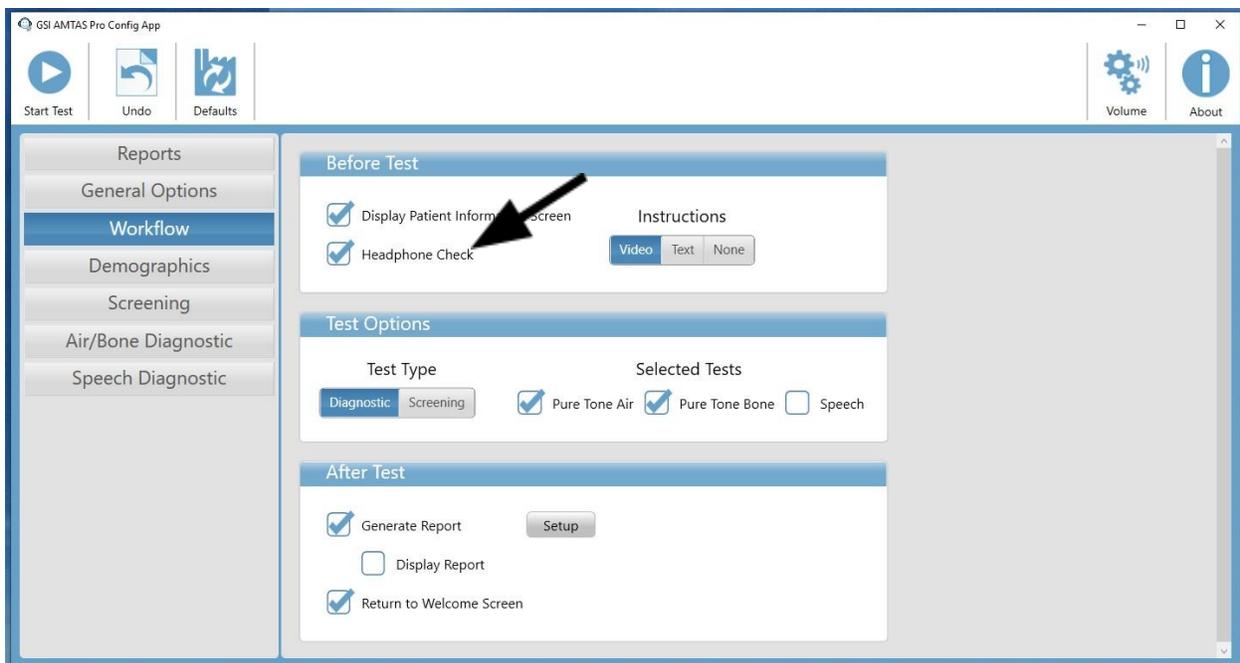
Section 1.08. Ambient Noise Check

Measurement and documentation of ambient noise levels in the test room was described in [Section 1.04](#). The information in this section supplements the earlier description of ambient noise recording with the **Decibel: dB sound level meter** Apple app. Again, the purpose of the informal ambient noise check is to verify an adequate test environment prior to data collection.

- Identify a quiet room that will be used as a test site. Verify adequately low sound levels (< 40 dB SPL).
- Immediately before data collection, place a sign outside the testing room door that reads,
“QUIET! HEARING TESTING IN PROGRESS.”
- Ensure that the AudioStar audiometer and the participant are located as far away as possible from the door and window, and other noise sources, such as an AC vent (see previous diagram of test room).
- As noted in [Section 1.04](#), before testing begins with a participant, research assistants should place the Apple device in the test room where the participant will sit during data collection, and measure sound levels using the **Decibel** app. The average dB level (AVG in upper right-hand portion of screen) should be recorded and documented (written down) prior to testing. If the measurement indicates a noise level in excess of 40 dB SPL, research assistants should make every attempt to reduce noise levels in the room
- After documenting the ambient noise level, proceed with testing. (Continue to section 1.09)

Section 1.09. Pre-Test Biological Hearing Threshold Check

- Prior to collecting data from a participant, verify that a normal hearing person (you or another normal hearing person) can detect examples of the stimuli from the GSI AudioStar audiometer that is used in hearing testing.
- Place the bone conductor securely on the forehead of the normal hearing person, using the AMBAND as described.
- Place the DD 450 earphones on the head of the normal hearing person (earphone with red marker over the right ear and earphone with the blue marker over the left ear).
- Verify that the earphones fit snugly with cushions placed around the ear.
- Using the earphones, select “Workflow” and then “Headphone Check” from the screen illustrated below.



- Verify that the normal hearing person can hear the air conduction stimulus.
- Repeat the process for the left earphone.
- Time permitting, complete AMTAS pure tone hearing testing with air- and bone conduction stimulation on a normal hearing person or yourself to verify normal equipment operation and an adequately quiet test setting.

Section 1.10. Participant (Subject) Preparation

Research assistants are encouraged to follow guidelines for greeting participants and for instructing participants about AMTAS pure tone hearing testing and SCAN-3 testing found in [Appendix D](#) at the end of the SOP. As noted in the guidelines, the two most important features of participant instruction are simplicity and clarity.

When the participant arrives in the test room:

- Follow appropriate protocol for infection control including mask wearing, limiting physical contact, and maintaining proper social distancing as possible.
- Greet the participant and introduce yourself in a polite and friendly manner.
- Explain that you will be performing several hearing tests using earphones over the ears and a plastic bone conductor device placed on the forehead (see [Appendix D](#)).
- Mention that the total test time will be approximately 30 to 35 minutes.
- State that the participant will not experience discomfort during the hearing testing.
- Explain that the participant needs to listen closely to instructions before the testing begins.
- Emphasize that the participant must remain alert and attentive throughout the testing.
- Assure that the participant is comfortable and ready for about 30 minutes of testing ● Ask the participant about visual ability and whether they wear glasses.
- Ask the participant about hearing aid use. *If the participant does wear hearing aids, see [Section 1.11](#) below.*
- Tell the participant that before the first test he or she will be instructed to listen carefully to some beeping tones in the first test. There may be some rushing water noise in the background at times during the test. Emphasize that the participant only needs to listen to the beeping tones. He or she should pay no attention to the rushing water noise.
- Ask the participant if they have any questions.

Section 1.11. Testing Participants Who Wear Hearing Aids

Ask the participant if they wear hearing aids. Follow these guidelines if a participant normally wears hearing aids.

- **AMTAS Pure Tone Hearing Testing:**

- ✓ Before placing earphones on the participant, ask the participant to remove their hearing aids.
- ✓ Administer AMTAS pure tone hearing testing after the participant has removed his/her hearing aids, i.e., without hearing aids in place.
- ✓ Verify that the participant puts the hearing aids in a safe and clean location for the duration of the testing.
- ✓ At the point prior to actual hearing testing when the participant listens to and watches the instructions on the computer, immediately request that the participant increase the volume of the instructions by sliding the volume scale to the right until the instructions are at a comfortable listening level for the participant.
- ✓ If the participant complains of difficulty hearing the instructions, touch **Quit** (lower left-hand corner) and begin the instructions again at a higher volume level.
- ✓ Press **“Get Started”** to perform the AMTAS pure tone hearing testing for air conduction and bone conduction after you have verified that the participant heard and understood the recorded instructions. In the free text box, note that “participant uses hearing aids.”
- ✓ Upon completion of AMTAS hearing testing procedure you should immediately remove the bone oscillator from the AMBAND for the remainder of testing (SCAN-3 tests).
- **SCAN-3 Testing:**
 - ✓ **Do not administer the SCAN-3 if the participant normally wears hearing aids.**
 - ✓ Administer the SCAN-3 if the participant has a pure tone average (PTA) of 25 dB HL or less for AMTAS hearing thresholds of 25 dB HL at test frequencies of 500 Hz, 1000 Hz, and 2000 Hz, 3000, and 4000 Hz. The AMTAS software automatically calculates the PTA for each ear. The PTA for the right ear and left ear is plotted as a number in a table in the lower left portion of the audiogram below the “AMCLASSTM Audiogram Classification”. **Do not administer the SCAN-3 if the participant has a PTA > 25 dB HL for one or both ears. In the monthly summary spreadsheet for audiometric data for participants, please state that SCAN-3 testing was not performed because the participant had a PTA > 25 dB HL.**
- **Research assistants are strongly encouraged to view the narrated PPT presentation ([LIMBIC-CENC Hearing Data Collection: Part 1](#)) that reviews in detail setting up the GSI AudioStar audiometer and the computer for AMTAS automated pure tone audiometry, plus verification of equipment operation and minimizing ambient noise.**

SECTION 2. PERFORMING AUTOMATED HEARING TESTING (AMTAS)

Section 2.01. Introduction

The pure tone hearing testing process is automated using a research-proven software program called Automated Method for Testing Auditory Sensitivity, abbreviated AMTAS. The AMTAS program permits a self-administered hearing test. Instructions for the test are shown on the GSI AudioStar audiometer screen. During testing, the participant receives a message to “Listen for a tone”, and then is asked “Did you hear the tone?”. Throughout testing, the AudioStar audiometer automatically detects, scores, and records the participant’s responses to tones.

Section 2.02. Remote Ambient Noise Monitoring Software

Information about newly developed ambient noise monitoring software will be included in later versions of the SOP after GSI officially releases the software for clinical and research applications. Pending the release of the GSI ambient noise monitoring software, conduct sound level measurement in the test room as described in [Section 1.04](#).

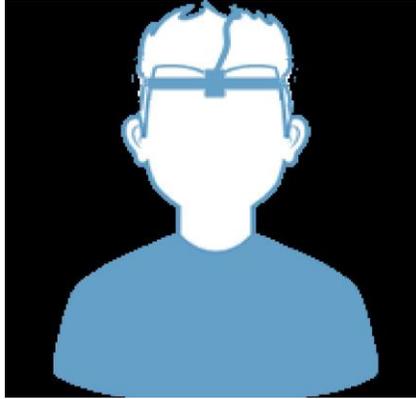
Section 2.03. Instructions to Participant

- Locate the participant in front of and quite close to the touch-screen computer.
- Verify that the participant can easily reach and touch the computer screen.
- Read the participant instruction from [Appendix D](#) to explain the hearing testing process.
- Repeat that you will be performing several hearing tests using earphones over the ears and a plastic bone conductor device placed on the forehead.
- Inform the participant that the AMBAND (headband) will fit snugly around the head, and the bone vibrator will press against the forehead.
- Emphasize that the bone vibrator will remain in place for the first part of the hearing testing, which is about 15 minutes. The headband and vibrator will be removed as soon as the first part of the hearing testing is complete.

- Explain that the participant needs to listen closely to instructions on the computer before the testing begins, as well as remain alert and attentive throughout the testing.
- Ask if the participant has any questions before the testing begins.

Section 2.04. Placement of Bone Vibrator (Oscillator)

- Place the AMBAND and bone vibrator on the participant's head *before* placing the earphones over the participant's ears.
- Always offer to place the AMBAND and bone vibrator on the participant's head. Do not initially expect participants to place the AMBAND and bone vibrator on their head.
- AMBANDs are available in only one size. If the fit is too snug, stretch the AMBAND before replacing on the participant's head.
- If the fit is still excessively snug and/or the participant expresses discomfort when the bone vibrator is on the forehead, remove the standard size AMBAND. Using the Velcro sticky tabs, attach two AMBANDS together to form one large double extra-large (XL) AMBAND before attempting to secure the bone vibrator on the participant's forehead.
- Save the XL AMBAND for use with other participants who have larger heads and/or who complain of discomfort with the standard AMBAND.
- Secure the bone vibrator on the AMBAND using the Velcro sticky tab on the bone vibrator, as noted above.
- Connect the Velcro ends of the AMBAND before sliding the AMBAND over the participant's head, with the vibrator on the forehead, and with the cord from the bone vibrator going upward away from the participant's face, as shown in the diagram below.
- Alternatively, you may wish to first connect each end of the AMBAND with the Velcro strips before sliding it over the participant's head and then inserting the bone vibrator inside the AMBAND and over the participant's forehead.



- Again, direct the bone vibrator cord upward and toward the back of the head.
- Verify that the AMBAND fits snugly and that the enclosed bone vibrator does not slip.

Section 2.05. Placement of Earphones

- Always offer to place the earphones on the participant's head. Do not initially expect participants to place the earphones on their head.
- Brush any hair back and away from the external ear, as shown in the photograph below.
- Inspect the participant's external ear (the pinna) on each side for anything unusual, such as a sore, bruise, cut, or growth.
- If you notice anything unusual about the external ear, ask the participant if they are aware of it and if they experience any discomfort (e.g., "Did you know you have a bruise on your ear? Is it uncomfortable?").



- If the participant does note ear discomfort, explain the following test process and verify that the participant agrees to the placement of earphones.
- If the participant wears earrings, ask the participant if the earrings can be removed for the duration of the testing (about 30 minutes).
- Instruct the participant to place the earphones in a safe place (e.g., on the table in front of the participant).
- Grasp each earphone in one of your hands, pull them apart slightly. Gently place the circum-aural (around the ear) earphones over the participant's ears, as shown in the photograph below (see arrow pointing to the right ear).



- Take special care to place the right earphone (red marker) over the right ear and the left earphone (blue marker) over the left ear.



- Verify that the ears are centered under the earphone cups and that the fit is secure and comfortable for the participant.



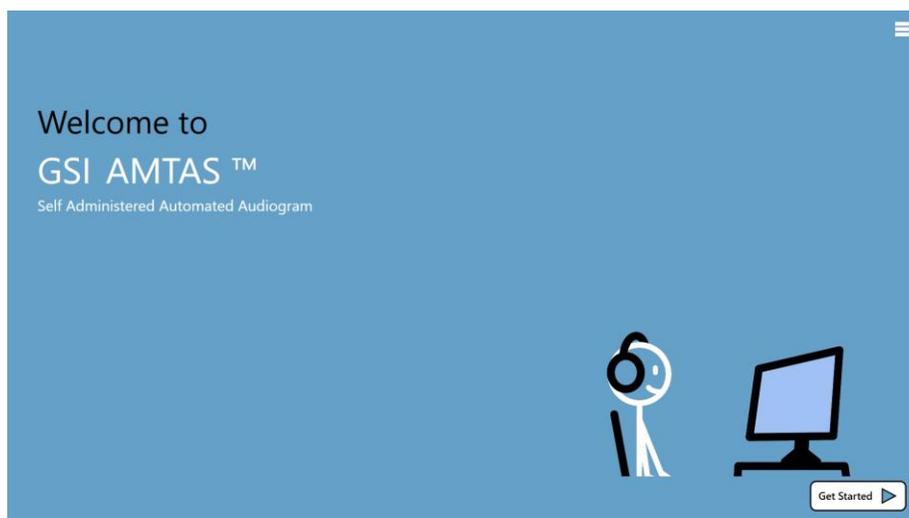
- If a participant wishes to place the earphones, give the earphones to the participant with the red (right) earphone in the participant's right hand and with the blue (left) earphone in the participant's left hand.
- Verify that the earphones are properly placed over the ears before proceeding with hearing testing.

Section 2.06. Performing Automated Pure Tone Hearing Testing



The following is a step-by-step description of AMTAS hearing testing. If you encounter any problems in beginning or carrying out the automated hearing testing, look for a solution in the **TROUBLE-SHOOTING** Guide at the end of the SOP.

- Double touch the **GSI AMTAS Pro** icon (upper-left region of the computer screen). The GSI AMTAS Pro icon is just below the GSI AMTAS Pro Config icon.
- AMTAS software puts the computer tablet into kiosk mode. No other programs may be accessed when AMTAS is running.
- You will be brought to the **Welcome** screen below.
- The “hamburg” icon in the upper right-hand corner (see arrow) is used to access settings and other options.



The research assistant should touch **Get Started** (lower-right corner of screen).

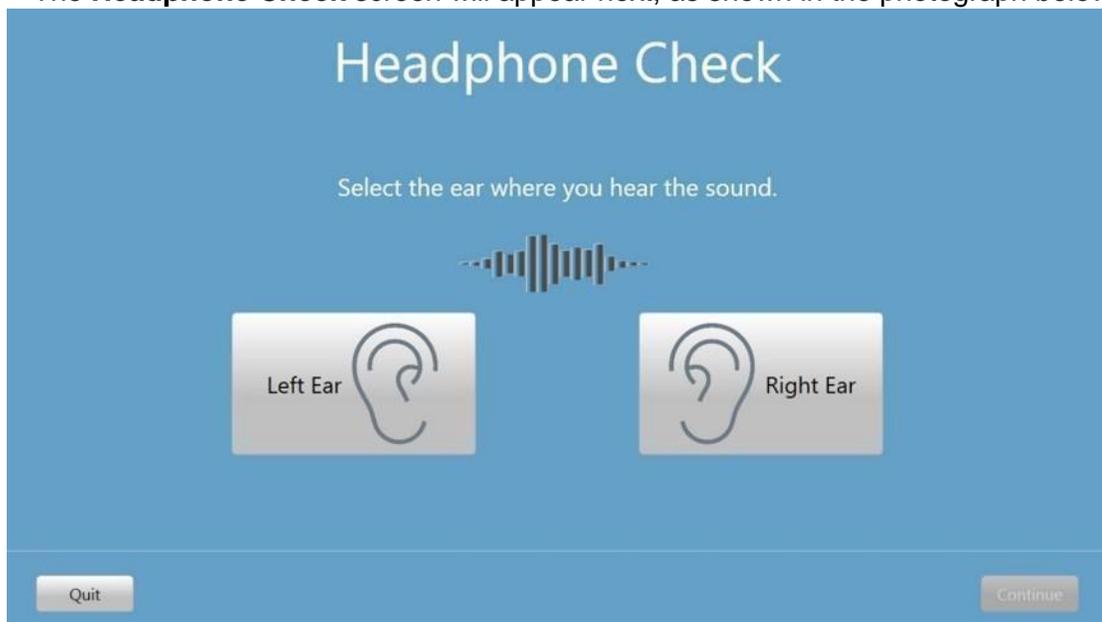
Optionally, the participant can touch **Get Started** on the screen.

The research assistant should select the **hamburger icon** (upper-right corner of the screen) for additional options or to exit the program.

- After selecting the “**Get Started**” icon to begin the test, the **Patient Information** screen will appear (see below).



- Enter the **Participant’s ID number** and press continue.
- If you have already placed the bone vibrator on the participant’s forehead using the AMBAND and you have placed the earphones (right = red and left = blue), the participant should touch **Continue**. Optionally, the research assistant can double touch **Continue** on the screen.
- The **Headphone Check** screen will appear next, as shown in the photograph below.

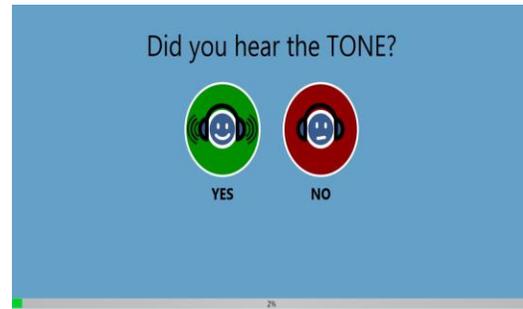


The participant should touch **Play** to begin the headphone (earphone) check. Optionally, the research assistant can touch **Play** on the screen.

The participant should follow directions on the screen, as illustrated in the photograph below. That is, the participant should touch the screen icon corresponding to the ear that the sound is heard in.



- If the message **Please ask consultant for assistance** appears when the participant touches the earphones during the Headphone Check, the research assistant should verify that the right (red) earphone is on the right ear and the left (blue) earphone is on the left ear.
- The research assistant should then touch **Recheck**.
- When **Headphone Check Complete** appears on the screen, the participant or research assistant should touch **Continue** (lower right-hand corner of screen).
- The participant should then listen to automated instructions as the participant begins the AMTAS automated hearing test.
- As already noted, feel free to immediately increase the volume of the instructions using the sliding scale toward the bottom of the screen (e.g., up to 60 or higher) if you know the participant has a hearing loss or if the participant complains about not hearing the instructions clearly.
- See the **TROUBLE-SHOOTING** Guide at the end of the SOP if you encounter any problems with the Headphone Check or any other step prior to actual automated hearing testing.
- Again, when the test is started selected instructions and test types will follow the on-screen instructions to complete the evaluation.
- Throughout the AMTAS automated hearing testing process, the participant will view the messages below ... first “Listen for a Tone” and then “Did you hear the Tone?”

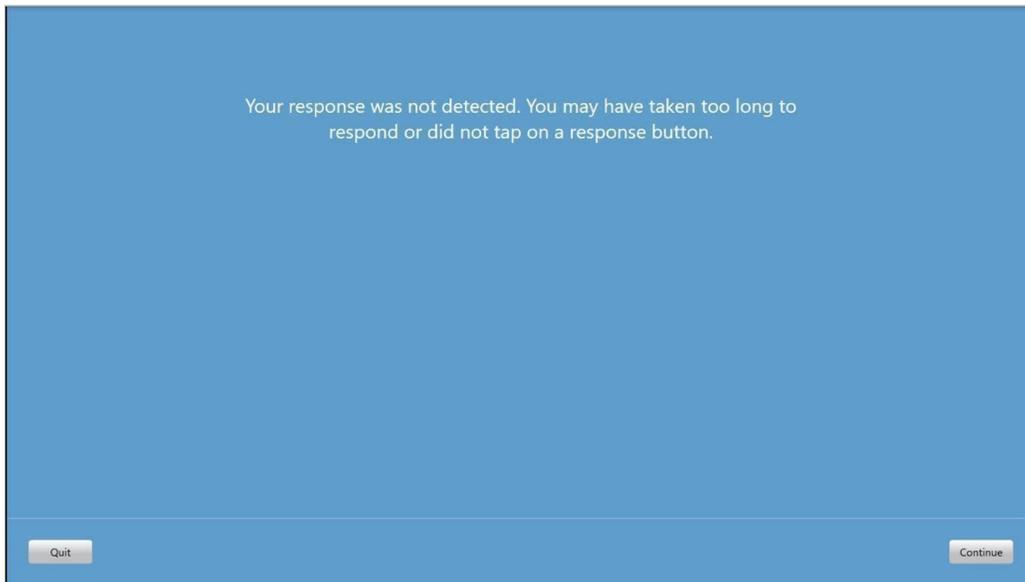


The participant should promptly touch the appropriate icon, that is, **Yes** if he or she heard the tone and **No** if he or she didn't hear the tone.

The message below may appear if the participant touched the Yes icon when no tone was presented.



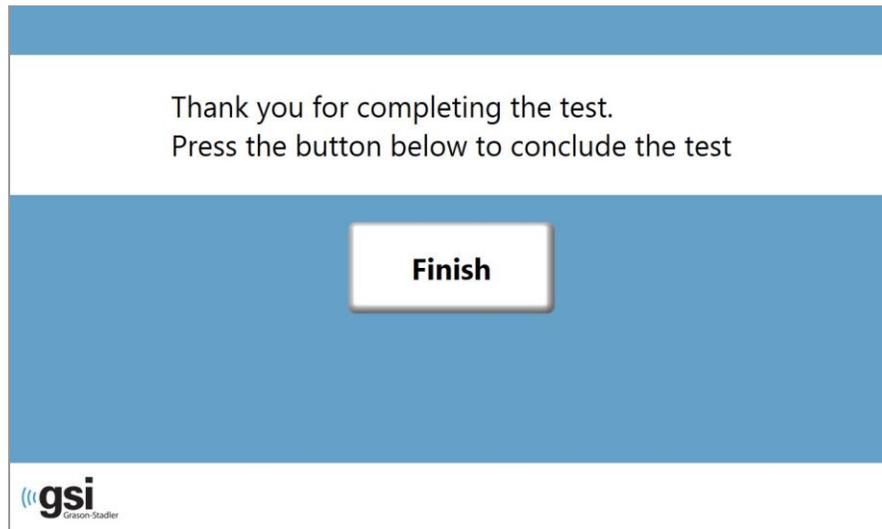
- Touching the Yes icon when there was no sound is a **False Alarm** response.
- There is no concern if the participant occasionally touches Yes when the tone was not really presented. You or the participant should simply touch **Continue** to proceed with testing.
- If this message appears repeatedly, it may be necessary to select **Quit** (see option in lower-left hand corner) and remind the participant about touching the Yes icon only when he or she hears the tone and about not paying attention to any rushing water noise.
- If the participant does select “Yes” or “No” after a reasonably response time, the message below will appear on the screen.



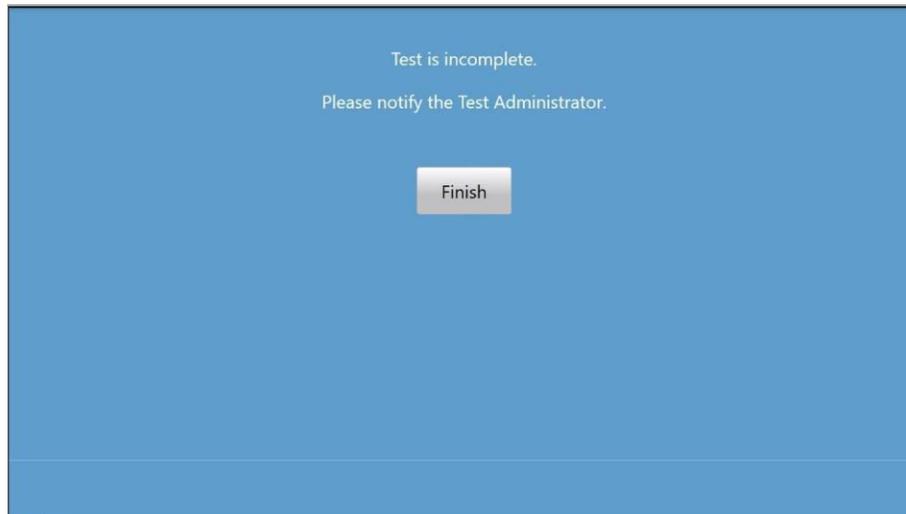
- Typically, you would instruct the participant to response “Yes” or “No” whenever prompted to do so. Then you, to proceed with testing you will select **Continue** (lower-right corner).

You can escape from AMTAS pure tone hearing screening at any time by purposefully not responding with “Yes” or “No”. Then you, to complete the escape from AMTAS testing you select **Quit** (lower-left corner).

- When the evaluation is complete (or ended for some reason), the message **Finish** will be displayed, as shown below.



- Select the **Finish** option to complete the AMTAS procedure.
- If the participant struggles to perform the AMTAS hearing test procedure, the following message will appear.



- If this message appears, ask the participant if they have any questions about the testing. Reinstruct the participant and attempt to begin the AMTAS hearing testing program again.

Section 2.08. Participant Break from Testing (Between AMTAS and SCAN-3)

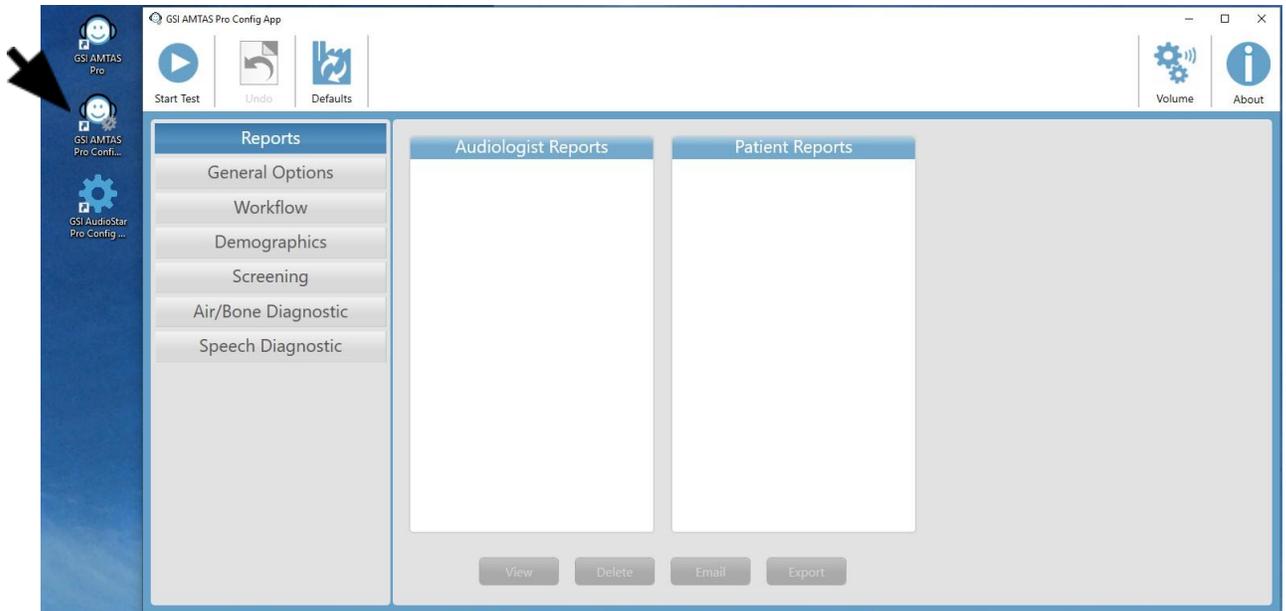
- There is necessarily a short time interval between finishing the AMTAS automated hearing testing and the beginning of the SCAN-3 testing.
- The participant can relax during this time interval while you prepare the equipment and the participant for SCAN-3 testing.
- Remove your headset/microphone and gently place it on a table nearby.
- Remove the earphones from the participant and gently place them on a table nearby.
- Remove the bone vibrator and AMBAND (Velcro headband) from the subject and gently place them on a table or any safe place. The AMBAND and bone vibrator is not used for the SCAN-3 tests.
- The participant may have a reddish area on the forehead where the bone vibrator was pressing against the skin, as shown with the arrow in the photograph below.



- Assure the participant that the red spot will go away soon.
- Inform the participant that there will be a brief break before the next test begins.
- Encourage the participant to relax, stretch, and rest before the next test begins in a few minutes.

Section 2.09. Entry of Hearing Threshold Data on CRF

- Pure tone audiometry threshold data for air- and bone conduction are found under the **Reports** screen on the AMTAS computer as shown in the photograph below.
- The Reports screen is accessible via the GSI AMTAS Pre-Config App on the left side of the computer screen (see arrow).

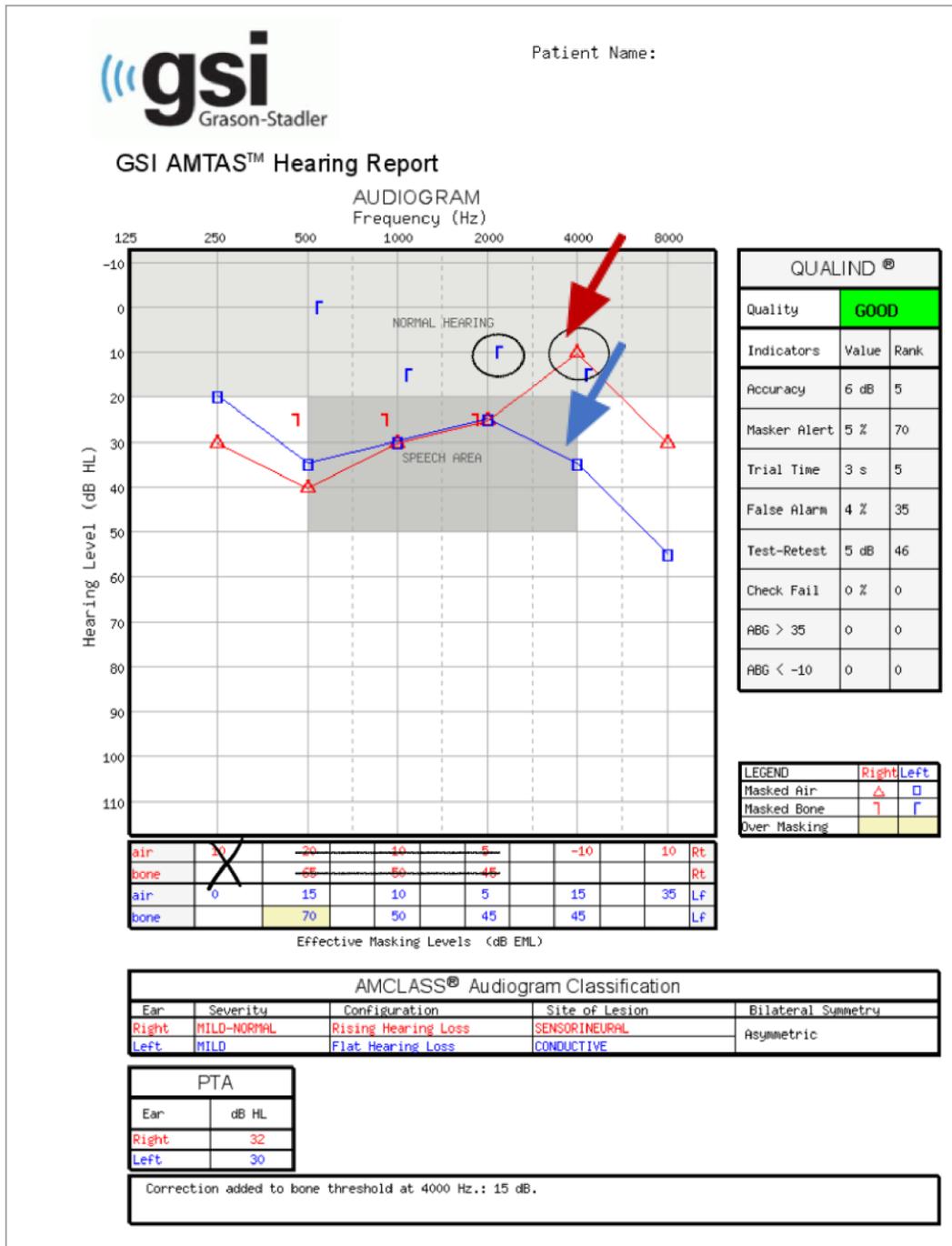


- Before first collecting data from a participant, research assistants are strongly encouraged to closely study the audiogram form and the symbol system and to practice entering data onto a blank CRF.
- Hearing threshold levels for air conduction and bone conduction pure tone audiometry must be entered manually into the appropriate CRF.
- **Although data entry for AMTAS automated pure tone audiometry is described here, you may (and probably will) perform actual data entry on the CRFs after all hearing testing is complete and the participant has been dismissed from the test room.**

The appropriate CRF is identified in a black portion at the top of the form with LIMBIC-CENC-01C on the left-hand side and AudioStar on the right-hand side, and also by the assessment quality data fields at the bottom of the CRF, as shown below.

LIMBIC-CENC-01C	AudioStar																											
Subject ID: <input style="width: 60px;" type="text"/>	Date: <input style="width: 20px;" type="text"/> - <input style="width: 20px;" type="text"/> - <input style="width: 20px;" type="text"/> <small>(DD) (MM) (YYYY)</small>																											
Visit: <input type="checkbox"/> Baseline <input type="checkbox"/> Year 1 <input type="checkbox"/> Year 3 <input type="checkbox"/> Year 5 <input type="checkbox"/> Year 10 <input type="checkbox"/> Year 15 <input type="checkbox"/> Year 20 <input type="checkbox"/> Year 25 <input type="checkbox"/> Year 30 <input type="checkbox"/> Year 35 <input type="checkbox"/> Year 40 <input type="checkbox"/> Year 45 <input type="checkbox"/> Year 50 <input type="checkbox"/> Year 55 <input type="checkbox"/> Year 60 <input type="checkbox"/> Year 65 <input type="checkbox"/> Year 70																												
AudioStar																												
1. How was the hearing test data collected? <input type="checkbox"/> Collected as part of study procedures <input type="checkbox"/> Collected as part of clinical/non-study hearing test (go to question 1a)																												
1a. If collected as part of clinical/non-study hearing test, what was the date of the last hearing test? Date: <input style="width: 20px;" type="text"/> - <input style="width: 20px;" type="text"/> - <input style="width: 20px;" type="text"/> <small>(DD) (MM) (YYYY)</small>																												
Instructions: For each frequency and testing condition, transpose the hearing level in dB into the corresponding cell within the "Air" or "Bone" rows. When there is No Response, "NR," indicated on the AudioStar report with a downward arrow that is red (right ear) or blue (left ear) transpose the stimulus dB level into the corresponding cell. Please fill-out page two after assessment is complete. and circle "NR."																												
2. Right Ear Air Conduction	<table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <tr style="background-color: #f2f2f2;"> <td style="width: 10%;"></td> <td style="width: 12.5%;">250</td> <td style="width: 12.5%;">500</td> <td style="width: 12.5%;">1K</td> <td style="width: 12.5%;">2K</td> <td style="width: 12.5%;">3K</td> <td style="width: 12.5%;">4K</td> <td style="width: 12.5%;">6K</td> <td style="width: 12.5%;">8K</td> </tr> <tr> <td style="text-align: left;">Air</td> <td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td> </tr> <tr> <td style="text-align: left;">No Response</td> <td>NR</td><td>NR</td><td>NR</td><td>NR</td><td>NR</td><td>NR</td><td>NR</td><td>NR</td> </tr> </table>		250	500	1K	2K	3K	4K	6K	8K	Air									No Response	NR							
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3. Right Ear Bone Conduction	<table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <tr style="background-color: #f2f2f2;"> <td style="width: 10%;"></td> <td style="width: 12.5%;">500</td> <td style="width: 12.5%;">1K</td> <td style="width: 12.5%;">2K</td> <td style="width: 12.5%;">4K</td> <td style="width: 12.5%;"></td> <td style="width: 12.5%;"></td> <td style="width: 12.5%;"></td> </tr> <tr> <td style="text-align: left;">Bone</td> <td></td><td></td><td></td><td></td><td></td><td></td><td></td> </tr> <tr> <td style="text-align: left;">No Response</td> <td>NR</td><td>NR</td><td>NR</td><td>NR</td><td>NR</td><td></td><td></td> </tr> </table>		500	1K	2K	4K				Bone								No Response	NR	NR	NR	NR	NR					
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4. Left Ear Air Conduction	<table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <tr style="background-color: #f2f2f2;"> <td style="width: 10%;"></td> <td style="width: 12.5%;">250</td> <td style="width: 12.5%;">500</td> <td style="width: 12.5%;">1K</td> <td style="width: 12.5%;">2K</td> <td style="width: 12.5%;">3K</td> <td style="width: 12.5%;">4K</td> <td style="width: 12.5%;">6K</td> <td style="width: 12.5%;">8K</td> </tr> <tr> <td style="text-align: left;">Air</td> <td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td> </tr> <tr> <td style="text-align: left;">No Response</td> <td>NR</td><td>NR</td><td>NR</td><td>NR</td><td>NR</td><td>NR</td><td>NR</td><td>NR</td> </tr> </table>		250	500	1K	2K	3K	4K	6K	8K	Air									No Response	NR							
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5. Left Ear Bone Conduction	<table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <tr style="background-color: #f2f2f2;"> <td style="width: 10%;"></td> <td style="width: 12.5%;">500</td> <td style="width: 12.5%;">1K</td> <td style="width: 12.5%;">2K</td> <td style="width: 12.5%;">4K</td> <td style="width: 12.5%;"></td> <td style="width: 12.5%;"></td> <td style="width: 12.5%;"></td> </tr> <tr> <td style="text-align: left;">Bone</td> <td></td><td></td><td></td><td></td><td></td><td></td><td></td> </tr> <tr> <td style="text-align: left;">No Response</td> <td>NR</td><td>NR</td><td>NR</td><td>NR</td><td>NR</td><td></td><td></td> </tr> </table>		500	1K	2K	4K				Bone								No Response	NR	NR	NR	NR	NR					
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6. Ambient Sound During Testing (dB)	<table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <tr style="background-color: #f2f2f2;"> <td style="width: 10%;"></td> <td style="width: 12.5%;">250</td> <td style="width: 12.5%;">500</td> <td style="width: 12.5%;">1K</td> <td style="width: 12.5%;">2K</td> <td style="width: 12.5%;">3K</td> <td style="width: 12.5%;">4K</td> <td style="width: 12.5%;">6K</td> <td style="width: 12.5%;">8K</td> </tr> <tr> <td></td> <td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td> </tr> </table>		250	500	1K	2K	3K	4K	6K	8K																		
	250	500	1K	2K	3K	4K	6K	8K																				
Assessment quality (Check one) <input type="checkbox"/> Good <input type="checkbox"/> Fair <input type="checkbox"/> Poor	Trial Time (s): <input style="width: 60px;" type="text"/>																											
False Alarm Rate: <input style="width: 60px;" type="text"/>																												
Final v1.0 September 12, 2019	1																											

- Enter the 7-digit participant (**subject**) ID in the appropriate place on the left-hand side.
- Enter the test **Date** in the appropriate place on the right-hand side.
- Check the box for the appropriate **Visit** (e.g., Baseline, Year 1, Year 3, etc.)
- Check the appropriate box for the question: **How was the hearing test data collected?**
In most cases, the proper response is "Collected as part of study procedures".
- Follow the instructions printed on the CRF, i.e., "For each frequency [in Hz] and test condition [threshold levels for air and for bone conduction testing], transpose..."
Remember, right ear data are displayed in red on the audiogram form and left ear data are displayed in blue as shown in the photograph below.



There are different symbols for:

- ✓ Right versus left ear pure tone hearing thresholds

- ✓ Air conduction thresholds (measured with earphones) and bone conduction thresholds (measured with the bone vibrator)
- ✓ Thresholds measured without masking of the non-test ear and thresholds measured with masking of the non-test ear
- ✓ Test conditions where the participant did not response (NR = no response) at the upper limits for intensity levels of air or bone conduction pure tone stimuli. "No response" outcomes are indicated on the audiogram with a downward arrow.
- **NOTE:** Pure tone thresholds for air and bone conduction are indicated with symbols on the audiogram form.
 - ✓ The symbols plotted at the dB levels on the audiogram form for each test frequency and test condition (air- and bone conduction) should be entered on the CRF.
 - ✓ In the above audiogram figure, pure tone thresholds for air and bone conduction are indicated with a circle. Again, these values should be entered on the CRF.
 - ✓ The numerical values below the audiogram are masking levels used during the AMTAS automated testing. The masking values are indicated with an "X" and crossed-out on the above figure. These numbers should *not* be entered on the CRF.
- Take care to enter the correct hearing thresholds in decibels for the correct test frequencies (in Hz) for each ear for air conduction and bone conduction test conditions, specifically:
 - ✓ Right ear air conduction: Threshold data in dB for 250, 500, 1K (1000), 2K (2000), 3K (3000), 4K (4000), 6K (6000), and 8K (8000) Hz
 - ✓ Right ear bone conduction: Threshold data in dB for 500, 1K (1000), 2K (2000), and 4K (4000) Hz
 - ✓ Left ear air conduction: Threshold data in dB for 250, 500, 1K (1000), 2K (2000), 3K (3000), 4K (4000), 6K (6000), and 8K (8000) Hz
 - ✓ Left ear bone conduction: Threshold data in dB for 500, 1K (1000), 2K (2000), and 4K (4000) Hz
- **NOTE:** With the AMTAS software, bone conduction pure tone audiometry is not performed for the right and/or left ear when air conduction pure tone hearing thresholds are 10 dB HL or better. When air conduction pure tone hearing thresholds are ≤ 10 dB HL, you will not see symbols for bone conduction testing on the audiogram. Only enter air conduction thresholds into the CRF, leaving the bone conduction entry spaces blank.

Air and bone conduction pure tone audiometry is conducted with 5 dB intensity increments (steps).

- The term “**No Response**”, abbreviated **NR**, is used when the participant does not respond to pure tone stimuli at the maximum intensity level for the audiometer.
- Maximum intensity levels for air conduction pure tone audiometry for each frequency are as follows: 250 Hz =110 dB HL; 500 Hz = 115 dB HL; 1000 Hz = 120 HL; 2000 Hz =115 dB HL; 3000 Hz = 115 dB HL; 4000 Hz = 115 dB HL; 6000 Hz = 105 dB HL; 8000 Hz = 105 dB HL
- Maximum intensity levels for bone conduction pure tone audiometry for each frequency are as follows: 500 Hz = 70 dB HL; 1000 Hz = 85 dB HL; 2000 Hz = 90 dB HL; 4000 Hz = 85 dB HL
- When hearing threshold levels exceed these maximum intensity levels for air- or bone conduction stimulation, enter the intensity level shown on the audiogram form where the downward arrow occurs, then circle **NR** on the CRF.
- When the ambient noise software is available, research assistants will enter noise levels (in dB) detected before data collection with the talkback headset microphone for the following frequencies: 250, 500, 1K (1000), 2K (2000), 3K (3000), 4K (4000), 6K (6000), and 8K (8000) Hz
- Next, review information in the **QUALIND** (Quality Indicators) box to the right of the audiogram graph (identified with an arrow). Enter onto the CRF the following data from the QUALIND box.
 - ✓ Assessment quality: Check the quality as indicated under QUALIND (e.g., Good, Fair, or Poor).
 - ✓ Trial time (in seconds): Enter the value for this quality indicator on the appropriate line in the CRF.
 - ✓ False alarm rate (in %): Enter the value for this quality indicator on the appropriate line in the CRF.
- Research assistants should contact Dr. James Hall (jwhall3phd@gmail.com) with any questions regarding the audiogram form, symbol system, or data entry on to the CRF.
- **Research assistants are also strongly encouraged to view the narrated PPT presentation (LIMBIC-CENC Hearing Data Collection: Part 2) that reviews in detail the process for AMTAS pure tone threshold data entry on to the appropriate CRF.**

Section 2.10. Identifying and Reporting Audiogram Asymmetry

This section describes the LIMBIC-CENC PLS SOP for identifying a significant asymmetry on audiogram testing that warrants participant notification for clinical referral. An audiogram asymmetry is a difference in air conduction hearing thresholds for one ear versus the other ear. Immediately following pure tone audiometry testing, the output should be reviewed to determine if there is a clinically significant asymmetry. If identified, the staff should recommend clinical assessment to the participant and offer referral of the participant to an audiologist for a comprehensive diagnostic hearing assessment. This is because asymmetry can be the sign of a serious medical condition such as an acoustic neuroma (tumor involving the 8th cranial auditory nerve).

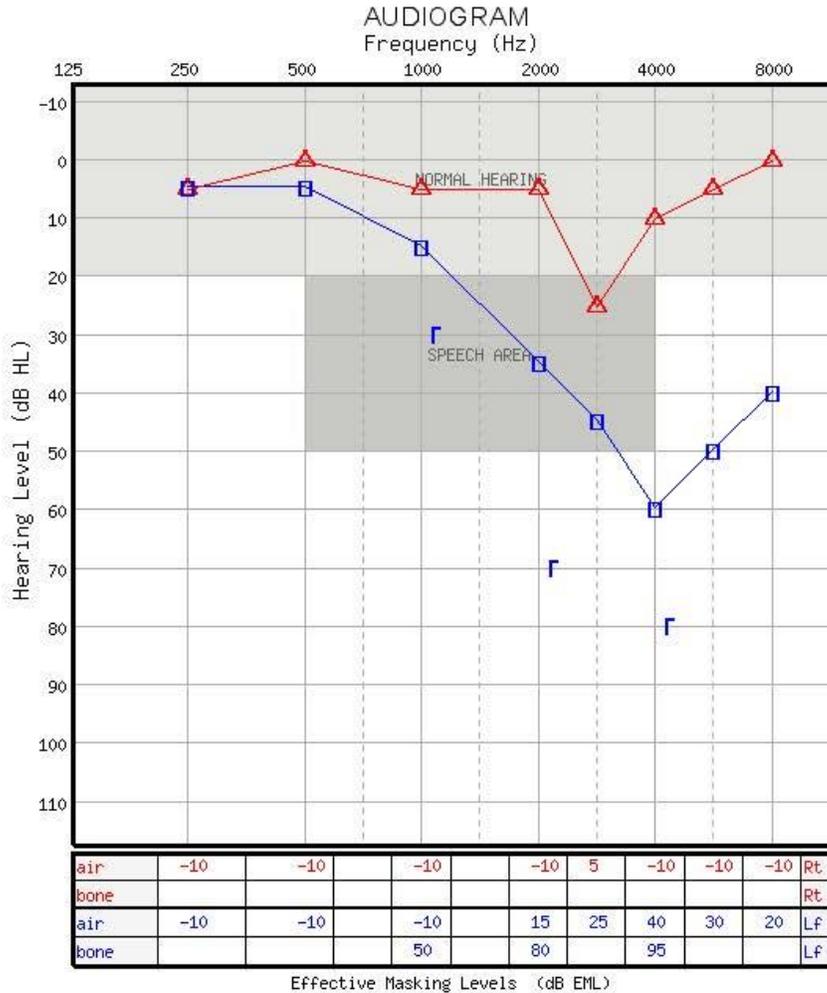
Identification of significant asymmetry:

The AMTAS software used with the GSI audiometer automatically calculates asymmetry based on interaural air-conduction threshold differences for octave frequencies of 250 to 8000 Hz. Audiograms are considered asymmetrical if there are three or more interaural differences of 10 dB or more, interaural differences of 15 dB or more for two frequencies, or an interaural difference of 20 dB or more for one frequency. With the AMTAS system, automatic calculation of asymmetry is reported on the audiogram form that is generated following pure tone audiometry. Following pure tone hearing testing with the AMTAS system, testers should inspect the “Bilateral Symmetry” field of the audiogram form. A red arrow in the figure points to the “Bilateral Symmetry” notation, located to the far right within the AMCLASS Audiogram Classification section of the form. You will note for the example below of a participant who underwent audiometric data collection at one of the LIMBIC-CENC sites a clear asymmetry in pure tone thresholds for the left ear versus right ear for test frequencies of > 1000 Hz.



Patient ID:

GSI AMTAS™ Hearing Report



QUALIND®		
Quality	FAIR	
Indicators	Value	Rank
Accuracy	8 dB	60
Masker Alert	0 %	0
Trial Time	3.3 s	20
False Alarm	20 %	85
Test-Retest	5 dB	46
Check Fail	0 %	0
ABG > 35	0	0
ABG < -10	2	80

LEGEND	Right	Left
Masked Air	△	□
Masked Bone	∟	∟

AMCLASS® Audiogram Classification				
Ear	Severity	Configuration	Site of Lesion	Bilateral Symmetry
Right	NORMAL		Cannot determine	Asymmetric
Left	NORMAL-MODERATE	Sloping Hearing Loss	SENSORINEURAL	

PTA	
Ear	dB HL
Right	3
Left	10

Correction added to bone threshold at 4000 Hz.: 15 dB.

Clinical Referrals:

If in the “Bilateral Symmetry” field of the audiogram form (located to the far right within the AMCLASS Audiogram Classification section of the form) displays the word “Symmetric”, then no clinical referral action is needed. However, if the message “Asymmetric” is displayed in this field, then the participant should be recommended for clinical evaluation and offered referral to a licensed audiologist for a complete diagnostic hearing assessment. Participants enrolled in the VA Health Care System should be encouraged to schedule the complete audiologic assessment with a VA audiologist. Appendix E in this SOP includes an example of a letter format that can be prepared and given to participants who warrant referral to an audiologist.

SECTION 3. PERFORMING SCAN-3 TESTS

Section 3.01. Introduction

Published research and clinical experience dating back over 60 years confirms the possibility of auditory processing disorders in persons with traumatic brain injury (TBI), even persons with mild TBI and normal hearing sensitivity as indicated by a normal audiogram (see reference list). Auditory processing disorders are hearing problems more often related to processing of auditory information in the brain than in the ear.

Common deficits in auditory processing include:

- Difficulty with speech perception in noise listening environments including a deficit in the ability to recognize words or sentences with non-verbal background noise or when other people are speaking.
- With advancing age, people with poor speech perception in noise are at risk for cognitive impairment and vice versa.
- Slower than normal auditory processing of auditory information (a temporal auditory processing deficit). A temporal auditory processing problem can interfere with speech perception.
- Poorer than normal auditory memory skills
- Reduced auditory discrimination abilities, such as difficulty distinguishing between similar speech sounds or words and problems understanding people who speak with an accent
- Problems determining the source of sound, such as a speaker's voice. Difficulty localizing a sound source is a spatial auditory processing deficit.

The SCAN-3 test battery consists of three different measures of auditory processing. The three tests are:

- **Gap Detection:** A screening test that measures the ability to detect brief silent gaps of variable duration (measured in milliseconds) between two tones (tone pairs). The Gap Detection Test evaluates temporal auditory processing deficits.

- **Auditory Figure Ground:** A test that assesses the ability to process speech (words) in the presence of background noise. The words are presented to each of the subject's ears at the same level of intensity (loudness) as background noise (multi-talker speech).
- **Competing Words:** This is one of many dichotic (die KAH tick) listening tests. The competing words test assesses the subject's ability to process pairs of monosyllabic words with one word presented simultaneously to each ear. The subject is instructed to repeat both words in any order. The Competing Words test evaluates temporal auditory processing and auditory memory skills.

These three tests in the SCAN-3 are used as a screening measure for auditory processing disorder. Additional verbal and non-verbal tests would be administered in comprehensive diagnostic assessment of persons with TBI who are at risk for auditory processing disorder and dysfunction within the central auditory nervous system (hearing regions of the brain). A recording of the SCAN-3 test materials is presented to participants using the same earphones and the same GSI AudioStar Pro audiometer that is used for pure tone audiometry.



- **Before beginning the SCAN-3, research assistants must set up the GSI AudioStar Pro audiometer so the participant can hear the three test materials in the right and left ear.**
- The participant listens to recorded instructions before beginning each test.
- Research assistants listen through the talkback headset to the same test materials that the participant is hearing.
- A microphone is placed in front of the participant so the research assistant can clearly hear through the headset the participant's responses.
- Participants should be seated so they are facing at an angle away from the research assistant (and the record form), but also so the research assistant can observe the subject's face.

As the participant responds to each item during administration of the three tests, the research assistant scores the participant's responses on a paper record form.

- Research assistants are allowed to give the participant general encouragement between tests, e.g., “Good job” or “You are doing fine.”
- Also, instructions preceding each test may be repeated (replayed) for participants upon request. However, each test cannot be stopped or paused until it is completed.

The entire process for administering and scoring the SCAN-3 is described in detail below. Administration time for the SCAN-3 is about 10 to 15 minutes. After the SCAN-3 is finished, research assistants tally up participant responses for each ear on each test. Then, research assistants perform a simple analysis of test findings. Before administering the SCAN-3 to subjects in the study, research assistants are strongly encouraged to:

- Read closely this operating manual
- View/listen to the narrated PPT presentations
- Practice administering the SCAN-3 to at least one normal hearing person (e.g., colleague, co-worker, office mate).

In addition, research assistants should verify that they can hear the SCAN-3 test materials in each ear before beginning the tests with a participant. A **TROUBLE-SHOOTING** guide at the end of this section of the operating manual lists some of the most common explanations for problems in administering the SCAN-3 tests with the AudioStar Pro audiometer.

Section 3.02. General Participant Instructions

The following information is taken directly from the SCAN-3 manual. Remember, participants listen to recorded instructions for each SCAN-3 test during the test process. Research assistants present recorded instructions by clicking on the appropriate SCAN-3 tracking using the mouse that is wirelessly connected to the AudioStar audiometer.

Research assistants may give the following instructions to a participant before placing earphones on the participant. Alternatively, using the talkback and monitoring headset and microphone, research assistants may give the following instructions after placing earphones on the participant.

Explain to the participant that earphones will be worn during the test.

- Tell the participant :“ *You will be asked to listen to sounds and to repeat words and sentences. You will hear a man’s voice through the earphones tell you what to do or say. The words and sentences may be hard to hear. If you’re not sure what you hear, take a guess.*”
- Place the earphones on the participant making sure the right earphone (red) is on the right ear and the left earphone (blue) is on the left ear and the earphones covering the ears and are comfortable for the participant.
- The participant will hear all specific test instructions through the earphones and will be asked to respond verbally to each test item.
- If you have not already done so, place the monitoring earphones and microphone on your head (right ear phone on the right ear with left earphone and microphone on the left) so you can hear in the correct ear all of the test materials that the participant is hearing.
- Adjust the intensity level of the test materials as necessary using the controls in the upper-left of the Front Panel as described in the next section.

Section 3.03. Verification of the AudioStar Set Up for SCAN-3

Introduction

There are differences in operation of the GSI AudioStar Pro for automated air and bone conduction pure tone audiometry versus administering the SCAN-3.

- Most of the previous set-up for operation of the GSI AudioStar Pro for automated air and bone conduction pure tone audiometry remains the same for the SCAN-3.
- Only the DD 450 earphones are used in administering the SCAN-3 ... not the bone vibrator.
- Participant’s do not need to wear the bone vibrator and AMBAND headband when you administer the SCAN-3. In the interest of participant comfort, remove the headband and bone vibrator immediately after the completion of AMTAS pure tone hearing testing.

- To administer the SCAN-3 tests, you will operate the AudioStar audiometer as described next.

Before administering the SCAN-3 test, verify that the microphone (shown in photograph below) is close to the participant.



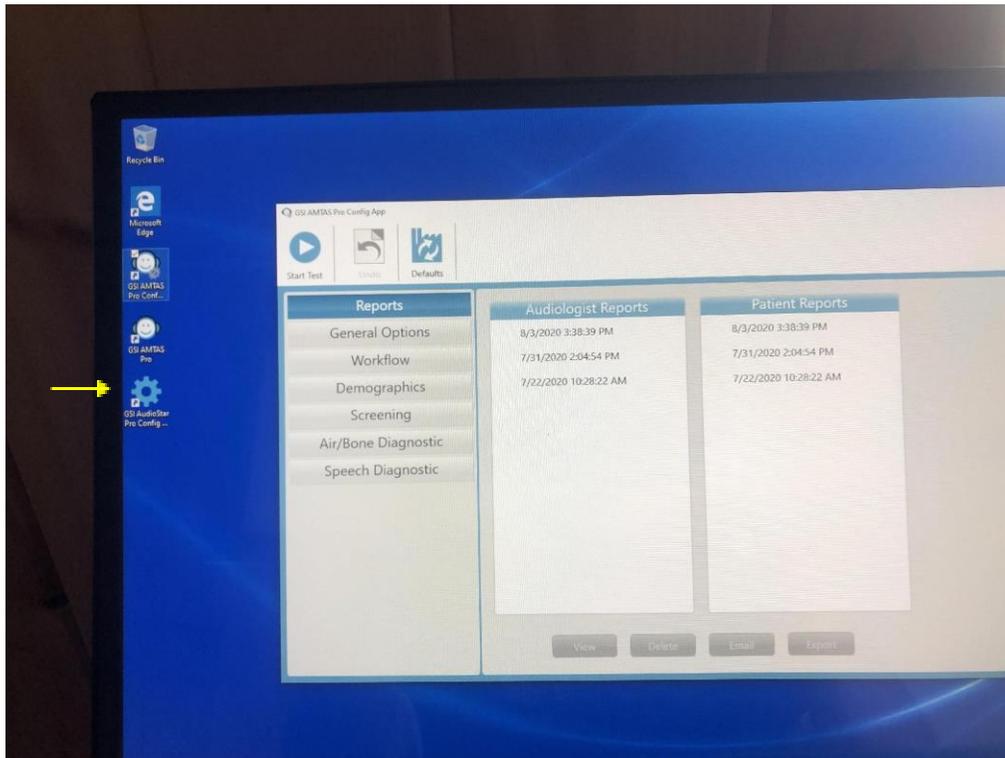
- One option is to carefully place the microphone on a flat surface (e.g., table) in front of and pointing toward the participant for the duration of SCAN-3 testing. The microphone must remain stable and immobile.
- If you experience difficulty hearing the participant's speech, you may request that the participant hold the microphone at about chest level during the SCAN-3 testing.

Installation of AudioStar Pro Configuration (Config) Application (App) on Computer



Some sites may need to install the AudioStar Pro Conf App on the study computer before completing the following step-by-step process for setting up the AudioStar audiometer to administer the SCAN-3 test. To determine whether you need to complete the installation, turn

on the computer and look for the AudioStar Pro Conf icon (gear shape icon) in the upper-left area of the screen, as indicated with the yellow arrow in the following photograph.



If you do not see the AudioStar Pro Conf icon on the screen of your computer, you must complete the installation process described earlier in [Section 1.06. Setting Up the GSI AudioStar Audiometer for SCAN-3 Testing](#). Return to Section 1.06 and complete the AudioStar Pro Config app installation process.

If the AudioStar Pro Conf icon appears on the screen of your computer, proceed directly to the section below with the heading: **Step by Step Process for Setting Up the AudioStar Audiometer for SCAN-3.**

Step by Step Process for Setting Up the AudioStar Audiometer for SCAN-3

Note to Research Assistants: The following step-by-step process for setting up the AudioStar audiometer to administer the SCAN-3 test is also reviewed in a narrated PPT presentation (Part 3).

- Automated activation of the following selections occurs when the GSI AudioStar is turned on, as indicated with lights around the buttons as shown in the photograph below. These are the default:



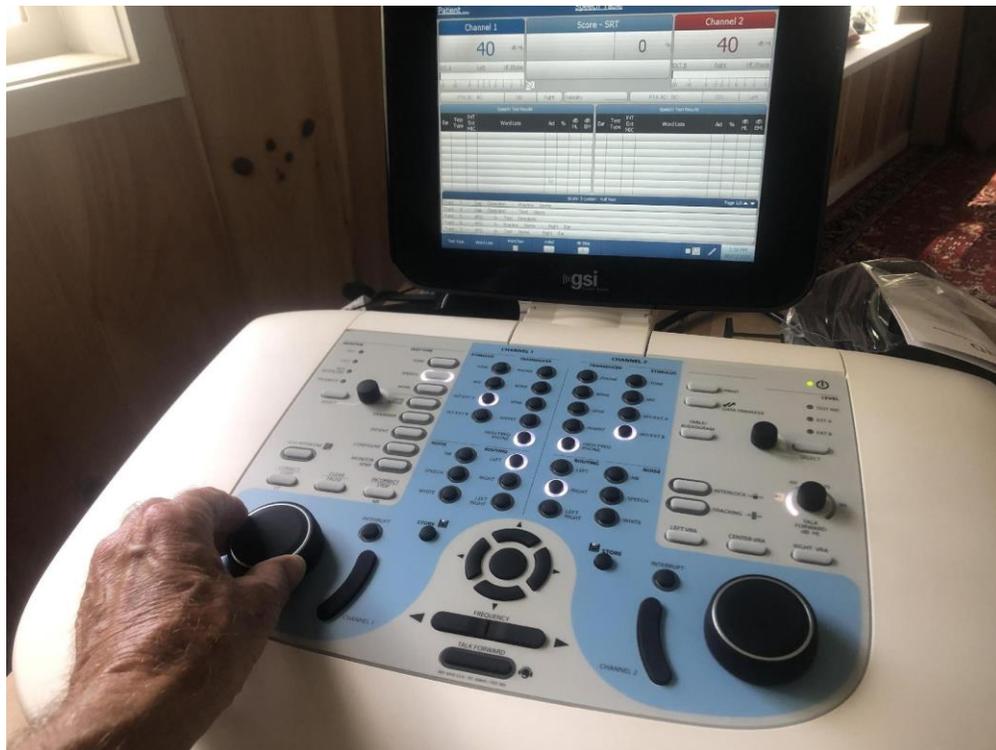
- Check to verify via inspection of the lighted buttons that the proper selections were made automatically.
- See the [TROUBLE-SHOOTING](#) section at the end of the SOP if different the automated selections appear on the front panel.

- Note: If the selections for controls are not automatically made when the AudioStar is turned on (after completion of installation of the AudioStar Pro Conf app as described above), and trouble-shooting does not resolve the problem, repeat the AudioStar Pro Conf app installation process. If problems persist, contact Dr. James Hall (jwhall3phd@gmail.com) for help.
- As a last resort, and only in a pinch when a participant is onsite for testing, research assistants have the option of manually selecting each setting or control on the AudioStar Pro audiometer.
- Automated settings on GSI AudioStar for administering the SCAN-3 are listed below. These settings are pre-selected via the AudioStar Pro configuration app. Each of these controls is identified in the photograph of the AudioStar front panel.
 - ✓ Under **Test Type** (left side of front panel on AudioStar), **Speech** is pre-selected
 - ✓ Under **Channel 1 Stimulus**, **Int/Ext A** is selected
 - ✓ Under **Channel 1 Transducer**, **High Freq Phone** is pre-selected
 - ✓ Under **Channel 1 Routing**, **Left** is selected
 - ✓ Under **Channel 2 Transducer**, **High Freq Phone** is selected
 - ✓ Under **Channel 2 Routing**, **Right** is selected
 - ✓ Under **Channel 2 Stimulus**, **Int/Ext B** is selected
- Select (press) **Interlock** button that is located to the right and below on the Front Panel as shown with the black arrow in the photograph. This is a critical step in the set up for SCAN-3. Activating the Interlock allows you to present SCAN-3 stimuli (i.e., one or two tones for Gap Detection and words for Auditory Figure Ground and Competing Words tests) to both ears at the same time.



- Using the large round knobs on the bottom right and left of the panel (see photograph below), **increase the intensity level from 40 dB HL to 50 dB HL for Channel 1 and Channel 2**. Toward the top of the AudioStar screen, you'll see the intensity levels in dB HL for the left ear (Channel 1) and the right ear (Channel 2).

- If a participant expresses difficulty in hearing the SCAN-3 materials during the practice tests and/or if a participant does not have normal hearing thresholds on AMTAS pure tone testing (thresholds > 25 dB HL), research assistants may increase the intensity level manually to 55 or 60 dB HL.
- These are the levels for the SCAN-3 materials as they are presented to the participant via the earphones.



- Remember **do not administer the SCAN-3 if the participant normally wears hearing aids** (as described in Section 1.11).
- It is appropriate to present the SCAN-3 tests at intensity levels higher than 50 dB HL (e.g., 60 dB HL or 70 dB HL) if a participant has decreased hearing on the AMTAS testing and complains of difficulty in hearing either the instructions for the SCAN-3 tests or hearing the practice items for the tests. This process is described further below and in the [TROUBLE-SHOOTING](#) guide.

- Repeatedly press the **Select** button (upper-left corner of the front panel) until the lowermost **Talkback** option is highlighted.
- Adjust the volume knobs to the right of the **Select** button to control the loudness of the SCAN-3 test materials that you are monitoring.
- With the participant holding the microphone or with the microphone placed on a flat surface (e.g., table) in front the participant, instruction the participant to talk to you (e.g., the participant counts to 10) and adjust the volume knobs to the right of the **Select** button to control the loudness of the participant's voice that you are monitoring.



- Place the tester headset (talkback earphones and microphone) on your head verifying that the red earphone is on the right ear and the blue earphone is on the left ear as confirmed by the boom microphone on the left side.
- Using the mouse that is interfaced with the AudioStar audiometer, click on **Gap Detection (track 1)**.
- Verify that you can comfortably hear the SCAN-3 speech materials in your ears.

- If you cannot hear the SCAN-3 materials (e.g., instructions for the Gap Detection test, verify that:
 - ✓ The **Interlock** button is selected (see above)
 - ✓ The talkback headset is plugged into the AudioStar audiometer ✓ Talkback volume is turned up, as described above.

Section 3.04. Placement of Earphones

The DD 450 earphones are placed over the participant's ears for SCAN-3 testing just as they were for AMTAS testing. Remember:

- The AMBAND and bone vibrator are not used for SCAN-3 testing.
- Spread the earphones apart slightly before sliding the headset over the participant's head.
- Verify that the red earphone is over the right ear and the blue earphone is over the left ear.
- It is appropriate to allow the participant to adjust the earphones to assure comfort.
- If a participant wishes to place the earphones, give the earphones to the participant with the red (right) earphone in the participant's right hand and with the blue (left) earphone in the participant's left hand.
- Verify that the earphones are properly placed over the ears before proceeding with hearing testing.
- The participant will have difficulty hearing you once the earphones are in place. When a participant is wearing earphones, you must use the talkback headset and boom microphone to communicate most effectively. To do so, you must press and hold the talk forward button (seen in pic above) and speak through the boom microphone

Section 3.05. Performing the SCAN-3 Tests

The following is a brief description for administering of each of the three SCAN-3 tests.

- Research assistants can begin SCAN-3 testing any time after the participant is given some general instructions and earphones have been placed on the participant.
- Use the up and down arrows in the lower-center portion of the Front Panel to scroll down or up on the list of SCAN-3 items.
- To begin SCAN-3 testing, you click on Gap Detection track 2 using the mouse that is interfaced to the AudioStar audiometer.
- Before actually beginning SCAN-3 testing with the participant, click on **Gap Detection track 2** to verify that you can hear the test materials.



- If you cannot hear the SCAN-3 test materials, review the list of possible problems below and/or consult the [TROUBLE-SHOOTING](#) guide at the end of the SOP.
- Once you verify that you can hear the SCAN-3 test materials, clicking on Gap Detection track 2 will initiate testing.
- By pressing the appropriate track, you can present instructions to the participant for each SCAN-3.
- The tracks containing recorded instructions always precede the practice items and the actual test items for each SCAN-3 test.
- The instructions and/or the practice portion of each test can be repeated one or two times as necessary to verify that the participant has grasped the task.
- Be prepared to score each SCAN-3 test as soon as you click on Gap Detection track 2.
- You should have SCAN-3 score sheets ready and a pen or pencil in hand at this time in the test process.
- **You will need to manually begin each SCAN-3 test by clicking on each track with the mouse and cursor.** You may need to slowly move the mouse to initially determine the location of the cursor on the AudioStar screen.
- Do not pause for long between each SCAN-3 test except to click on the next track.
- Once you begin a SCAN-3 test, the test should continue until the last item is presented. You cannot pause the testing process and then start again once you have started a test.

- You can terminate (abort) a SCAN-3 test by pressing the **Talk Forward button** in the center and very bottom of the Front Panel (see the dotted arrow in the previous photograph of the Front Panel),
- Only terminate a test if a problem arises during the test process. Examples of problems include:
 - ✓ Participant cannot hear the test items.
 - ✓ You cannot hear the test items.
 - ✓ Participant doesn't respond to the practice items for a test.
 - ✓ Participant expresses confusion about the test task.
 - ✓ Any other participant concern regarding the test.
- If the participant does express concern about the test (e.g., about not correctly responding to test items)
 - ✓ Reassure the participant that most people have trouble hearing some of the sound and words.
 - ✓ Reinstruct the participant.
 - ✓ Encourage the participant to make an attempt to respond to each item and not to worry about their performance on the test.
- Continue with SCAN-3 testing until the participant responds to the final items on the Competing Words test (the word "soft" presented to the right ear and the word "last" presented to the left ear).
- Review closely Section 3.07 (Scoring Participant Responses During SCAN-3 Testing) before conducting the SCAN-3 tests with a participant.

Gap Detection

- The Gap Detection test is found on tracks 2, 3, and 4 which are listed on the AudioStar screen when the audiometer is first powered on, as identified with the arrow in the photograph below.
- Recorded instructions for the test are on track 2.

- Most participants will respond on the Gap Detection test by simply saying “1” or “2” when they hear 1 or 2 tones.
- Any participant who has a speech problem or who wishes may also respond on the Gap Detection test by raising one or two fingers.
- You may supplement the recorded instructions with verbal instructions to the participant when you are wearing the talkback headset and the participant is wearing earphones.
For example:
 - You will hear one or two tones.
 - If you hear one tone, say “1” and if you hear two tones say “2”.
 - Sometimes the two tones are so close together they almost sound like a single tone.
 - If you do not clearly hear only one tone, you can say “2”.
- Practice items for the test are on track 3
- Test items for the Gap Detection test are on track 4.
 - The gaps for test items on track 4 increase in duration (in milliseconds), i.e., 0, 2, 5, 10, 15, 20, 25, 30, and 40-ms.
- If the participant cannot respond correctly to any practice items after repeated instructions and practice attempts, do not administer the Gap Detection test.

Patient ... Speech Table

Channel 1	Score - WRS	Channel 2
50	0	50
dB HL	%	dB HL
INT A Left HF Phone		INT B Right HF Phone
-20 -10 -5 -3 -2 -1 0 1 2 3		-20 -10 -5 -3 -2 -1 0 1 2 3
PTA AC: BC: SII: Right Reliability		PTA AC: BC: SII: Left

Speech Test Results							Speech Test Results								
Ear	Test Type	INT Ext MIC	Word Lists	Aid	%	dB HL	dB EM	Ear	Test Type	INT Ext MIC	Word Lists	Aid	%	dB HL	dB EM

SCAN- 3 Custom : Full Test										Page 1/3	
Track 2	-	Gap	Detection	-	Test	Directions					
Track 3	-	Gap	Detection	-	Practice	Items					
Track 4	-	Gap	Detection	-	Test	Items					
Track 5	-	AFG	0-	Test	Directions						
Track 6	-	AFG	0-	Practice	Items	-	Right	Ear			

Test Type	Word Lists	Word Nav	Aided	dB Step	4:12 PM 09/16/2020
		<input type="checkbox"/>	<input type="checkbox"/>	5	

Auditory Figure-Ground

- The **Auditory Figure-Ground** test is found on **tracks 5 through 9** which are listed on the AudioStar screen, immediately below tracks for the Gap Detection test.
- The participant's task for the Auditory Figure-Ground test is to repeat back words that are heard while the participant also hears multi-talker babble in the background at the same intensity level (a signal to noise ratio or SNR of 0 dB).
- Recorded instructions for the test are on track 5.
 - You may replay the instructions several times.
 - There are two practice items on track 6.
 - If the participant responds incorrectly to both of the practice items, you may supplement the recorded instructions with verbal instructions to the participant when you

are wearing the talkback headset and the participant is wearing earphones. For example:

- ✓ In this test, you will hear some words at the same time you are hearing people talk in the background.
 - ✓ During the test, you will hear 20 words in your right ear and 20 different words in your left ear.
 - ✓ You will hear the phrase “Say the word ...” before you hear the word.
 - ✓ You will need to listen very carefully to the words.
 - ✓ Try to repeat back the word you hear even if you are not sure.
 - ✓ Just do the best you can on this test.
- Test items for the Auditory Figure-Ground test are on track 9.
 - Once you begin the test items (track 9), the test cannot be paused.
 - Score the Auditory Figure-Ground test as described below in Section 3.07.
 - **Auditory Figure-Ground test items cannot be replayed.**

Competing Words Test

- The **Competing Words** test is a dichotic listening test.
- The participant’s task is to listen to 20 sets of two words, with one word presented to the right ear at the same time as another word is presented to the left ear.
- The Competing Words test is quite challenging, even for normal hearing persons.
- The Competing Words test is a sensitive measure of auditory processing in the central auditory nervous system.
- The Competing Words test is found on **tracks 10, 11, and 12**.
- These tracks are listed on the AudioStar screen immediately below tracks for the Auditory Figure-Ground test.
- The participant’s task for the Competing Words test is to immediately repeat back in any order the two words that are heard simultaneously in each ear.
- Recorded instructions for the test are on track 10.
- You may replay the instructions several times.

- There are two practice items on track 11.
- If the participant responds correctly to one or both of the practice items, you should proceed to track 12 (test items).

- If the participant responds incorrectly to both of the practice items on track 11, you may supplement the recorded instructions with verbal instructions to the participant when you are wearing the talkback headset and the participant is wearing earphones. For example:
 - ✓ In this test, you will hear some words.
 - ✓ You will hear one word in the right ear and at the same time you will hear another word in the left ear.
 - ✓ You need to quickly repeat back each of the words that you hear in each ear.
 - ✓ You will need to listen very carefully to the words. You can repeat them back in any order.
 - ✓ Try to repeat back the word you hear even if you have trouble hearing each of them, and then wait for the next two words.
 - ✓ Take a guess if you are not sure of each word that you hear.
 - ✓ This test is quite challenging, but just do the best you can.
- Test items for the Competing Words test are on track 12.
- Once you begin the test items (track 12), the test cannot be paused.
- Score the Competing Words test as described below in Section 3.07.
- **Competing Words test items cannot be replayed.**

Section 3.06. Possible Problems during SCAN-3 Test Administration

This is a list of possible problems you might encounter in administering the SCAN-3 tests. Solutions to problems are also reviewed in the [TROUBLE-SHOOTING](#) guide at the end of the SOP and also in a narrated PPT presentation (Part 4).

- SCAN-3 tests are not shown on screen of AudioStar audiometer:

- ✓ SCAN-3 is not the default option among for word recognition testing options
- ✓ See Section 1.03 about how to set up the AudioStar audiometer for SCAN-3 testing and to make SCAN-3 the default for speech audiometry
- Participant doesn't hear the test items when the SCAN-3 is started:
 - ✓ Be sure the Interrupt Button is activated
 - ✓ Verify that the participant is wearing earphones (red = right; blue = left)
 - Test items are too soft for the participant when the first test is started
- Verify that you previously increased the intensity level from 40 to 50 dB HL for Channel 1 and Channel 2, using the volume knobs toward the bottom of the front panel.
- If a participant still expresses difficulty in hearing the SCAN-3 materials during the practice tests and/or if a participant does not have normal hearing thresholds on AMTAS pure tone testing (thresholds > 25 dB HL), research assistants may increase the intensity level manually to 55 or 60 dB HL.
- Ask the participant if he or she wears a hearing aid. Discontinue SCAN-3 testing if the answer is yes.
- You don't hear the test items when the SCAN-3 is started:
 - ✓ Be sure the Interrupt Button is activated
 - ✓ Are you wearing the talkback headset?
- Volume of test items is low for you as you monitor them when the first test is started
 - ✓ Increase talkback volume as already described using the monitor Select button in the upper-left corner of the front panel.

Section 3.07. Scoring Participant Responses During SCAN-3 Testing

You should always have a supply of SCAN-3 score sheets with the test equipment and available whenever you are scheduled for data collection from a participant. You'll also need a pencil or pen to score the SCAN-3 tests. Blank score sheet forms are in Appendix 2 at the end of the SOP. They can also be downloaded from the website where other study materials are stored.

Scoring the Gap Detection Test

A sample score sheet for the Gap Detection test is shown in the figure below.

- You are monitoring via the talkback headset the presentation of each test item to the participant.
- There are a total of 9 items on track 4.
- Circle the number 1 if the participant says “1” for an item and circle the number 2 if the participant says “2” for an item
 - Circle “Pass” if the participant responds correctly by indicating two tones for three or more consecutive items in the shaded area (items 2 through 8).
- Circle “Fail” if the participant does not respond correctly to three or more consecutive items in the shaded area (items 2 through 8).

Test Items	2	Gap (msec)	Circle one: Pass Fail
1.	2	1	0
2.	2	1	2
3.	2	1	5
4.	2	1	10
5.	2	1	15
6.	2	1	20
7.	2	1	25
8.	2	1	30
9.	2	1	40

Circle one: **Pass** Fail
Pass = 3 or more consecutive 2s in shaded area
Fail = Fewer than 3 consecutive 2s in shaded area

SCAN-3 Gap Detection Scoring Table

Instructions

Circle One: Pass Fail

Pass = 3 or more consecutive "2s" in the shaded area

Fail = Fewer than 3 consecutive "2s" in the shaded area

Test Item	Subject Response	Subject Response	Gap (milliseconds)
1	2	1	0
2	2	1	2
3	2	1	5
4	2	1	10
5	2	1	15
6	2	1	20
7	2	1	25
8	2	1	30
9	2	1	40

Scoring the Auditory Figure Ground Test

A sample score sheet for the Auditory Figure Ground test is shown in the figure below.

- You are monitoring via the talkback headset the presentation of each test item to the participant.
- There are 2 practice items for the right ear on track 6 and 20 test items for the right ear on track 7.
- There are 2 practice items for the left ear on track 8 and 20 test items for the left ear on track 9.
- Circle the positive (+) symbol for when the participant repeats the test item word correctly.
- Circle the negative (-) symbol when the participant says a word that differs from the test item, if the participant doesn't respond to the test item, or if the participant states "I don't know".
- You may tally up the participant's scores for the Auditory Figure-Ground immediately after test is finished (the participant responds to the last word for the left ear (lead) or you may wait to tally up the scores until the entire SCAN-3 test process is finished.
- Responses to practice items are not tallied.
- Add the number of + test item responses for the right ear and enter the sum in the box for the RE Score.
- Add the number of + test item responses for the left ear and enter the sum in the box for the LE Score.
- Total the scores for each ear in the box for AFG Total Score.

Right Ear		Left Ear	
Practice Items		Practice Items	
a. <input checked="" type="radio"/> coco		c. <input checked="" type="radio"/> tin	
b. <input checked="" type="radio"/> cat		d. <input checked="" type="radio"/> turn	
Test Items		Test Items	
1. oil <input checked="" type="radio"/> -		21. ship <input checked="" type="radio"/> -	
2. book <input checked="" type="radio"/> -		22. load <input checked="" type="radio"/> -	
3. ant <input checked="" type="radio"/> -		23. dirt <input checked="" type="radio"/> -	
4. tick <input checked="" type="radio"/> -		24. grass <input checked="" type="radio"/> + <i>glass</i>	
5. goat <input checked="" type="radio"/> -		25. see <input checked="" type="radio"/> -	
6. we <input checked="" type="radio"/> -		26. top <input checked="" type="radio"/> -	
7. stay <input checked="" type="radio"/> -		27. quit <input checked="" type="radio"/> -	
8. base <input checked="" type="radio"/> + <i>baste</i>		28. pest <input checked="" type="radio"/> -	
9. fit <input checked="" type="radio"/> -		29. tank <input checked="" type="radio"/> + <i>thank</i>	
10. well <input checked="" type="radio"/> -		30. slide <input checked="" type="radio"/> -	
11. best <input checked="" type="radio"/> -		31. grade <input checked="" type="radio"/> -	
12. lot <input checked="" type="radio"/> + <i>got</i>		32. mark <input checked="" type="radio"/> -	
13. pat <input checked="" type="radio"/> -		33. poke <input checked="" type="radio"/> -	
14. bug <input checked="" type="radio"/> -		34. fuss <input checked="" type="radio"/> -	
15. may <input checked="" type="radio"/> -		35. spot <input checked="" type="radio"/> + <i>bus</i>	
16. seat <input checked="" type="radio"/> -		36. toe <input checked="" type="radio"/> -	
17. pain <input checked="" type="radio"/> -		37. rat <input checked="" type="radio"/> -	
18. care <input checked="" type="radio"/> -		38. show <input checked="" type="radio"/> -	
19. fast <input checked="" type="radio"/> -		39. tell <input checked="" type="radio"/> -	
20. wall <input checked="" type="radio"/> -		40. lead <input checked="" type="radio"/> + <i>leak</i>	
RE Score <input type="text" value="18"/>		LE Score <input type="text" value="16"/>	
		= <input type="text" value="34"/>	
*See note on page 3.		AFG 0 Total Score	

Scoring the Competing Words Test

A sample score sheet for the Competing Words test is shown in the figure below.

- You are monitoring via the talkback headset the presentation of each test item to the participant.
- There are 2 practice items for the right ear on track 11 and 20 test items for the right ear on track 12.
- There are 2 practice items for the left ear also on track 11 and 20 test items for the left ear also on track 12.
- Circle the positive (+) symbol for when the participant repeats correctly in any order each test item word (for the right and left ear).
- Circle the negative (-) symbol when the participant says a word that differs from the test item or if the participant doesn't respond to the test item".
- You may tally up the participant's scores for the Competing Words test immediately after the test is finished (the participant responds to the last set words for each ear (soft and last or you may wait to tally up the scores until the entire SCAN-3 test process is finished.
- Responses to practice items are not tallied.
- Add the number of + test item responses for the right ear and enter the sum in the box for the RE Score.
- Add the number of + test item responses for the left ear and enter the sum in the box for the LE Score.
- Total the scores for each ear in the box for CW-FR Total Score.

Right Ear		Left Ear					
Practice Items		Practice Items					
a. dig		barn					
b. yard		hill	bill				
Test Items		Test Items					
1. fell	⊖ -	pink	⊖ -				
2. coat	+ ⊙	tent	⊖ -				
3. glove	⊖ -	milk	⊖ -				
4. road	⊖ -	bake	+ ⊙				
5. hope	⊖ -	room	⊖ -				
6. lake	⊖ -	ant	⊖ -				
7. tell	⊖ -	woke	⊖ -				
8. wet	⊖ -	hand	+ ⊙				
9. feel	⊖ -	sheep	⊖ -				
10. bad	⊖ -	read	⊖ -				
11. care	⊖ -	bed	⊖ -				
12. fruit	⊖ -	bus	+ ⊙				
13. nest	⊖ -	mud	⊖ -				
14. chip	⊖ -	night	⊖ -				
15. gave	⊖ -	some	⊖ -				
16. five	⊖ -	gone	⊖ -				
17. ice	⊖ -	move	⊖ -				
18. ran	⊖ -	gold	⊖ -				
19. frog	⊖ -	mean	⊖ -				
20. soft	⊖ -	last	⊖ -				
RE Score	19	+	LE Score	17	=	CW-FR Total Score	36

Section 3.08. Time Out Immediately After Completion of SCAN-3 Testing

The following is a description of steps to take after completion of SCAN-3 testing.

- After collecting SCAN-3 data, quickly verify the following before removing earphones from the participant that the right ear phone (red marking) was over the right ear and left earphone (blue marking) was over the left ear.
- Remove earphones from the participant.
- Inform the participant that all testing has been completed.
- Ask the participant how he or she is doing, i.e., ensure that the participant is comfortable and not in distress.
- Encourage the participant to relax for a few minutes.
- Verify that data for each SCAN-3 test were recorded on the appropriate score sheet.
 - The participant is free to leave the test area.

Section 3.09. Entry of SCAN-3 Data on CRF

Before first collecting SCAN-3 data from a participant, research assistants are strongly encouraged to closely study the SCAN-3 score sheets and the SCAN-3 CRF, shown here.

LIMBIC-CENC-01C		SCAN-3	
Subject ID: <input type="text"/>		Date: <input type="text"/> - <input type="text"/> - <input type="text"/>	
Visit: <input type="checkbox"/> Baseline <input type="checkbox"/> Year 1 <input type="checkbox"/> Year 3 <input type="checkbox"/> Year 5 <input type="checkbox"/> Year 10 <input type="checkbox"/> Year 15 <input type="checkbox"/> Year 20 <input type="checkbox"/> Year 25 <input type="checkbox"/> Year 30 <input type="checkbox"/> Year 35 <input type="checkbox"/> Year 40			
<input type="checkbox"/> Year 45 <input type="checkbox"/> Year 50 <input type="checkbox"/> Year 55 <input type="checkbox"/> Year 60 <input type="checkbox"/> Year 65 <input type="checkbox"/> Year 70			
SCAN-3			
Instructions: Please see detailed instructions in the SOP for scoring procedure.			
Intensity Level: <input type="checkbox"/> 50 dB HL <input type="checkbox"/> Other <input type="checkbox"/> dB HL			
Screening Test I: Gap Detection Test			
1. Gap detection test grade: <input type="checkbox"/> Pass <input type="checkbox"/> Fail		Pass = 3 or more consecutive 2 responses in shaded area Fail = Less than 3 consecutive 2 responses in shaded area	
Screening Test II: Auditory Figure-Ground 0 dB			
1. Right ear total score:	<input type="text"/>	5. Auditory Figure-Ground test grade: <input type="checkbox"/> Pass <input type="checkbox"/> Fail	
2. Left ear total score:	<input type="text"/>		
3. Combined total score:	<input type="text"/>		
4. Age Scaled total score:	<input type="text"/>	Do not enter Age-Scaled total score if subject is >50 yrs old.	
Screening Test III: Competing Words – Free Recall			
1. Right ear total score:	<input type="text"/>	5. Competing Words—Free recall test grade: <input type="checkbox"/> Pass <input type="checkbox"/> Fail	
2. Left ear total score:	<input type="text"/>		
3. Combined total score:	<input type="text"/>		
4. Age Scaled total score:	<input type="text"/>	Do not enter Age-Scaled total score if subject is >50 yrs old.	
Final v1.0 September 12, 2019		1	

General Instructions

- SCAN-3 data entry onto the CRF is described here. You may (and probably will) perform actual data entry on the CRF after the participant has been dismissed from the test room.
- The appropriate CRF is identified in a black portion at the top of the form with LIMBIC-CENC-01C on the left hand side and SCAN-3 on the right hand side, as shown in the nearby blank CRF,
- Enter the 7-digit participant (**subject**) ID in the appropriate place on the left-hand side.
- Enter the test **Date** in the appropriate place on the right-hand side.
- Check the box for the appropriate **Visit** (e.g., Baseline, Year 1, Year 3, etc.)
- The next section for data entry is simply identified as SCAN-3.
- **Do not report SCAN-3 data if testing was attempted but the participant was too impaired to complete one or more tests. Specifically, the participant is able to**

begin the test or activity, but is unable to complete the required tasks because of fatigue or impairment.

- If the SCAN-3 was administered at the default intensity level of 50 dB, check the corresponding ___ for **Intensity Level**.
- If a higher intensity level was used in administration of the SCAN-3, enter the level (e.g., **60 dB HL**).

Screening Test I: Gap Detection Test

- Check the appropriate box to enter the outcome of the Gap Detection Test.
- Review the SCAN-3 scoring procedure in Section 3.07 if necessary.

Screening Test II: Auditory Figure-Ground 0 dB

- Enter in the appropriate boxes the participant's total scores for the right and the left ears (one digit per box).
- Enter the participant's total (combine) scores for both ears in the combined total score boxes.
- Determine the Pass/Fail outcome from analysis of the participant's total raw score for the appropriate participant age group using the **Screening Pass/Fail Criterion Table** below.
- Enter the Pass or Fail outcome under item 5 on the CRF for the Auditory Figure Ground and Competing Words test.
- Verify that you already enter the Pass/Fail outcome for the Gap Detection Test.

Screening Pass/Fail Criterion Table

Subject Age (years/months)	Gap Detection	Auditory Figure Ground Raw Score	Auditory Figure Ground Pass	Competing Words Raw Score	Competing Words Pass
16.0 – 19.11	Pass/Fail		≥ 28		≥ 26
20 – 39.11	Pass/Fail		≥ 27		≥ 26
40 - 50	Pass/Fail		≥ 25		≥ 26

Section 3.10. Completion of Patient Reliability Data for SCAN-3

On the SCAN-3 data sheet, make note of **the Participant’s Reliability** in performing the SCAN-3 tests.

- Good Reliability: The SCAN-3 tests were administered to completion without any deviation from standard procedure. Results are judged to be reliable.
- Fair Reliability: The SCAN-3 tests were administered to completion but there was some departure from standard procedure, or there are some minor internal inconsistencies within the participant’s responses. Examples for SCAN-3 tests include repeating instructions more the one time after the initial standard instructions.
- Poor Reliability: SCAN-3 tests were completed by the participant but there is a significant departure from standard procedure which compromises reliability, or the participant is unable to provide consistent and reliable responses because of the presence of cognitive, behavioral, or physical impairment. Examples for SCAN-3 tests include no response for more than 10% of the items on a test.

Section 3.11. Wrap Up with Participant

Before a participant is dismissed, research assistants should verify completion of all auditory data collection. Again, research assistants will typically enter onto the CRFs after the participant has left the test room. The following are general suggestions for wrapping up the test session with a participant.

LIMBIC-CENC Hearing Data Collection Standard Operating Procedures (SOP version 5.2, 01/08/2024)

- Confirm with the participant that testing is complete.
- Verify that the participant has in his or her possession all items that were brought into the test room including cell phone and any items that might have been removed for testing, e.g., jewelry or hearing aids.
- Verify that the participant is feeling well.
- Ask the participant if he or she has any general questions before leaving the test room.
- Walk the participant to the door and officially dismiss the participant from the test site.
- Refer to [Appendix D](#) for participant instructions

Section 3.12. General Clean Up

The test area should be organized and tidied up after the participant leaves the room. The following are general steps for clean up:

- Power down the computer and the AudioStar audiometer.
- Pack up equipment and supplies if they are not stored in the test room.
- Cover the AudioStar audiometer.
- If equipment remains in the test room, neatly place the earphones, the bone vibrator, the talkback headset, the microphone, Ambands, etc., next to the computer and the AudioStar audiometer.
- Untangle wires and cables as necessary.
- Place chairs in their proper locations in the test room.
- Properly dispose of any debris and trash.

Section 3.13. Compilation of Data Documents

All data documents, including note, SCAN-3 worksheets, and CRF sheets, should be retained after a test session.

- Research assistants should gather together all data documents, such as notes, SCAN-3 score sheets, and CRFs.
- Data documents should be removed from the test room according to typical study protocol

- Data documents should be kept on file according to typical study protocol.
- **Research assistants are also strongly encouraged to view the narrated PPT presentation (LIMBIC-CENC Hearing Data Collection: Part 3) that reviews in detail the process for SCAN-3 data entry on to the appropriate CRF.**

Section 3.14. Uploading AMTAS Audiometric Data to the SFTP Site

External hard drive

- Connect an external hard drive to enable data storage from the non-networked computer.
- Then connect the external hard drive to a networked computer for data transfer.

VAMC Guest wireless network

- Should the computer be equipped with internet access, the local VAMC Guest wireless network may be an available option.

SECTION 4.0. CLEANING HEARING TEST EQUIPMENT AND TEST ENVIRONMENT

Section 4.01. Cleaning Test Equipment

- According to the recommendations from the CDC, audiometric equipment is considered to be non-critical medical equipment and typically requires cleansing followed by low to intermediate level disinfecting.
- Turn off the GSI AudioStar audiometer and disconnect power before cleaning.
- Turn off the touch screen computer and disconnect power before cleaning.
- Use a soft cloth lightly dampened with cleaning solution to clean all exposed surfaces.
- Be careful to avoid allowing liquid to come in contact with the metal parts inside the earphones.
- Do not permit solutions or disinfecting agents to seep into the electronic portions of the equipment.
- Do not use any abrasive cleaners.
- Take special care around controls, connectors, and panel edges.
- If necessary, use a brush to dislodge any dirt on or around the connectors and panel edges.
- Remove stubborn dirt with a soft cloth slightly dampened with mild detergent and water.
- Sanitization is done with the application of EPA-registered hospital disinfectant.
- Use of a non-alcohol based disinfectant is recommended for larger areas and earphones.
- Non-alcohol based products containing the active ingredient referred to as quaternary ammonia compound or hydrogen peroxide based cleaner, such as Oxivir Disinfectant Wipes, should be used to clean the ear cushions, earphones, bone vibrator, and to wipe down the audiometer. The quaternary ammonia compound and hydrogen peroxide are specifically designed to disinfect rubber, plastic, silicone and acrylic products which are commonly used in hearing evaluation instruments.

Section 4.02. Cleaning Test Environment

Follow standard CDC and institutional guidelines for cleaning and sanitizing the test environment. Using appropriate sanitizing agents and supplies while wearing clean gloves be sure to clean the following and any other appropriate items in the test room:

- Computer screen and frame
- Table tops and other surfaces that are touched during the testing or that are used for storage of equipment or supplies (e.g., earphones).
- Chair surfaces.
- Door knobs.
- Light switches.
- Pens or pencils

SECTION 5.0. TROUBLE-SHOOTING GUIDE

Research assistants are strongly encouraged to view the narrated PPT presentation (LIMBIC-CENC Hearing Data Collection: Part 4) that discusses problems you are likely to encounter in hearing testing and how to identify and solve the problems.

The **mouse** for the AudioStar audiometer is not working, that is, you don't see a cursor on the audiometer screen:

- Verify that the special flash drive is plugged into a USB port on the audiometer, as shown in a photograph in Section 1.03.
- Verify that the mouse is near the audiometer.

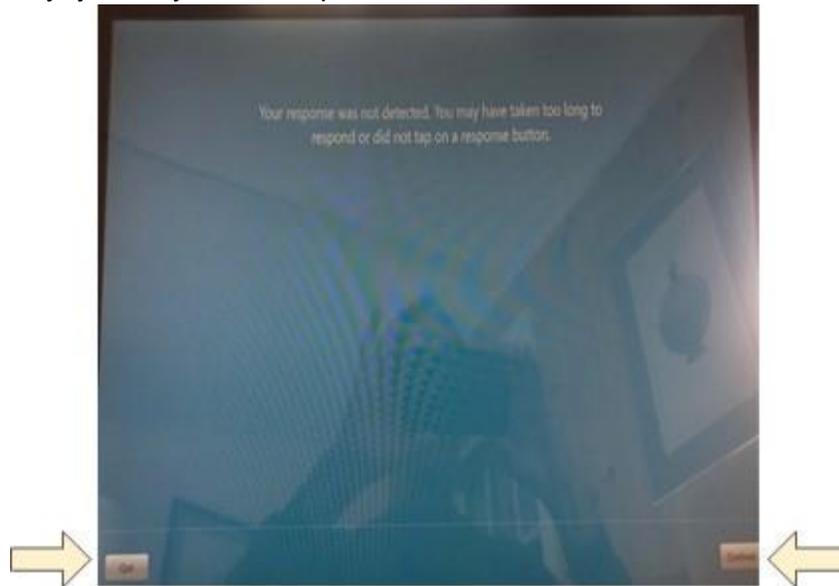
You wish to escape or to make changes in the AMTAS automated test process before hearing testing has been completed.

- Touch the **“hamburger” icon** in the upper-right corner of the computer screen (three horizontal lines).
- Select **Exit**
- Or, go to **Settings**.
- You will be returned to the screen with a pull down menus for Reports, General Options, Workflow, etc.
- Make any necessary changes and then touch **“Start Test”** in the upper-left corner.

You wish to escape the AMTAS automated test process at some time during hearing testing before hearing has been completed, perhaps because you discovered a problem (e.g., participant isn't ready, earphones or bone vibrator is not on the participant's head).

- Do not touch the screen during testing (or instruct participant to refrain from touching the screen).
- The AMTAS software will detect a deviation from the test process and the message shown below will appear on the computer screen.

- Select “Quit” in the lower-left corner.
- Alternatively, you may solve the problem and select “Continue” in the lower-right corner.



You receive the message “**Unable to communicate with the audiometer ...**” at the beginning of the AMTAS automated hearing testing.

- Power down the computer as described below.
- Be sure the computer is entirely turned off by selecting the Windows icon in the lower-left corner of the computer screen
- Then touch the power icon also in the lower-left corner of the computer screen.
- Then, touch “shut down”.
- Turn off the audiometer with the manual switch on the right side.
- Then, turn on the audiometer until it completely boots up.
- Finally, turn on the computer with the power switch in the lower-right corner of the computer.

The **Headset Check** cannot be performed at the beginning of the AMTAS automated hearing testing, immediately after **Continue** is pressed and the **Apply Headphones** message appears, i.e., no sound is presented via the right or left earphones during the Headset Check:

- If you see a message “**Unable to communicate with the audiometer**” during the Headset Check, verify that the computer is connected to the audiometer.

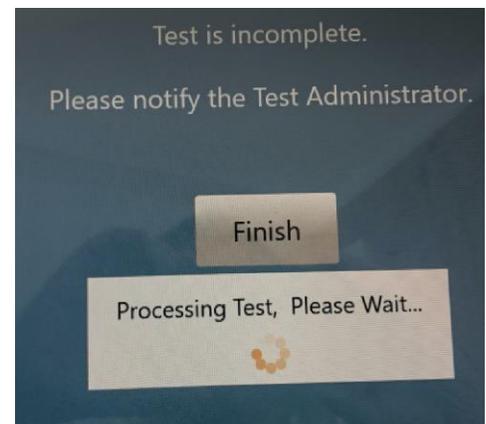
- Power down the computer and the audiometer. Then, first power on the audiometer until it completely boots up. Then power on the computer.
- Place the earphones on your ears to verify that a sound is presented to the right or left earphones when you press “**Play**” and then **left ear** and **right ear**.
- The computer must be entirely powered off (not simply sleeping) when the AudioStar audiometer is powered on.

Participant cannot clearly hear the instructions for AMTAS automated air conduction pure tone testing.

- If a participant has a hearing loss, it may be necessary to increase the volume level of the audio instructions for AMTAS automated hearing testing.
- At the beginning of the AMTAS hearing testing, during the introduction and instructions, you will see a volume scale or bar at the bottom of the computer screen.
- Slide the volume to the right until the participant can clearly hear the instructions.
- For any participant who appears to have difficulty hearing before testing begins, and definitely for any participant who wears hearing aids, move the volume bar to a higher level (e.g., 50 or 60) before the instructions are delivered to the participant.

“Test is incomplete” message during hearing testing:

- The message indicated here will appear if the participant doesn’t respond within a reasonable time, or doesn’t respond at all, during the hearing testing.



Participant doesn’t respond during automated air conduction pure tone testing:

- Speaking loudly, ask the participant if he or she is hearing any beeping sounds. If the participant cannot hear you, it may be necessary to remove the earphones to communicate. The audiometer is locked during aMTAS with a padlock icon so research assistants will be unable to communicate via mic monitor headset.
- The audiometer is locked during aMTAS with a padlock icon – the research assistant will be unable to communicate via mic monitor headset.
- As necessary, reinstruct the participant to press the button every time they hear a beeping sound, even if the sounds are very faint.
- Verify that the participant is wearing the earphones and that they are properly covering the ears
- Verify that the earphone cables are plugged into the proper socket in the back panel and plugs are pushed all the way in (red = right; blue = left)
- Verify that the participant is correctly touching the yes or no response icons on computer screen

Participant doesn't respond during automated bone conduction pure tone testing:

- Using the talk back system and your headset microphone, ask the subject if he or she is hearing any beeping sounds
- As necessary, reinstruct the subject to press the yes or no icons on the computer screen every time they hear a beeping sound, even if the sounds are very faint
- Verify that the participant is wearing the bone vibrator (oscillator) on the forehead
- Verify that the bone vibrator is pressed firmly against the participant's forehead
- Verify that the bone conduction cable is plugged into the proper socket in the back panel (far right side as shown in previous photographs) and it is pushed all the way in

Participant doesn't respond During SCAN-3 testing:

- Using the talk back system and your headset microphone, ask the subject if he or she is hearing any words
- As necessary, reinstruct the subject to repeat the words, even if the words are very faint
- Verify that the subject is wearing the headset and earphones are over the ears

- Verify that the earphone cables are plugged into the proper socket in the back panel and plugs are pushed all the way in (red = right; blue = left)
- Verify that the participant is wearing the microphone (about 6" away from the mouth)
- Verify that the response button cable is plugged into the proper socket in the back panel and plug is pushed all the way in

Participant complains about only hearing faint sounds during pure tone or SCAN-3 testing:

- First verify that the earphone cables (right and left) and the bone conduction cable are plugged into the proper sockets in the back panel (see figure in Section 1.03) and each plug is pushed all the way in, as far as it can go.
- As necessary, reinstruct the subject to repeat the words, even if the words are very faint
- Verify that the subject is wearing the headset and earphones are over the ears
- Verify that the earphone cables are plugged into the proper socket in the back panel and plugs are pushed all the way in (red = right; blue = left)
- Verify that the participant is wearing the microphone (about 6" away from the mouth)
- Verify that the response button cable is plugged into the proper socket in the back panel and plug is pushed all the way in
- The participant may have a hearing loss. Reinstruct the subject to repeat the words, even if the words are very faint

Participant complains about not hearing you clearly when he or she is wearing earphones:

- If you are wearing the tester headset with boom microphone, turn up the Talk Forward knob on the right side of the AudioStar front panel. Turn to the right while talking to the participant until he or she can hear you comfortably.
- Remove the earphones from the participant and then speak to the participant loudly and slowly while the participant is looking at you.

SECTION 6.0. KEY REFERENCES

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LIMBIC-CENC Hearing Data Collection Standard Operating Procedures (SOP version 5.2, 01/08/2024)

APPENDIX A: SCAN-3 Score Sheets

Use the form below for scoring the three SCAN-3 tests:

1. Gap Detection Test
2. Auditory Figure-Ground Test
3. Competing Words Test

Screening Tests

Administer all test items. Do not pause the CD or replay test items.

Gap Detection

The examinee may say "one" or "two" or raise one or two fingers to indicate how many tones he or she hears. Circle the number of tones the examinee indicates he or she hears.

Tracks	Practice Items	Gap (msec)	Test Items	Gap (msec)
2 Test Directions	a. 2 1	60	1. 2 1	0
3 Practice Items	b. 2 1	40	2. 2 1	2
4 Test Items	c. 2 1	25	3. 2 1	5
	d. 2 1	15	4. 2 1	10
	e. 2 1	5	5. 2 1	15
			6. 2 1	20
			7. 2 1	25
			8. 2 1	30
			9. 2 1	40

Circle one: **Pass** **Fail**
Pass = 3 or more consecutive 2s in shaded area
Fail = Fewer than 3 consecutive 2s in shaded area

***Auditory Figure-Ground 0 dB (AFG 0)**

Circle + for words that are repeated correctly. Circle - for incorrect responses or no response.

Tracks	Tracks
5 Test Directions	8 Practice Items-Left Ear
6 Practice Items-Right Ear	9 Test Items-Left Ear
7 Test Items-Right Ear	

Right Ear		Left Ear	
Practice Items		Practice Items	
a. race		c. his	
b. cat		d. turn	
Test Items		Test Items	
1. oil	+ -	21. ship	+ -
2. book	+ -	22. load	+ -
3. ant	+ -	23. dirt	+ -
4. tick	+ -	24. grass	+ -
5. goat	+ -	25. see	+ -
6. we	+ -	26. top	+ -
7. stay	+ -	27. quilt	+ -
8. base	+ -	28. pest	+ -
9. fit	+ -	29. tank	+ -
10. well	+ -	30. slide	+ -
11. best	+ -	31. grade	+ -
12. lot	+ -	32. mark	+ -
13. pat	+ -	33. poke	+ -
14. bug	+ -	34. fuss	+ -
15. may	+ -	35. spot	+ -
16. seat	+ -	36. toe	+ -
17. pain	+ -	37. rat	+ -
18. care	+ -	38. show	+ -
19. fast	+ -	39. tell	+ -
20. wall	+ -	40. lead	+ -

Competing Words-Free Recall (CW-FR)

Circle + for words that are repeated correctly. Circle - for incorrect responses or no response.

Tracks	Tracks
10 Test Directions	11 Practice Items a & b
11 Practice Items a & b	12 Test Items
12 Test Items	

Right Ear		Left Ear	
Practice Items		Practice Items	
a. dig		barn	
b. yard		hill	
Test Items		Test Items	
1. fell	+ -	pink	+ -
2. coat	+ -	tent	+ -
3. glove	+ -	milk	+ -
4. road	+ -	bake	+ -
5. hope	+ -	room	+ -
6. lake	+ -	ant	+ -
7. tell	+ -	woke	+ -
8. wet	+ -	hand	+ -
9. feel	+ -	sheep	+ -
10. bad	+ -	read	+ -
11. care	+ -	bed	+ -
12. fruit	+ -	bus	+ -
13. nest	+ -	mud	+ -
14. chip	+ -	night	+ -
15. gave	+ -	some	+ -
16. five	+ -	gone	+ -
17. ice	+ -	move	+ -
18. ran	+ -	gold	+ -
19. frog	+ -	mean	+ -
20. soft	+ -	last	+ -

RE Score + LE Score =

*See note on page 3. AFG 0 Total Score

RE Score + LE Score =

CW-FR Total Score

APPENDIX B: SCAN-3 Gap Detection Scoring Table

**SCAN-3 Gap Detection
Scoring Table**

Instructions

Circle One: Pass Fail

Pass = 3 or more consecutive "2s" in the shaded area

Fail = Fewer than 3 consecutive "2s" in the shaded area

Test Item	Subject Response	Subject Response	Gap (milliseconds)
1	2	1	0
2	2	1	2
3	2	1	5
4	2	1	10
5	2	1	15
6	2	1	20
7	2	1	25
8	2	1	30
9	2	1	40

SCAN-3 Gap Detection Screening Criterion and Screening Summary

Instructions

- ∨ Transfer total scores from the record form into the Raw Score columns for the Auditory Figure Ground and Competing Words tests
- ∨ Circle pass or fail in the appropriate row for Gap Detection in the Screening Pass/Fail Criterion Table below
- ∨ Circle Yes or No in the Screening Summary table below if the subject passed or failed the Gap Detection test
- ∨ Compare the subject's score to the age-appropriate criterion score for the Auditory Figure Ground and the Competing Words tests in the Screening Pass/Fail Criterion Table below.
- ∨ Circle Yes in the Screening Summary Table below if the subject's total Auditory Figure Ground score is equal to or greater than the pass criterion. If the subject's score is less than the pass criterion, circle No.
- ∨ Circle Yes in the Screening Summary Table below if the subject's total Competing Words test score is equal to or greater than the pass criterion. If the subject's score is less than the pass criterion, circle No.

Screening Pass/Fail Criterion Table

Subject Age (years/months)	Gap Detection	Auditory Figure Ground	Auditory Figure Ground	Competing Words	Competing Words
		Raw Score	Pass	Raw Score	Pass
16.0 – 19.11	Pass/Fail		≥ 28		≥ 26
20 – 39.11	Pass/Fail		≥ 27		≥ 26
40 - 50	Pass/Fail		≥ 25		≥ 26

**SCAN-3 Gap Detection
Scoring Table**

Instructions

Circle One: Pass Fail

Pass = 3 or more consecutive "2s" in the shaded area

Fail = Fewer than 3 consecutive "2s" in the shaded area

Test Item	Subject Response	Subject Response	Gap (milliseconds)
1	2	1	0
2	2	1	2
3	2	1	5
4	2	1	10
5	2	1	15
6	2	1	20
7	2	1	25
8	2	1	30
9	2	1	40

APPENDIX C: CRFs

AMTAS CRF

LIMBIC-CENC-01C

AudioStar AMTAS

Subject ID:

Date: - -
(DD) (MMM) (YYYY)

Visit: Baseline Year 1 Year 3 Year 5 Year 10 Year 15 Year 20 Year 25 Year 30 Year 35 Year 40
 Year 45 Year 50 Year 55 Year 60 Year 65 Year 70

AudioStar AMTAS

1. How was the hearing test data collected? Collected as part of study procedures
 Collected as part of clinical/non-study hearing test (go to question 1a)

1a. If collected as part of clinical/non-study hearing test, what was the date of the last hearing test? Date: - -
(DD) (MMM) (YYYY)

Instructions: For each frequency and testing condition, transpose the hearing level in dB into the corresponding cell within the "Air" or "Bone" rows. When there is No Response, "NR," indicated on the AudioStar report with a downward arrow that is red (right ear) or blue (left ear) transpose the stimulus dB level into the corresponding cell. Circle NR to indicate that the intensity level doesn't reflect a hearing threshold but, rather, there was no response. For more detailed instructions, please see AudiologySOP.

2. Right Ear Air Conduction	250	500	1K	2K	3K	4K	6K	8K
Air								
No Response	NR	NR	NR	NR	NR	NR	NR	NR
3. Right Ear Bone Conduction		500	1K	2K		4K		
Bone								
No Response		NR	NR	NR		NR		
4. Left Ear Air Conduction	250	500	1K	2K	3K	4K	6K	8K
Air								
No Response	NR	NR	NR	NR	NR	NR	NR	NR
5. Left Ear Bone Conduction		500	1K	2K		4K		
Bone								
No Response		NR	NR	NR		NR		
6. Ambient Sound During Testing (dB)	250	500	1K	2K	3K	4K	6K	8K

Assessment quality (Check one)

Good Fair Poor

Trial Time (s): _____

False Alarm Rate: _____

SCAN-3 CRF

LIMBIC-CENC-01C

SCAN-3

Subject ID:

Date: - -

Visit: Baseline Year 1 Year 3 Year 5 Year 10 Year 15 Year 20 Year 25 Year 30 Year 35 Year 40
 Year 45 Year 50 Year 55 Year 60 Year 65 Year 70

SCAN-3

Instructions: Please see detailed instructions in the SOP for scoring procedure.

Intensity Level: ____ 50 dB HL Other _____ dB HL

Screening Test I: Gap Detection Test

1. Gap detection test grade: Pass **Pass = 3 or more consecutive 2 responses in shaded area**
 Fail **Fail = Less than 3 consecutive 2 responses in shaded area**

Screening Test II: Auditory Figure-Ground 0 dB

1. Right ear total score:
2. Left ear total score:
3. Combined total score:
4. Age Scaled total score:
5. Auditory Figure-Ground test grade: Pass
 Fail
- Do not enter Age-Scaled total score if subject is >50 yrs old.

Screening Test III: Competing Words – Free Recall

1. Right ear total score:
2. Left ear total score:
3. Combined total score:
4. Age Scaled total score:
5. Competing Words—Free recall test grade: Pass
 Fail
- Do not enter Age-Scaled total score if subject is >50 yrs old.

APPENDIX D: Instructions for Participants

Note to Research Assistants: *Following are guidelines for instructing participants about the hearing testing process. There are three parts to the instructions: 1) General greeting before testing begins, 2) AMTAS pure tone hearing testing, 3) SCAN-3 testing of auditory processing, 4) Comments to the participant after testing is completed. This is not provided as a script to be read to the participants but, rather, as suggested wording to ensure that participants understand the tasks and perform them as well as possible. The two most important features of participant instruction are simplicity and clarity.*

Greeting

“Hello [or good morning]! I’m [state your name].

Today we are going to conduct some hearing tests. The total time for the hearing tests is approximately 30 minutes. Do you need to use the restroom, or are you ready to begin now?

You will need to look at a computer screen for the first test. If you wear glasses and you need to put them on to see the computer screen, please take a moment to do so now.

Do you wear hearing aids? If so, you will need to remove them at this time, before we begin the hearing tests. *[instruct the participant to place the hearing aids on the table next to the computer.]*

OK. Let’s get started.

AMTAS Testing

In the first test you will hear some very faint beeping tones. This hearing test is done with the computer that is in front of you. A message on the computer screen will tell you when you need to respond to the tones. You will hear *[or ask if the participant prefers to read the directions]* more instructions for the test just before it begins.

Before we begin the test, I need to place a little bone vibrator device on your forehead and a set of earphones over your ears. *[show the participant the earphones and bone oscillator].*

Would you like me to place the bone vibrator on your forehead and this headband around your head, or would you prefer to place them? *[verify that the bone vibrator is firmly but comfortably pressed against the middle of the participant's forehead.]*

Very good. Now, would you like me to place these earphones over your ears, or would you prefer to place them? *[In advance, determine whether the participant wears earrings. If so, ask the participant to remove them if possible. If the participant places the earphones, be sure the red earphone is placed over the right ear and the blue earphone is placed over the left ear. Verify that the earphones are securely and properly placed over his or her ears.]*

[Start the AMTAS testing process for the participant.]

[When the participant has completed the AMTAS testing, immediately remove the earphones and the headband with bone vibrator, or ask the participant to do so.]

We are now finished with the first hearing test. This would be a good time for you to stand up and relax for several minutes before we begin the second hearing test.

[You may wish to take a moment to review the AMTAS audiogram on the computer screen to verify that all data were collected.]

SCAN-3 Testing

[For SCAN-3 testing, locate the participant a short distance away from the computer and the audiometer so you do not need to reach past or crowd the participant, and so the participant cannot easily watch you and is not distracted as you complete the record sheets.]

In the next test you will need to listen closely to some tones. Then, in the final two tests you will need to listen carefully to some words. You will use the same earphones for these tests. Once we have placed the earphones, you will hear a recording of the instructions for each of the three tests. *[Hold the earphones in front of the participant.]*

Would you like me to place these earphones over your ears, or would you prefer to place them?
[If the participant places the earphones, be sure the red earphone is placed over the right ear and the blue earphone is placed over the left ear. Verify that the earphones are securely and properly placed over his or her ears.]

[Place the talkback headset on your head and adjust the microphone so it is in front of your mouth. Talk to the participant and verify that he or she can easily hear your voice through the earphones. Also, ask the patient to count to ten and adjust the talkback volume control so you can easily and clearly hear the patient's voice.]

[Make sure the SCAN-3 score sheets are nearby and that you have a functional pen or pencil. Also, verify that the intensity level is 50 dB for each channel. If necessary, increase the intensity with the two large knobs ... one for each channel ...on the GSI AudioStar Pro audiometer. Then to begin SCAN-3 testing, click on the first tract of the gap detection test using the mouse connected to the GSI AudioStar Pro audiometer.]

Completion of Hearing Testing

[When the participant has completed SCAN-3 testing, immediately remove the earphones or ask the participant to do so.]

We are now finished with all of the hearing tests. Are you feeling OK? Good. You are now free to collect your belongings and to leave. Thank you for participating in the hearing testing. *[Verify that the participant retrieves all of his or her items, e.g., jewelry, hearing aids, jacket/sweater, etc.]*

APPENDIX E: Clinical Referral Letter Example

[INSTITUTION NAME]
[Institution Address]
[Institution Address]
[Institution Address]



[Date]

[Veteran Name]
[Street Address]
[City, State ZIP]

Dear [Veteran Name],

On [DATE], you participated in an observational research study investigating combat exposure. As a result of the testing, a finding was revealed that was outside the range that is considered medically acceptable.

I have consulted with a study clinician about **a difference in your hearing for the [right/left] versus [right/left] ear**. We recommend a clinical appointment with an audiologist for further evaluation of your hearing status. If you are registered and enrolled in [VA/DoD] health care, you may request an appointment with the [Institution Name] Audiology Department by calling ***-***-**** or through [MyHealtheVet](#). The Audiology Department will be able to discuss details about the visit, including any copays for whom those apply.

The testing provided as part of the study is intended to collect measures for research and is not intended for clinical diagnostic and treatment purposes. The findings disclosed to you are done so with your permission, as indicated on the informed consent form that you had signed for study participation.

Should you have any questions, or you would prefer the study clinician to contact you, you may contact me at ***-***-**** to discuss next steps.

Sincerely,

[PI Name]
LIMBIC-CENC Principal Investigator
[Institution Address]
[Institution Address]
[Institution Address]