

Manual - OSP Software

Requirements and installation steps for OSP hardware or software are covered more comprehensively in these separate guides below.

- [“Getting Started Guide - OSP Software \(macOS\)”](#)
- [“Getting Started Guide - OSP Hardware”](#)

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1 - Purpose of Document

To explain how to use the Open Speech Platform's (OSP) software, which mainly composes of the following (all explained later in this document):

- **Embedded Web Server (EWS)** - This serves as the main graphical user interface for using the bulk of various OSP features. EWS can be used with or without hardware, depending on how OSP was installed.
- **Apps and Demos** - Within EWS, various features of the OSP software that are intended as supporting tools for doing hearing-related investigations. Some features (“apps”) are more refined and closer to their intended functionality than others (“demos”).
- **Real Time Master Hearing Aid (RT-MHA)** - This is the hearing-aid algorithm which takes the audio from the environment and modifies it for the listeners’ specific prescription. This can be manipulated via EWS (limited to the apps and demos provided) or via a command line interface such as a terminal (with more customized control).

The majority of this document will assume that you have already fulfilled the requirements needed to operate OSP software and/or hardware and have successfully completed the installation steps, covered more in-depth in the following guides:

- [“Getting Started Guide - OSP Software \(macOS\)”](#)

- “[Getting Started Guide - OSP Hardware](#)”

2 - How to Set Up the Software

2.0 Set Up Your Hardware

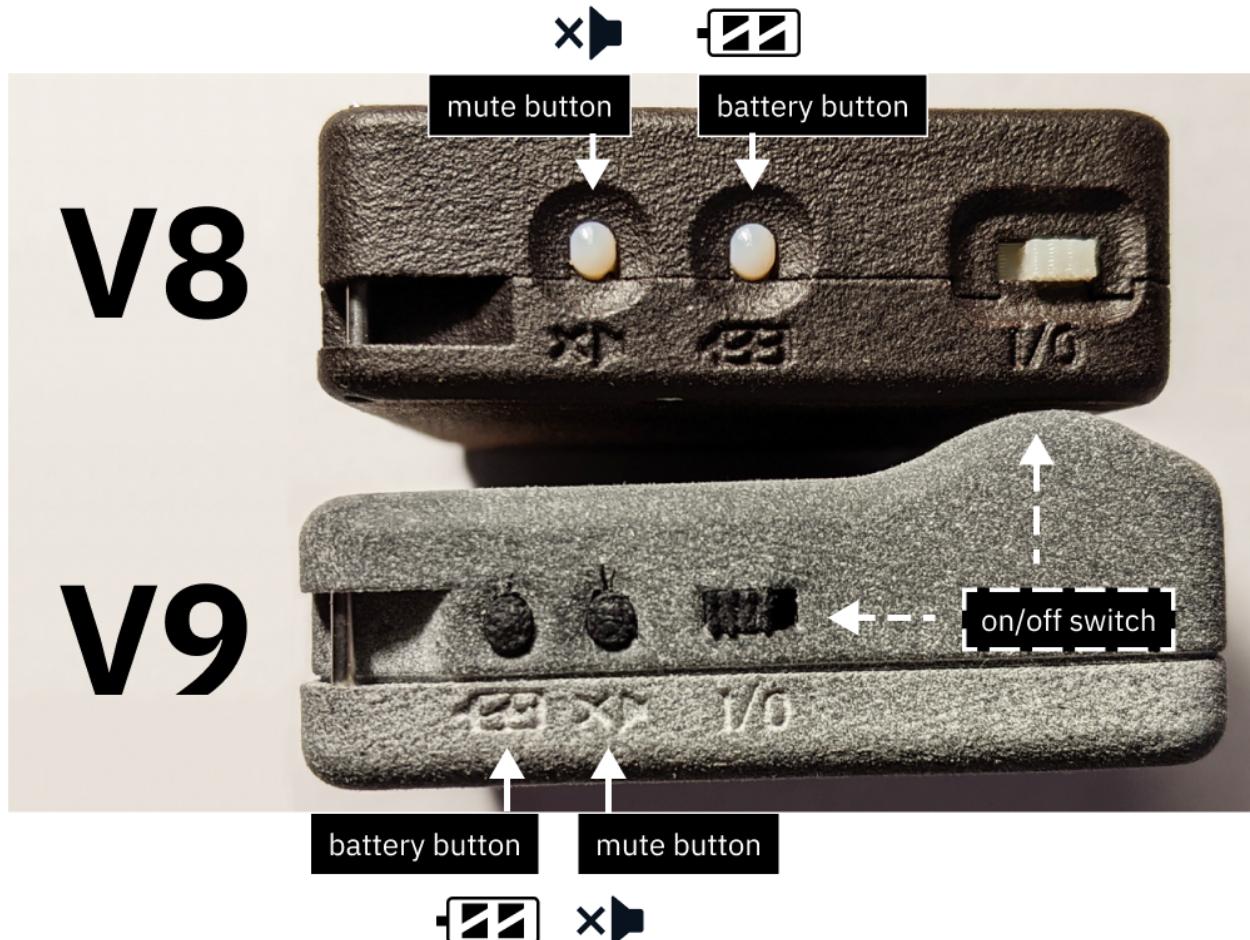
This step is only required if you have OSP software within your hardware (a.k.a. your Processing and Communication Device, PCD), otherwise skip to [“2.1 Open a Terminal”](#).

Depending on which version of the device you have, do one of the following:

- **If you have the V8 version with two micro-usb ports**, attach one micro-usb cable to the “ADB” port. Attach the other cable to your computer or the USB hub.
- **If you have the V9 version with one micro-usb port**, attach one micro-usb cable and connect the cable to your computer via the USB hub.

Do one of the following for your **device** version (also see image below).

- *V8 Version* - Flick the on/off switch **towards the battery button**.
- *V9 Version* - Flick the on/off switch **towards the mute button**.



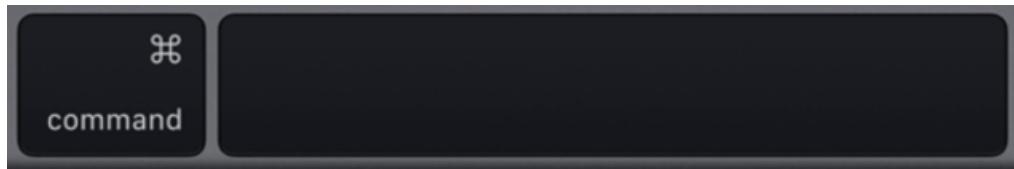
(top area) V8 device. The battery button is closer to the on/off switch.
(bottom area) V9 device. The mute button is closer to the on/off switch.

2.1 Open a Terminal

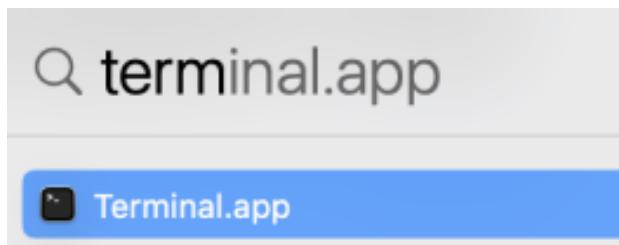
For MacOS (OSP software or hardware)

1. Open Spotlight Search (or simultaneously press the command and spacebar keys), which looks like a long horizontal area on your

screen with a Search icon.



2. Type in “terminal”, and the application should show up automatically. Press enter.

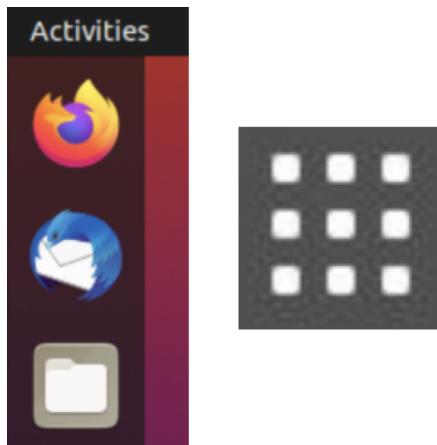


For Linux (OSP hardware only)

1. Simultaneously press the "Ctrl", "Alt", and "t" keys on your keyboard to open a terminal.

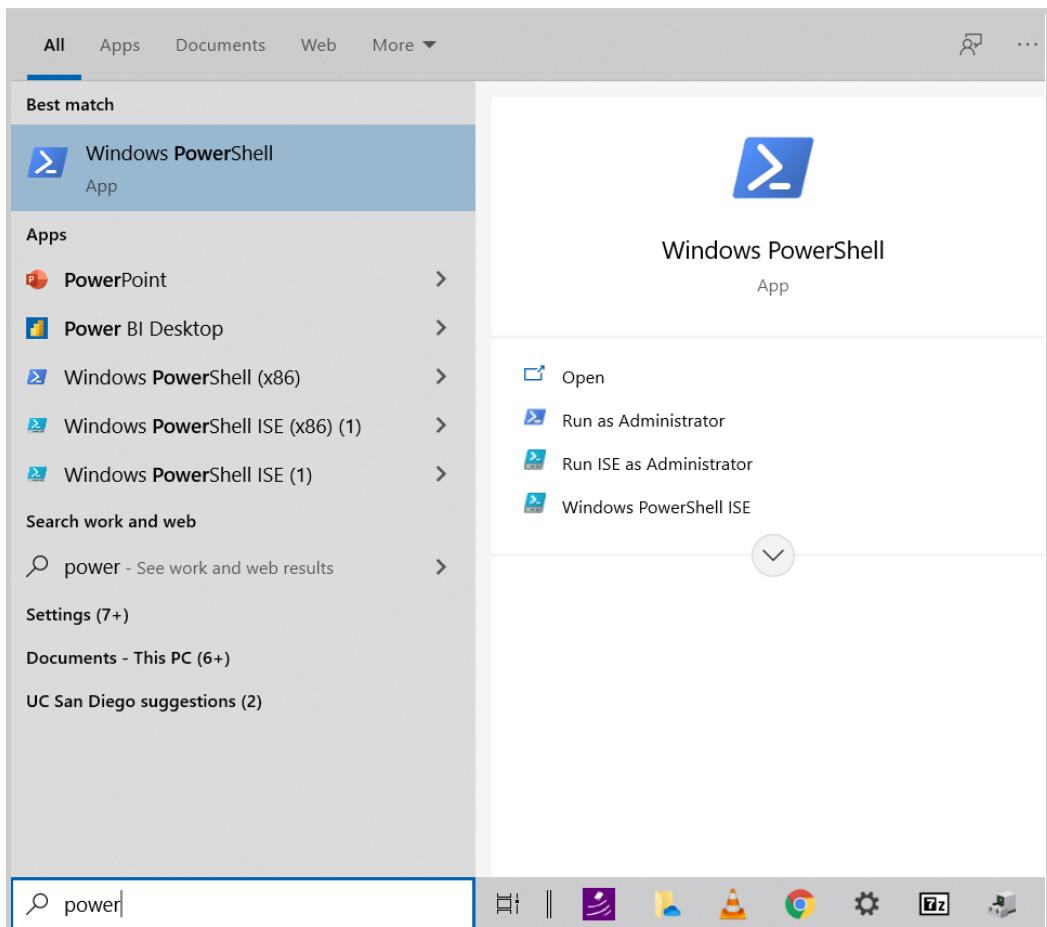


2. If this doesn't work, select "Activities" on the upper left corner of your screen or click on the 3x3 icon on the side of your screen. Use the search feature to type in "terminal" and open the terminal app.



For Windows (OSP hardware only)

1. Go to the Search box in the Windows taskbar, and start typing "Microsoft Powershell" to open the program.



You will see a blue terminal window with a message similar to below.

```
Windows PowerShell
Copyright (C) Microsoft Corporation. All rights
reserved.

PS C:\Users\[USERNAME]>
```

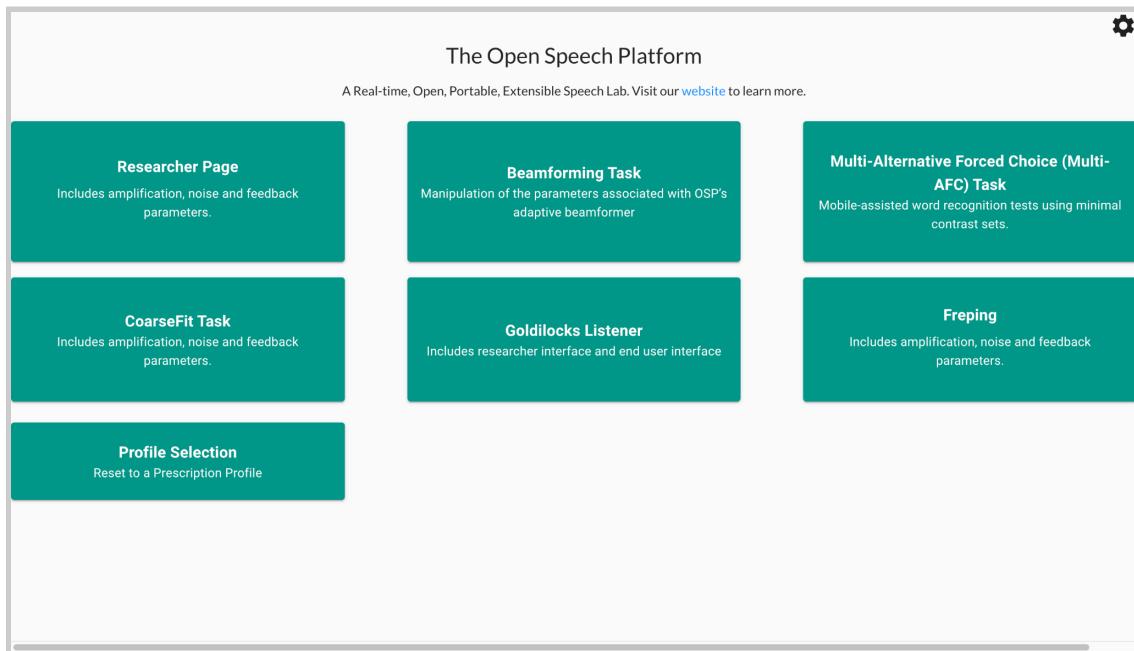
2.2 Launch EWS in Your Terminal

Do one of the following:

If you have OSP software only...

1. Simply enter the command: **run_osp**
2. Wait for several seconds. You should see five terminal tabs opening and executing OSP processes. You would be redirected to a browser window/tab.

Once EWS launches, the browser search bar should say “localhost:5000” and you’ll see the landing page like the image below.



Optionally, you can access the PHP/Laravel version by typing into the search bar “localhost:8080”.

If you have OSP software within your hardware (PCD)...

1. In your terminal, navigate to the folder that contains the PCD download (e.g. “pcd-[DATE]” or “pcd-windows-[DATE]”). Refer to one of the specific steps from one of the installation guides if you can’t find it.
 - a. See section “3.7 - Navigate to the “pcd-[date]” Folder” in the guide [Quick Guide - OSP Hardware \(macOS, Linux\)](#).
 - b. See step #2 of section “3.7 - Connect to the PCD Using Windows Powershell” in the guide [Quick Guide - OSP Hardware \(Windows\)](#).
2. Then, connect to the PCD by enter one of the following commands:
 - a. For macOS/Linux: **./pcdtool conn**
 - b. For Windows: **./pcdtool.exe conn**
3. Wait a few moments. When the terminal stops sending messages, press the enter key once or twice.
4. Enter the command: **print_mode** to check whether your PCD is in Hotspot mode or NetworkManager mode. You will also need to find the IP address.

- a. If your PCD is in Hotspot mode, you should see the following.

**Note the IP address for the PCD's hotspot, which is
“192.168.8.1”.**

```
root@ospboard:~> print_mode
Hotspot Mode
Connect to the device at SSID "ospboard"
password "hearingaid" then
open a browser and connect to
http://192.168.8.1:5000 and/or
http://192.168.8.1
If you wish to put the board back into
NetworkManager mode then use following
command:

set_mode nm
```

- b. If your PCD is in NetworkManager mode, you should see available wifi networks, represented as a list of “SSID”s. The name of your preferred wifi network name should show up here. You will also need to prepare the password to your preferred wifi network.

```
root@ospboard:~> print_mode
```

NetworkManager Mode

Connect to your wifi with one of the following:

```
> nmcli dev wifi con MYSSID password "MY  
PASSWORD"
```

or

```
> nmtui
```

IN-USE	SSID	MODE	CHAN	RATE	SIGNAL	BARS
SECURITY						
	DNRC	Infra	1	130 Mbit/s	49	-- WPA2
	DNRC	Infra	6	130 Mbit/s	42	-- WPA2
	DNRC	Infra	6	130 Mbit/s	40	-- WPA2

If you wish to put the board back into hotspot mode then use following command:

```
set_mode hs
```

Then, enter the command: **nmcli dev wifi con MYSSID
password "MY PASSWORD"**

MYSSID would be your wifi network's name.

You should see the following in your terminal.

```
root@ospboard:~> nmcli dev wifi con MYSSID  
password "MY PASSWORD"  
[ 203.944162] wlan0: authenticate with  
70:3a:cb:2a:06:d8  
[ 203.989349] wlan0: send auth to  
70:3a:cb:2a:06:d8 (try 1/3)  
[ 204.000409] wlan0: send auth to  
70:3a:cb:2a:06:d8 (try 2/3)  
[ 204.002978] wlan0: authenticated  
...  
More terminal messages...  
...  
[ 204.164330] IPv6: ADDRCONF(NETDEV_CHANGE):  
wlan0: link becomes ready  
Device 'wlan0' successfully activated with  
'2ce4abfd -9c36 -446c-9a25 -6511d85c9dea'.
```

Finally, enter the command: **print_mode** again to find the IP address associated with your wifi network. You can find it to the right of “inet”, as underlined.

```
root@ospboard:~> print_mode  
NetworkManager Mode
```

```
inet 192.168.86.38 netmask 255.255.255.0
```

```
broadcast 192.168.86.255
```

```
Connected
```

If you wish to put the board back into hotspot mode then use following command:

```
set_mode hs
```

5. Find your list of wifi networks and connect to an available network.

Do one of the following:

- a. *If your device is in Hotspot mode*, find “ospboard” within the list of wifi networks. Login using the password “hearingaid”.
- b. *If your device is in NetworkManager mode*, you can connect to any other available wifi network, using the chosen wifi network’s name and password.

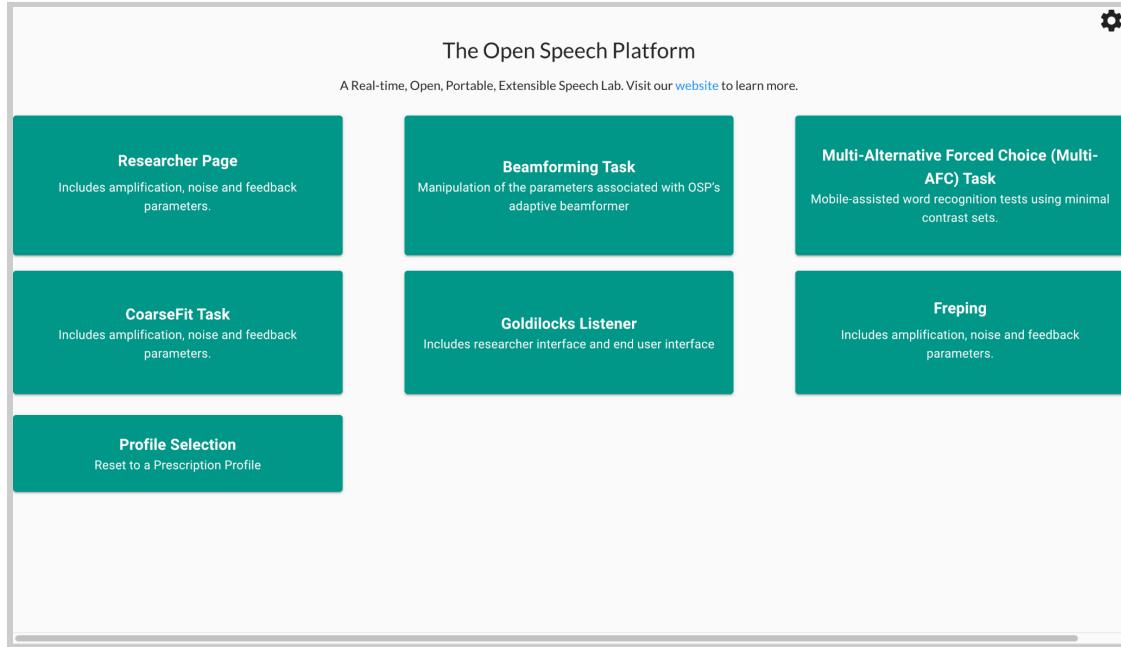
6. Enter one of the following into the search bar:

http://ospboard.local:5000 or

http://ospboard.lan:5000

If neither of them work, you can try using the IP address found from the **ifconfig** command. For example, if your IP address is “192.168.8.1”, you would enter “**http://192.168.8.1:5000**”

You'll see the landing page like the image below.



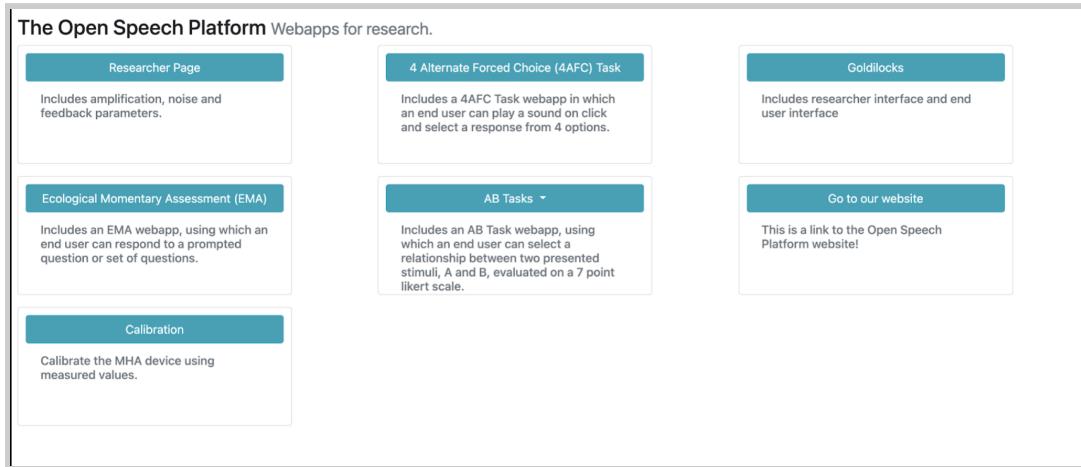
Optionally, you can access the legacy version of OSP software by simply entering one of the following into the search bar:

- **http://ospboard.local**
- **http://ospboard.lan**
- **http://[YOUR_IP_ADDRESS]**

Your IP address can be found from the **ifconfig** command.

For example, if your IP address is “192.168.8.1”, you would enter “**http://192.168.8.1**”.

You'll see the landing page like the image below.



3 - Sanity Checks

This section covers aspects to test that the following work as expected on OSP software:

- Audio input/output sources
- Node.js version of EWS
- PHP/Laravel version of EWS
- RT-MHA functionality

3.1 - Checking Audio Input/Output Sources

This section describes two different applications on macOS - System Preferences and Audio MIDI Setup - to check your audio input/output

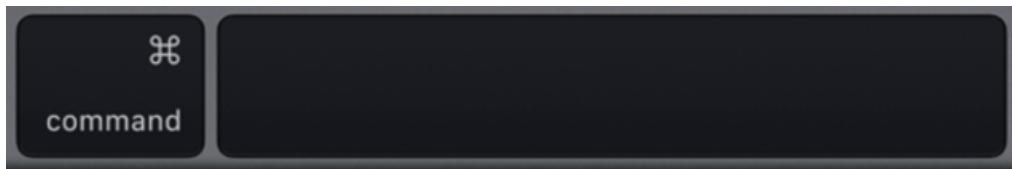
sources. You will use the terminal to run OSP and check that your sources are heard and working properly.

1. First, access settings for available audio input and output sources.

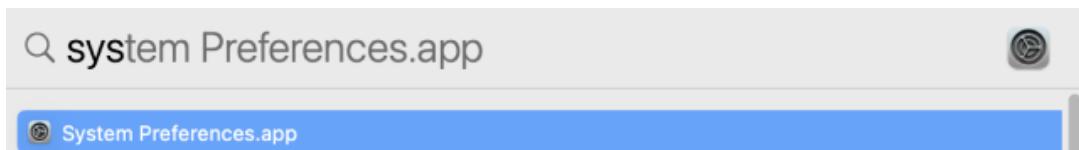
There are two ways to do so: **System Preferences and Audio MIDI Setup.**

For System Preferences:

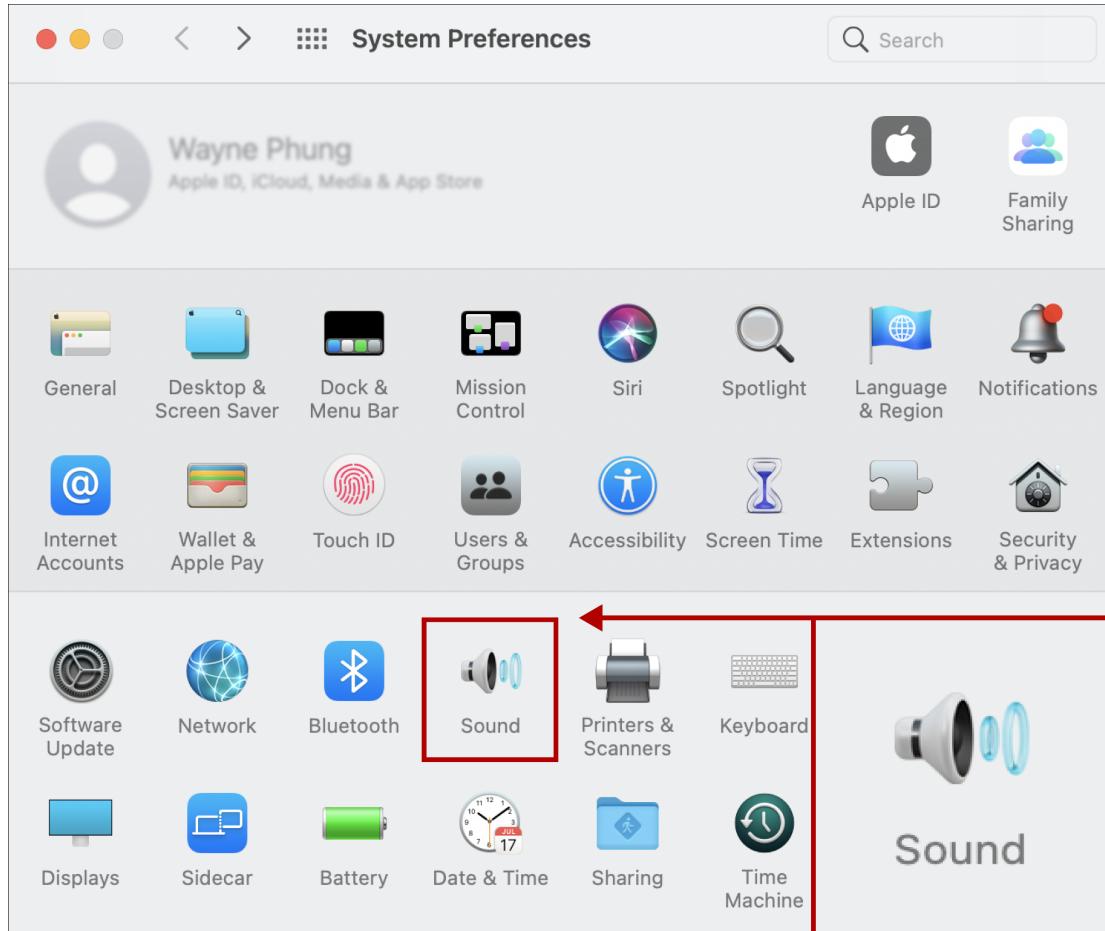
- To access, press the command and spacebar keys on your keyboard to open Spotlight Search.



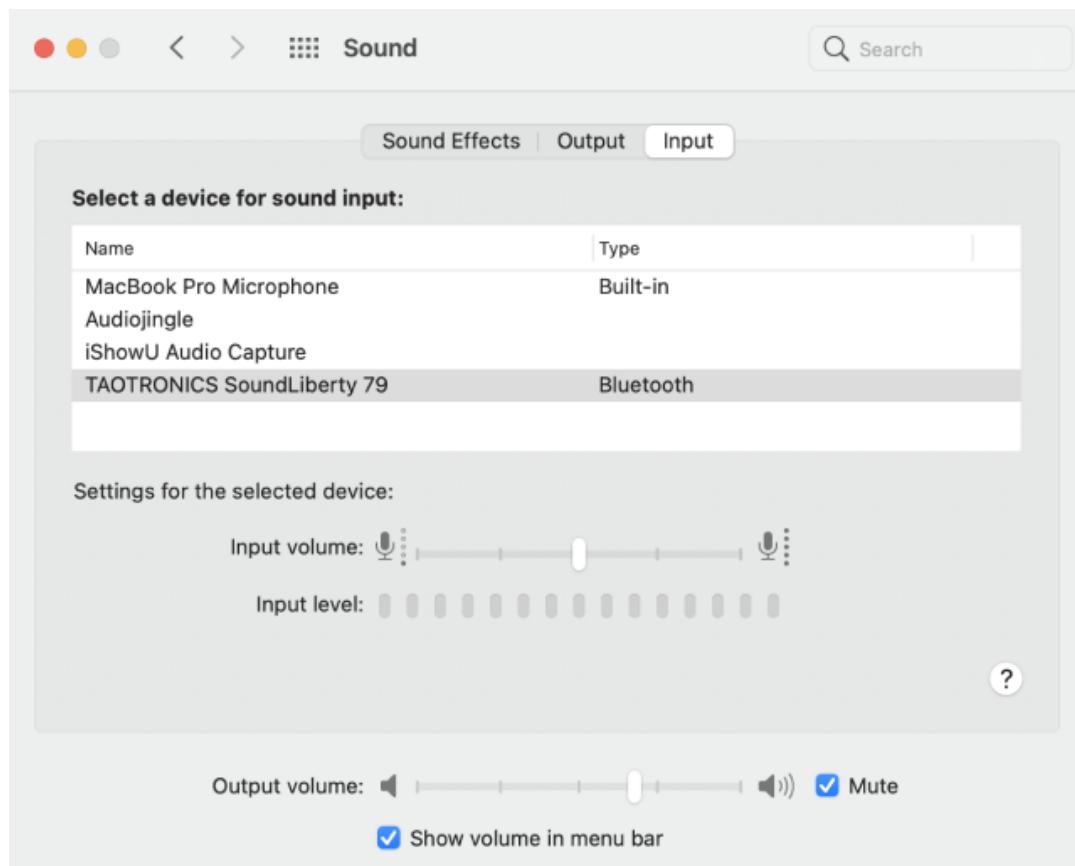
- Start typing “system preferences”. The app name will be highlighted. Press enter.



- You should see this interface of the System Preferences. Then, click on “Sound”.

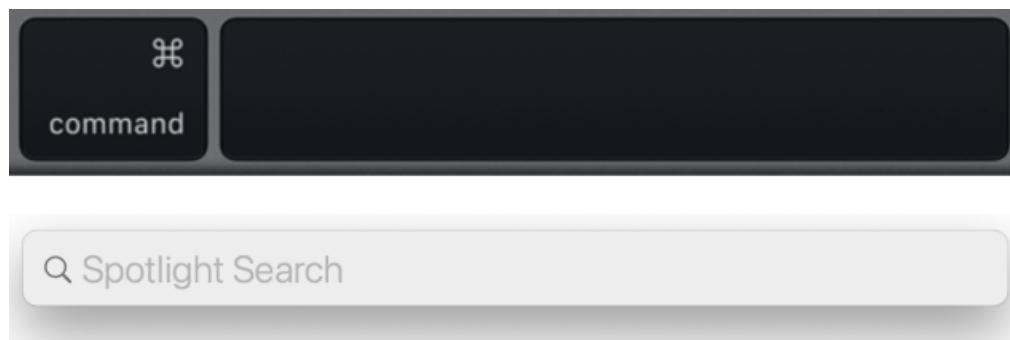


- There are tabs labeled “Output” and “Input”, where you can connect available audio microphone input and volume output sources. **Ensure that both audio input and output are not set to mute.**



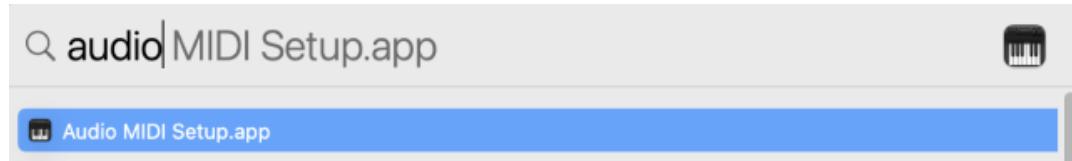
For Audio MIDI Setup:

- To access, press the command and spacebar keys on your keyboard to open Spotlight Search.

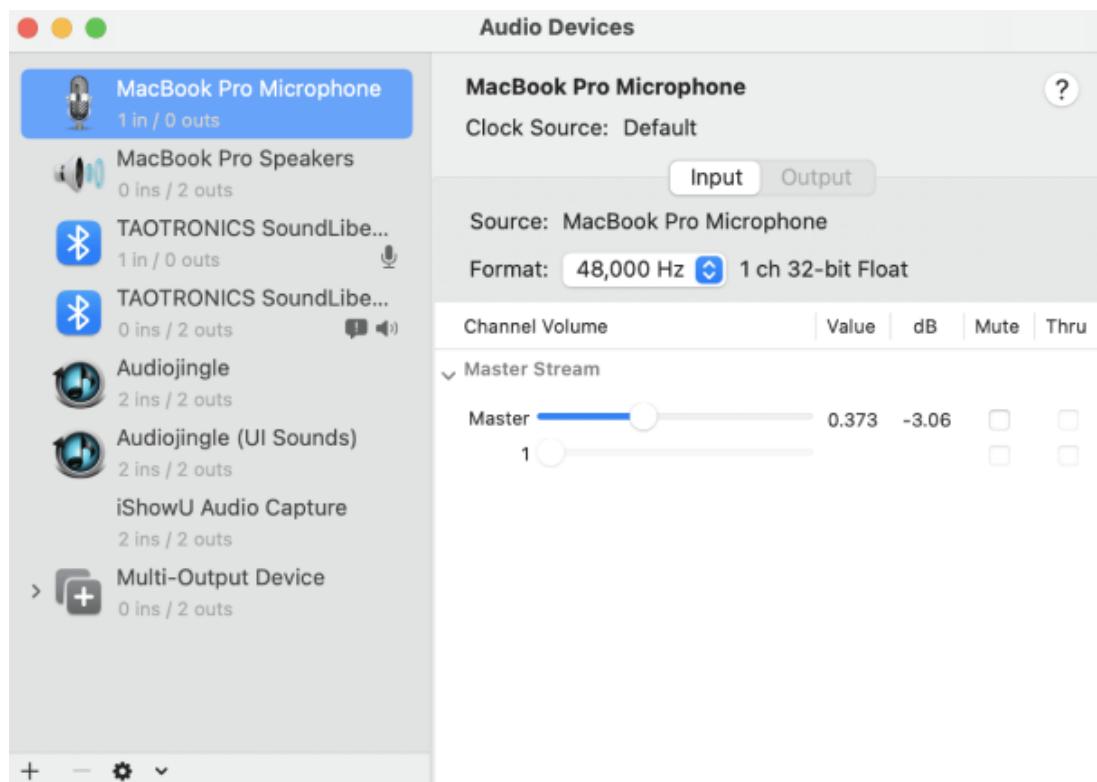


- Start typing “audio midi setup”. The app name will be highlighted.

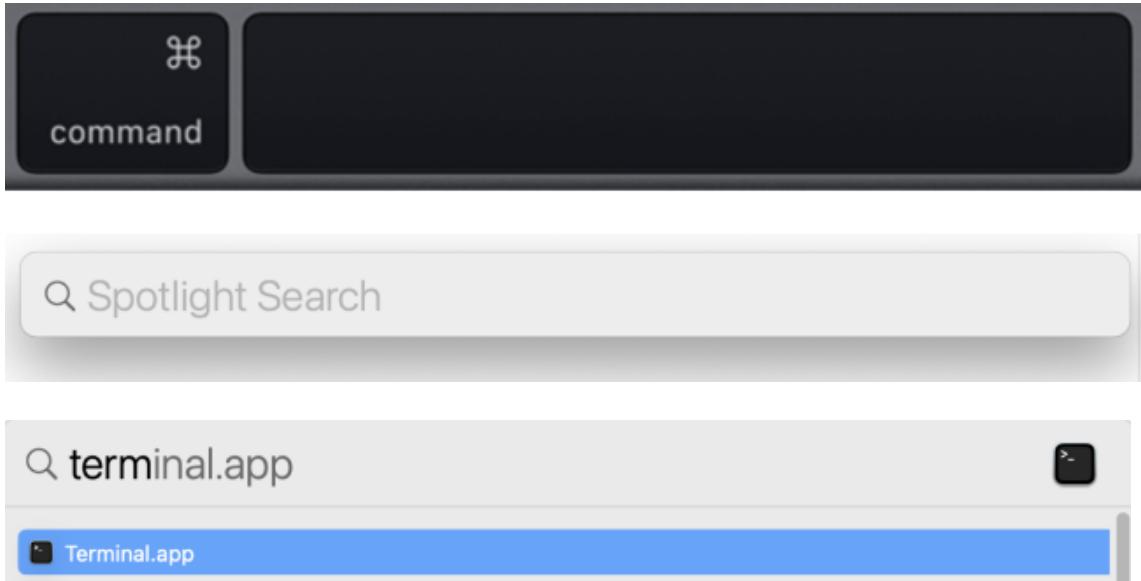
Press enter.



- The image below is the Audio MIDI Setup interface, where you can connect your audio sources for microphone input and volume output and make other changes to sound settings. Ensure that both audio input and output are not muted.



2. After you connected your desired audio sources, return to Spotlight Search (command and spacebar keys on your keyboard). Type in “terminal”, and the application should show up automatically.



3. In the terminal, enter the command “**run_osp**”. You should see 5 terminal tabs automatically opened, running processes, and generating messages without errors. This signifies that OSP is successfully running. You would be automatically redirected to the browser that shows the Node.js version of EWS.

```
— bash — 80x21
~ — -bash      ~ — osp_cli      ~ — osp      ...      ...bin — -bash      ...◀ start-ews      ...      +
Last login: Thu Jul  8 10:23:39 on ttys000
You have new mail.

The default interactive shell is now zsh.
To update your account to use zsh, please run `chsh -s /bin/zsh` .
For more details, please visit https://support.apple.com/kb/HT208050.
(base) MacBook-Pro:~ waynephung$ run_osp
Setting OSP_MEDIA to /Library/OSP/1.4.2/release/media

Running all processes in Terminal tabs.

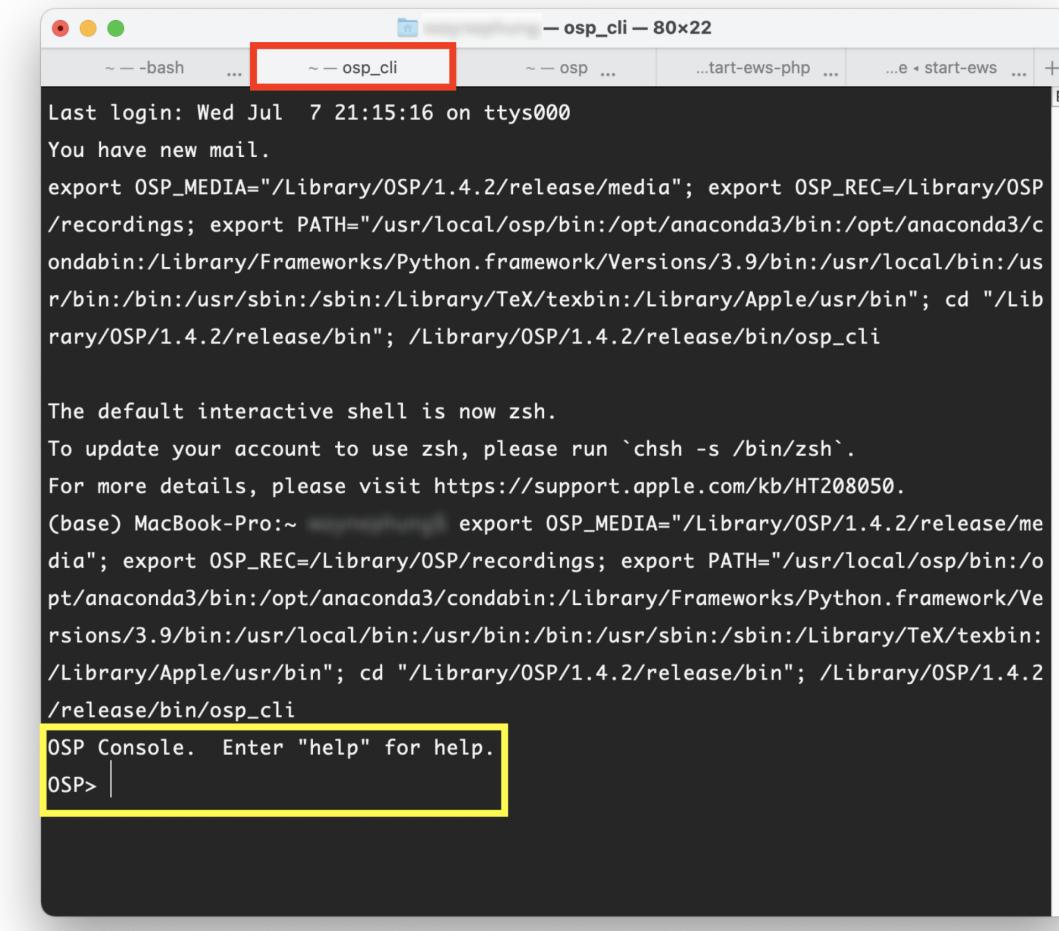
If you get 'execution error: Not authorized to send Apple events..
Then you must goto
System Preferences -> Security & Privacy -> Privacy -> Automation
and check the Terminal/System Events checkbox.
You might also need to go to
System Preferences -> Security & Privacy -> Privacy -> Accessibility
and check the Terminal box

Warning: closing tabs may not stop the running process.
```

4. You may hear an increase in background noise. Try speaking to your microphone/audio input source and you should be able to hear yourself speaking.



5. Return to the terminal and click on the tab named “**osp_cli**”.



```
Last login: Wed Jul  7 21:15:16 on ttys000
You have new mail.

export OSP_MEDIA="/Library/OSP/1.4.2/release/media"; export OSP_REC=/Library/OSP
/recording; export PATH="/usr/local/osp/bin:/opt/anaconda3/bin:/opt/anaconda3/c
ondabin:/Library/Frameworks/Python.framework/Versions/3.9/bin:/usr/local/bin:/us
r/bin:/bin:/usr/sbin:/sbin:/Library/TeX/texbin:/Library/Apple/usr/bin"; cd "/Lib
rary/OSP/1.4.2/release/bin"; /Library/OSP/1.4.2/release/bin/osp_cli

The default interactive shell is now zsh.
To update your account to use zsh, please run `chsh -s /bin/zsh` .
For more details, please visit https://support.apple.com/kb/HT208050.
(base) MacBook-Pro:~      export OSP_MEDIA="/Library/OSP/1.4.2/release/me
dia"; export OSP_REC=/Library/OSP/recording; export PATH="/usr/local/osp/bin:/o
pt/anaconda3/bin:/opt/anaconda3/condabin:/Library/Frameworks/Python.framework/Ve
rsions/3.9/bin:/usr/local/bin:/usr/bin:/bin:/usr/sbin:/sbin:/Library/TeX/texbin:
/Library/Apple/usr/bin"; cd "/Library/OSP/1.4.2/release/bin"; /Library/OSP/1.4.2
/release/bin/osp_cli

OSP Console. Enter "help" for help.
OSP>
```

6. Enter the command “**play**”, and press return/enter. You should hear an audio file played. You should also see parameters and the word “success” in the terminal.

```
OSP> play
Sending {"method": "set", "data": {"left": {"audio_file_name": "tomsdiner.wav", "audio_play": 1, "alpha": 1}, "right": {"alpha": 1}}}
success
OSP>
```

7. To immediately stop the audio file playing, type in the command “**stop**” and press return/enter. You should hear an audio file played. You should also see parameters and the word “success” in the terminal.

```
[OSP> stop
]
Sending {"method": "set", "data": {"left": {"audio_play": 0}}}
success
OSP>
```

3.2 - Checking Node.js version of EWS

The steps below assume that you have already:

- executed the command “**run_osp**” to successfully launch OSP.
- properly set up your audio input and output sources such as microphone, speakers, headphones, etc.

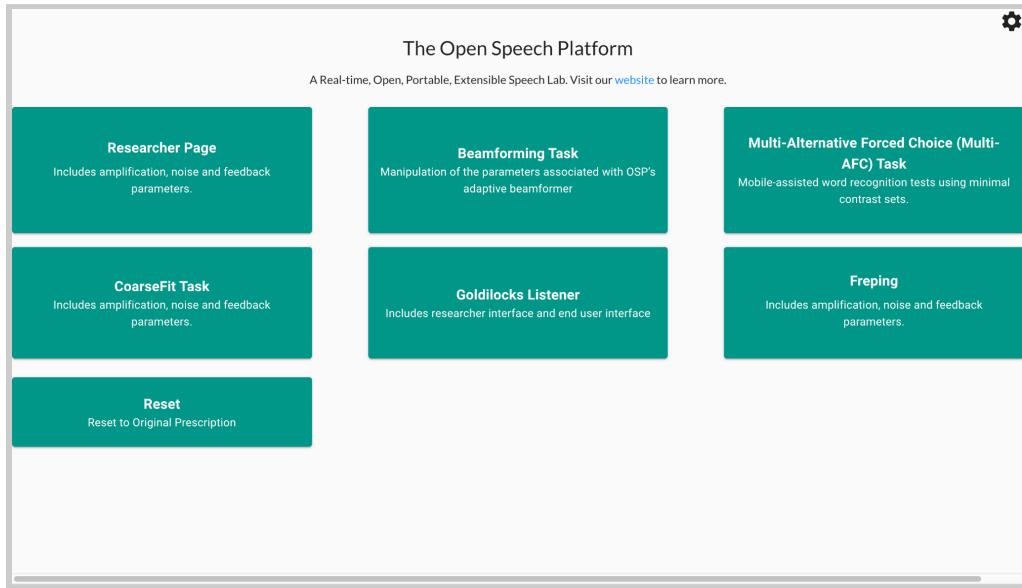
You will see images that depict the desktop version of EWS, but the steps apply similarly when using EWS on mobile and tablet devices.

1. Go to a new browser tab, type in “<http://localhost:5000>”, and press enter.

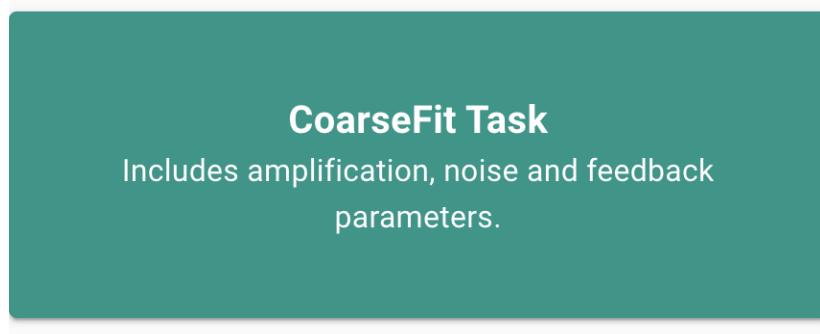
If you have the OSP hardware already set up, the URL will be different. Try one of the following.

- a. <http://ospboard.local:5000>
- b. <http://ospboard.lan:5000>
- c. [http://\[IP_ADDRESS\]:5000](http://[IP_ADDRESS]:5000)

The IP address found from the **ifconfig** command, For example, if your IP address is “192.168.8.1”, you would enter **“<http://192.168.8.1:5000>”**

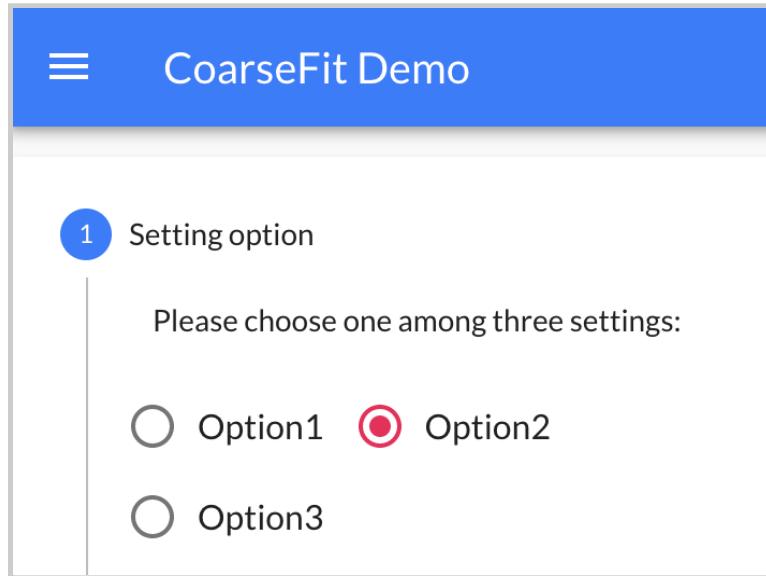


2. You will test out EWS and RT-MHA by accessing and using a series of demos. First, try to access the CoarseFit demo. To do so, select a button labeled “CoarseFit Task”. On mobile, you may need to scroll down to find this button before selecting.



3. You can select one of three coarse adjustment options.
 - a. **Option 1:** Worst band hearing loss, based on the range of worst hearing loss level.

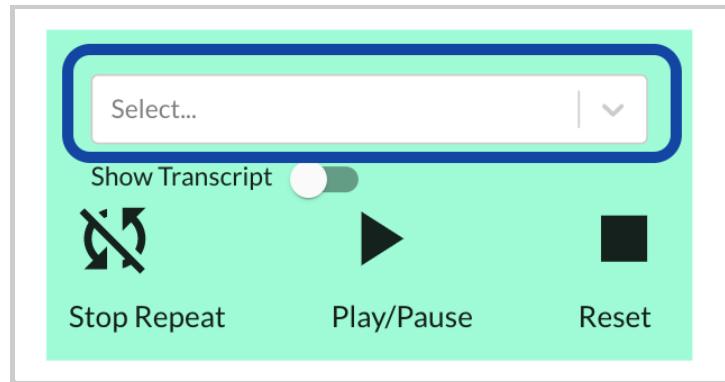
- b. **Option 2:** All band average hearing loss, based on the range of average hearing loss level.
- c. **Option 3:** Four band average hearing loss, for four frequencies: 500, 1000, 2000, 4000 Hz.



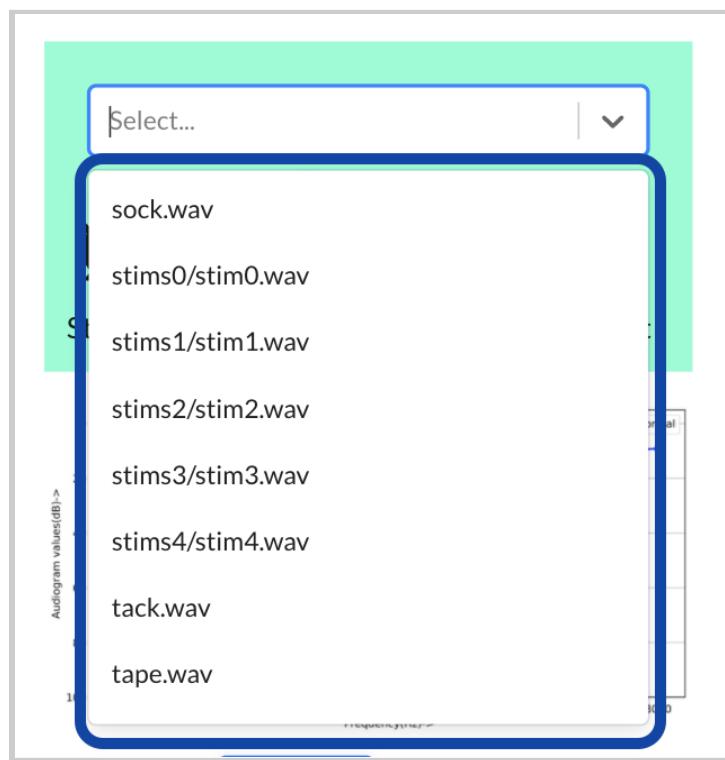
4. Select the “Next” button to proceed to the next part of CoarseFit.

NEXT

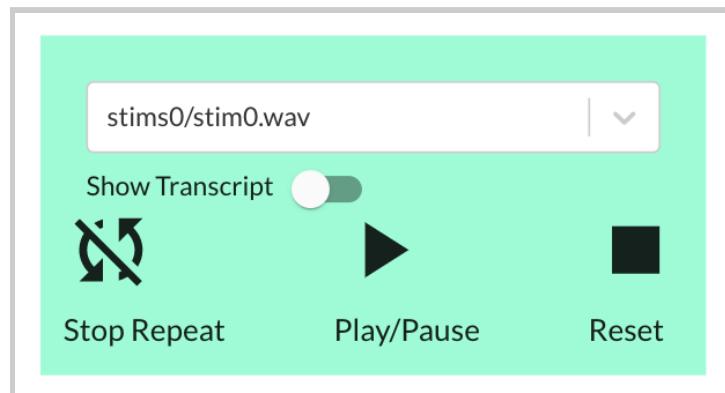
5. Select the dropdown menu.



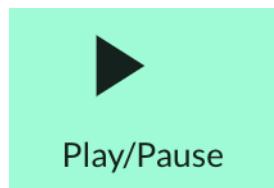
You should be able to view and select one of the available audio files.



Scroll down to find and select a file named “stims0/stim0.wav”.



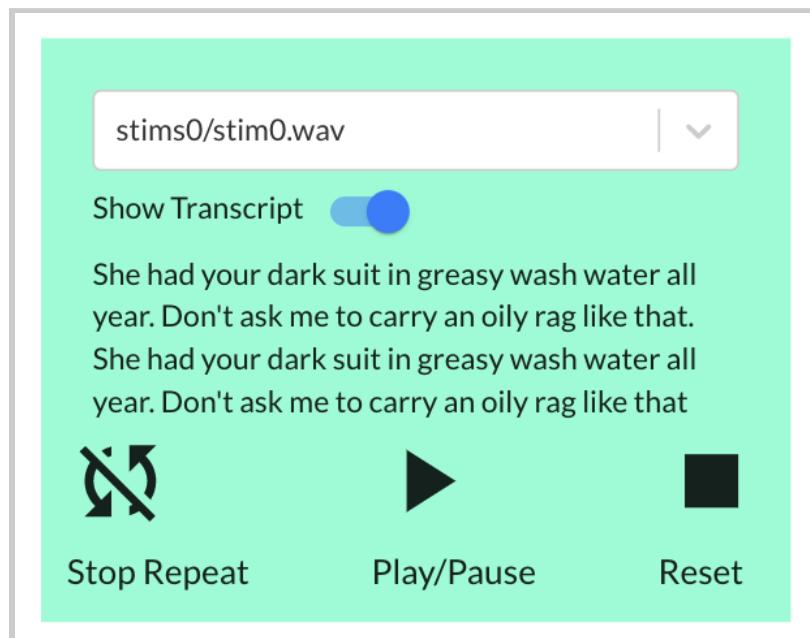
6. Select the “Play/Pause Button” to play the audio file. You should be able to hear sound. Adjust the volume on your computer accordingly until you can comfortably listen to the audio file.



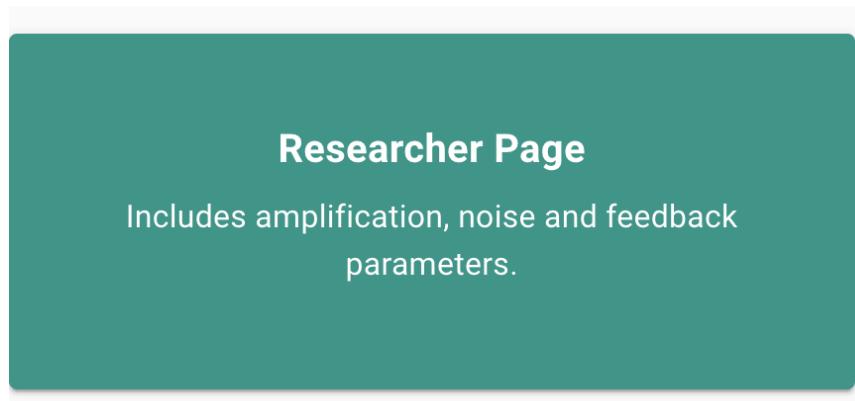
You can then select a different hearing loss profile (normal, mild, medium, severe, profound). You should perceive changes to the overall volume level.



7. Only files named “stims#/stims#” have transcripts. You can select the toggle next to the label “Show Transcript” to show a transcription of the audio file.



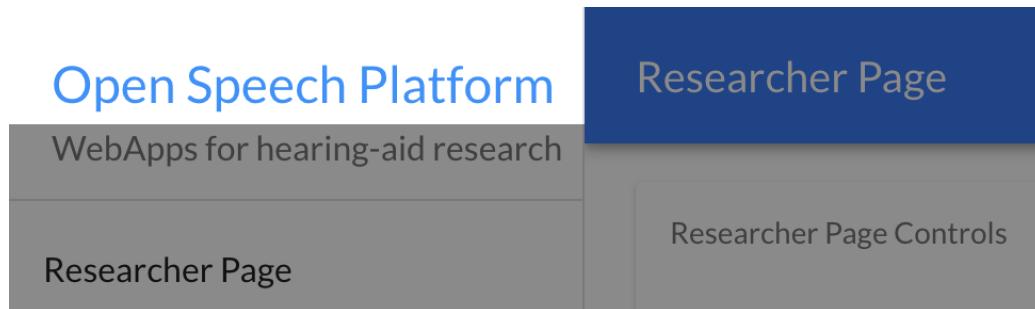
8. When you are finished with the CoarseFit demo, you will then learn how to access the global RT-MHA settings, how to switch the available frequency bands, and verify that the frequency bands show up correctly for the other apps and demos. First, navigate to the Researcher Page demo by selecting the button labeled “Researcher Page”.



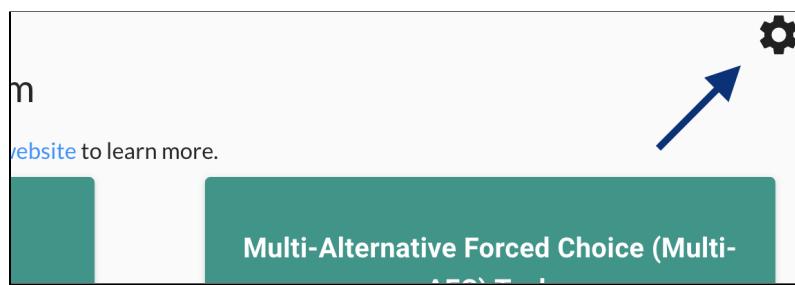
9. Notice that under “Parameter Settings”, there are six column headers showing the values of the center frequency bands (in Hertz): 250, 500, 1000, 2000, 4000, and 8000

Parameter Settings					
250	500	1000	2000	4000	8000

10. Select “Open Speech Platform” on the upper left corner to navigate back to the landing page.

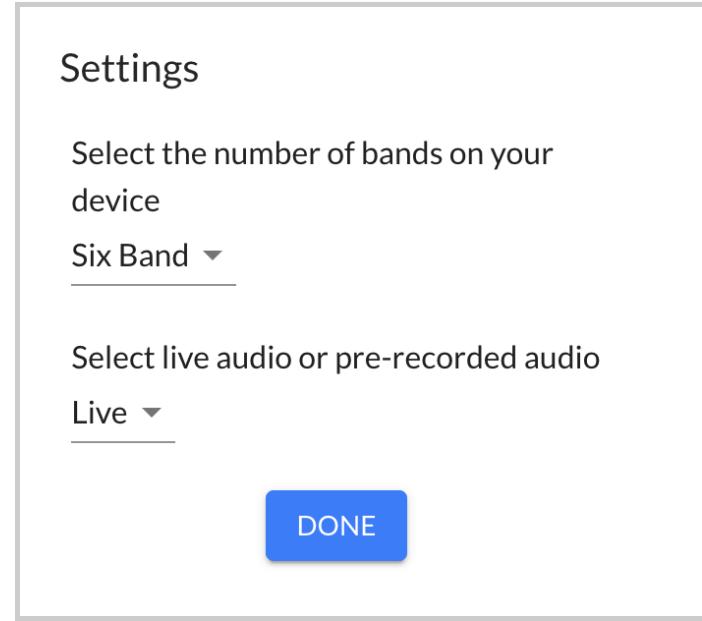


11. From the landing page, select the gear icon in the upper-right corner of the screen.

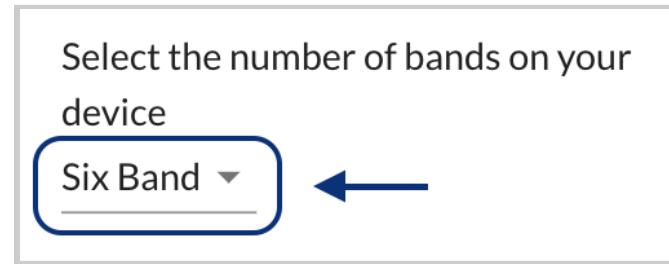


You will see a popup with two different settings, one for selecting the number of bands and one for selecting the type of

audio. These are treated as global settings from RT-MHA.



12. Select the top-most dropdown menu (labeled “Six Band” by default) to change from “Six Band” to “Ten Band”.



Settings

Select the number of bands on your

Six Band

Ten Band

Select the number of bands on your device

Ten Band ▾

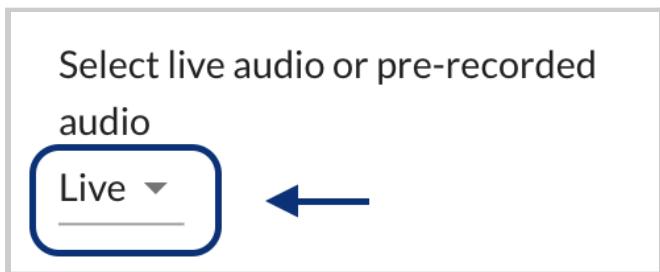
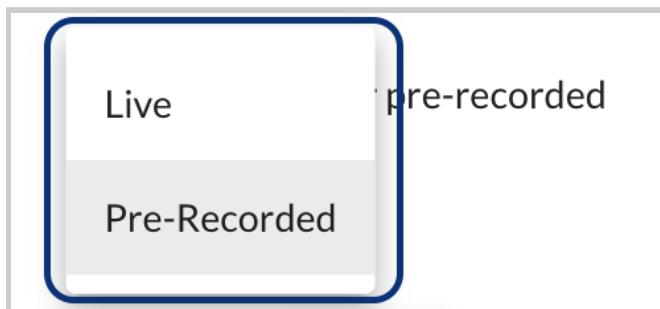


13. Under “Select live or pre-recorded audio”, make sure that you see “Live”. If the label shows “Pre-Recorded”, select the dropdown menu to change to “Live”.

Select live audio or pre-recorded audio

Pre-Recorded ▾





You should try speaking to see if you can hear feedback from the source audio input (e.g. microphone).

14. Exit the settings interface by selecting the “Done” button or selecting the gray area outside of the settings interface.



You will see a message that confirms your saved settings.

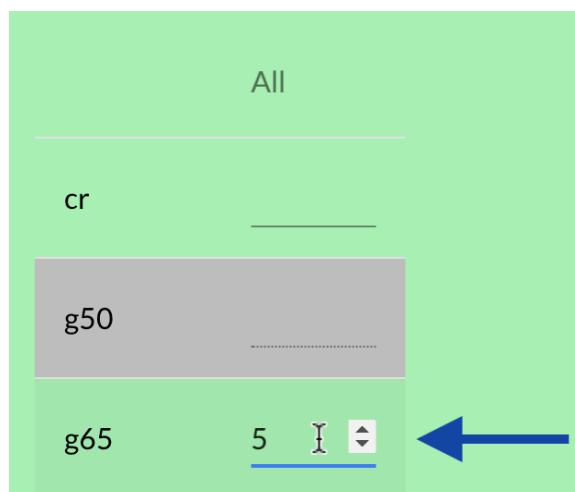
Now using 10 band mode with live audio

OK

15. Return to the Researcher Page by selecting the button with the same label. In the “Parameter Settings” table, you should now see ten column headers instead of six for the center frequencies: 250, 500, 750, 100, 2000, 3000, 4000, 6000, 8000

250 500 750 1000 1500 2000 3000 4000 6000 8000

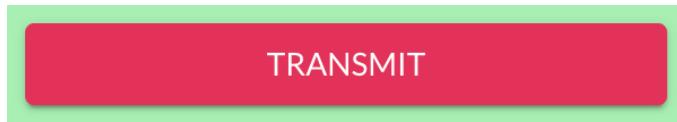
16. Select the horizontal line that aligns with “All” and “g65” and enter a value of 5.



You will notice that all values within the “g65” row for all of the center frequencies (200 to 8000) will all change to 5.

g65	5	5	5	5	5	5	5	I	▼
-----	---	---	---	---	---	---	---	---	---

17. Below the table, you will see two buttons labeled “Pull” and “Transmit”. Select the “Transmit” button. You should now hear changes to the live audio input.



18. At this point, you can explore the other demos in the OSP software. Other sections of this document will explain in greater detail how each demo should work.

3.3 - Checking PHP/Laravel Version of EWS

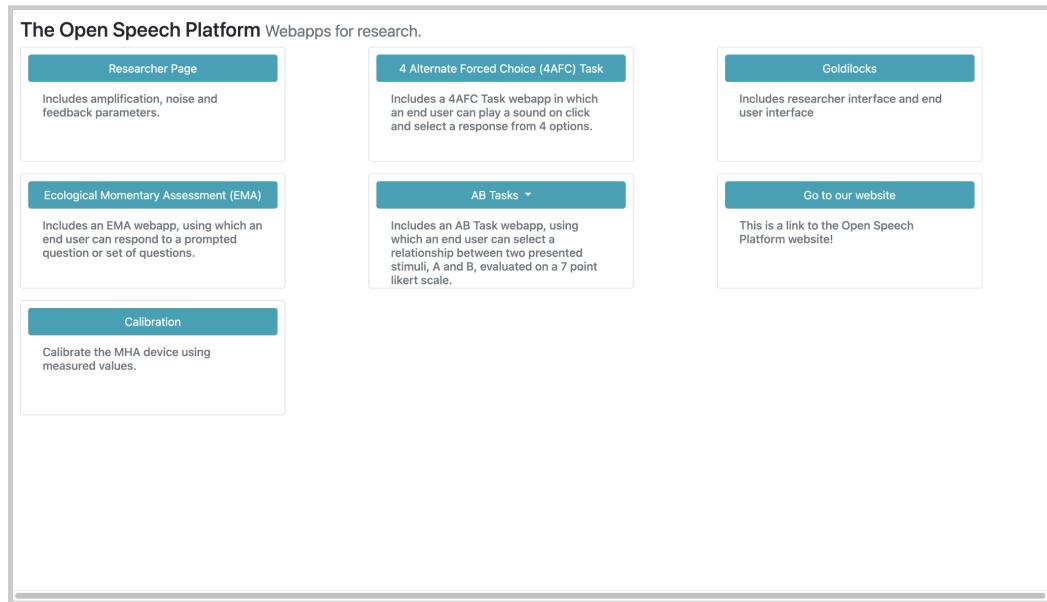
1. Go to a new browser tab, type in “<http://localhost:8080>”, and press enter. You should see the legacy version of EWS, as shown below.

If you have the OSP hardware already set up, the URL will be different. Try one of the following.

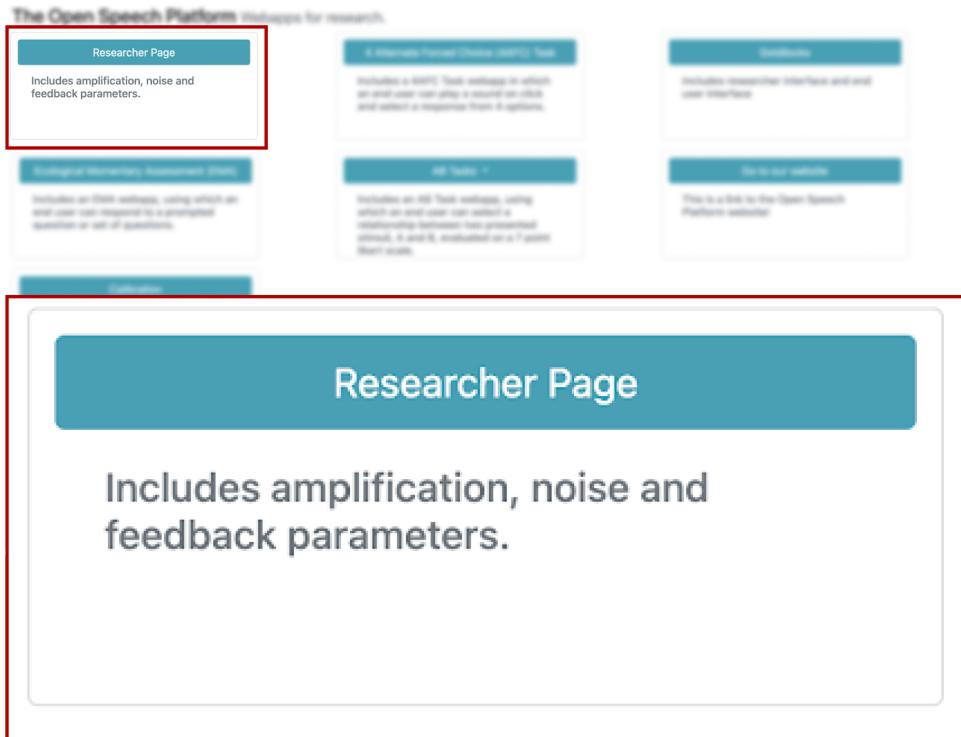
- a. <http://ospboard.local>

- b. **http://ospboard.lan**
- c. **http://[IP_ADDRESS]**

The IP address found from the **ifconfig** command, For example, if your IP address is “192.168.8.1”, you would enter **“http://192.168.8.1”**.



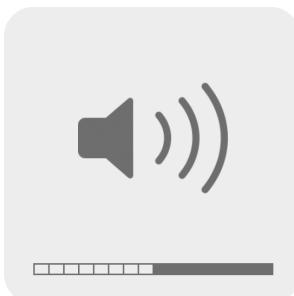
2. In the upper-right hand corner, click on the button labeled “Researcher Page”.



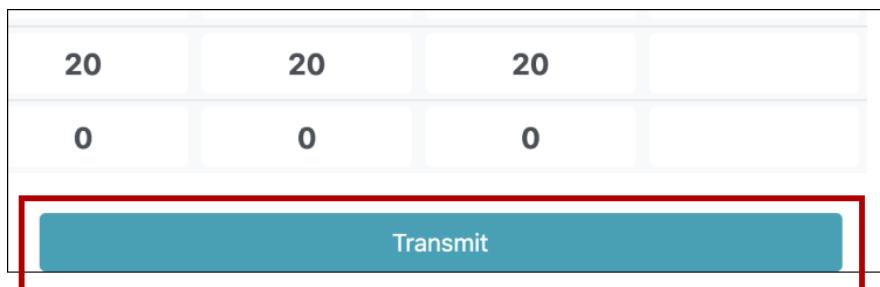
3. You should see this screen for the Researcher Page, within "Amplification".

Parameter	250	500	1000	2000	4000	8000	All
CR	1	1	1	1	1	1	1
G50	0	0	0	0	0	0	0
G65	0	0	0	0	0	0	0
G80	0	0	0	0	0	0	0
Knee	45	45	45	45	45	45	45
MPO	120	120	120	120	120	120	120
Attack	5	5	5	5	5	5	5
Release	20	20	20	20	20	20	20

- At this point, you should have an audio input and output source connected to your computer and ready for listening. If not, refer to the previous section "[3.1 - Checking Your Audio Devices](#)". Make sure that your audio output is not muted.



- Scroll to the bottom of the page and click on the "Transmit" button. Then, speak into your computer or headset's microphone and listen for immediate audio feedback.

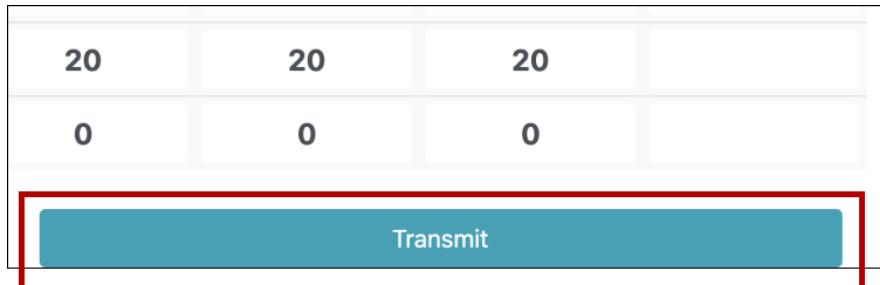


6. Scroll back up and view the “Controls” settings. Next to “Control Via:”, click on CR/G65. Then, in the boxed cell within the “All” column and “G65” row, type in “5”. Notice the change in values.

Changing the value in the boxed cell to “5” should change the gain for “g65” to be 5 decibels (dB SPL) across all frequency bands (250 to 8000 Hertz).



7. Scroll to the bottom of the page and click on the “Transmit” button again. Speak into your computer or headset’s microphone and listen for immediate audio feedback. Notice the differences in volume.



4 - The Embedded Web Server (EWS)

4.1 - Introduction

At this time, EWS features these apps and demos.

- [Multiple Alternative Forced Choice \(Multi-AFC\)](#)
- [Beamforming](#)
- [CoarseFit](#)
- [Freping](#)
- [Researcher Page](#)

Other features include:

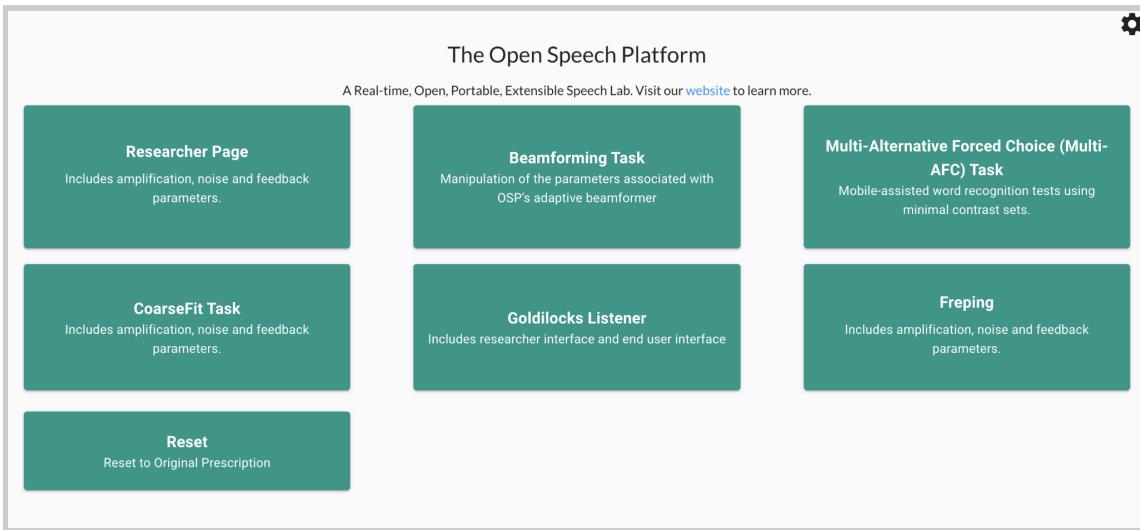
- [Ability to switch between 6 and 10 frequency bands.](#)
- [Ability to switch between pre-recorded and live audio.](#)
- [Profile Selection](#)

All of these features can be selected in the landing page.

The screenshot shows a mobile landing page for 'The Open Speech Platform'. At the top, there's a header with a gear icon and the text 'The Open Speech Platform'. Below the header, a sub-header reads: 'A Real-time, Open, Portable, Extensible Speech Lab. Visit our [website](#) to learn more.' The main content area is divided into three sections, each with a teal background and white text:

- Researcher Page**
Includes amplification, noise and feedback parameters.
- Beamforming Task**
Manipulation of the parameters associated with OSP's adaptive beamformer
- Multi-Alternative Forced Choice (Multi-AFC) Task**
Mobile-assisted word recognition tests

Scrollable landing page via mobile view.



Landing page via desktop view.

4.2 - Background Behind OSP Software

The software of the Open Speech Signal Processing Platform (OSP) primarily consists of two main components (also see *Figures 4.1 and 4.2*):

- **Real Time Master Hearing Aid (RTMHA)** - This is the hearing-aid algorithm which takes the audio from the environment and modifies it to the listener's specific prescription.
- **Embedded Web Server (EWS)** - This is a graphical user interface that can control the RTMHA algorithm, hosted on any web browser-enabled device. There are two versions of EWS, written in two different programming languages: Node.js and PHP/Laravel. The Node.js version is currently being developed and will eventually replace the PHP version.

Figure 4.1: A high-level overview of the OSP architecture. It shows the relationship between the OSP hardware, how it processes audio input for a person to listen to, and the usage of a browser-based interface to manipulate the software within the hardware.

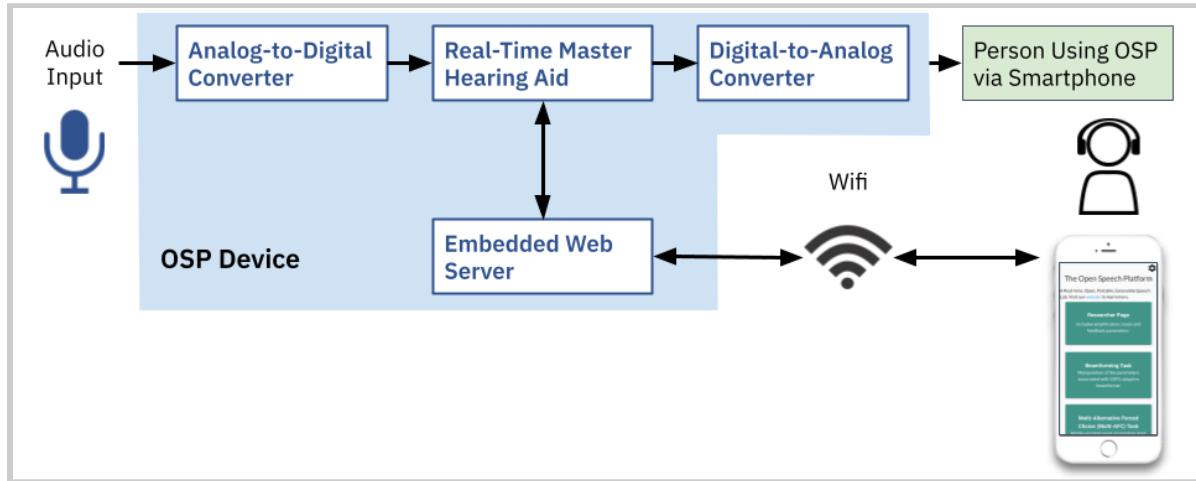
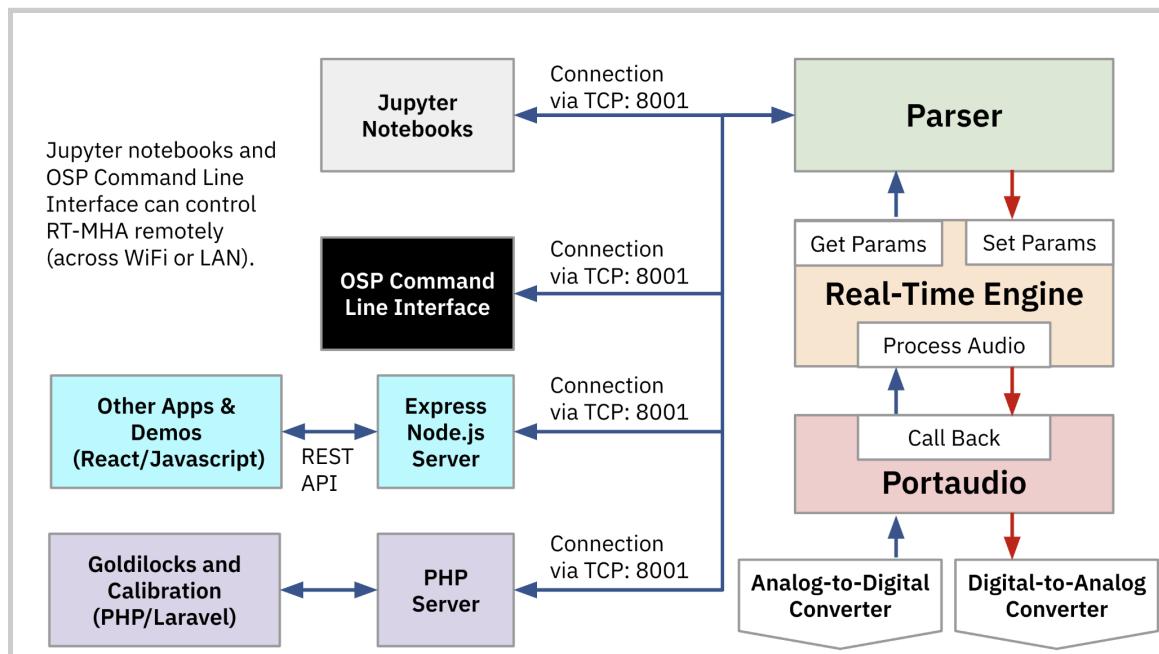


Figure 4.2: A more detailed framework of the Real-Time Master Hearing Aid.



4.3 - Multiple Alternative Forced Choice (Multi-AFC)

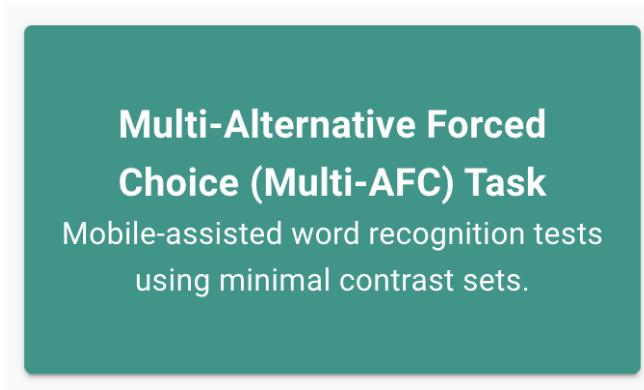
4.3.1 - Introduction to Multi-AFC

Multi-AFC administers a multiple choice test where a person would listen to a series of word-based audio files and choose words that they have heard; it is based on the Modified Rhyme Test (MRT) and consists of three parts:

1. **Test Settings** - A person would be able to set up the test by selecting 1 of 45 of MRT word files, amount of test questions to present, and question order.
2. **The Test** - An audio file would automatically play, which contains one of the six word answer choices. The person can hear the audio file and select one of the six answer choices based on the word that they heard. They repeat the test until they have answered all of the test questions.
3. **Results** - After the person finishes the test, they can see which set of words they answered (in)correctly and their overall percentage score for word-level accuracy.

To access Multi-AFC, either:

- Select a button labeled “Multi-Alternative Forced Choice (Multi-AFC) Task” in the landing page. On mobile, you may need to scroll down before selecting.



- Select the label “Multi-AFC” within the left sidebar.

A screenshot of the 'Open Speech Platform' mobile application. The top navigation bar is blue and contains the text 'Multi-AFC Demo'. The main content area is titled 'Multi-AFC Demo'. Step 1, 'Settings for Multi-AFC Test', includes fields for 'Stimuli Selection here:' (set to 'MRT_1') and 'Number of Test Questions:' (set to '4'). Step 2, 'Multi-AFC Test', is partially visible at the bottom. On the left, a sidebar lists several demo options: 'Researcher Page', 'CoarseFit Demo', 'Freping Demo', 'Beamforming Demo', 'Multi-AFC Demo' (which is highlighted with a blue box and has a blue arrow pointing to it), and 'Reset'.

Open Speech Platform
WebApps for hearing-aid research

Researcher Page

CoarseFit Demo

Freping Demo

Beamforming Demo

Multi-AFC Demo

Reset

Multi-AFC Demo

1 Settings for Multi-AFC Test

Stimuli Selection here:
Select the stimuli you would like to use for the test.
MRT_1

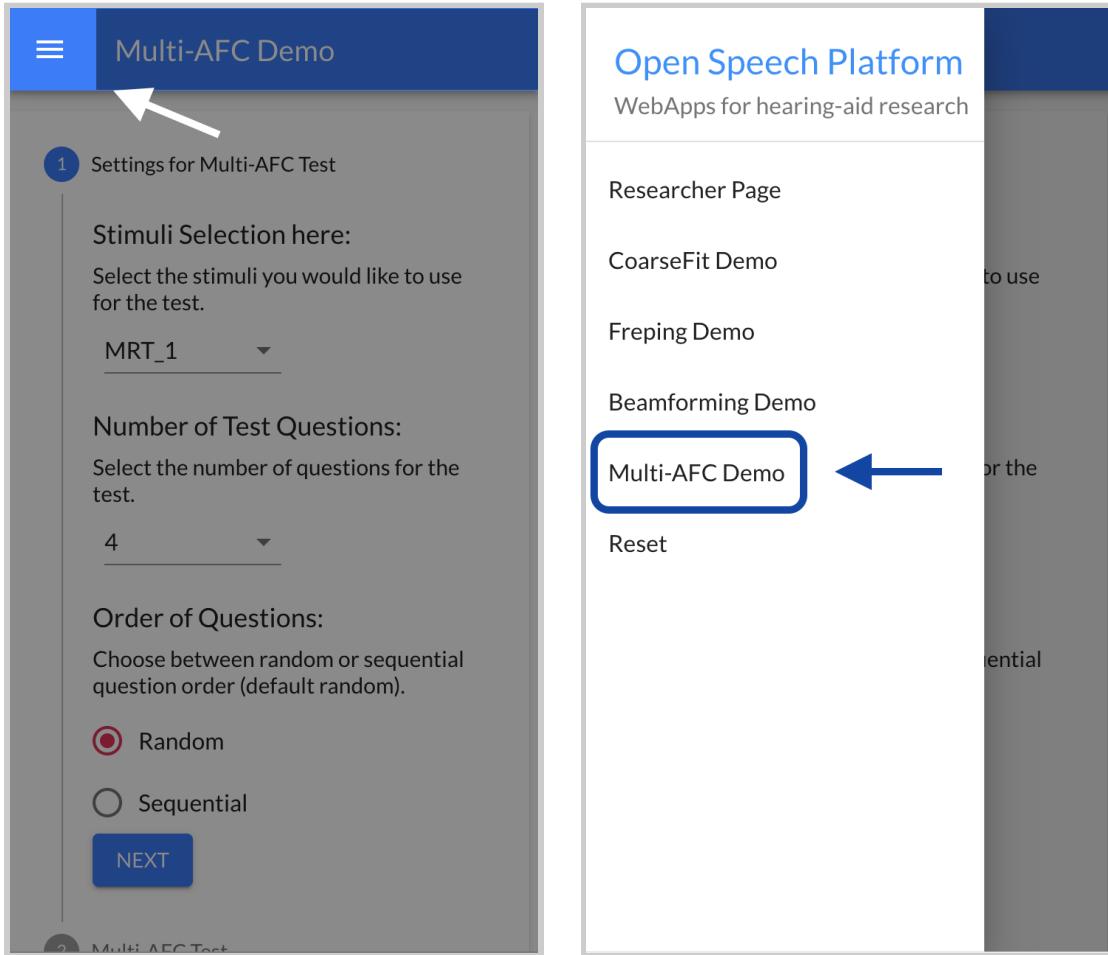
Number of Test Questions:
Select the number of questions for the test.
4

Order of Questions:
Choose between random or sequential question order (default random).
 Random
 Sequential

NEXT

2 Multi-AFC Test

On mobile, the sidebar appears when you first tap the hamburger menu icon on the upper left-hand corner of the screen.

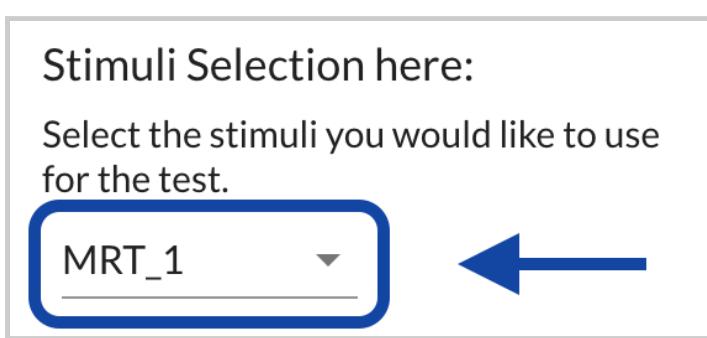


4.3.2 - Multi-AFC Test Settings

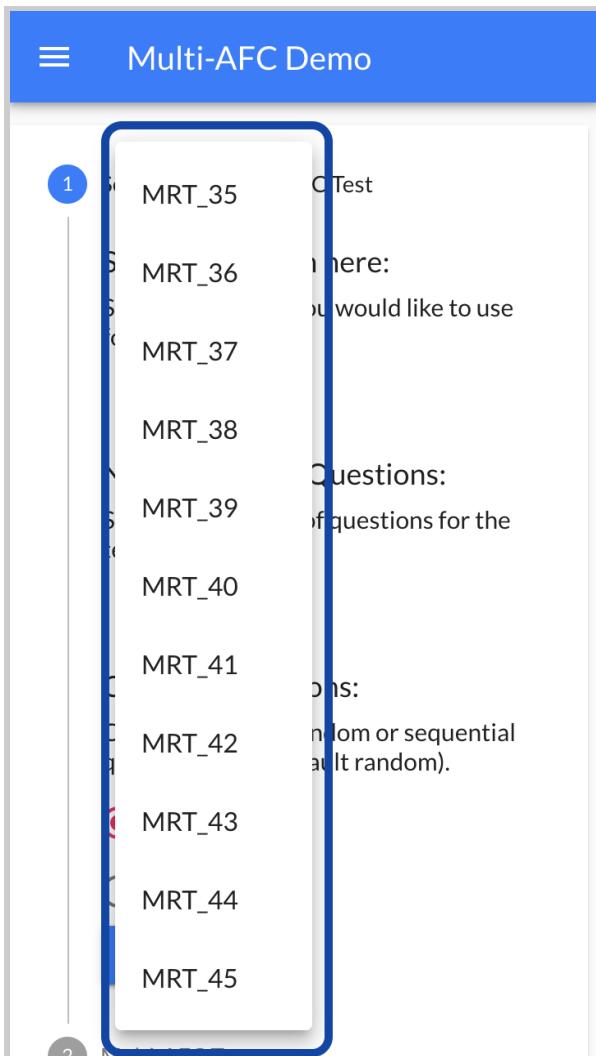
Before you begin a test within Multi-AFC, you are given three different settings on setting up the test.

The screenshot shows a mobile application titled "Multi-AFC Demo". The main screen has a blue header bar with three horizontal lines on the left and the text "Multi-AFC Demo" next to it. Below the header, there is a numbered list "1 Settings for Multi-AFC Test".
Stimuli Selection here:
Select the stimuli you would like to use for the test.
A dropdown menu is open, showing "MRT_1" as the selected option, with a small arrowhead pointing down to indicate it can be changed.
Number of Test Questions:
Select the number of questions for the test.
A dropdown menu is open, showing "4" as the selected option, with a small arrowhead pointing down to indicate it can be changed.
Order of Questions:
Choose between random or sequential question order (default random).
Two radio buttons are shown: "Random" (selected, indicated by a red dot) and "Sequential".
At the bottom right is a blue button labeled "NEXT".

- To select which set of words to present as test questions, go to the dropdown menu in “Stimuli Selection here”. There should be a small arrowhead sign pointing down.



Then, select one of the 45 available Modified Rhyme Test (MRT) word sets. Each word set has a pre-defined order of words to present for each test question. By default “MRT_1” is selected.



Stimuli Selection here:

Select the stimuli you would like to use for the test.

MRT_40 ▾

- You can also select 4 (default), 8, 16, or 32 questions for the test.

Number of Test Questions:

Select the number of questions for the test.

4 ▾

Number of Test Questions:

Select the number of questions for the test.

4

8

16

32

- By default, the questions presented would be randomized. You also have the option to present the questions in the sequential order of the selected MRT word set.

When you are satisfied with the current settings, click or tap the “Next” button to begin your test.

Order of Questions:

Choose between random or sequential question order (default random).

Random

Sequential

NEXT

4.3.3 - The Multi-AFC Test

Once you begin the test, you should see:

1. A sentence describing the instructions. (“*Please click the word you heard:*”)

Please click the word you heard:

2. A small gray circle with a question mark. When hovered over, you should see a message that clarifies the instructions.



word you heard: ?

Click the play button to hear the audio, then choose the word that matches best to the audio

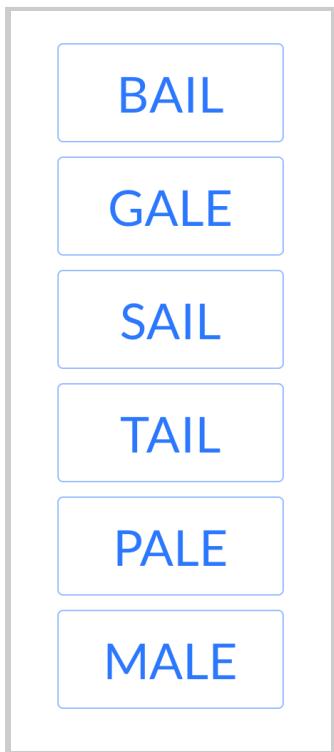
3. A horizontal line. This is a progress bar that would help you indicate your current completion of the test.



4. A large, clickable circle with a play icon. This would enable you to listen to the audio file that was played for the correct word.



5. Six different words as selectable answer choices.

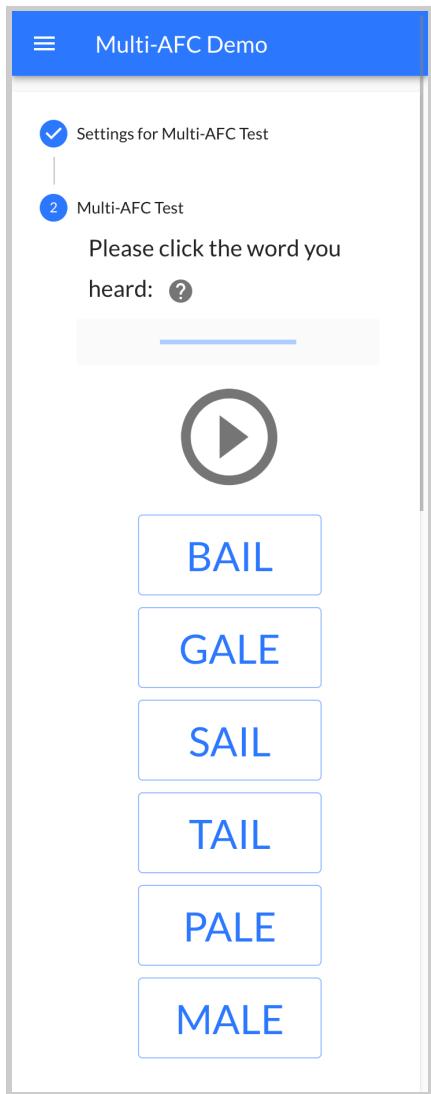


You may need to scroll down to view all of the answer choices.

The screenshot shows a web-based application titled "Multi-AFC Demo" from the "Open Speech Platform". The sidebar on the left lists various demo options: Researcher Page, CoarseFit Demo, Freping Demo, Beamforming Demo, Multi-AFC Demo, and Reset. The main content area is titled "Multi-AFC Demo" and contains two sections: "Settings for Multi-AFC Test" (with a checked checkbox) and "Multi-AFC Test". In the "Multi-AFC Test" section, there is a text input field asking "Please click the word you heard:" followed by a question mark icon. Below this is a large play button icon. A horizontal line indicates where the user should type their response. Six options are listed below the play button: BAIL, GALE, SAIL, TAIL, PALE, and MALE.

Interface of test in desktop view.

Interface of test in mobile view.



When starting each question, the audio file would be automatically played and you would be able to hear the word that was spoken. Then, you would select one of the six words that correctly represents the word heard. You would then move on to the next question, hear a different word, and repeat answering the word heard until you have gone through all of the questions.

4.3.4 - Test Results

After you have answered all of the questions, you will be presented with your word-level accuracy score, shown as a percentage.

You can also view the questions that you were asked, your answers, and the correct answers. Questions that were answered incorrectly would be highlighted in yellow.

You are finished

Word-Level Accuracy: 50.00%

Answer Options	Your Answer	Correct Answer
(A) bail · (B) gale · (C) sail · (D) tail · (E) pale · (F) male	bail	sail
(A) ray · (B) raise · (C) rate · (D) rave · (E) rake · (F) race	rake	rake
(A) fun · (B) sun · (C) bun · (D) gun · (E) run · (F) nun	sun	nun
(A) save · (B) same · (C) sale · (D) sane · (E) sake · (F) safe	sane	sane

CLICK TO RESTART TEST!

There is a “CLICK TO RESTART TEST!” button that will take you back to Multi-AFC settings.

4.4 - Beamforming

Beamforming uses signals from the left and right microphone to amplify the voice of the person you are looking at and listening to.

4.4.1 - Background on How People Hear In General

When the person speaking to you is directly in front of you, their sound should arrive at the same time to both ears. However, if the person is speaking to the right of you, their sound will arrive to your right ear before it arrives to your left ear. The sound will have a lower amplitude in the left ear as well.

4.4.2 - Introduction to Beamforming Capabilities

With beamforming enabled, the OSP's hearing aid algorithm:

- looks at the differences in time of arrival (amplitude) between the left and right ear
- boosts the signals coming from the front
- suppresses all other signals at different levels, improving signal clarity

Beamforming is best used:

- with OSP hardware
- when there is a talker and a source for audio interference

4.4.3 - How Beamforming Works

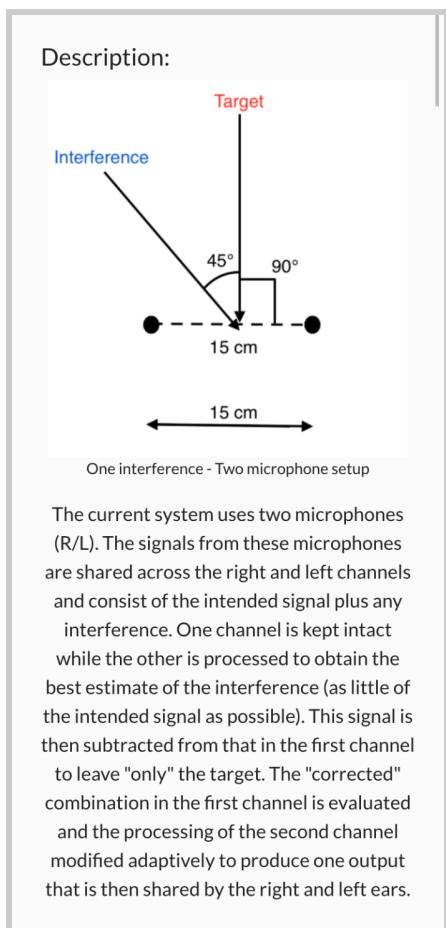
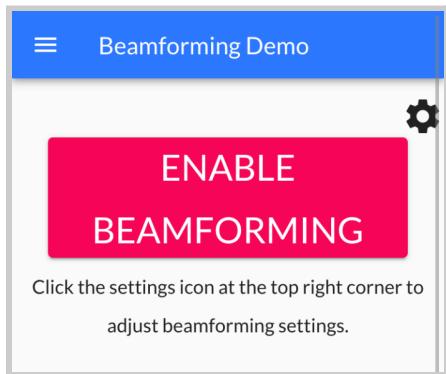
For OSP, there would be two microphones (left and right), with two signals shared across both left and right channels.

- The signal for the first channel incorporates both audio interference and the intended signal.
- The signal for the second channel incorporates both audio interference and *very little* of the intended signal. This channel is processed to obtain the best estimate of the interference. It would be processed adaptively to achieve a minimum on (some parameter).

Both channels are “subtracted” into an audio output signal in one channel, with natural interaural level and time differences removed. This output would be shared with both left and right ears.

More technical information can be found from [this poster “Noise Management Features in Open Speech Platform”](#).

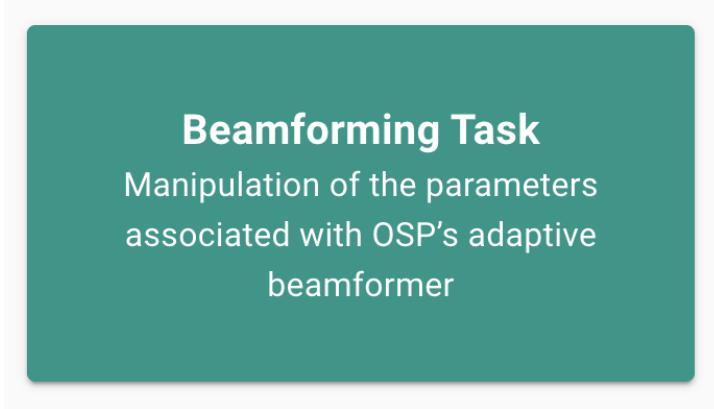
General interface for beamforming, which consists of an “Enable/Disable Beamforming Button”, a gear icon for beamforming settings, and a description of beamforming.



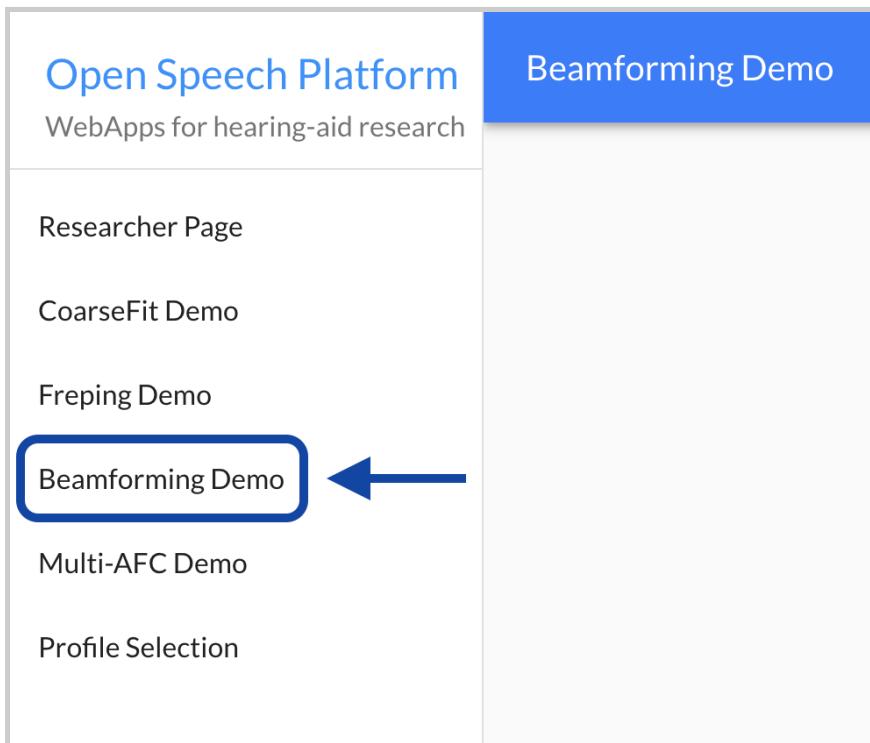
4.4.4 - Beamforming Interface

To access beamforming, either:

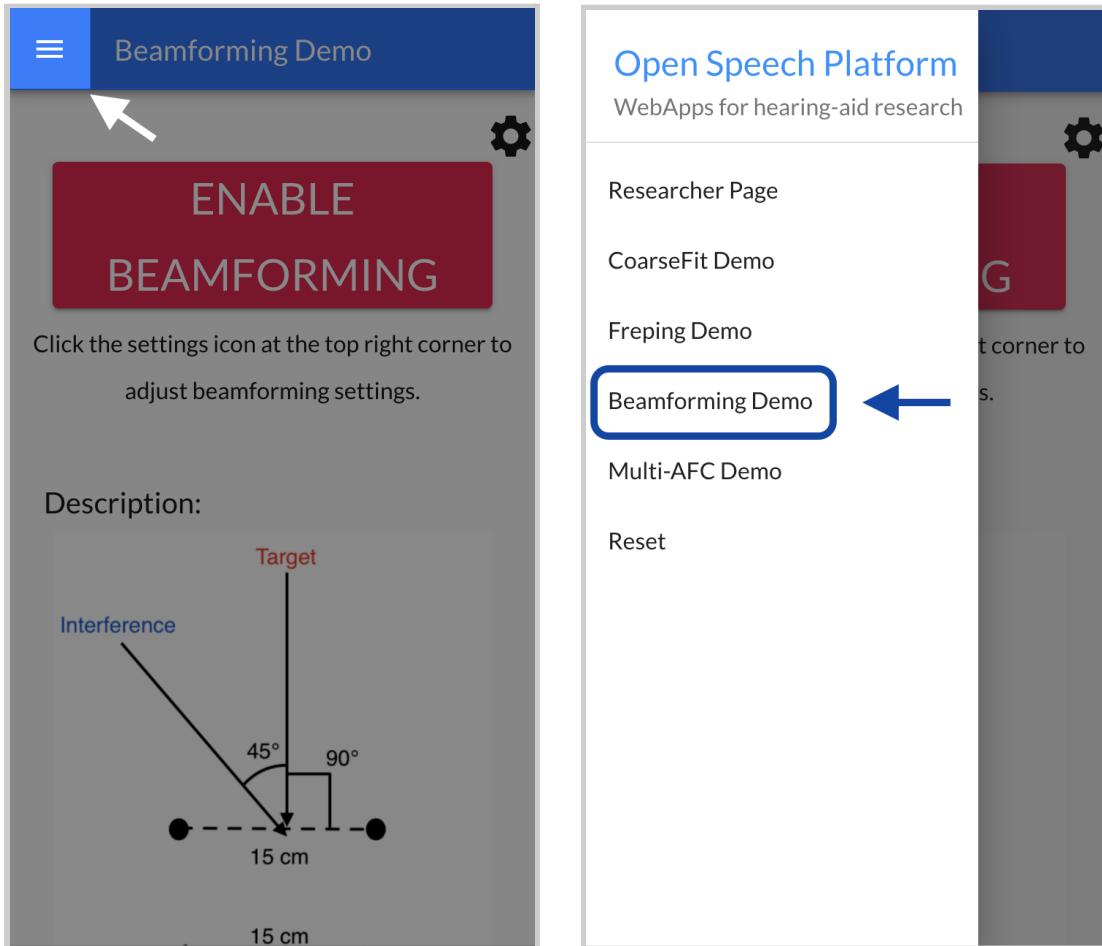
- Select a button labeled “Beamforming Task” in the landing page. On mobile, you may need to scroll down before selecting.



- Select the label “Beamforming Demo” within the left sidebar.

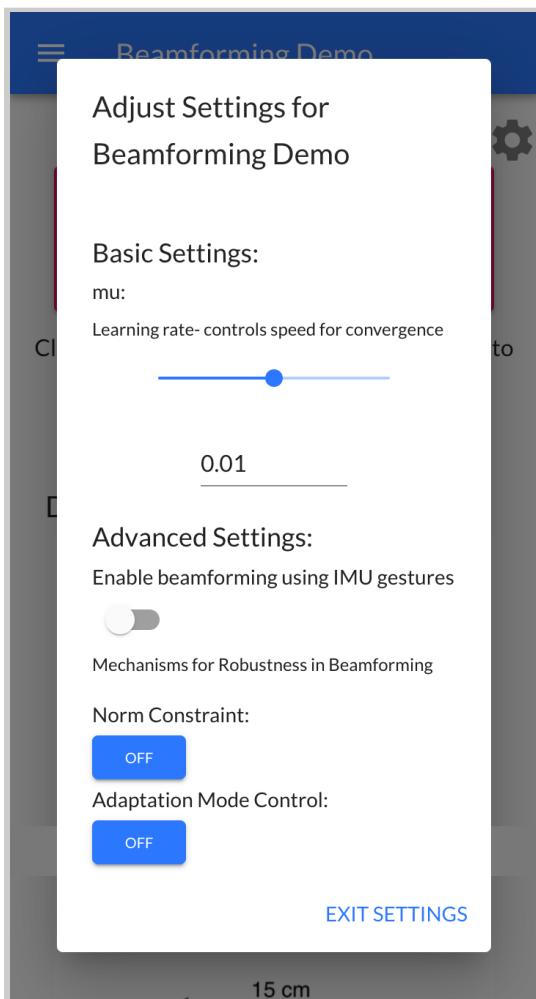
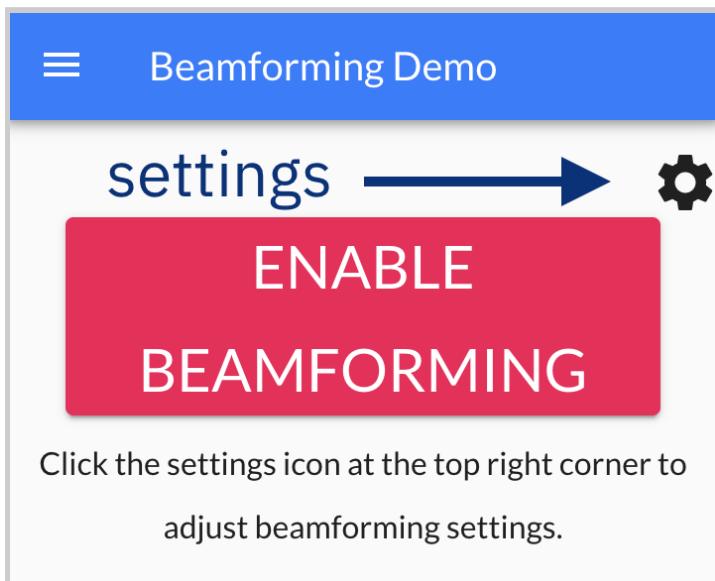


On mobile, the sidebar appears when you first tap the hamburger menu icon on the upper left-hand corner of the screen.



The interface consists of two main components:

- “*Enable/Disable Beamforming*” Button - When clicked or tapped on, this turns beamforming on and off.
- *Settings* - Accessed via a button in the upper right corner (shaped as a gear icon), adjustments to beamforming can be made.

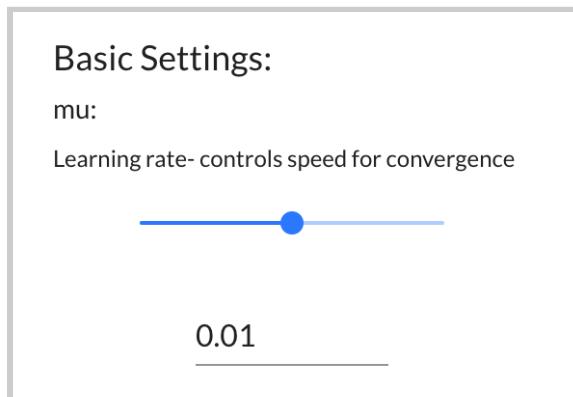


4.4.5 - Beamforming Settings

There are four different options to adjust beamforming.

- **mu** - This is a parameter for learning rate step size, which controls speed for convergence. You can adjust this by
 - either using the slider shown and moving the circle left and right or...
 - by changing the default number value.

By default, it is set to 0.01.



- **Enable beamforming using IMU gestures** - This enables the OSP hardware (the Processing and Communication Device, aka PCD) to recognize a “flip” detection of to toggle beamforming on/off automatically instead.

By default, this setting is turned off. To turn it on, simply click on the toggle and you will see a circle move to the right. To turn it back off,

simply click on the toggle again.

Advanced Settings:

Enable beamforming using IMU gestures



Advanced Settings:

Enable beamforming using IMU gestures



Setting is turned off.

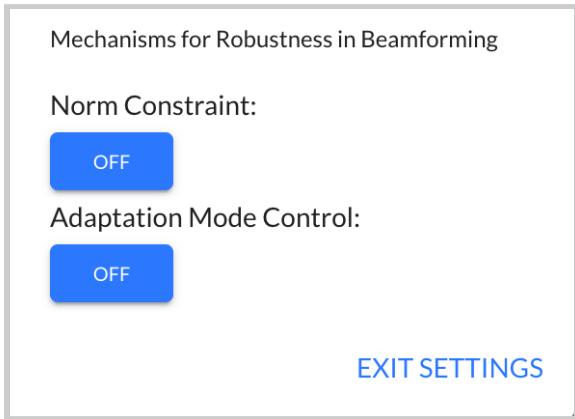
Setting is turned on.

A separate [document called “OSP Demo: Gesture Detection Using IMUs”](#) also covers how to make the PCD work with this setting.

- **Norm Constraint and Adaptation Mode Control** - Each represented as an “On/Off” button, they represent mechanisms for robustness in beamforming to mitigate the effect of direction of arrival mismatch and microphone array mismatch.

By default, both settings are turned off.

- To turn each of them on, click on the “On/Off” button until the button label shows “On”.
- To turn each of them back off, simply click on the button again so that it says “Off”.



To exit out of settings, simply select “EXIT SETTINGS” or click/tap on the gray area surrounding the settings interface.

4.5 - CoarseFit

NOTE: CoarseFit is not available to use when enabling ten frequency bands.

4.5.1 - Introduction to CoarseFit

CoarseFit enables audiologists to classify a patient’s/person’s hearing loss to one of five different profiles (normal, mild, medium, severe, profound), by choosing one of three coarse adjustment options.

CoarseFit consists of two parts:

- First, you can select one of three coarse adjustment options (further described in the next section).
- Then, you can select from a list of available audio files and listen to one. They can select one of the five hearing loss profiles to adjust their perceived volume of the audio file.

To access CoarseFit:

- Select a button labeled “CoarseFit Task” in the landing page. On mobile, you may need to scroll down before selecting.

CoarseFit Task

Includes amplification, noise and feedback parameters.

- Select the label “CoarseFit Demo” within the left sidebar.

Open Speech Platform

WebApps for hearing-aid research

Researcher Page

CoarseFit Demo

Freping Demo

Beamforming Demo

Multi-AFC Demo

Profile Selection

←

CoarseFit Demo

1 Setting option

Please choose one among three settings:

Option1 Option2 Option3

The audiograms are classified to different types by classifying seven frequencies 500,1000,2000,3000,4000,6000,8000 (Range: 25-40 dB) - 4842 profiles , Medium (Range: 40-60 dB) - 1404 profiles.

Audiogram coarse

Frequency Band	Blue (dB)	Green (dB)	Red (dB)	Cyan (dB)	Magenta (dB)
500	-10	-15	-18	-22	-30
1000	-8	-12	-15	-18	-25
2000	-5	-10	-13	-16	-28
3000	-3	-8	-11	-14	-32
4000	-2	-6	-9	-12	-35
6000	-1	-4	-7	-10	-38
8000	-1	-3	-6	-9	-40

On mobile, the sidebar appears when you first tap the hamburger menu icon on the upper left-hand corner of the screen.

Setting option

Please choose one among three settings:

Option1 Option2
 Option3

The audiograms are classified to different types by classification of the range of the worst hearing loss level corresponding to the seven frequencies 500,1000,2000,3000,4000,6000,8000 Hz. The node occupancy of Normal (Range: <25dB) - 17584 profiles , Mild (Range: 25-40 dB) - 4842 profiles , Medium (Range: 40-70 dB) - 3350 profiles, Severe (Range: 70-80 dB) - 2675 profiles, Profound (>80 dB) - 1404 profiles.

Audiogram coarse adjustment

Open Speech Platform
WebApps for hearing-aid research

Researcher Page

CoarseFit Demo

Freping Demo

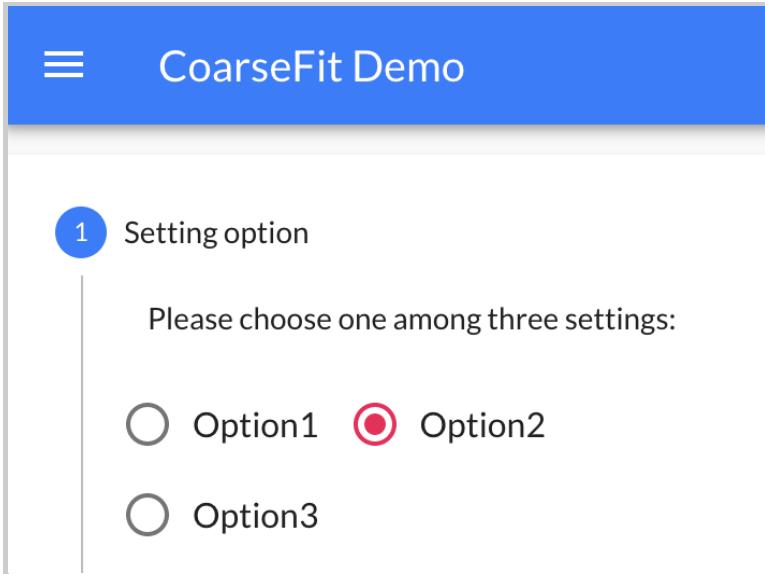
Beamforming Demo

Multi-AFC Demo

Profile Selection

4.5.2 - Coarse Adjustment Options

In the interface, the three coarse adjustment options are selectable as toggle buttons. Descriptions and graphs for each option would be shown.



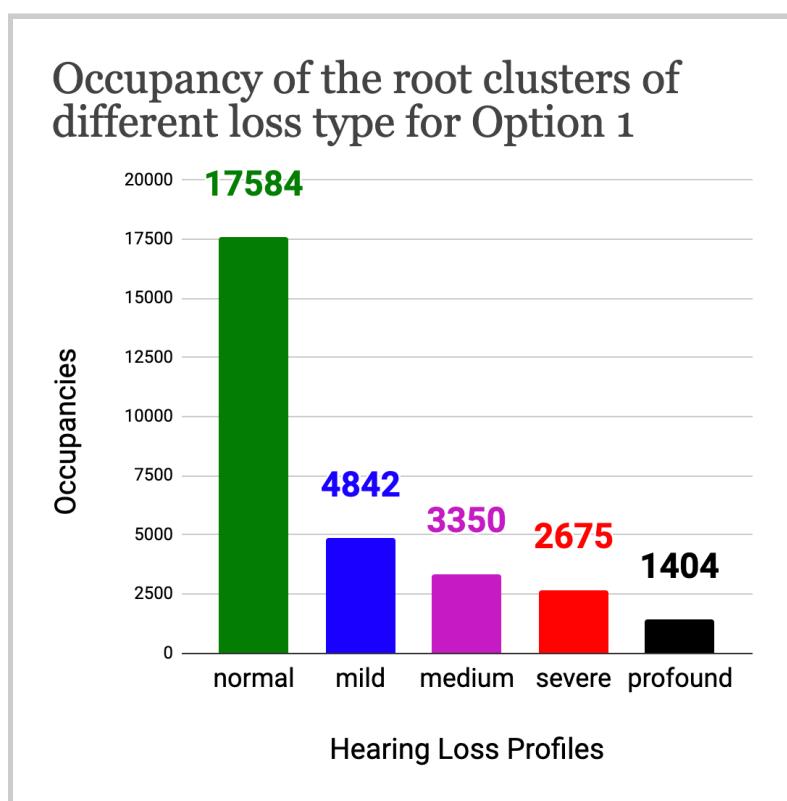
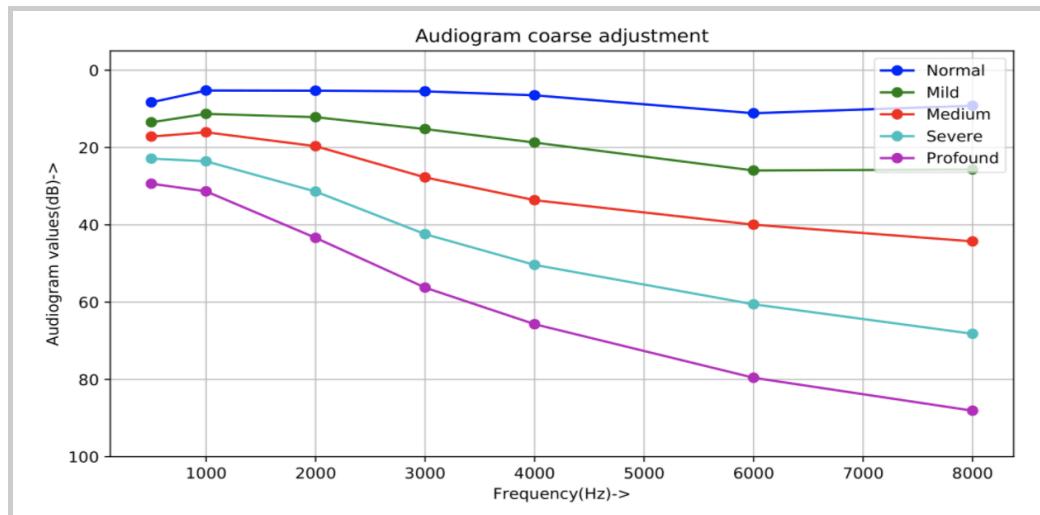
When a desired option is shown, select the “Next” button to proceed to the next part of CoarseFit (covered in the [next section "Listening to Audio Files from Hearing Loss Profiles"](#)).

NEXT

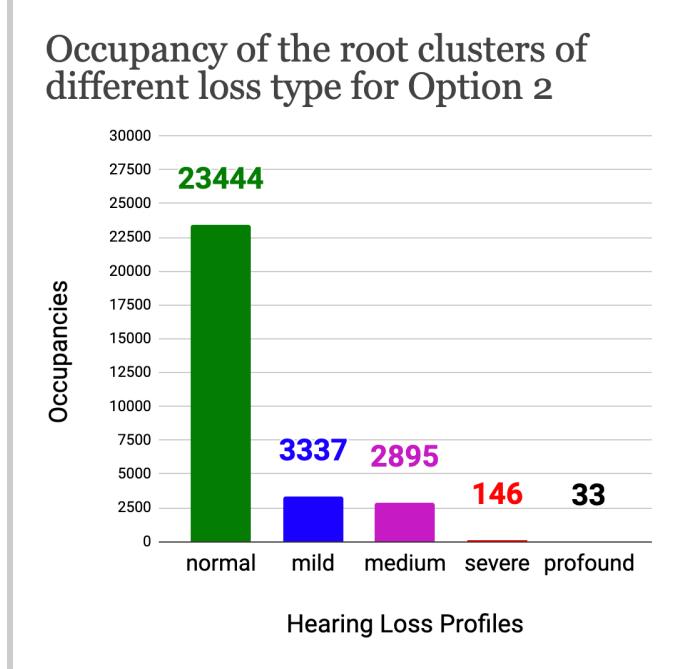
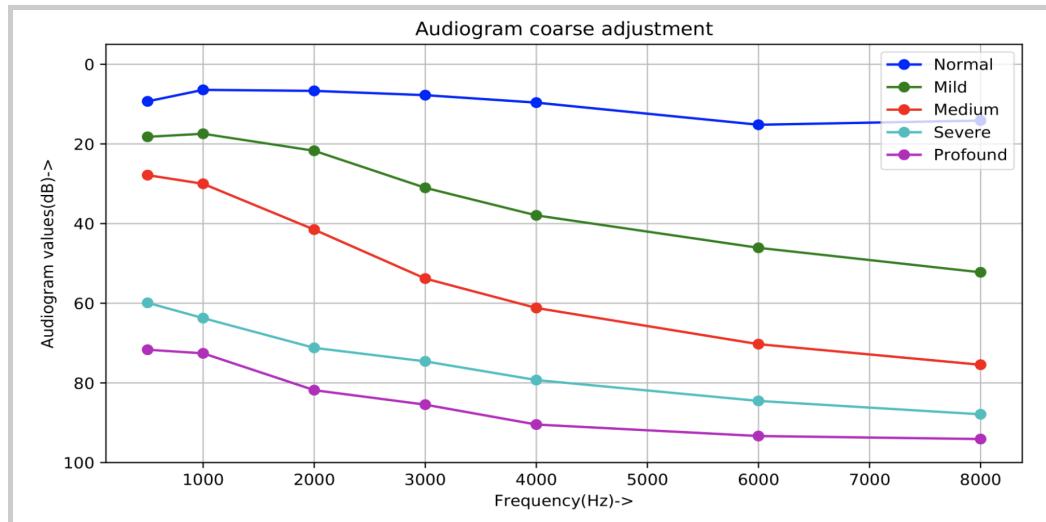
These are the following three options described in detail (note that bar graph images are not shown and are simply for reference only).

- **Option 1:** Worst band hearing loss - Audiograms are categorized based on the range of worst hearing loss level, across these seven

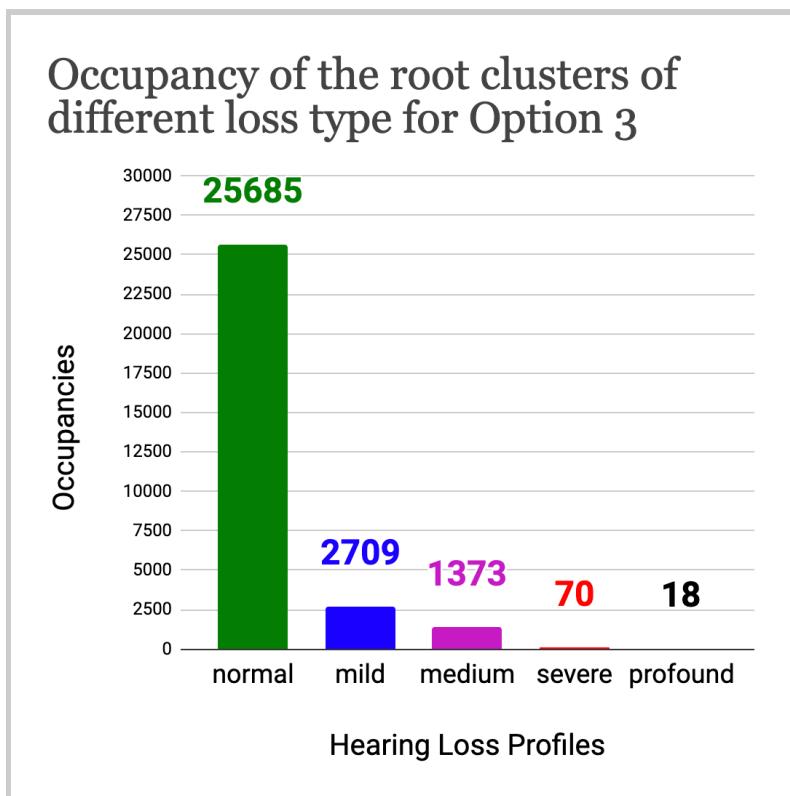
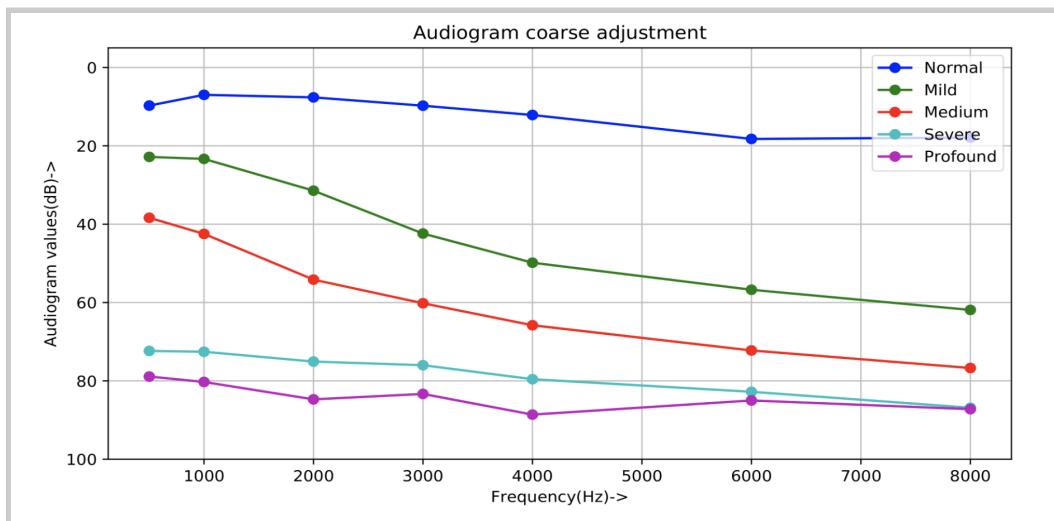
frequencies: 500, 1000, 2000, 3000, 4000, 6000, 8000 Hz.



- **Option 2:** All band average hearing loss - Audiograms are categorized based on the range of average hearing loss level, across these seven frequencies: 500, 1000, 2000, 3000, 4000, 6000, 8000 Hz.



- **Option 3:** Four band average hearing loss - Audiograms are categorized based on these four frequencies: 500, 1000, 2000, 4000 Hz.

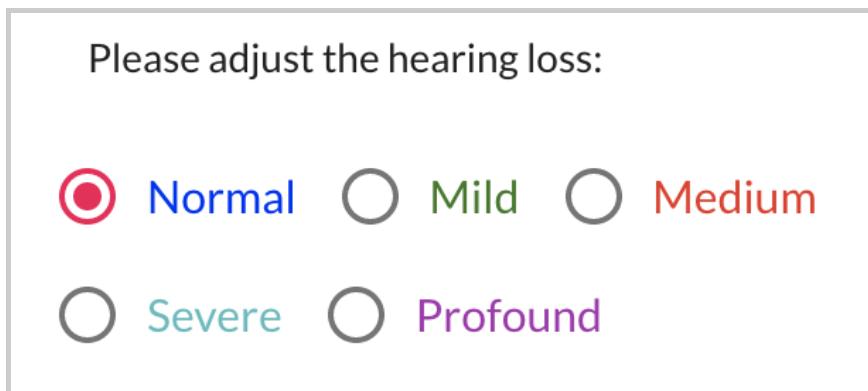


4.5.3 - Listening to Audio Files from Hearing Loss

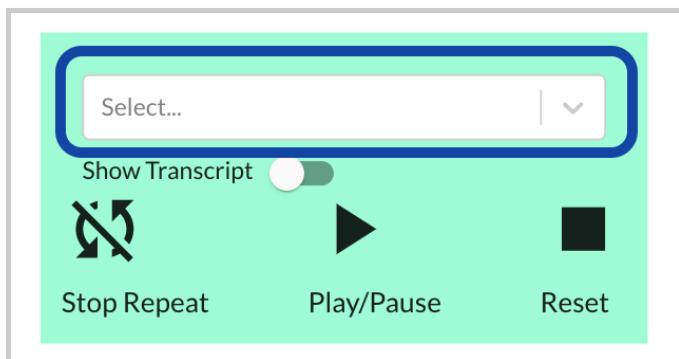
Profiles

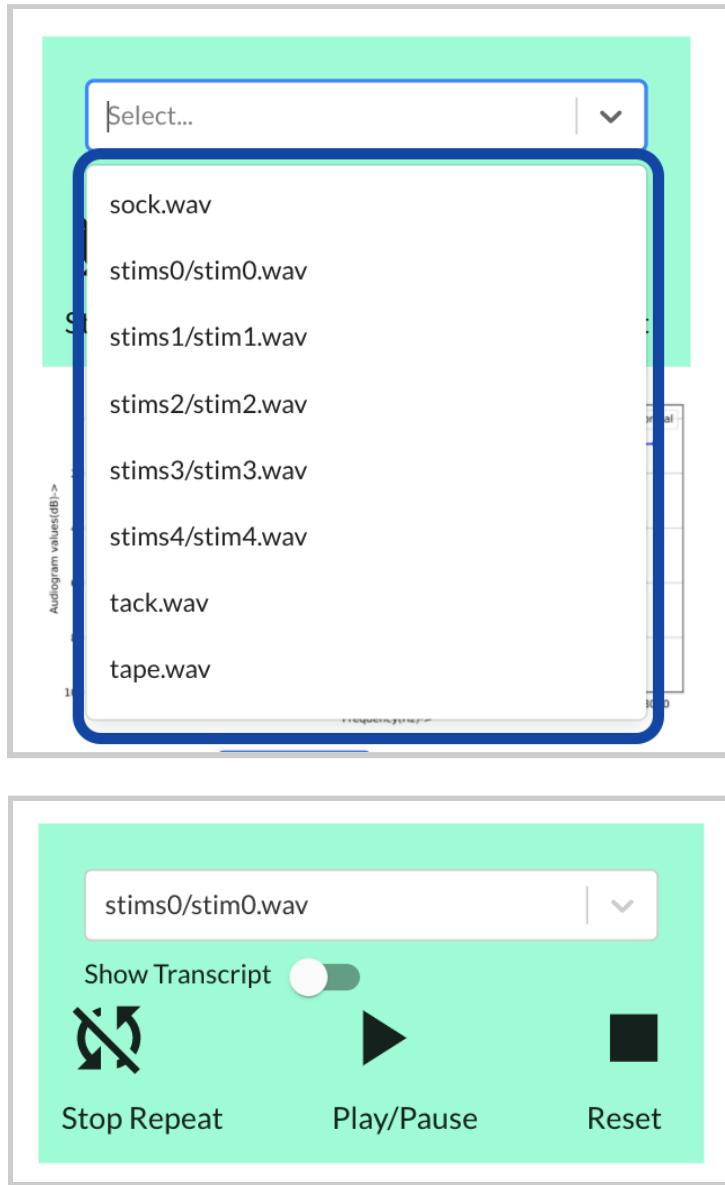
After a coarse adjustment option is selected, you can proceed to either:

- Select one of five hearing loss profiles classified from the option selected (normal, mild, medium, severe, profound). They are represented as labeled toggle buttons. By default, “Normal” is selected.



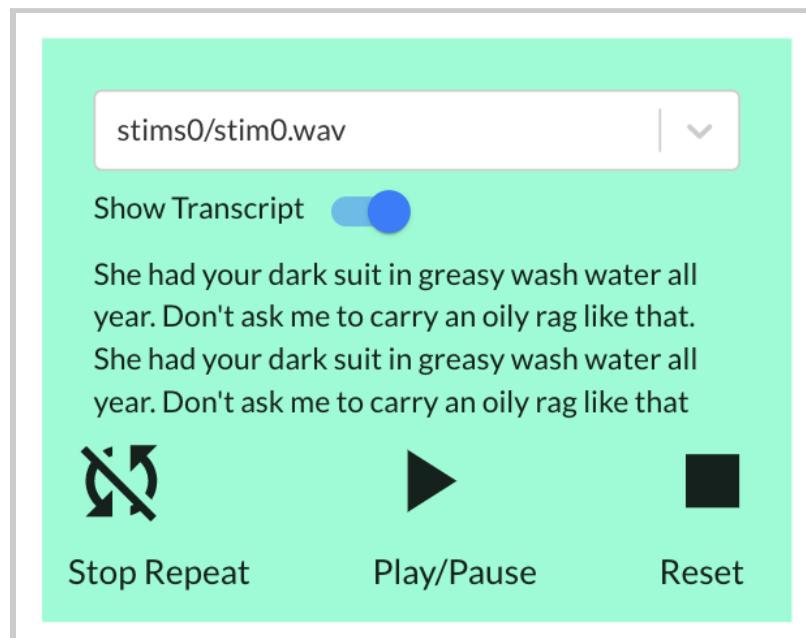
- Select and play an audio file from the dropdown menu. You can then select a different hearing loss profile to adjust the perceived volume.



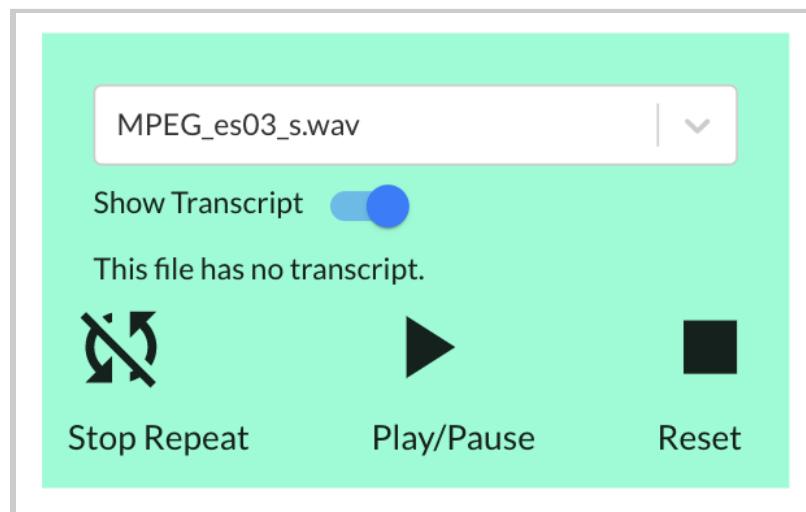


There are a series of buttons that adjust your experience of listening to the audio file.

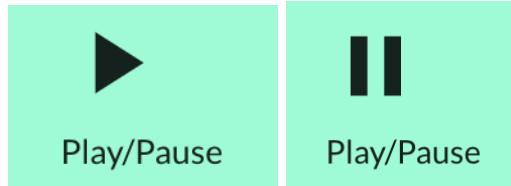
- **Show Transcript Toggle** - When selected, this will reveal a transcript for the audio file (if available). Only files named "stims#/stims#" have transcripts enabled.



The rest of the files will not have a transcript, so when enabling “Show Transcript”, the message “This file has no transcript.” will appear.

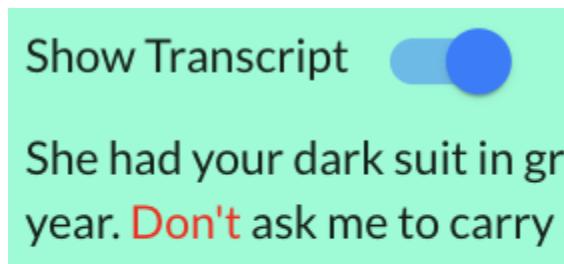


- “Play/Pause” Button

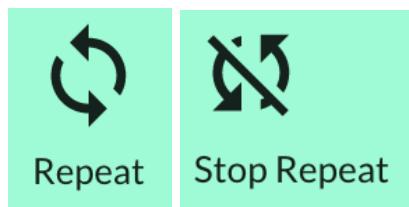


When first clicked, this will start playing the audio file and the icon will change from play ► to pause ||. To stop playing the audio file, simply select the button again.

If the “Show Transcript” toggle is enabled for any audio file with a transcript, you will see a word change its color to red, which corresponds to the word heard at a specific time frame of the audio file.



- “Repeat/Stop Repeat” Button

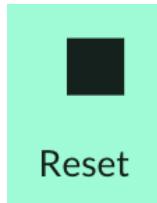


By default, the audio file played won’t be repeated and “Stop

“Repeat” would be shown. When selected, this will restart the selected audio file to be played back again in an endless loop and will change the button icon and label to “Repeat”. The audio file will not stop playing until the “Stop Repeat” label is shown or when you navigate away from the CoarseFit page.

Currently, if you select the “Repeat” button while the audio file is paused, the audio file *will* begin playing from the beginning.

- “Reset” Button



This button restarts the audio file to the beginning.

This audio file player interface is also used in [freping](#), explained in the next section.

4.6 - Freping

4.6.1 - Introduction to Freping

Freping (a portmanteau for Frequency Warping) is a novel approach that uses all-pass networks to perform frequency compression and expansion in each band. In OSP software, it is a demo that seeks to enable audiologists to:

- operate frequency warping in real time
- assess improvements to feedback control and frequency shifting in lab and field environments by modifying different freping settings

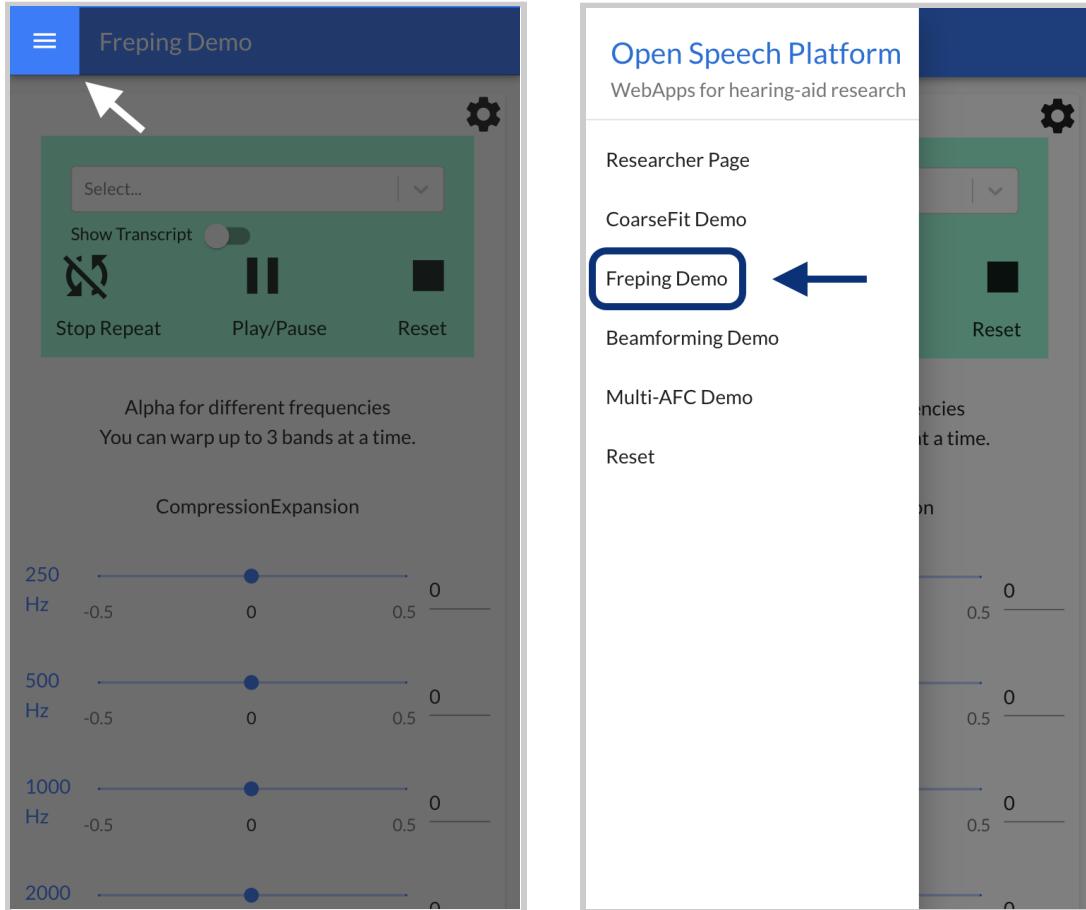
To access freping, either:

- Select a button labeled “freping” in the landing page. On mobile, you may need to scroll down before selecting.

- Select the label “Freping Demo” within the left sidebar.

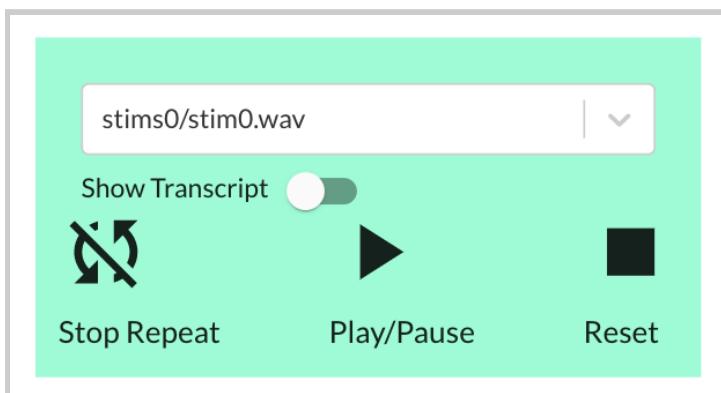
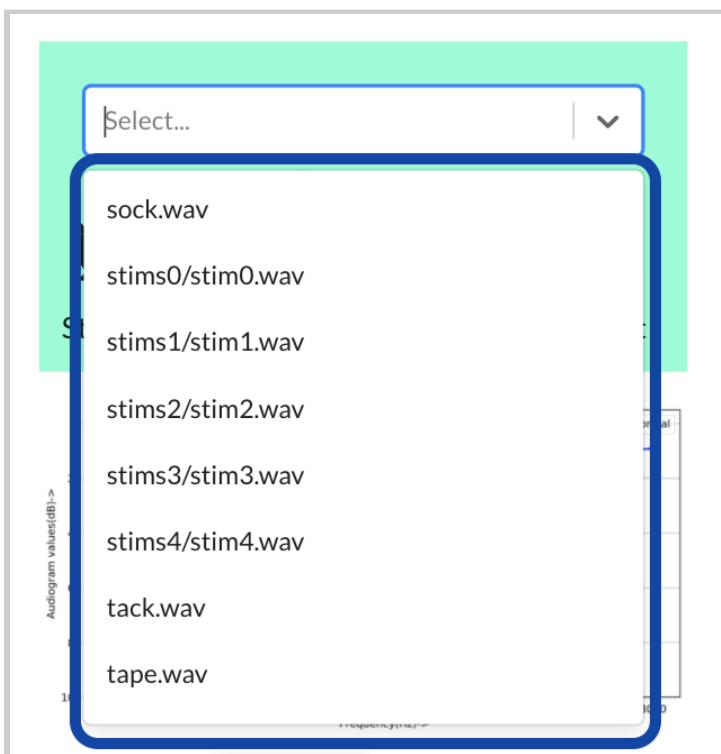
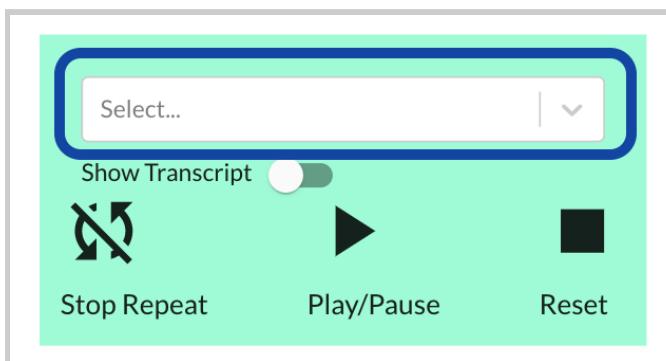
The screenshot shows the Open Speech Platform interface with the "Freping Demo" tab selected. On the left sidebar, the "Freping Demo" option is highlighted with a blue border and a blue arrow points to it from the left. The main content area displays a green control bar with a dropdown menu, a transcript toggle switch, and playback controls (Stop Repeat, Play/Pause, Reset). Below this, a section titled "CompressionExpansion" shows five frequency bands (250, 500, 1000, 2000, 4000 Hz) each with a slider ranging from -0.5 to 0.5. A note above the sliders states: "Alpha for different frequencies" and "You can warp up to 3 bands at a time."

On mobile, the sidebar appears when you first tap the hamburger menu icon on the upper left-hand corner of the screen.



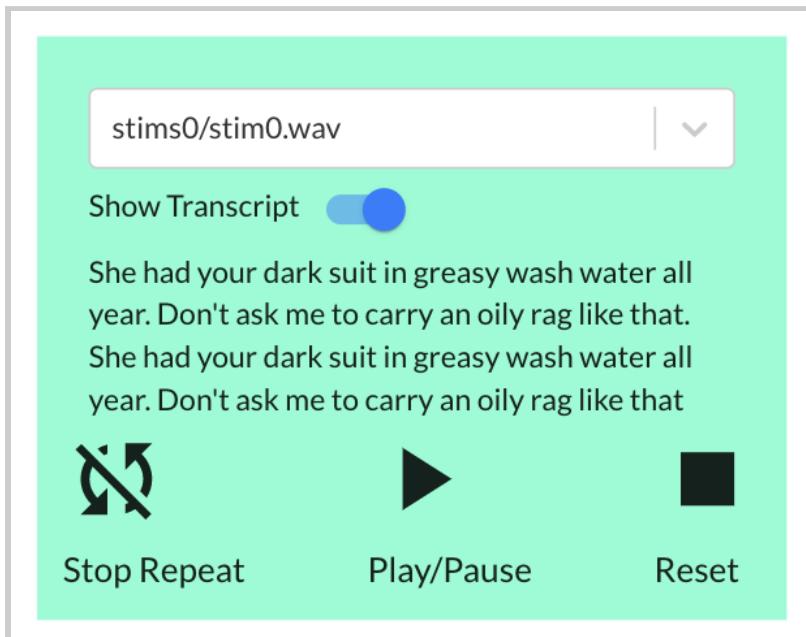
4.6.2 - Listening to Audio Files

Similar to the previous section for [CoarseFit](#), there is an audio file player interface which allows you to select and play an audio file from a dropdown menu.



There are a series of buttons that adjust your experience of listening to the audio file.

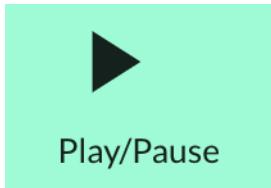
- **Show Transcript Toggle** - When selected, this will reveal a transcript for the audio file. Only files named stims#/stims# have transcripts enabled.



The rest of the files will not have a transcript, so when enabling “Show Transcript”, the message “This file has no transcript.” will appear.



- “Play/Pause” Button



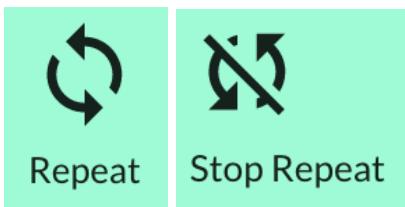
When first clicked, this will start playing the audio file and the icon will change from to . To stop playing the audio file, simply select the button again.

If the “Show Transcript” toggle is enabled for any audio file with a transcript, you will see a word change its color to red, which corresponds to the word heard at a specific time frame of the audio file.

Show Transcript

She had your dark suit in gre
year. **Don't** ask me to carry a

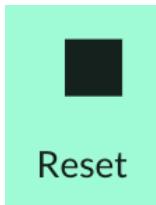
- “Repeat/Stop Repeat” Button



By default, the audio file played won't be repeated and “Stop Repeat” would be shown. When selected, this will restart the selected audio file, play it again in an endless loop, and change the button icon and label to “Repeat”. The audio file will not stop playing until the “Stop Repeat” label is shown or when you navigate away from the CoarseFit page.

Currently, if you select the “Repeat” button while the audio file is paused, the audio file *will* begin playing from the beginning.

- “Reset” Button

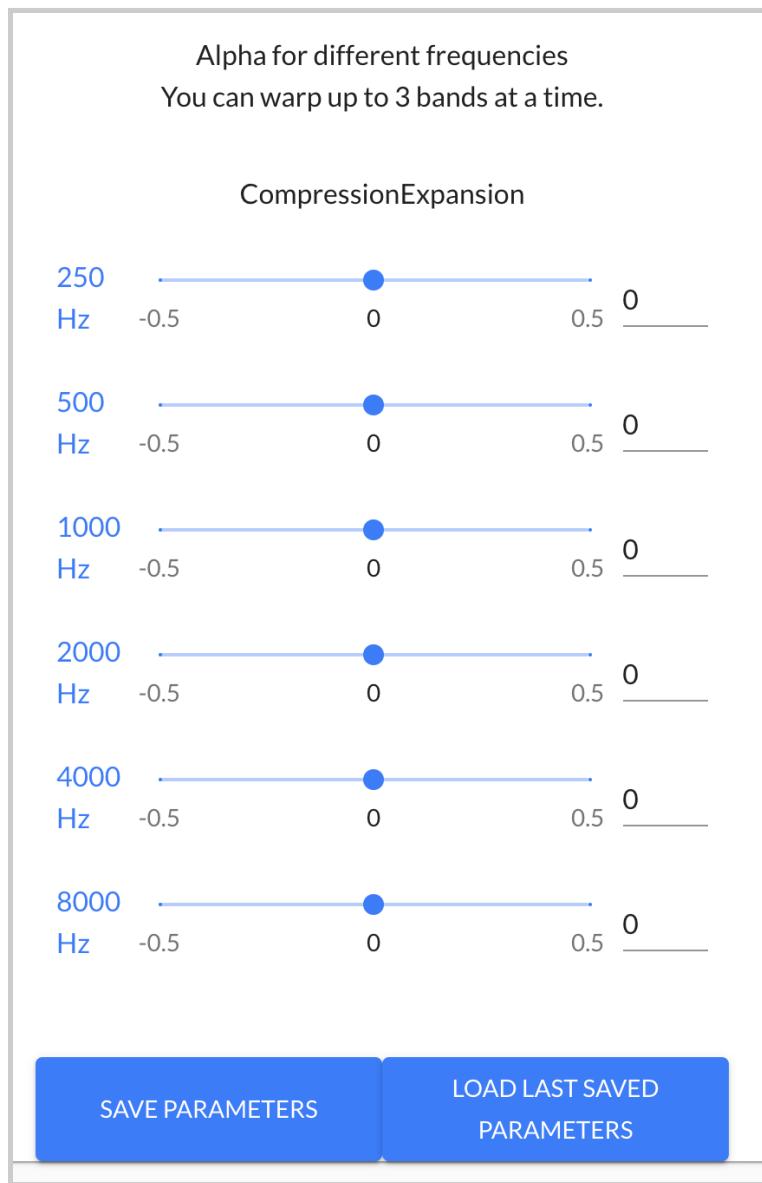


This button restarts the audio file to the beginning while it is being played.

4.6.3 - Adjusting Frequency Bands

Freping is best used after selecting and playing an audio file.

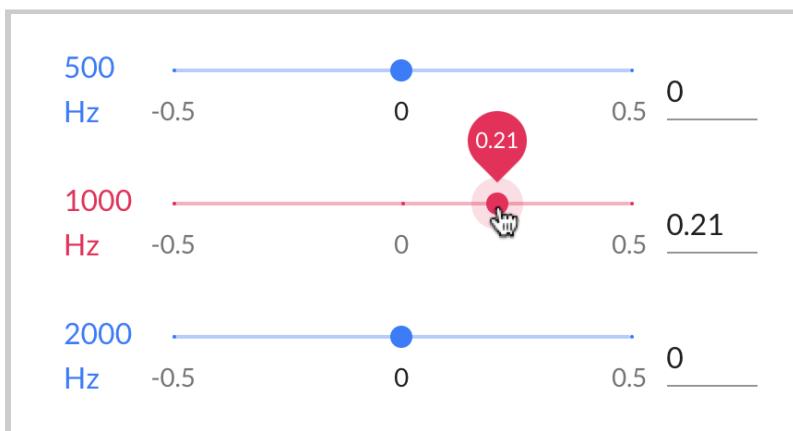
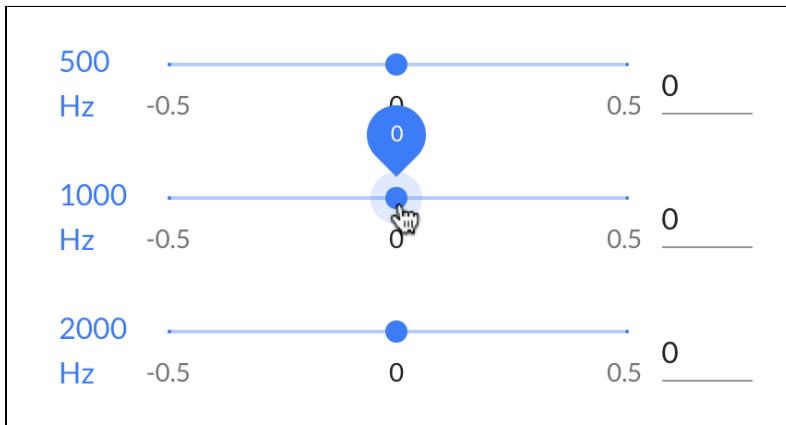
There are a series of sliders and number input fields associated with each frequency band shown, used for adjusting parameters for the different frequencies associated with the audio file that you would hear. The number of sliders and numbers depends on whether the OSP software sets 6 bands or 10 bands (default is 6 bands).



Freping interface consists of a series of sliders and number input fields that adjust each frequency band. By default, 6 bands are shown.

To make adjustments to the hearing perception of the audio file, find the frequency band that you want, and then either:

- use the slider to adjust the parameter value of that band or...



- enter a number in the number input field to change the parameter value (you can also use the up and down arrows to adjust the value by +/- 0.01).



You should be able to hear changes to the audio file almost instantly (all changes take effect in < 1 millisecond). Any changes to the current value set for each frequency band will change the color of the text, slider, and number input field to red.

Note that you can only adjust parameter values for three frequency bands at a time. If you have three bands with non-zero values, other sliders and number input fields for all other bands will be disabled and will have values set to zero.

To make changes to other frequency bands instead, you have to set the parameter value of one or more of the currently modified bands to zero.

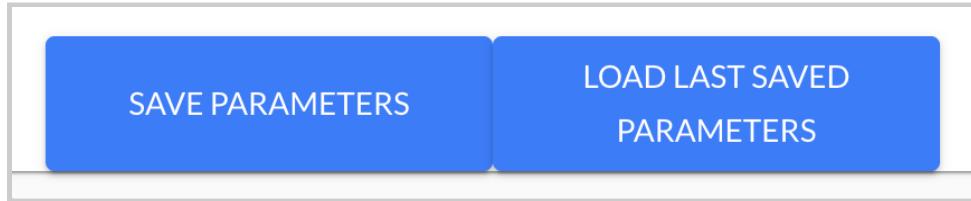


4.6.4 - Saving and Loading Parameters

There are two buttons for saving and loading your parameter values for your desired frequency bands.

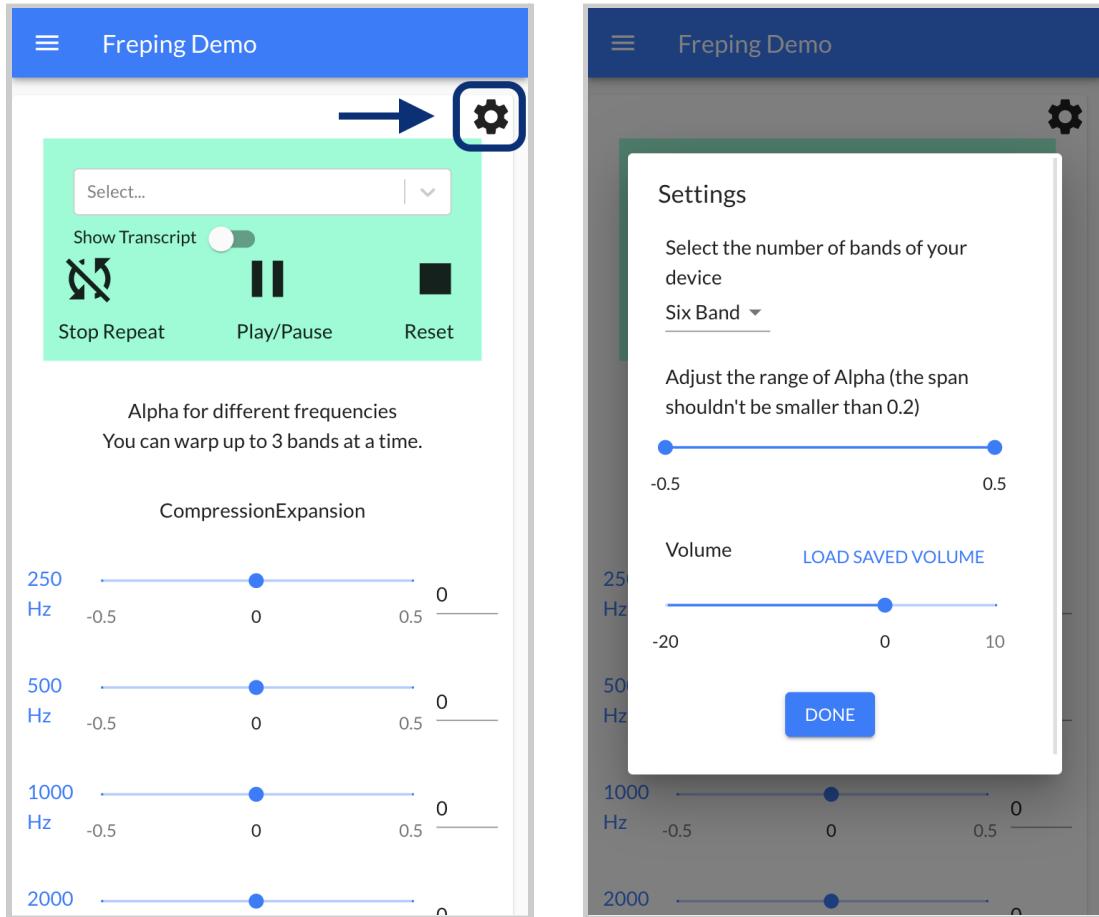
- To save your parameter values, click on the “Save Parameters” button. You may see that the unsaved parameters in frequency bands colored red revert to blue.

- To load previously saved parameter values, click on the “Load Last Saved Parameters”. You will see values and sliders adjusted for each of the frequency bands.



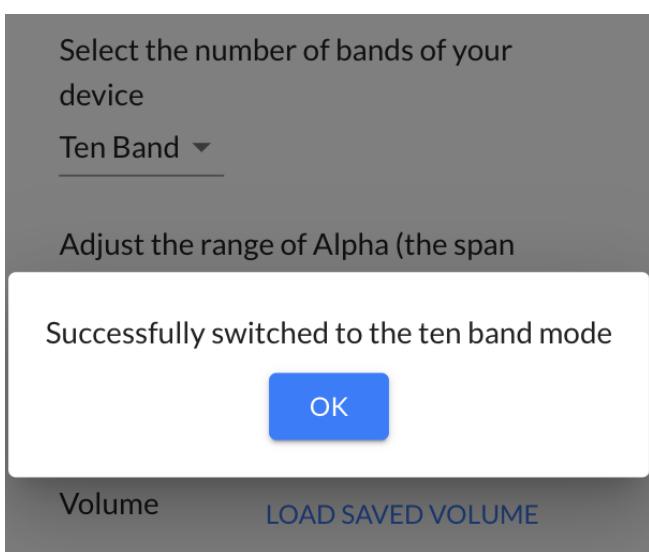
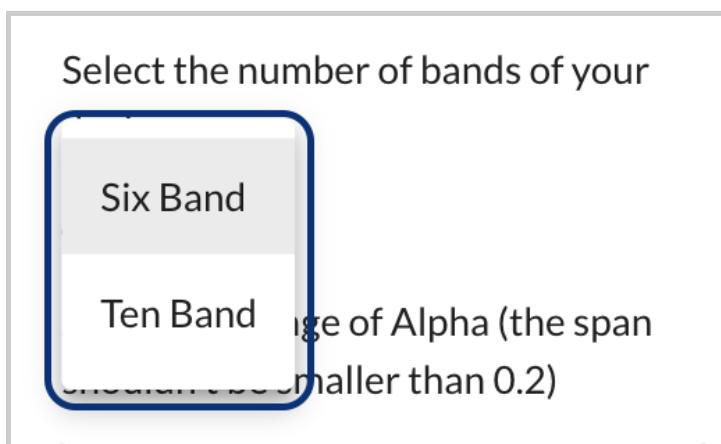
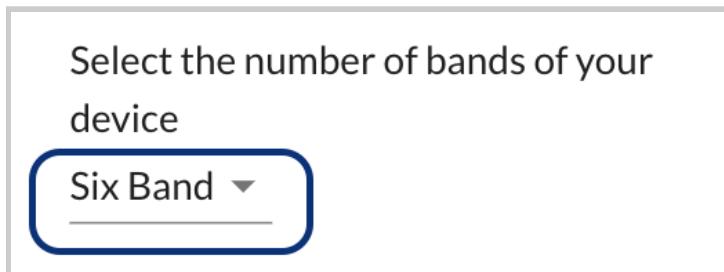
4.6.4 - Freping Settings

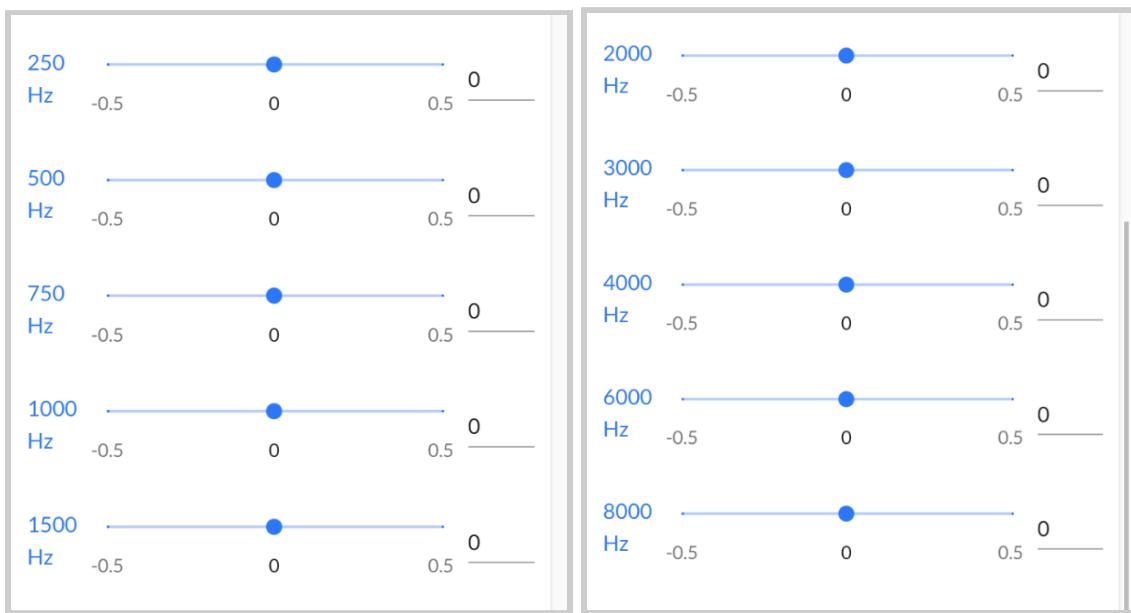
To view additional freping settings, click on the gear icon button.



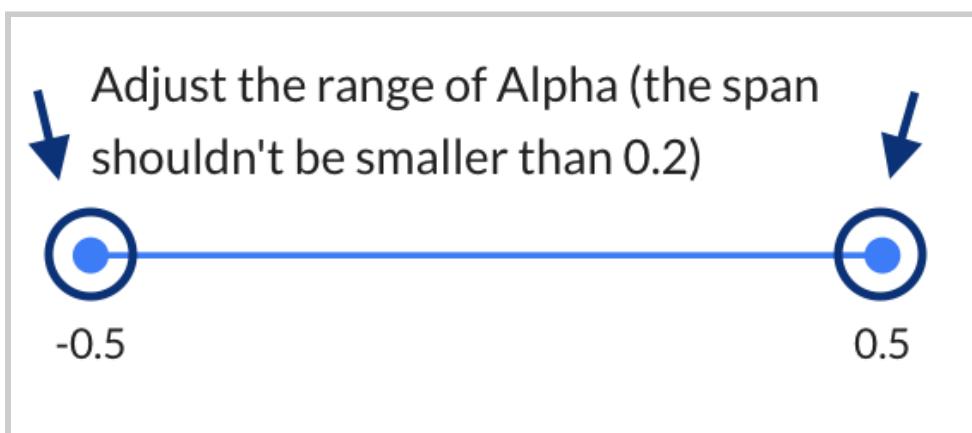
In the settings interface, you'll be able to:

- **Adjust the number of bands shown** - To do so, select the dropdown menu and choose either “Six Band” or “Ten Band”.





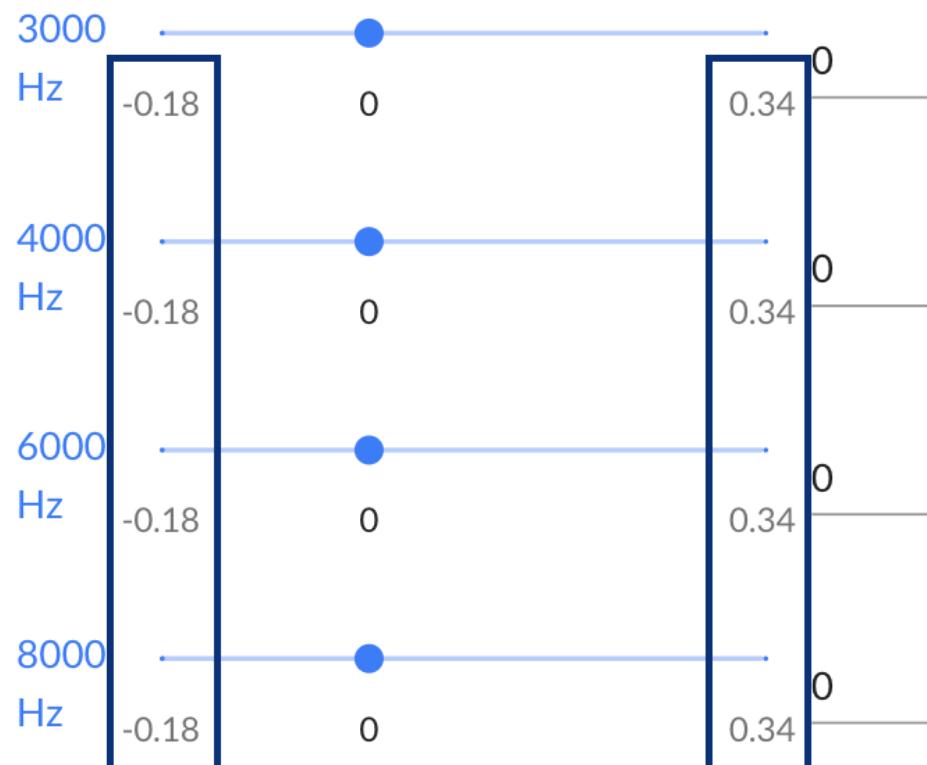
- **Adjust the minimum/maximum range of parameter values** - To do so, click and drag one of the circles left or right to the desired minimum or maximum value shown. On mobile, you would tap, hold down, and drag one of the circles left or right. By default, minimum is set to -0.5, maximum +0.5.



Adjust the range of Alpha (the span shouldn't be smaller than 0.2)

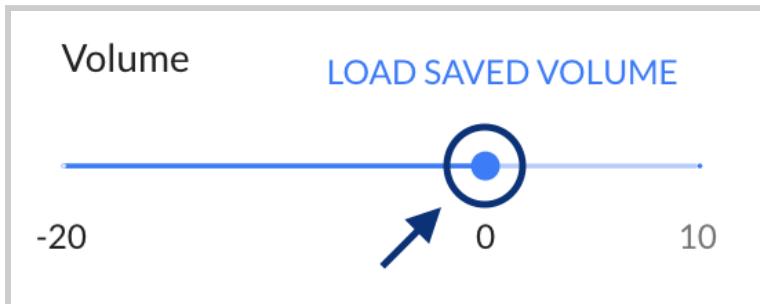


When you select the “Done” button, you’ll see the minimum and maximum values reflected in the freping sliders.



- **Adjust the volume** - To do so, click and drag the circle left or right to the desired volume (measured in dB). By default, value is set to zero.

“Load Saved Volume” is clickable, and retrieves the last saved value for volume. Default is set to zero.

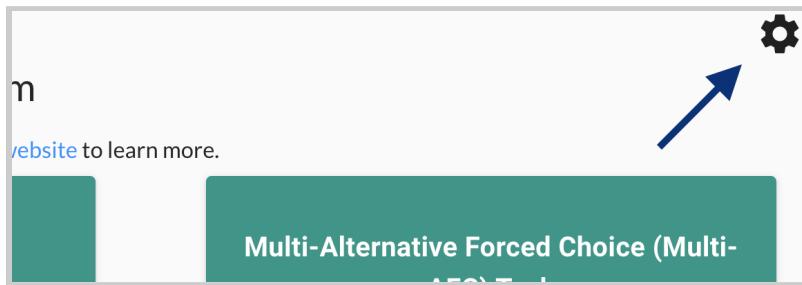


4.7 - Global Settings (Band and Audio Switching)

These are the additional default settings for the OSP software:

- Researcher Page and freping show only six bands.
- Pre-recorded audio would be used for using the apps and demos.

You can change these default settings in the landing page by selecting the button in the upper-right corner of the screen (it looks like a gear icon).

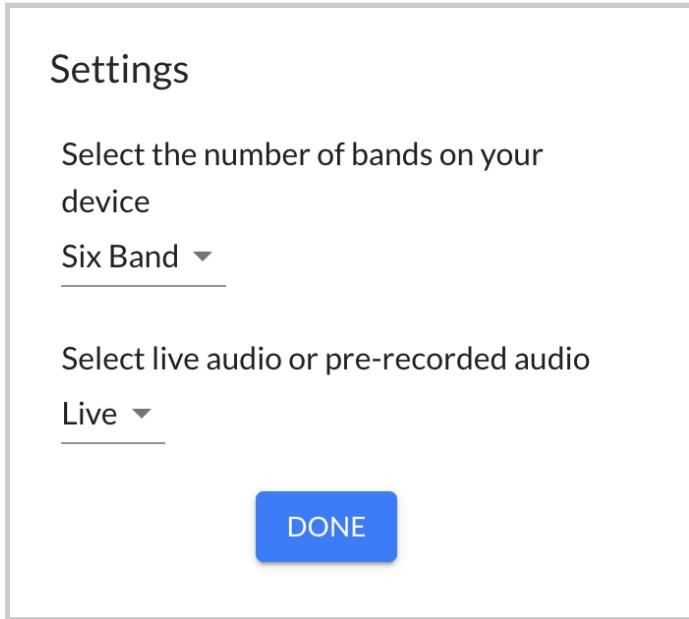


Landing page button (with gear icon) via desktop view.

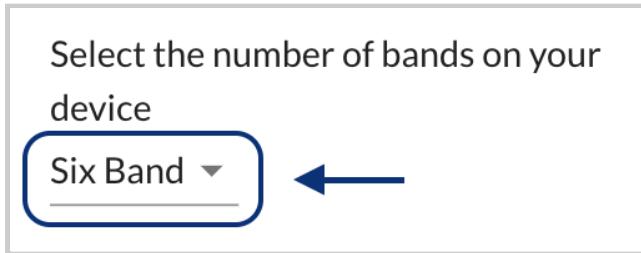
Two screenshots of a mobile device displaying the landing page. The left screenshot shows the main landing page with three green buttons: "Researcher Page", "Beamforming Task", and "Multi-Alternative Forced Choice (Multi-AFC) Task". The right screenshot shows a modal window titled "Settings" with dropdown menus for "Select the number of bands on your device" (set to "Six Band") and "Select live audio or pre-recorded audio" (set to "Pre-Recorded"). A "DONE" button is at the bottom of the modal. A blue arrow points from the text "Landing page button (with gear icon) via mobile view." to the gear icon in the top right corner of the main landing page screenshot.

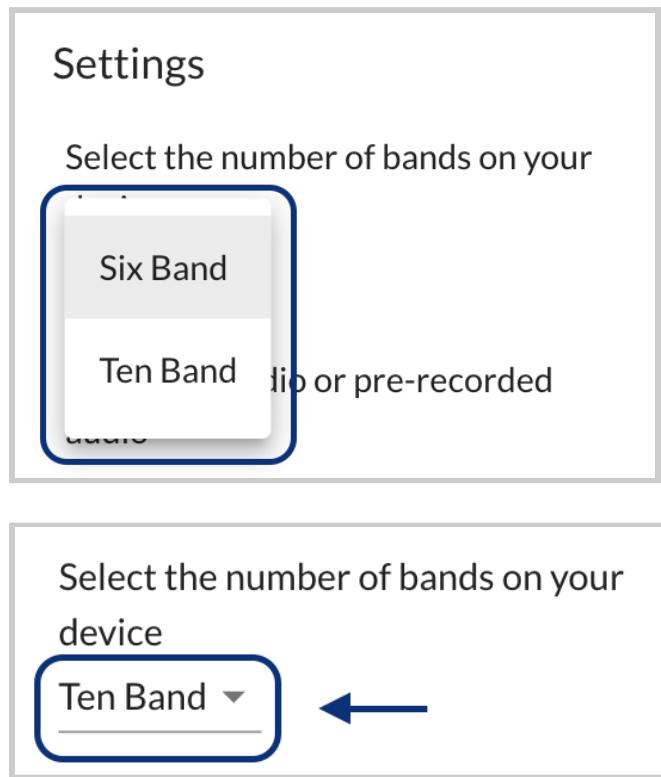
Landing page button (with gear icon) via mobile view.

You will see a popup with two different settings, one for selecting the number of bands and one for selecting the type of audio.



Select the top-most dropdown menu (labeled “Six Band” by default) to change from “Six Band” to “Ten Band” or vice versa.



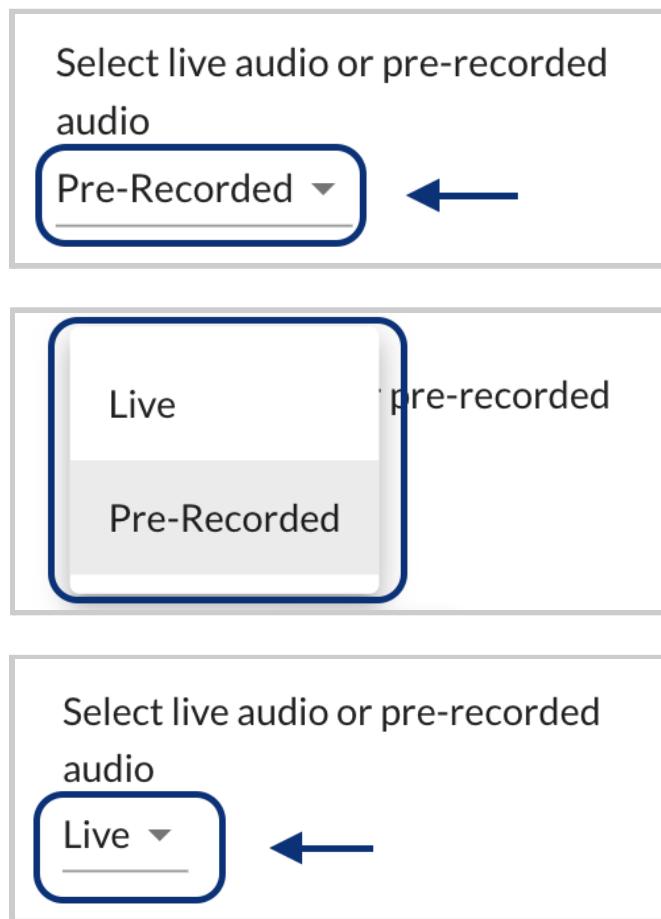


NOTE: CoarseFit is not yet ready to be used when enabling ten frequency bands (“Ten Band” mode). You may experience unexpected behaviors or errors when you use it.

Once you have selected “Six Band” or “Ten Band”, check Researcher Page and [Freping](#) to see if the number of frequency bands shown is six for “Six Bands”, ten for “Ten Bands”.

You can change between pre-recorded and live audio. According to the [OSP CLI](#), this will affect the **alpha** parameter value.

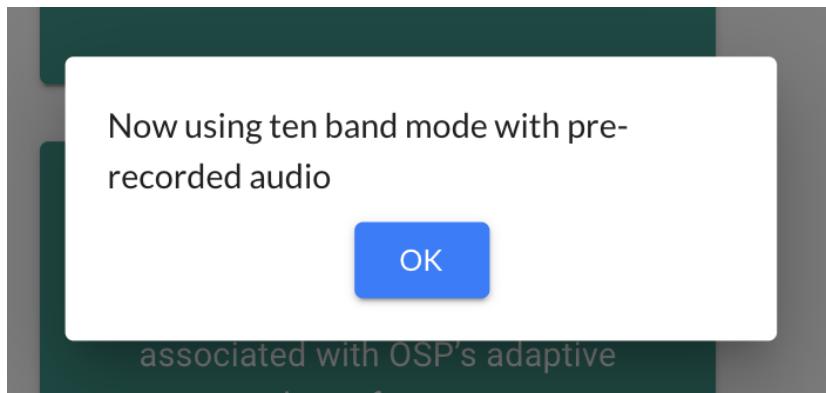
- “Live” will capture live audio input from your microphone. For the **alpha** parameter value, “Live” sets **alpha** to 0.
- “Pre-Recorded” is virtual sound that you experience from audio playback, generally used when listening to OSP’s audio files provided. For the **alpha** parameter value, “Pre-Recorded” sets **alpha** to 1.



Once you are finished and want to exit out of the settings, you can select the “Done” button or select the gray area outside of the settings interface.

DONE

You will see a message that confirms your saved settings.



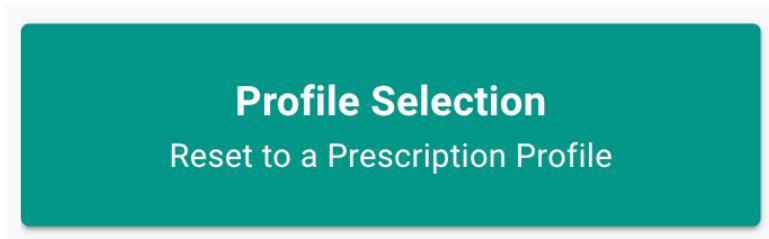
4.8 - Profile Selection

In the OSP software, there are pre-made “profiles” in which each has default values of the audio parameters set by the RTMHA.

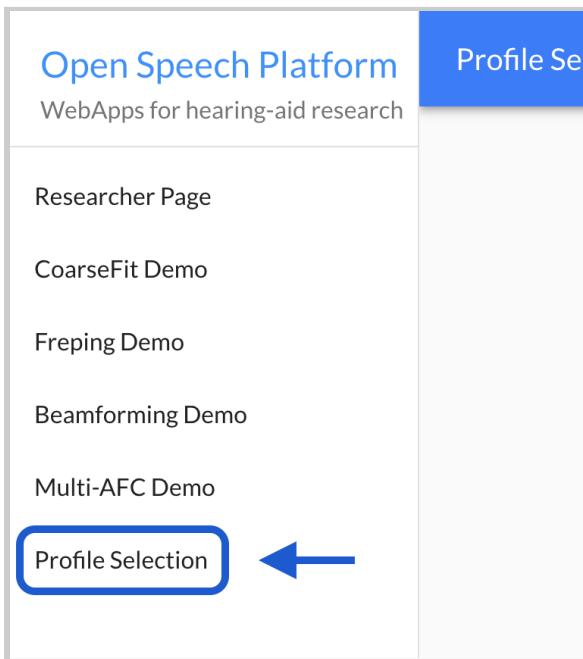
Whenever you interact with the apps and demos, the values for those parameters would be changed. You can select these profiles to revert your changes to the audio parameters back into the default values for the profiles.

To access this:

- Select a button labeled “Profile Selection” in the landing page. On mobile, you may need to scroll down before selecting.

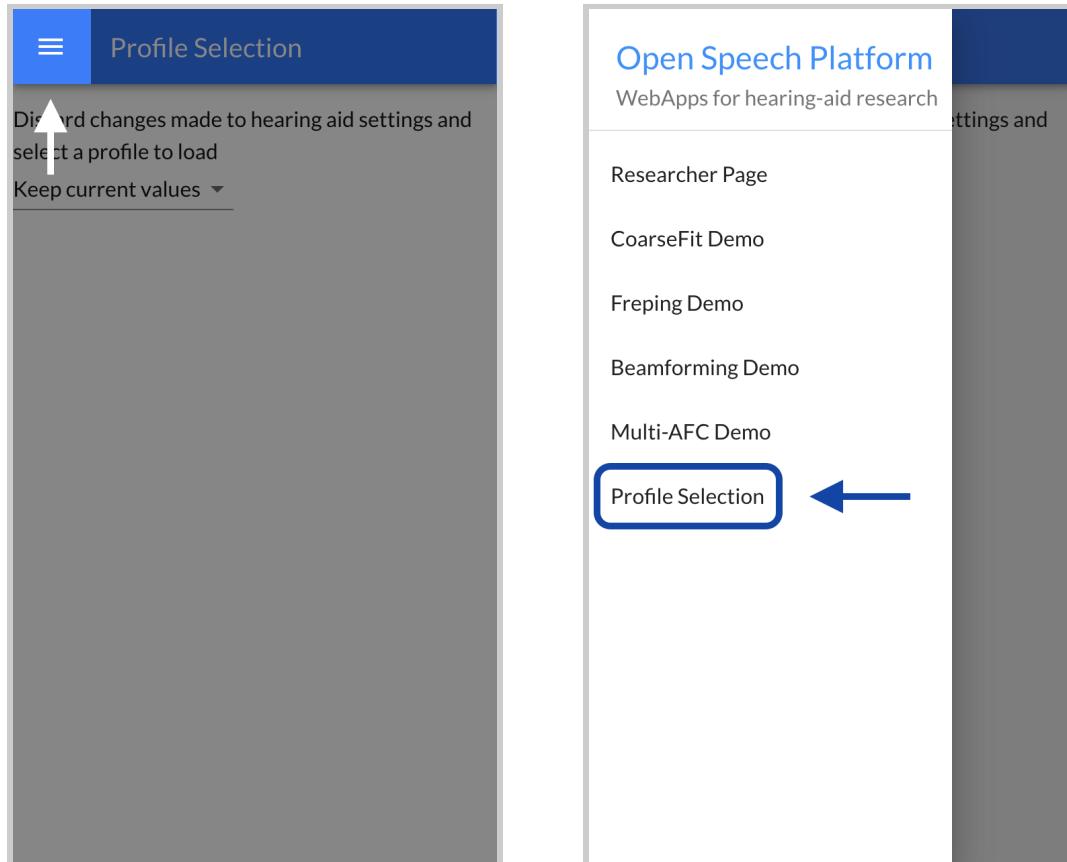


- Select the label “Profile Selection” within the left sidebar.

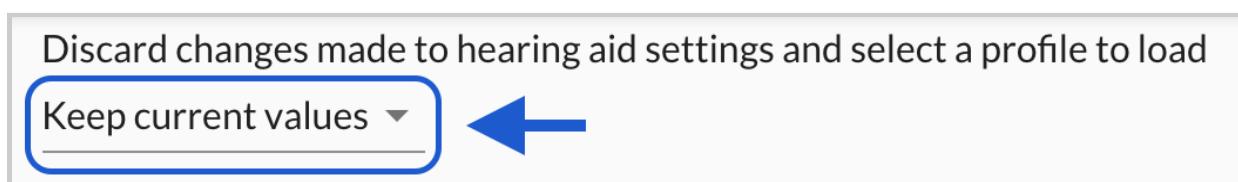


On mobile, the sidebar appears when you first tap the hamburger

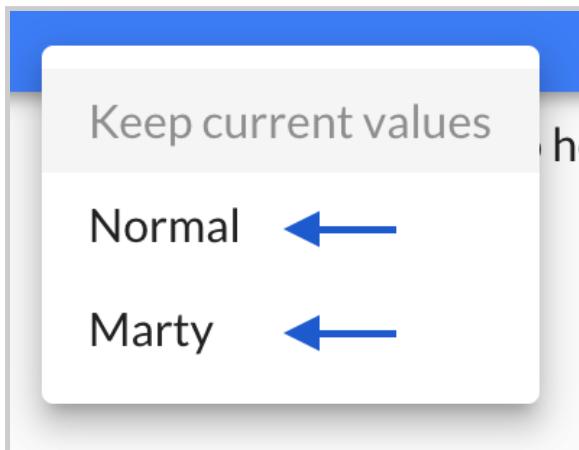
menu icon on the upper left-hand corner of the screen.



Under the description, select the dropdown menu currently labeled “Keep current values”.



You can currently select either the “Normal” or “Marty” profile.



Once you make your selection, you will hear an audible difference. You can further experiment with the profiles by:

- trying out the apps and demos in EWS
- using the “osp_cli” terminal tab (the [OSP Command Line Interface](#)) to enter commands to retrieve and modify the values of the RTMHA parameters

4.9 - Researcher Page

The Researcher Page visually represents the parameters in OSP’s main hearing aid algorithm (RT-MHA), and is intended to enable researchers to change the initial default audio settings through a digital interface (see the following image).

The screenshot shows the 'Researcher Page' of the Open Speech Platform. The left sidebar lists various demo options: Researcher Page, CoarseFit Demo, Freping Demo, Beamforming Demo, Multi-AFC Demo, and Profile Selection. The main area is titled 'Researcher Page' and contains three tabs: 'AMPLIFICATION' (which is active), 'NOISE', and 'FEEDBACK'. Under the 'AMPLIFICATION' tab, there are sections for 'Researcher Page Controls' (with 'Control Via' buttons for G50/G80 and CR/G65, and 'Channel' buttons for Left, Right, and Both), 'Parameter Settings' (with 'LOAD PROFILE' and 'SAVE PROFILE' buttons), and 'RTMHA Controls' (with 'AFC' and 'Freping' On/Off switches, and a 'Global MPO' input field set to 120). Below these is a large 'Parameter Settings' table:

	250	500	1000	2000	4000	8000	All
cr	2.72727	2.72727	3	3	2.5	2.142857
g50	9.5	4.5	15	22.5	32	18
g65	0	-5	5	12.5	23	10
g80	-9.5	-14.5	-5	2.5	14	2
kneeLow	45	45	45	45	45	45
mpo	110	110	110	110	110	110
attack	5	5	5	5	5	5
release	20	20	20	20	20	20
frepingAlpha	0	0	0	0	0	0

At the bottom of the page are two pink buttons: 'PULL' and 'TRANSMIT'.

The Researcher Page is based on the [Goldilocks](#) app in the legacy version of the OSP software (that had a PHP/Laravel framework). [Goldilocks](#) and its supplementary app, [Calibration](#), is discussed in the next sections.

4.10 - Introduction to Calibration and Goldilocks

[Goldilocks](#) was intended to enable researchers to change the initial default audio settings through a digital interface, mainly called the “Researcher Page”. The [Researcher Page](#) visually represents the parameters in OSP’s main hearing aid algorithm (see the following image).

Back

Listener ID: listener	Channel:	Control via:	AFC:	Read ▾
Tester ID: researcher	Left Right Both	CR/G65 G50/G80	On Off	Save
Listener PIN: 2				Save-as

	0250	0500	1000	2000	4000	8000	All
CR	1.4	1.4	1.4	1.4	1.4	1.4	
G50	19.3	7.3	9.3	22.3	23.3	11.3	
G65	15	3	5	18	19	7	
G80	10.7	-1.3	0.7	13.7	14.7	2.7	
Knee	45	45	45	45	45	45	
MPO	110	110	110	110	110	110	
Attack	5	5	5	5	5	5	
Release	20	20	20	20	20	20	
G50 Max	35	35	35	35	35	35	
G80 Min	35	35	35	35	35	35	
Targets	59	61	62	73	75	64	Set
LTASS	44	58	57	55	56	57	Monitor
Thresh	25	30	35	45	55	85	
L Mult	0	3	3	0	0	0	
H Mult	0	0	0	3	3	3	

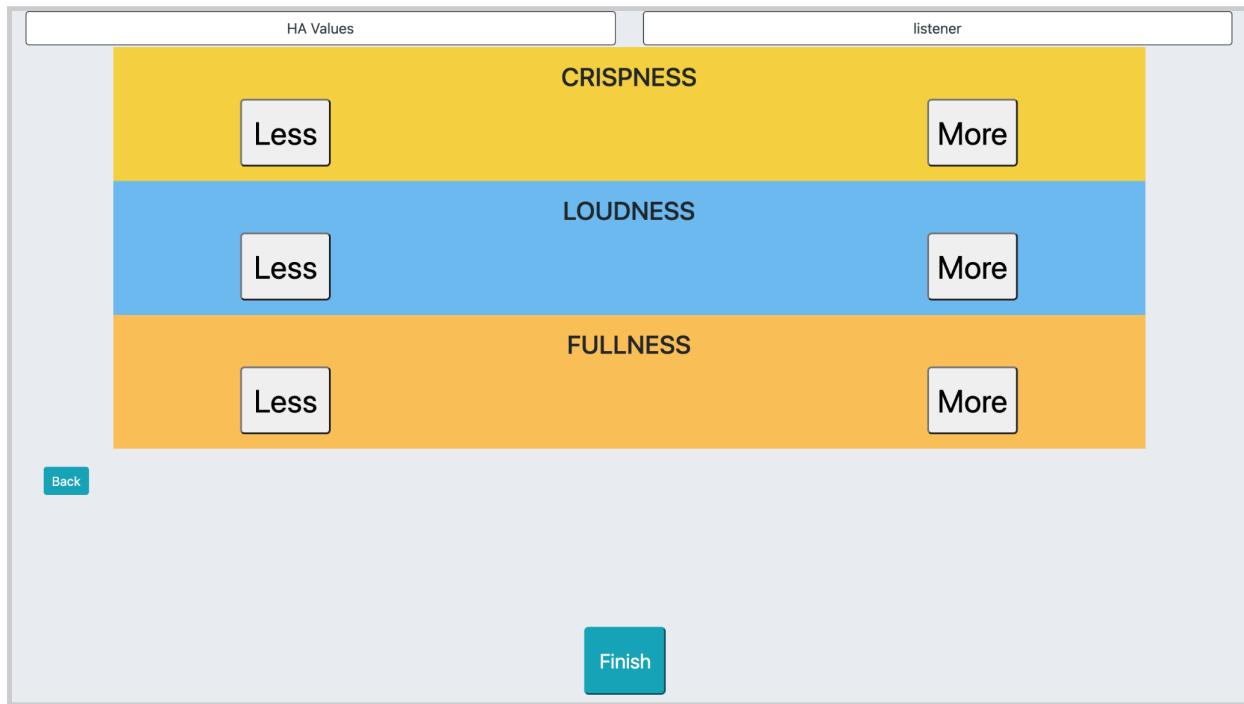
L V H Adjustments

Step	1	3	1	Num:	3	2	
Min	-40	-40	-40	First:	V	H	
Max	40	40	40	Seq:	Sequence	Volume only	Compact

Transmit Continue

These changes would be reflected in a different [listener interface](#) for participants/listeners to make preferred adjustments to their auditory sensation. Participants/listeners can make these adjustments using three simple controls (see the following image):

- one control that modifies volume “loudness”
- one control that modifies high frequencies “crispness”
- one control that modifies low frequencies “fullness”



However, using Goldilocks is not as straightforward as being able to enter whatever values you desire, as the measured values retrieved from RTMHA may not reflect your desired values. This is where [Calibration](#) comes in to introduce correction factors that will ensure the desired values entered into Goldilocks will be reflected in the measured values from RTMHA (see the image below for the Calibration interface).

Back

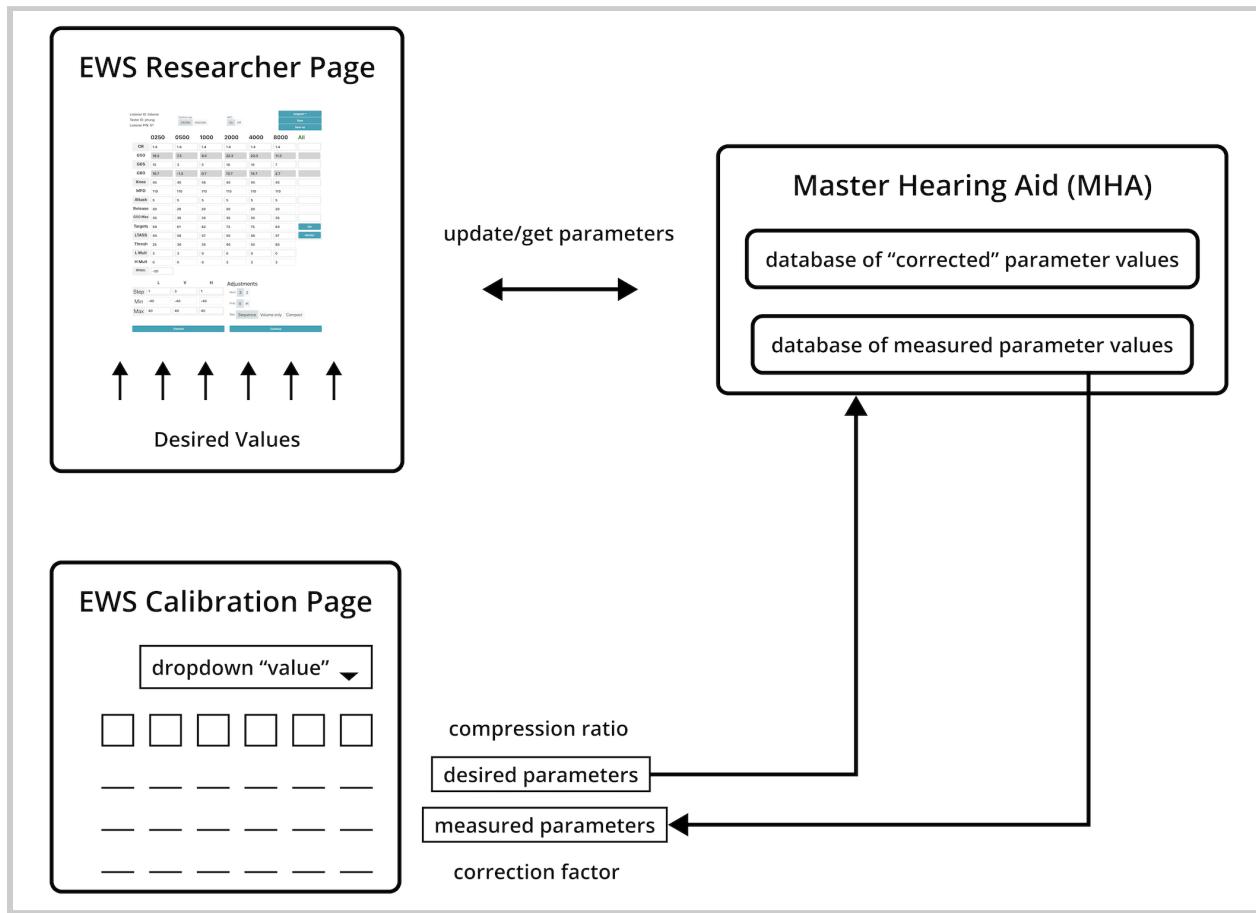
No calibration selected ▾
[Save](#)
[Save-as](#)
[Transmit Desired Parameters](#)
[Delete Current Calibration](#)

MHA Calibration

Channel: Left Right

	0250	0500	1000	2000	4000	8000	All	Calibrated
CR	1	1	1	1	1	1		
○ G65	Desired							<input type="checkbox"/>
	Measured							
	Subtraction							<input type="checkbox"/>
○ MPO	Desired							<input type="checkbox"/>
	Measured							
	Subtraction							<input type="checkbox"/>
○ Attack	Desired							<input type="checkbox"/>
	Measured							
	Division							<input type="checkbox"/>
○ Release	Desired							<input type="checkbox"/>
	Measured							
	Division							<input type="checkbox"/>
○ Knee	Desired							<input type="checkbox"/>
	Measured							
	Subtraction							<input type="checkbox"/>

See the next image to better understand the relationship between EWS, RTMHA, [Goldilocks Researcher Page](#), and [Calibration](#).



4.11 - Calibration (PHP Version of EWS)

Calibration ensures that your future desired changes made to the parameters in the [Goldilocks Researcher Page](#) will be reflected in the measured values from RTMHA, which also affects the default settings made in the [Listener Interface](#).

To access Calibration from the landing page, simply select the button labeled “Calibration”.

Calibration

Calibrate the MHA device using measured values.

You should see the following interface for Calibration.

Back

MHA Calibration
Channel: Left Right

No calibration selected ▾

Save

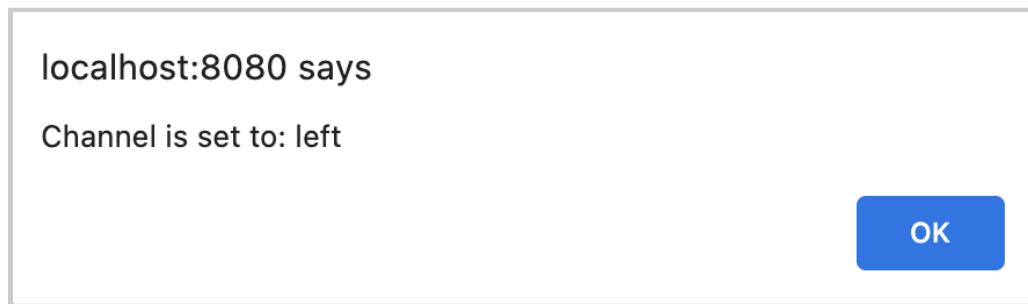
Save-as

Transmit Desired Parameters

Delete Current Calibration

	0250	0500	1000	2000	4000	8000	All	Calibrated
CR	1	1	1	1	1	1		
G65	Desired							
	Measured							
	Subtraction							<input type="checkbox"/>
MPO	Desired							
	Measured							
	Subtraction							<input type="checkbox"/>
Attack	Desired							
	Measured							
	Division							<input type="checkbox"/>
Release	Desired							
	Measured							
	Division							<input type="checkbox"/>
Knee	Desired							
	Measured							
	Subtraction							<input type="checkbox"/>

You may also see a popup message that says the current channel.



4.11.1 - Quick Set Up

1. If you have OSP software only, the browser search bar should say “localhost:8080”.
2. If you have OSP hardware (PCD) set up, the browser search bar should say either “http://ospboard.local” or “http://[YOUR_IP_ADDRESS]”.
3. Select the left or right channel to calibrate the parameters.
4. Select the toggle button next to G65.
5. Input any “Desired” values into the boxed cells for any and/or all frequency bands that you want to modify.
6. Input any “Measured” values into the boxed cells for any and/or all frequency bands that you want to modify. You will automatically see “Subtraction” values.
7. Select the “Transmit Desired Parameters” button.
8. Repeat steps #2-4 for “Knee”.
9. Repeat steps #2-4 for “MPO”.
10. If you want to, you may repeat steps #2-4 for “Attack” time and “Release” time.
11. Select the “Save-as” button to save your parameters as a new calibration.
12. Select the “Save” button.
13. If you want to calibrate the other channel, select either the “Left” or “Right” toggle buttons and repeat steps #2-8 and #10.

4.11.2 - Interface Components of Calibration

The Calibration interface features the following:

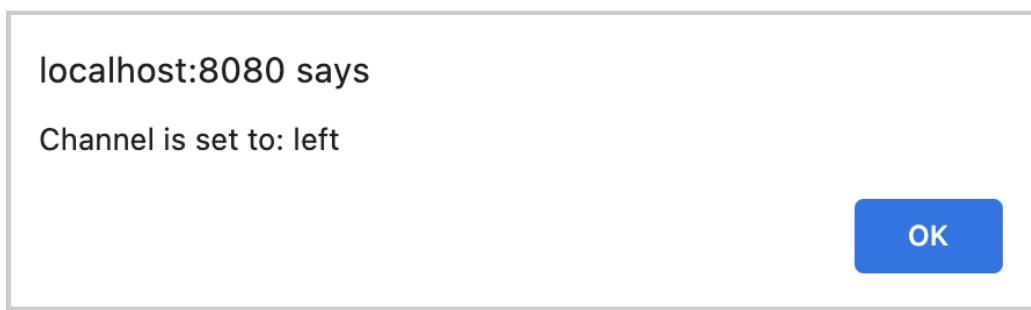
1. “Back” button

Located in the upper left-hand corner of the screen, this will exit out of the Calibration interface and return to the landing page of the PHP version of EWS.



2. Left and right channels

By default whenever you open Calibration, a popup message that says the current channel that you’re currently calibrating.



In the upper left-hand corner of your screen you will see a label called “Channel” and toggle buttons “Left” and “Right”.

MHA Calibration

Channel:

Left Right

When selecting the toggle buttons, you can switch between the two channels that you're calibrating. **Note that values for the parameters and bands are separate for both channels.**

3. Table of 6 frequency bands and audio parameters

		0250	0500	1000	2000	4000	8000	All	Calibrated
CR		1	1	1	1	1	1		
<input type="radio"/> G65	Desired								
	Measured								
	Subtraction								<input type="checkbox"/>
<input type="radio"/> MPO	Desired								
	Measured								
	Subtraction								<input type="checkbox"/>
<input type="radio"/> Attack	Desired								
	Measured								
	Division								<input type="checkbox"/>
<input type="radio"/> Release	Desired								
	Measured								
	Division								<input type="checkbox"/>
<input type="radio"/> Knee	Desired								
	Measured								
	Subtraction								<input type="checkbox"/>

A majority of what you'll see in calibration are:

- a. Six frequency bands (units in Hertz) as headers: 250, 500, 1000, 2000, 4000, 8000
- b. Six audio parameters: compression ratio (CR), G65, maximum power output (MPO), attack time, release time, and knee point (knee). There are small circled toggle buttons that enable selection and editing of a single parameter.



You must select a parameter first before editing, otherwise the “Please first select parameter to calibrate” pop-up message

will appear.

localhost:8080 says

Please first select parameter to calibrate

OK

- c. Boxed cells for inputting values for each frequency band and audio parameter. For each parameter, you'll find three additional rows of cells. Any cells in the "Desired" row are values that you want to input for Goldilocks. Any cells in the "Measured" row are the values that would be measured by Verifit or any other hearing aid measuring aid device. For each band, the value in the "Subtracted" cell is automatically calculated based on the difference between the value in the "Measured" cell and the value in the "Desired" cell.

0250		
CR		1
<input checked="" type="radio"/> G65	Desired	20
	Measured	12
	Subtraction	-8

Setting a value in any cells under the “All” column will set the same values in a row of cells for a given parameter across ALL bands.

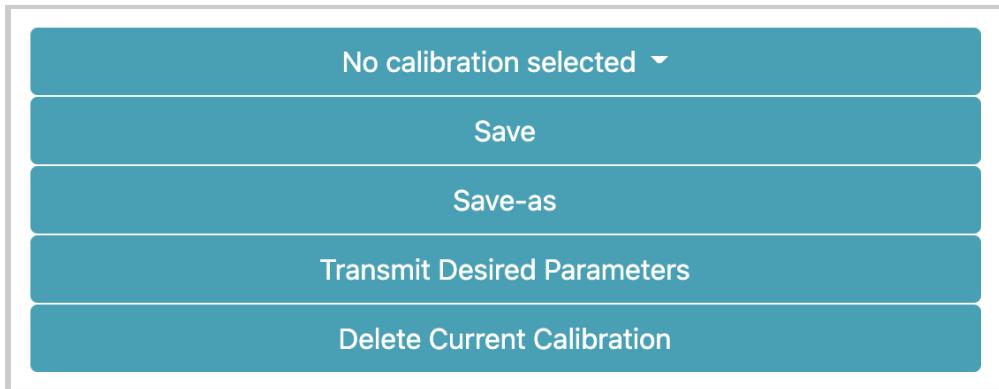
For example, setting “20” in the cell for the “Desired” row and “All” column for G65 will set all desired values to 20 across all the frequency bands. Similarly, setting “12” in the cell for the “Measured” row and “All” column for G65 sets all measured values to 12 for all the bands, thus setting all the subtraction values to -8 for all the bands (measured minus desired, $12 - 20$).

	0250	0500	1000	2000	4000	8000	All
CR	1	1	1	1	1	1	
G65	Desired	20	20	20	20	20	20
	Measured	12	12	12	12	12	12
	Subtraction	-8	-8	-8	-8	-8	

- d. “Calibrated” column to indicate which audio parameters have already been calibrated (as checkmarked boxes).



4. Series of Buttons

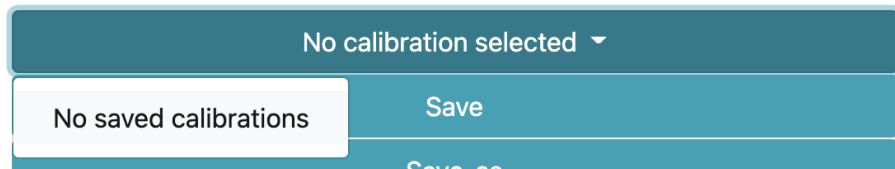


Located in the upper right-hand corner, each of these buttons do the following.

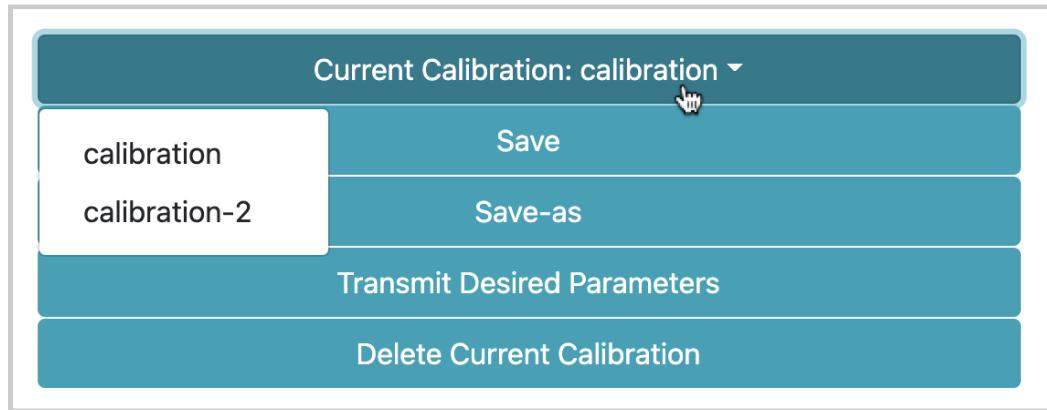
a. *Calibration dropdown menu button*

This shows your last set of parameters, which consists of all the previously saved values within the boxed cells for each and every parameter and band.

By default, if there are no calibrations selected or saved, the label would be “*No calibration selected*”. When you select it with no saved Calibrations, it would say “*No saved calibrations*”.

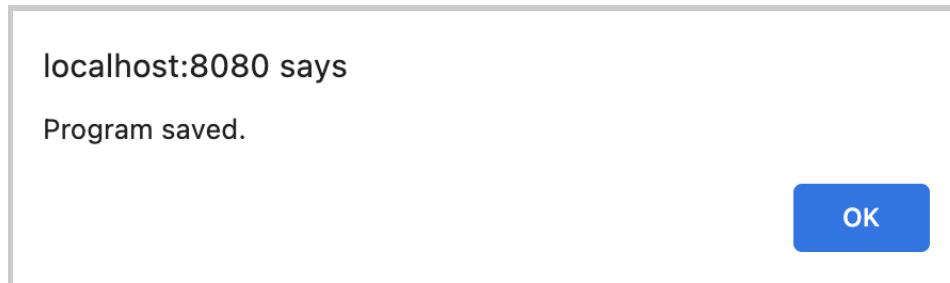


When there is a calibration selected, the label will change to show the current calibration's name. When selected, you'll be able to switch between different calibrations.



b. “Save” button

This saves and stores all current values set for each and every parameter and band for the current calibration, as shown in the pop-up message that appears every time you select this button.



However, If you try to select this button without transmitting and saving the parameters as a calibration, you will get the “Transmit and calibrate the selected parameter before save” pop-up message instead.

localhost:8080 says

Transmit and calibrate the selected parameter before save

OK

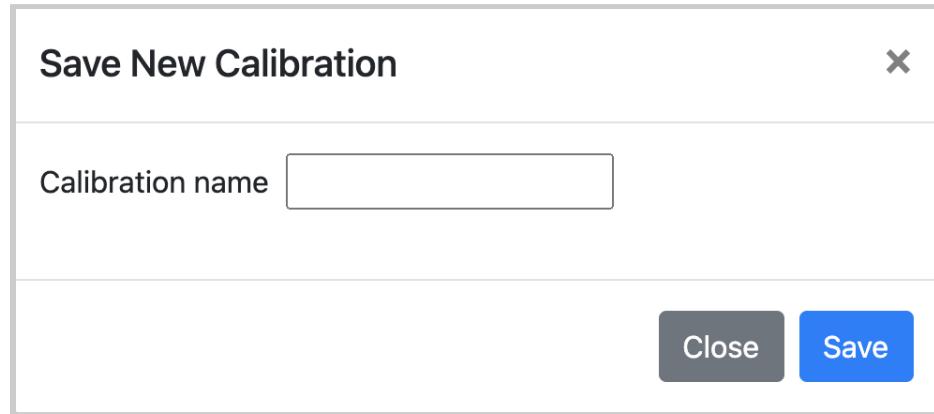
If you transmit the parameters via the “*Transmit Desired Parameters*” button and select this button with no existing calibration selected, you’ll see the “No setting selected. Click Save As.” pop-up message instead, meaning that you have to first save your values as a new calibration or select an existing calibration.

localhost:8080 says

No setting selected. Click Save As.

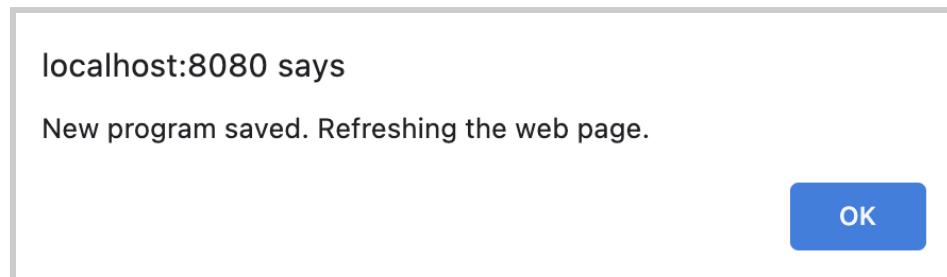
OK

- c. “Save-as” button - This saves all of the values in the cells for future retrieval and usage. You would need to enter a name for your new calibration.

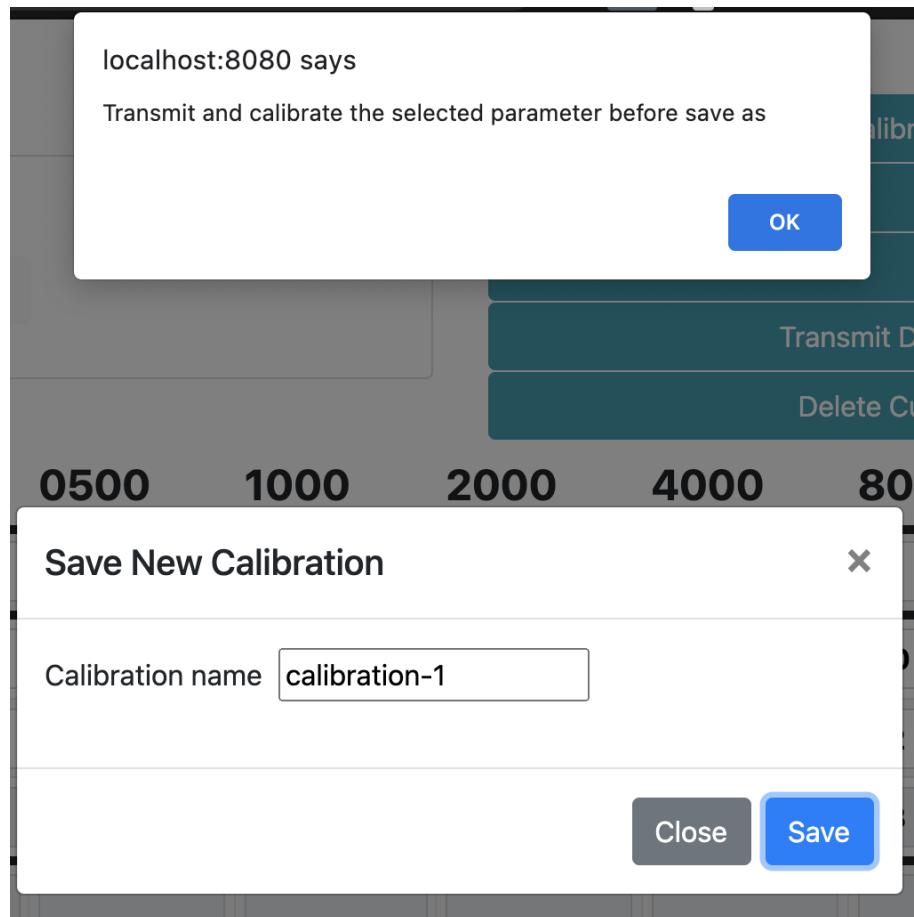


Select the blue “Save” button to confirm your calibration or the “Close” button/”x” icon to not save the calibration and return to the interface.

You will see a pop-up message to confirm that your calibration is saved and that your browser will refresh to update the current calibration shown: “New program saved. Refreshing the web page.”



However, If you try to save a new calibration without transmitting the parameters to RTMHA, you will get the “Transmit and calibrate the selected parameter before save” pop-up message instead.



You will see a change in the label for the *Calibration dropdown menu button* that will reflect the current calibration selected.



d. “Transmit Desired Parameters” button

When selected, this would transfer all values shown in the boxed cells for every band in the selected parameter into RTMHA.

If you haven't yet selected a parameter (CR, MPO, etc.), then you will see this “Must select one param to transmit” pop-up message instead.

localhost:8080 says
Must select one param to transmit

OK

Otherwise, if you have selected a parameter via the toggle button, you will see this pop-up message that confirms values associated with that select parameter have been sent to RTMHA.

localhost:8080 says
Selected parameter is transmitted

OK

e. *“Delete Current Calibration” button*

When selected, you will see a pop-up message asking you to confirm your choice. **Deleting the selected calibration would be an irreversible action.**

localhost:8080 says
Are you sure you want to delete the current calibration

Cancel

OK

Select “OK” to confirm or “Cancel” if you don’t want to delete the calibration.

Should you select “OK”, you will see the “Current calibration successfully deleted” pop-up message.

localhost:8080 says
Current calibration successfully deleted

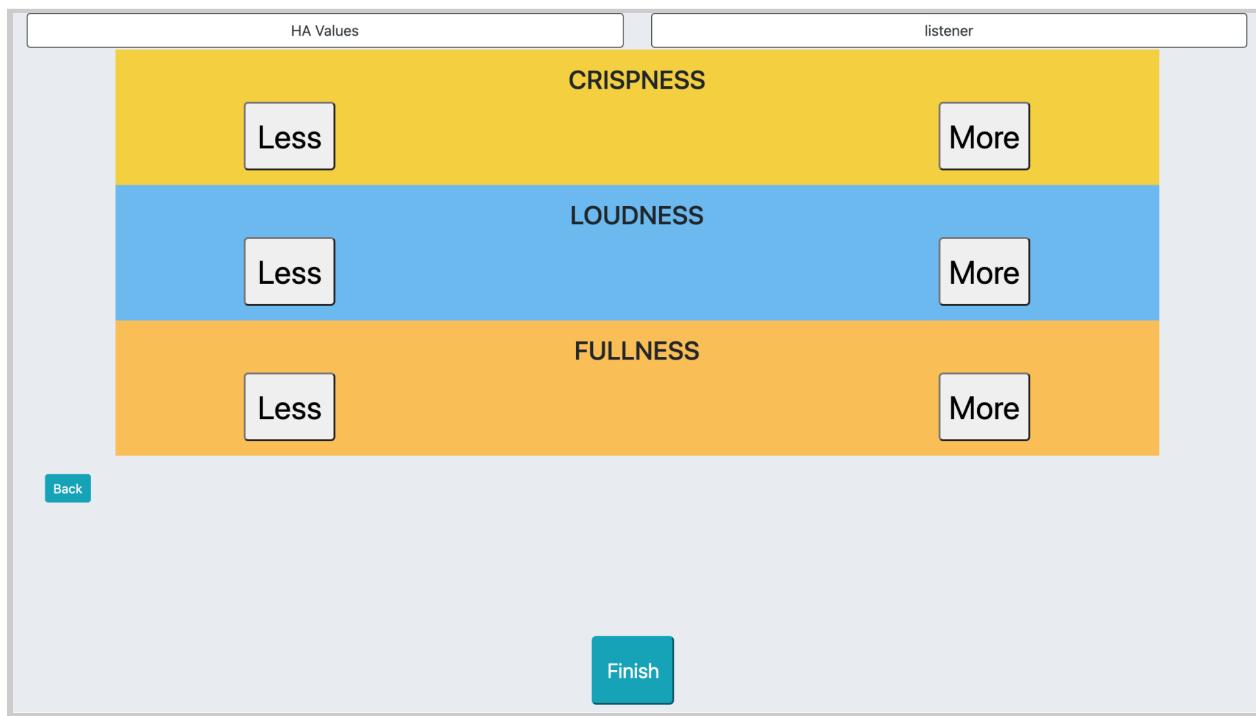
OK

4.12 - Goldilocks (PHP Version of EWS)

4.12.1 - Summary of Capabilities

Goldilocks enables you to do the following.

- You can create and manage digital profiles of researchers and listeners.
- You can edit the parameters from RTMHA and create programs tailored to each listener.
- You can select one of these programs and preview the [listener interface](#) to test how the selected program will behave across the three different button controls:
 - one control that modifies volume “loudness”
 - one control that modifies high frequencies “crispness”
 - one control that modifies low frequencies “fullness”



Based on the interactions in the [listener interface](#) and adjustments made to the parameters of the listener's program, you can also view logged data

of each and every interface interaction and adjustment made to the listener's program.

You can even make adjustments to the default parameters set by RTMHA.

The screenshot shows a web-based administrative interface for the Goldilocks Generic Program. At the top, there are buttons for 'Back' and 'Save'. Below these are dropdown menus for 'Control via:' (set to CR/G65) and 'AFC:' (set to Off). A large grid below contains numerical values for various parameters across different frequency bands (0250, 0500, 1000, 2000, 4000, 8000) and a summary row labeled 'All'. The parameters listed include CR, G50, G65, G80, Knee, MPO, Attack, Release, G50 Max, Targets, LTASS, and Thresh. The 'Targets' row includes a 'Set' button, and the 'LTASS' row includes a 'Monitor' button. The 'Thresh' row has a value of 85 highlighted in blue.

	0250	0500	1000	2000	4000	8000	All
CR	1.4	1.4	1.4	1.4	1.4	1.4	
G50	19.3	7.3	9.3	22.3	23.3	11.3	
G65	15	3	5	18	19	7	
G80	10.7	-1.3	0.7	13.7	14.7	2.7	
Knee	45	45	45	45	45	45	
MPO	110	110	110	110	110	110	
Attack	5	5	5	5	5	5	
Release	20	20	20	20	20	20	
G50 Max	35	35	35	35	35	35	
Targets	59	61	62	73	75	64	<button>Set</button>
LTASS	44	58	57	55	56	57	<button>Monitor</button>
Thresh	25	30	35	45	55	85	

Finally, you can export .csv files of researcher profiles, listener profiles, and logs made from adjusting the listener program(s).

The screenshot shows a user interface titled "Goldilocks / Download Logs". Below the title, there is a vertical list of six CSV download options, each enclosed in a light gray box:

- Researchers CSV
- Listeners CSV
- Programs CSV
- Listener Click Logs CSV (Old)
- Listener Adjustment Logs CSV (New)
- Device On-Off Logs CSV

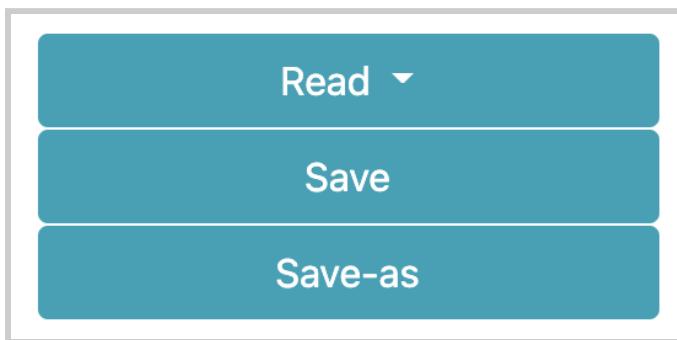
At the bottom left of the interface is a blue "Back" button.

4.12.2 - Quick Set Up with Goldilocks

Follow these steps to get started:

1. From the landing page, select the button in the upper right-hand corner labeled “Goldilocks”.
2. Select “Admin”, followed by “Researchers”. Create a new researcher profile by selecting the “Create New” button.
3. Enter a name and select “Create”.
4. Return to “Admin”, then select “Listeners”. Create a new listener profile by selecting the “Create New” button.
5. Enter a name and select “Create”.

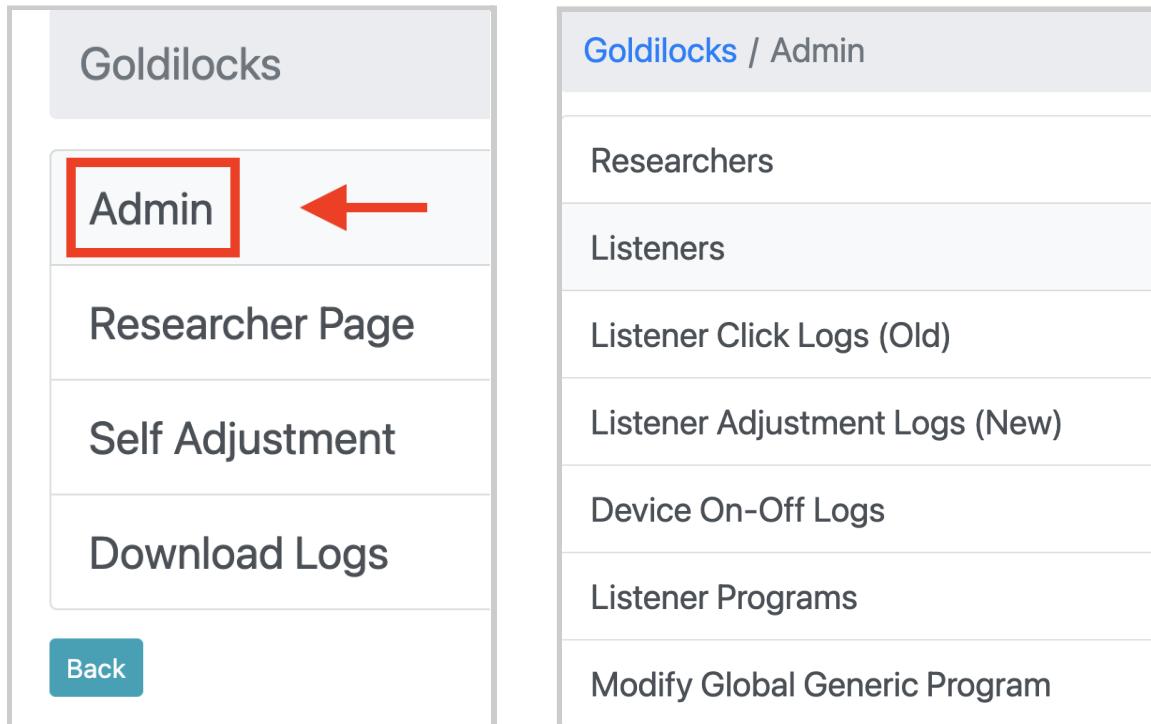
6. Return to “Goldilocks”, then select “Researcher Page”.
7. In the search text box, type in the researcher profile that you created and select the desired listener profile.
8. In the upper right-hand corner, you should see three sets of buttons. Select the bottom-most button, labeled “Save-as”.



9. Save the program as a new name, and select “Save”. You’ll see a pop-up message confirming that your program is saved.
10. You may see the browser refresh the page. Check that your new program name is labeled in the top-most button on the upper right-hand corner of the page. Otherwise, you may need to select the “Read” button again and select your program name.



4.13 - Goldilocks: Admin



Admin consists of several parts:

- “**Researchers**” - You can create, manage, and delete researcher profiles.
- “**Listeners**” - You can create, manage, and delete listener profiles.
- “**Listener Click Logs (Old)**” - You can view logged data of the interactions made to the [listener interface](#) for each listener profile.
- “**Listener Adjustment Logs (New)**” - You can view logged data of adjustments made to corresponding listener programs.
- “**Device On-Off Logs**” - This gathers data from. This may not be a functioning feature.

- “Listener Programs” - You can manage and delete listener programs.
- “Modify Global Generic Program” - You can change the values of the default parameters set by RTMHA.

4.13.1 - Admin: Researchers

How to navigate: Select “Admin”, then “Researchers”.

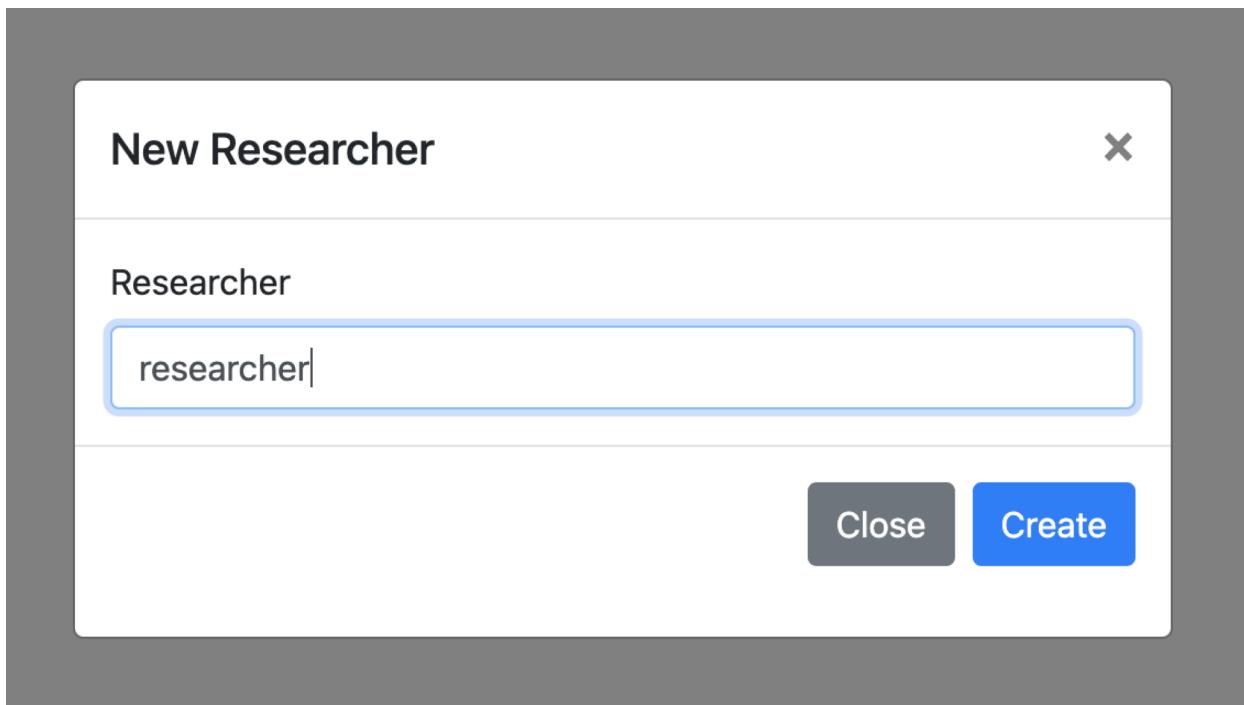
When you navigate to “Researchers” from opening the PHP version of EWS for the very first time, you will see this default interface with no researcher profiles shown.

Goldilocks / Admin / Researchers				
ID	Researcher	Created At	Updated At	Delete Researcher
				Create New
Back				

The blue “Create New” button allows you to create a new researcher profile.

[Create New](#)

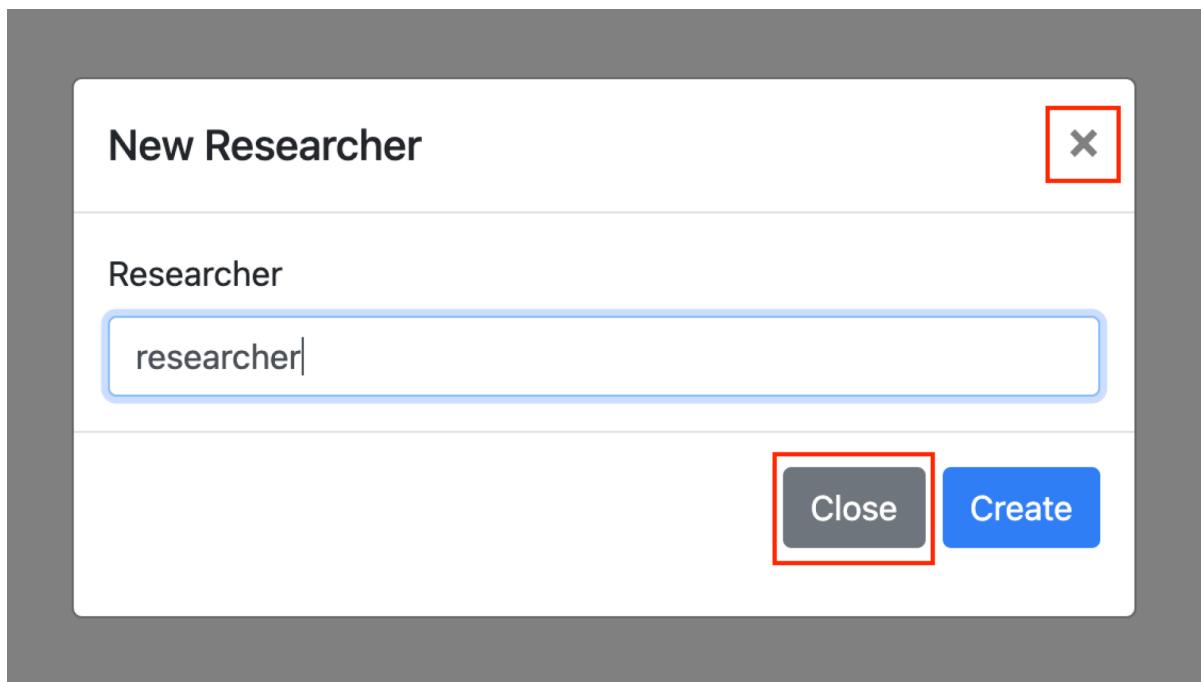
There would be a window with a text field for you to type in a new name for the researcher profile.



To confirm creation of the new researcher profile, select the blue “Create” button.

Create

Otherwise, if you wish to not make a new researcher profile, select the “Close” button, the “X” icon in the upper right-hand corner, or anywhere in the outside gray area.



The new researcher profile will be created with the following information.

Goldilocks / Admin / Researchers				
ID	Researcher	Created At	Updated At	Delete Researcher
1	researcher	2021-06-09 04:39:21	2021-06-09 04:39:21	<button>Delete</button>
<button>Create New</button>				

- *ID* - represented as a number unique to the researcher profile
- *Researcher* - name of the researcher profile
- *Created At* - Date and time that the researcher profile was created, formatted as yyyy-mm-dd hh:mm:ss.
- *Updated At* - Date and time that the researcher profile was last changed, formatted as yyyy-mm-dd hh:mm:ss.

If you wish to remove a researcher profile, you can do so by selecting the “Delete” button.



Delete

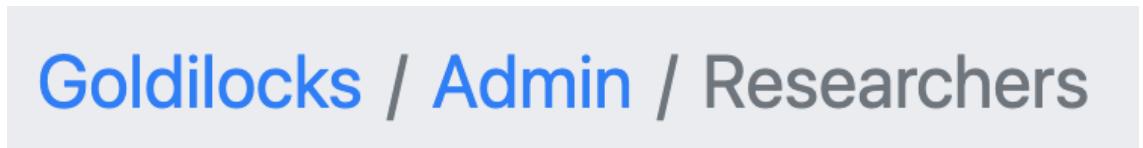
You can do one of the following to exit out of the interface:

- Select the “Back” button. This will return to the “Admin” interface.



Back

- Select “Goldilocks” or “Admin” in the top portion of your screen.



Goldilocks / Admin / Researchers

- Change the URL in the browser search bar, some examples include:
 - “<http://localhost:8080/>” or
“[http://\[WIFI_IP_ADDRESS\]:8080/](http://[WIFI_IP_ADDRESS]:8080/)” to go back to the landing page
 - “<http://localhost:8080/goldilocks/>” or
“[http://\[WIFI_IP_ADDRESS\]:8080/goldilocks/](http://[WIFI_IP_ADDRESS]:8080/goldilocks/)” to go back to Goldilocks.

- “<http://localhost:8080/goldilocks/researchers/>” or
“[http://\[WIFI_IP_ADDRESS\]:8080/goldilocks/researchers/](http://[WIFI_IP_ADDRESS]:8080/goldilocks/researchers/)” to
go back to “Goldilocks” > “Researchers”.

4.13.2 - Admin: Listeners

How to navigate: Select “Admin”, then “Listeners”.

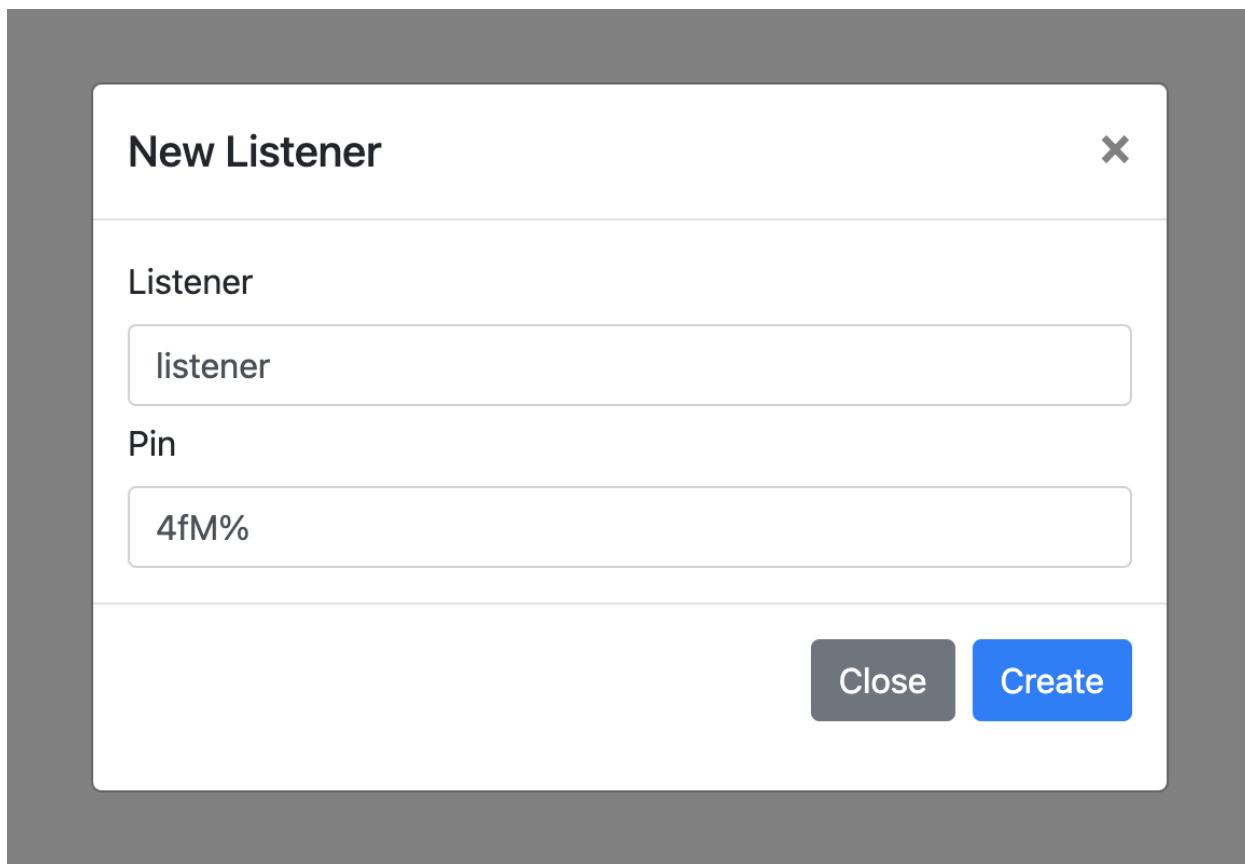
When you navigate to “Listeners” from opening the PHP version of EWS for the very first time, you will see this default interface with no researcher profiles shown.

Goldilocks / Admin / Listeners					
ID	Listener	Pin	Created At	Updated At	Delete Listener
Create New					

The blue “Create New” button allows you to create a new researcher profile.

Create New

There would be a window with a text field for you to type in a new name and pin for the researcher profile.

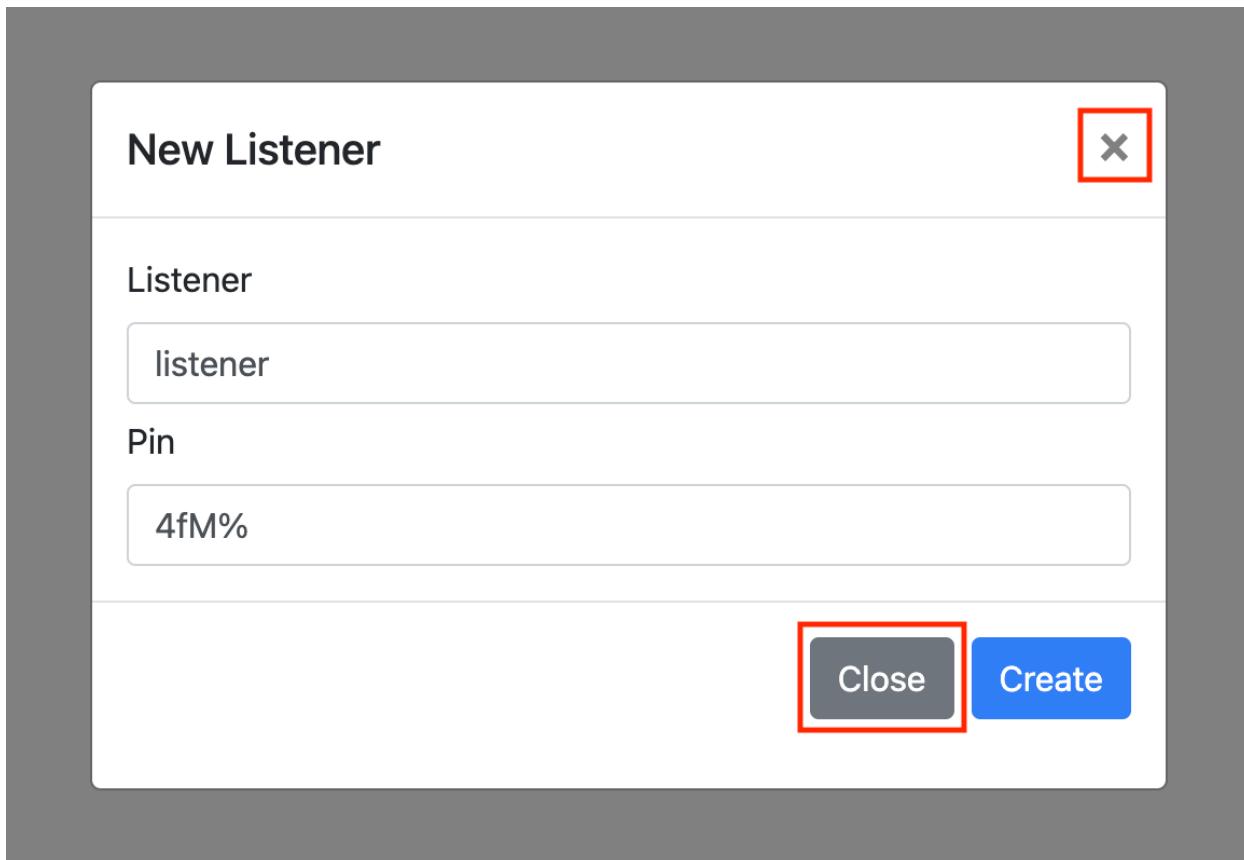


To confirm creation of the new researcher profile, select the blue “Create” button.

Create

Otherwise, if you wish to not make a new researcher profile, select the “Close” button, the “X” icon in the upper right-hand corner, or anywhere in

the outside gray area.



The new researcher profile will be created with the following information.

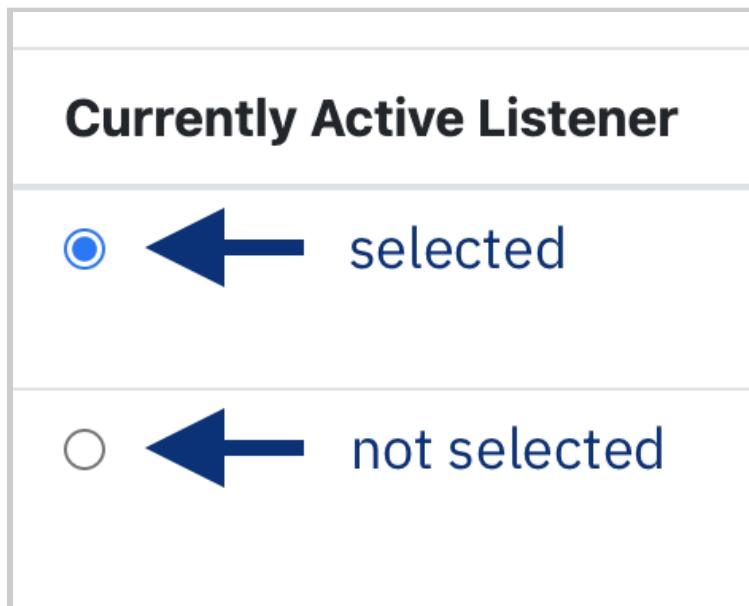
Goldilocks / Admin / Listeners						
ID	Listener	Pin	Created At	Updated At	Delete Listener	Currently Active Listener
2	listener	4fM%	2021-06-09 05:17:06	2021-06-09 20:50:25	<button>Delete</button>	<input checked="" type="radio"/>
3	listener2	M*9)	2021-06-09 20:48:16	2021-06-09 20:50:25	<button>Delete</button>	<input type="radio"/>
						<button>Create New</button>

- *ID* - represented as a number unique to the listener profile
- *Listener* - name of the listener profile

- *Pin* - assigned to the listener
- *Created At* - Date and time that the researcher profile was created, formatted as yyyy-mm-dd hh:mm:ss.
- *Updated At* - Date and time that the researcher profile was last changed, formatted as yyyy-mm-dd hh:mm:ss.
- *Delete Listener* - There would be a red “Delete” button for you to choose to remove the available listener.

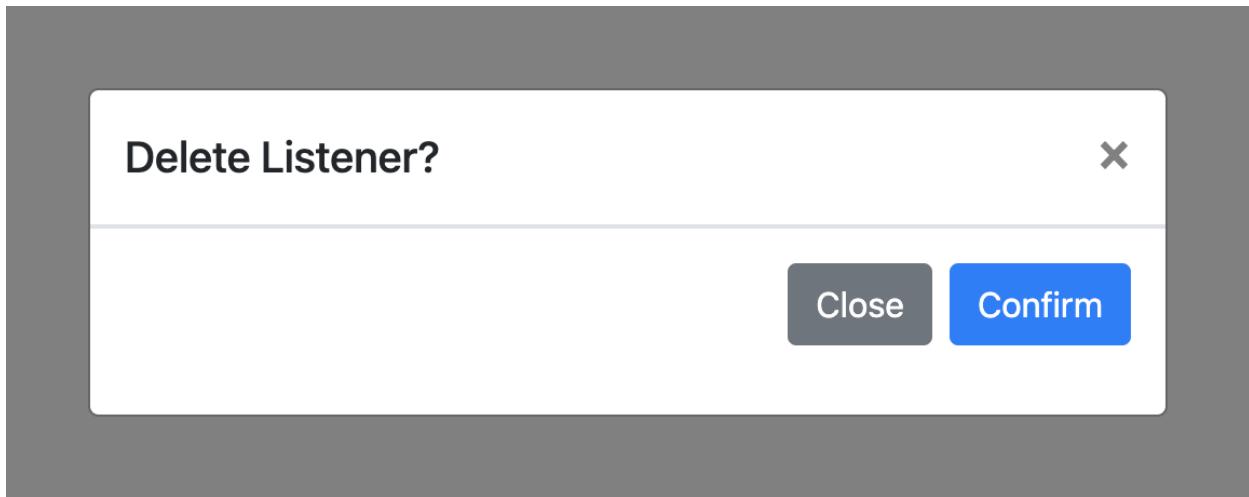
Delete

- *Currently Active Listener* - This is the listener profile that would be selected in the [Self Adjustment page](#). Clicking on a toggle button that is not selected will change the selected listener profile.



If you select the “Delete” button to delete the listener profile, you will be asked to confirm your choice.

- To proceed, select the “Confirm” button.
- Otherwise to cancel deletion of the profile, select the “Close” button, the “X” icon in the upper right-hand corner, or anywhere in the outside gray area.



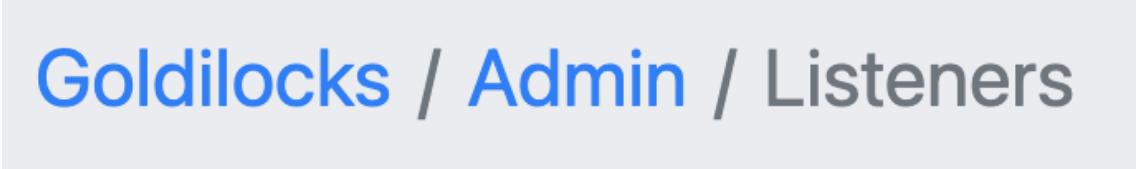
You can do one of the following to exit out of the interface:

- Select the “Back” button. This will return to the “Admin” interface.



Back

- Select “Goldilocks” or “Admin” in the top portion of your screen.



Goldilocks / Admin / Listeners

- Change the URL in the browser search bar, some examples include:

- “<http://localhost:8080/>” or
“[http://\[WIFI_IP_ADDRESS\]:8080/](http://[WIFI_IP_ADDRESS]:8080/)” to go back to the landing page
- “<http://localhost:8080/goldilocks/>” or
“[http://\[WIFI_IP_ADDRESS\]:8080/goldilocks](http://[WIFI_IP_ADDRESS]:8080/goldilocks)” to go back to Goldilocks.
- “<http://localhost:8080/goldilocks/admin/>” or
“[http://\[WIFI_IP_ADDRESS\]:8080/goldilocks/admin](http://[WIFI_IP_ADDRESS]:8080/goldilocks/admin)” to go back to “Goldilocks” > “Admin”.

4.13.3 - Admin: Listener Click Logs (Old)

How to navigate: Select “Admin”, then “Listener Click Logs (Old)”.

Note that this aspect of Goldilocks is no longer being developed. You may want to instead refer to the [next section “Admin - Listener Adjustment Logs \(New\)”\).](#)

When you open this page for the very first time, you will see this default interface with no logs shown.

ID	Listener ID	Action	LVH	Program State	Created At	Updated At
Back						

4.13.4 - Admin: Listener Adjustment Logs (New)

How to navigate: Select “Admin”, then “Listener Adjustment Logs (New)”.

When you open this page for the very first time, you will see this default interface with no logs shown.

ID	Listener ID	Listener	Researcher ID	Researcher	Starting Program ID	Starting Program Name	Ending Program ID	Ending Program Name	Timestamp	Timezone	Final LVH	Steps	Seconds Elapsed	Step-By-Step Changes	Starting G65	Compression Ratio	Low Multipliers	High Multipliers	Ending G65
Back																			

4.13.5 - Admin: Device On-Off Logs

How to navigate: Select “Admin”, then “Device On-Off Logs”.

When you open this page for the very first time, you will see this default interface with no device logs shown.

Goldilocks / Admin / Device On-Off Logs		
ID	On Time	Off Time
Back		

4.13.6 - Admin: Listener Programs

How to navigate: Select “Admin”, then “Listener Programs”.

When you open this page for the very first time, you will see this default interface with no listener programs shown.

Goldilocks / Admin / Programs						
ID	Listener ID	Name	Parameters	Created At	Updated At	Delete Program
Back						

4.13.7 - Admin: Modify Global Generic Program

How to navigate: Select “Admin”, then “Listener Programs”.

When you open this page for the very first time, you will see this interface with default values for all of the parameters and frequency bands set by RTMHA.

[Back](#)
Control via:
CR/G65 G50/G80
AFC:
On Off
[Save](#)

	0250	0500	1000	2000	4000	8000	All
CR	1.4	1.4	1.4	1.4	1.4	1.4	
G50	19.3	7.3	9.3	22.3	23.3	11.3	
G65	15	3	5	18	19	7	
G80	10.7	-1.3	0.7	13.7	14.7	2.7	
Knee	45	45	45	45	45	45	
MPO	110	110	110	110	110	110	
Attack	5	5	5	5	5	5	
Release	20	20	20	20	20	20	
G50 Max	35	35	35	35	35	35	
Targets	59	61	62	73	75	64	Set
LTASS	44	58	57	55	56	57	Monitor
Thresh	25	30	35	45	55	85	
L Mult	3	3	0	0	0	0	
H Mult	0	0	0	3	3	3	
Atten.	0						

	L	V	H	Adjustments
Step	1	3	1	Num: 3 2
Min	-40	-40	-40	First: V H
Max	40	40	40	Seq: Sequence Volume only Compact

Any changes saved into this interface will be reflected in the [Researcher Page](#) when you view the default parameters for a listener profile with no assigned program.

Explanation of the parameters and settings are explained in the next section [“4.4 - Researcher Page”](#).

4.14 - Goldilocks: Researcher Page (PHP)

How to navigate: Select “Goldilocks”, then “Researcher Page”.

When you open this page for the very first time, you will see this interface with no listeners available. You will need to create at least one researcher profile and one listener profile, as covered in the previous sections.



When selecting the gray “Click Here to Create Listener” button, you will be taken to the [“Listeners” page](#) in “Admin” to set up a listener profile. To set up the profile, refer back to section [4.3.2 - Listeners](#).

ID	Listener	Pin	Created At	Updated At	Delete Listener
Create New					

Once you create a listener profile, you'll be able to see available listener profiles.

The screenshot shows the Goldilocks application interface. At the top, it says "GOLDILOCKS". Below that, there's a "Researcher" section with a text input field containing "researcher". Underneath, there's a "Listeners" section with two teal bars labeled "listener" and "listener2". At the bottom left, there's a "Back" button.

To get started:

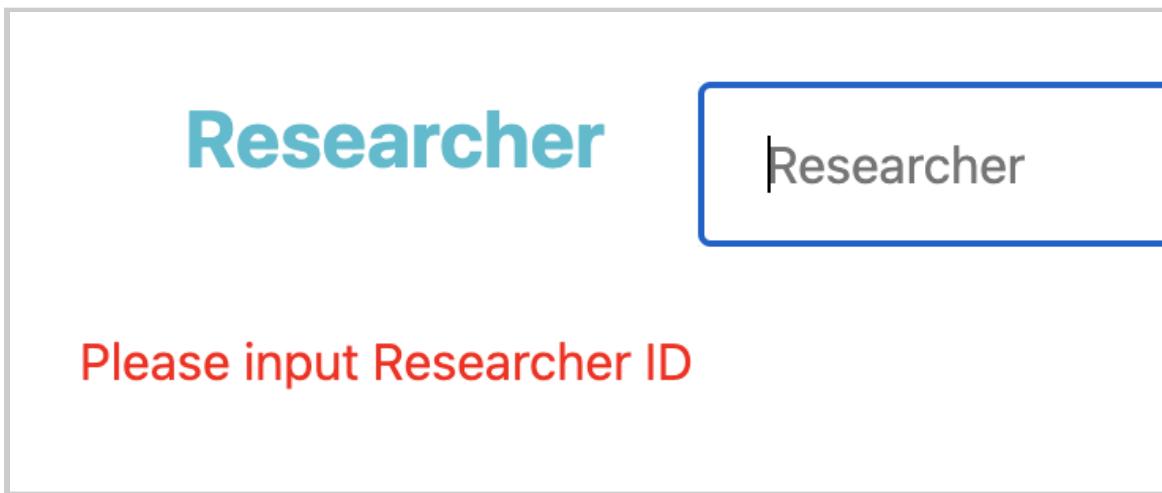
1. In the rectangular text input field, type in the name of your desired researcher profile. If you haven't created a researcher profile, refer back to section "[“4.3.1 - Researchers”](#) in “Admin”.

The screenshot shows the Goldilocks application interface. On the left, there's a "Researcher" section. To its right is a text input field with the placeholder "researcher" and a cursor inside. The entire interface is enclosed in a light gray border.

2. Select one button of the name of the listener profile that you want.



If you try to select an available listener without entering the researcher name (in the previous step), you will see this error message “Please input Researcher ID”, preventing you from continuing to the Researcher Page.



You'll see the interface in the next page, with the default values for each parameter set by the generic program from RTMHA.

Back

Listener ID: listener
Tester ID: researcher
Listener PIN: 4fM%

	0250	0500	1000	2000	4000	8000	All
CR	1.4	1.4	1.4	1.4	1.4	1.4	
G50	19.3	7.3	9.3	22.3	23.3	11.3	
G65	15	3	5	18	19	7	
G80	10.7	-1.3	0.7	13.7	14.7	2.7	
Knee	45	45	45	45	45	45	
MPO	110	110	110	110	110	110	
Attack	5	5	5	5	5	5	
Release	20	20	20	20	20	20	
G50 Max	35	35	35	35	35	35	
G80 Min	0	0	0	0	0	0	
Targets	59	61	62	73	75	64	Set
LTASS	44	58	57	55	56	57	Monitor
Thresh	25	30	35	45	55	85	
L Mult	3	3	0	0	0	0	
H Mult	0	0	0	3	3	3	

L V H Adjustments

Step	1	3	1	Num:	3	2	
Min	-40	-40	-40	First:	V	H	
Max	40	40	40	Seq:	Sequence	Volume only	Compact

Transmit Continue

All values initially shown for a given listener are based on the values set in the Global Generic Program.

The Researcher Page consists of the following components.

4.14.1 - Researcher Page: “Back” button

Located in the upper left-hand corner of the screen, this will exit out of the Researcher Page interface and return to the default Goldilocks page.



4.14.2 - Researcher Page: Listener ID, Tester ID, and Listener PIN

Located in the upper left-hand corner of the screen:

- “Listener ID” shows the name of the selected listener profile.
- “Tester ID” shows the name of the selected researcher profile.
- “Listener PIN” is the listener’s PIN.

Listener ID: listener
Tester ID: researcher
Listener PIN: 4fM%

This information is created and viewable via “Goldilocks” → “Admin” → “Researchers” or “Listeners”.

4.14.3 - Researcher Page: Frequencies and RT-MHA Parameters

This consists of:

- 7 column headers

6 center frequency bands (0250, 0500, 1000, 2000, 4000, 8000)
and “All”

0250	0500	1000	2000	4000	8000	All
------	------	------	------	------	------	-----

The boxed cells under the “All” column enable you to set the same value for a given parameter across all frequency bands.

	0250	0500	1000	2000	4000	8000	All
CR	2	2	2	2	2	2	2

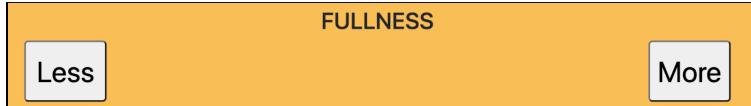
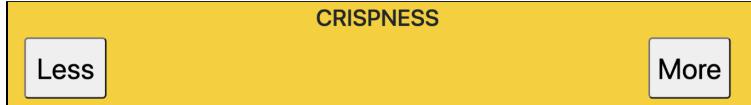
- 15 parameters (applied to the frequency bands)

Parameter Name	Description
Compression Ratio CR	Shows (and, if enabled, sets) compression ratio in each band. Values measured from RTMHA for this parameter may be subject to prior calibration of this parameter.
G50 G50	Shows (and, if enabled, sets) band gain for a 50 dB SPL input. Values measured from RTMHA for this parameter may be subject to prior calibration of the G65 parameter.
G65 G65	Shows (and, if enabled, sets) band gain for a 65 dB SPL input. Values measured from RTMHA for this parameter may be subject to prior calibration of this parameter.
G80 G80	Shows (and, if enabled, sets) band gain for a 80 dB SPL input. Values measured from RTMHA for this parameter may be subject to prior calibration of the G65 parameter.
Knee Knee	Sets the SPL band input level above which compression will be applied. Values measured from RTMHA for this

	parameter may be subject to prior calibration of this parameter.
Maximum Power Output (MPO) MPO	Sets the maximum SPL output level in each band. Values measured from RTMHA for this parameter may be subject to prior calibration of this parameter.
Attack (time) Attack	Attack time of compression, which only becomes relevant when CR is greater than 1. Values measured from RTMHA for this parameter may be subject to prior calibration of this parameter. Note that values of attack and release time are dependent on definitions of “reach” and “return”. ANSI published definitions in terms of size of the adjustment and proximity to completion (in dB). They have, however, dropped this definition.
Release (time) Release	Release time of compression, which only becomes relevant when CR is greater than 1. Values measured from RTMHA for this parameter may be subject to prior calibration of this parameter. Note that values of attack and release time are dependent on definitions of “reach” and “return”. ANSI published definitions in terms of size of the adjustment and proximity to

	completion (in dB). They have, however, dropped this definition.
G50 Max G50 Max	Sets an upper gain limit to prevent excessive acoustic feedback. In the listener interface , if any requested band gain is above this value: <ul style="list-style-type: none">• The “More” button will be disabled and its label will be changed to “MAX”.• The listener will be informed that a maximum has been reached for “L”/“Fullness”, “V”/“Loudness”, or “H”/“Crispness”.
G80 Min G80 Min	Sets a lower gain limit to prevent further reductions of gain when sound level in the ear canal is dominated by leakage through or past the earmold or receiver dome. In the listener interface , if any requested band gain is below this value: <ul style="list-style-type: none">• The “Less” button will be disabled and its label will be changed to “MIN”.• The listener will be informed that a minimum has been reached for “L”/“Fullness”, “V”/“Loudness”, or “H”/“Crispness”.
Targets Targets	This is where you can input your desired values for real-ear band outputs for a 65 dB SPL broad-band speech input level. The targets you enter may be based on any desired prescriptive formula or prescription,

	<p>such as:</p> <ul style="list-style-type: none">• The National Acoustic Laboratories second formula for Non-Linear amplification (NAL-NL2)• The Desired Sensation Level formula from Western Ontario University (DSL) <p>Note that any available prescriptive formulae is not an exact prescription for the individual/listener, which may influence the targets that you may set. Rather, the targets that you set provides the individual/listener a starting response that matches the average preference for people with a similar audiogram. This would influence the default starting response for the listener interface.</p>
Long-Term Average Speech Spectrum (LTASS) LTASS	<p>Note that the “Set” button computes the difference between target and LTASS and enters the result for G65.</p> <p style="text-align: center;">Set</p>
Threshold (Thresh) Thresh	<p>This is a parameter that is still a work in progress.</p> <p>This would calculate the NAL-NL2 targets from thresholds without needing Verifit to obtain/establish targets.</p>
L Mult L Mult	The band-specific value for this parameter would be multiplied with the value in the boxed cell for “Step” and “L”/“Fullness” to set the step size for changes of

	<p>Low-frequency output (“L”/“Fullness”) for the corresponding frequency band.</p> <p>Ultimately, this value would impact the difference heard for the corresponding frequency band when a listener selects the “Less” or “More” button for “Fullness” in the listener interface.</p> 
H Mult H Mult	<p>The band-specific value for this parameter would be multiplied with the value in the boxed cell for “Step” and “H”/“Crispness” to set the step size for changes of High-frequency output (“H”/“Crispness”).</p> <p>Ultimately, this value would impact the difference heard for the corresponding frequency band when a listener selects the “Less” or “More” button for “Crispness” in the listener interface.</p> 

- *100 boxed cells*
 - Each of the 90 cells set the values for the corresponding parameter and frequency band.

- Each of the 10 cells in the “All” column sets the same value for all boxed cells in each corresponding row.
- “Set” button

This button computes the difference between target and LTASS and enters the result for G65.

A teal rectangular button with the word "Set" centered in white text.

Set

- “Monitor” button

This button retrieves values for each parameter and frequency band currently set within RTMHA and displays them in the Researcher Page. Doing this replaces the current values shown.

A teal rectangular button with the word "Monitor" centered in white text.

Monitor

4.14.4 - Researcher Page: Table for Step, Min, Max, and LVH

The parameters at the bottom left of the Researcher Page are labeled as L, V, and H respectively; each have individual settings that affect the experience and controls shown in the [listener interface](#).

	L	V	H
Step	1	3	1
Min	-40	-40	-40
Max	40	40	40

When used in conjunction with the “L Mult” and “H Mult”, this table will provide you with a wide range of control over what will happen when the listener makes changes with the [Listener Interface](#) via the “More” and “Less” buttons.



Below is a table defining “L”, “V”, and “H” for the column header.

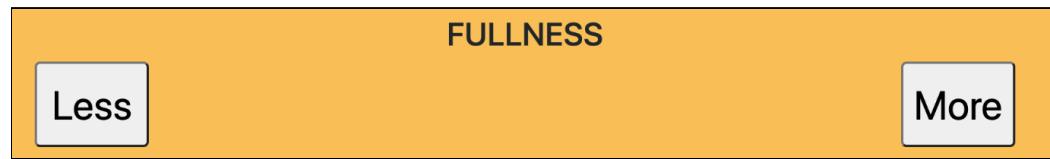
Parameter Name	Definition	Name Used in Listener Interface
L	Low-frequency output (cut or boost)	“Fullness”

		FULLNESS
V	overall output/Volume	“Loudness” LOUDNESS
H	High-frequency output (cut or boost)	“Crispness” CRISPNESS

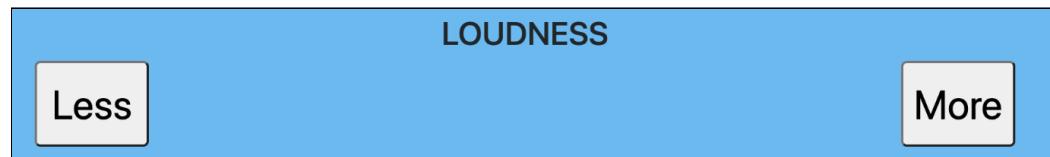
“Step” has different meanings with the column headers:

L	V	H
Step	1	3

- “Step” with “L”
 - The value for this parameter would be multiplied by the value in the boxed cell “L Mult” to set the step size for changes to Low-frequency output (“L”/“Fullness”) for the corresponding frequency band.
 - Ultimately, this value would impact the difference heard for the corresponding frequency band when a listener selects the “Less” or “More” button for “Fullness” in the [listener interface](#).



- “Step” with “V”
 - Step size in dB for user adjustment of overall output (Volume).
 - Ultimately, this value would impact the difference heard when a listener selects the “Less” or “More” button for “Loudness” in the [listener interface](#).



- “Step” with “H”
 - The value for this parameter would be multiplied by the value in the boxed cell “H Mult” to set the step size for changes to High-frequency output (“H”/“Crispness”) for the corresponding frequency band.
 - Ultimately, this value would impact the difference heard for the corresponding frequency band when a listener selects the “Less” or “More” button for “Crispness” in the [listener interface](#).



“Min” for “L”, “V”, and “H” sets the lower limit on output decrease from a starting response in the [listener interface](#) based on the number of steps taken rather than requested gain.



In the [listener interface](#), this is best represented as buttons that are labeled “MIN” and that cannot be selected until a “More” button is selected one or more times.



“Max” for “L”, “V”, and “H” sets the upper limit on output increase from a starting response in the [listener interface](#) based on the number of steps taken rather than requested gain.



In the [listener interface](#), this is best represented as buttons that are labeled “MAX” and that cannot be selected until a “Less” button is selected one or more times.



4.14.5 - Researcher Page: Adjustments

These settings affect the available controls, usage, and behavior of the [listener interface](#).

Adjustments

Num: **3** 2

First: **V** H

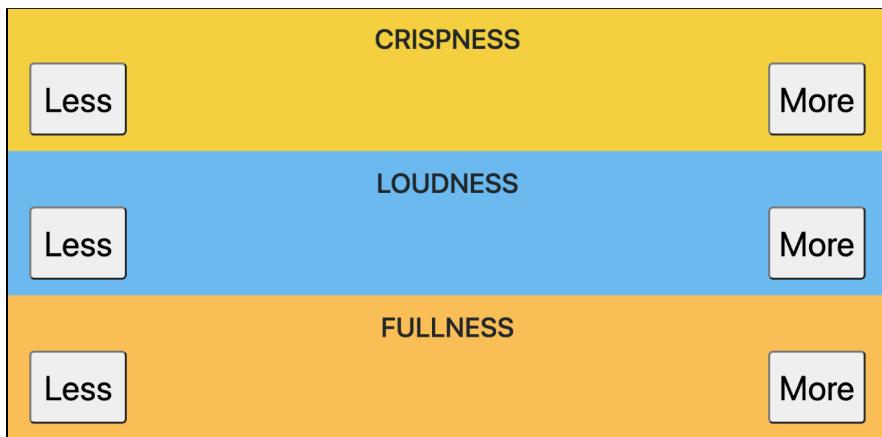
Seq: **Sequence** Volume only Compact

The settings are each labeled “Num:”, “First:”, and “Seq:”. Each setting has a set of toggle buttons, with the selected options for each shown with a darker gray background.

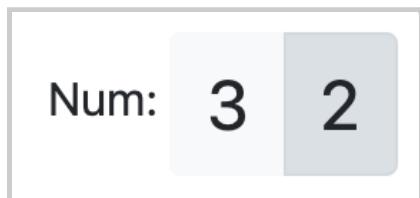
“Num:” - “3” is selected

Num: **3** 2

When this option is selected, three separate sets of button controls will appear for “H”/“Crispness”, “V”/“Loudness”, and “L”/“Fullness”.



“Num:” - “2” is selected



When this option is selected, “L”/“Fullness” and “H”/“Crispness” are combined. In the [listener interface](#), this would appear as one set of button controls, named as “Crispness”. Thus, button controls for “H”/“Crispness” and “V”/“Loudness” are only shown.

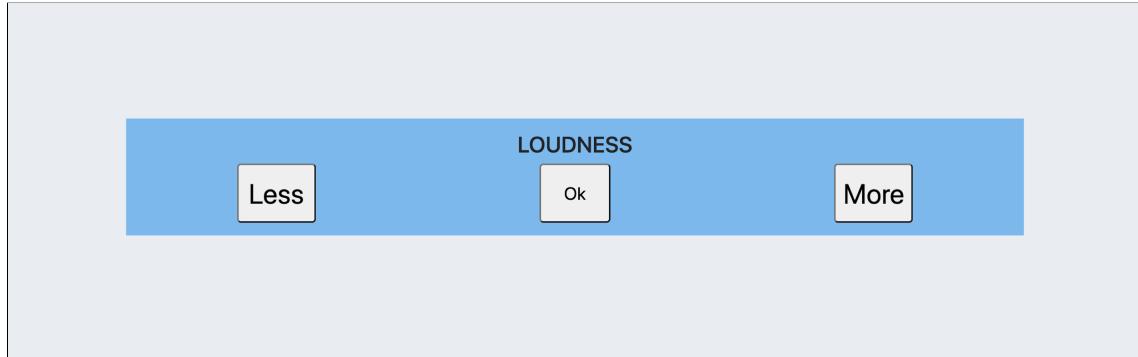


Any increase of “H”/“Crispness” is accompanied by a reduction of “L”/“Fullness” (the exact spectral tilt is determined by “L Mult” and “H Mult”).

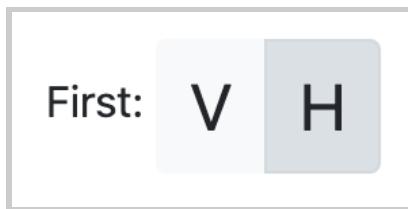
“First: ” - “V” is selected (“Loudness”)



When this option is selected, only button controls for “V”/“Loudness” are shown first in the [listener interface](#), followed by controls for “L”/“Fullness” and “H”/“Crispness”.

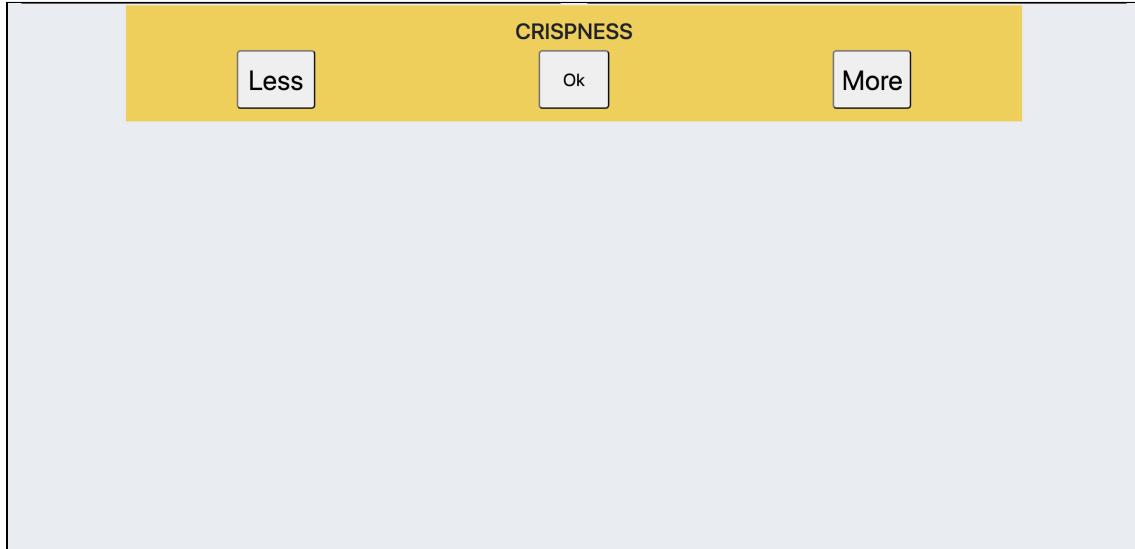


“First: ” - “H” is selected (“Crispness”)

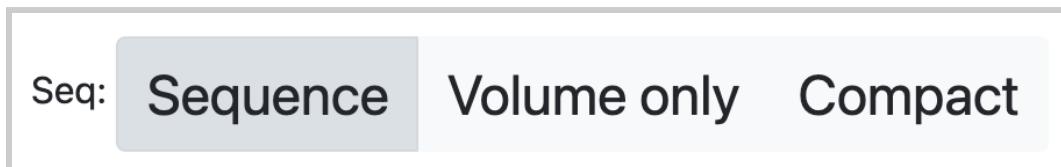


When this option is selected, only button controls for “H”/“Crispness” are shown first in the [listener interface](#), followed by controls for

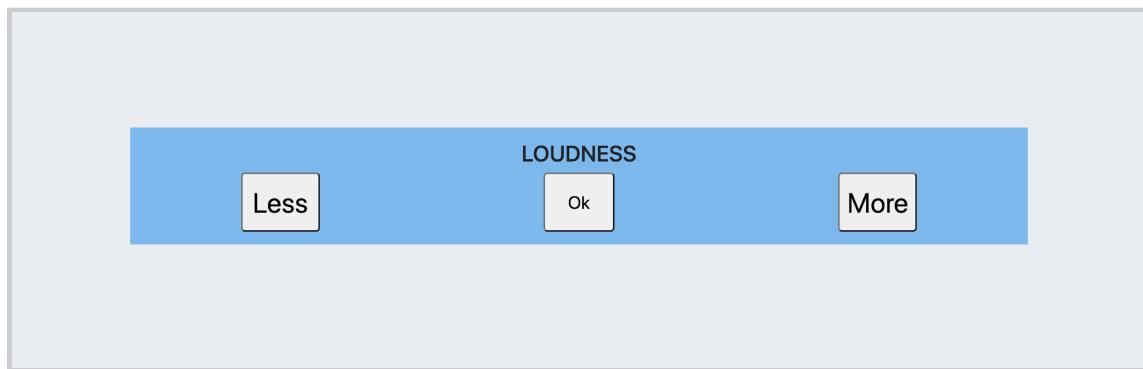
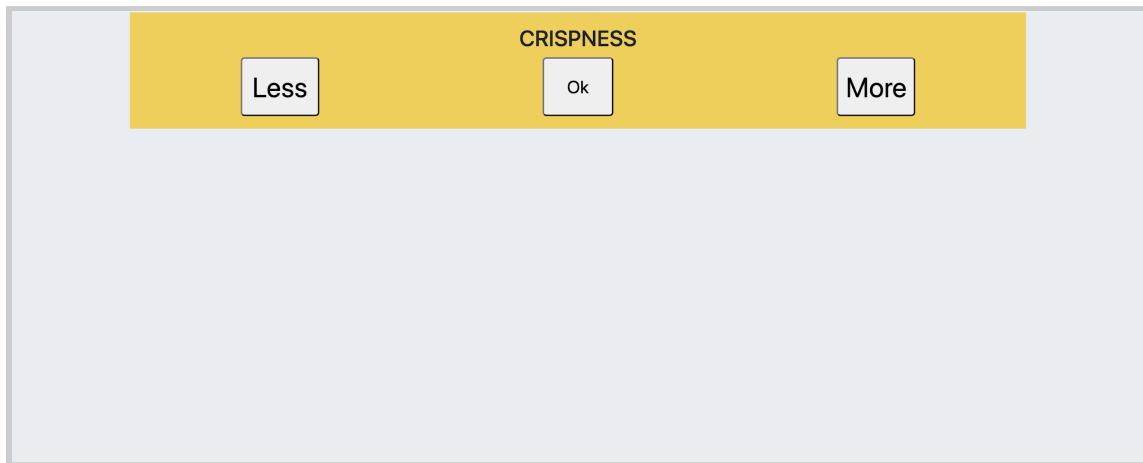
“V”/“Loudness” and “L”/“Fullness”.

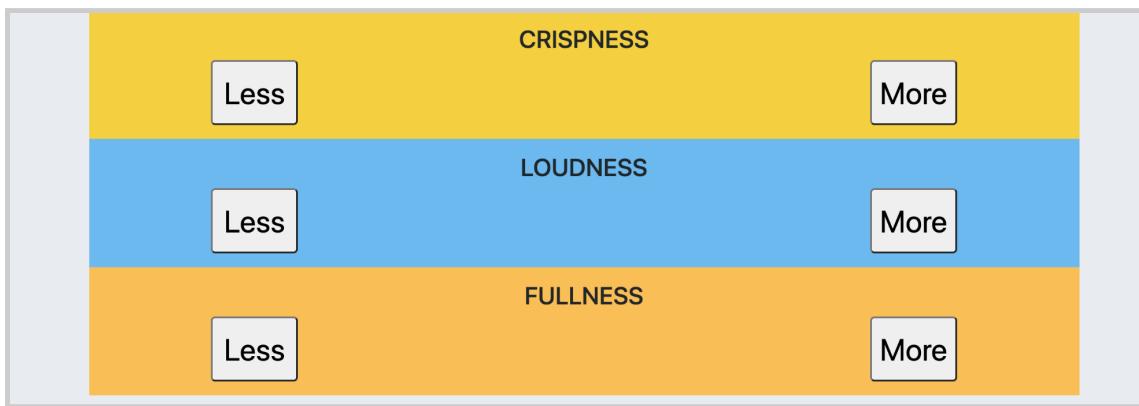


“Seq: ” - “Sequence” is selected



When this option is selected, each set of button controls are shown one at a time in the [listener interface](#), before presenting all three sets of controls at once.

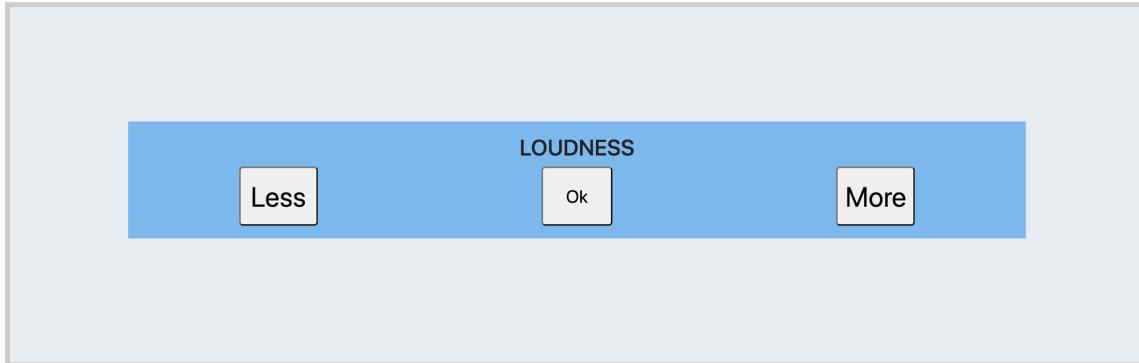




“Seq: ” - “Volume only” is selected

Seq: **Sequence** **Volume only** **Compact**

When this option is selected, only button controls for “V”/“Loudness” are presented in the [listener interface](#). This is analogous to the volume control on a traditional hearing aid.



“Seq: ” - “Compact” is selected

Seq: Sequence Volume only Compact

When this option is selected, all three sets of controls are presented at once for “H”/“Crispness”, “V”/“Loudness”, and “L”/“Fullness” in the [listener interface](#).



4.14.6 - Researcher Page: “Channel:” Buttons

Channel:

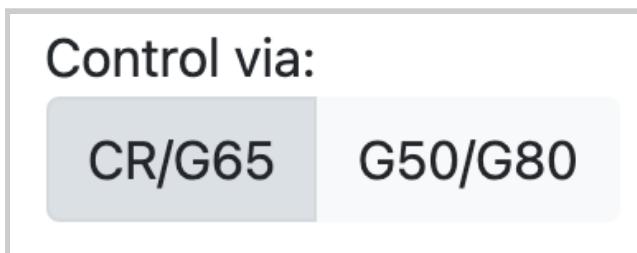
Left Right Both

There are three buttons, labeled “Left”, “Right”, and “Both”. When one of them is selected, all values for the parameters and bands would be shown for the corresponding channel(s).

You may witness color changes as well.

- When “Left” is selected, you’ll see a blue color for the table for the parameters and frequencies.
- When “Right” is selected, you’ll see a red color for the table.
- When “Both” is selected, you’ll see a green color for the table.

4.14.7 - Researcher Page: “Control Via:” Buttons



There are two buttons, labeled “CR/G65” and “G50/G80”:

- “CR/G65”: When selected, this allows you to edit values within the boxed cells for CR and G65 parameters. This will also prevent you from editing values for G50 and G80 parameters (the boxed cells that can’t be edited will have a gray fill color).

	0250	0500
can edit	CR 1.4	1.4
<u>cannot edit</u>	G50 19.3	7.3
can edit	G65 15	3
<u>cannot edit</u>	G80 10.7	-1.3

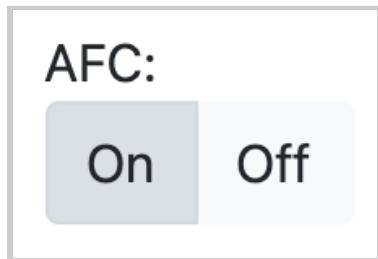
- “G50/G80”: When selected, this allows you to edit values within the boxed cells for G50 and G80 parameters. This will also prevent you from editing values for CR and G65 parameters (the boxed cells that can’t be edited will have a gray fill color).

	0250	0500
<u>cannot edit</u>	CR 1.4	1.4
can edit	G50 19.3	7.3
<u>cannot edit</u>	G65 15	3
can edit	G80 10.7	-1.3

4.14.8 - Researcher Page: Adaptive Feedback

Cancellation (AFC)

The parameters of the algorithm are set on the general researcher page.



- When turned “On”, this tracks the variations in the acoustic feedback path and cancels the feedback signal as a result of the physical placement of the microphone and receiver in a hearing aid device.
- When turned “Off”, this does nothing to the acoustic feedback path and feedback signal.

4.14.9 - Researcher Page: “Save” and “Save-as” Buttons

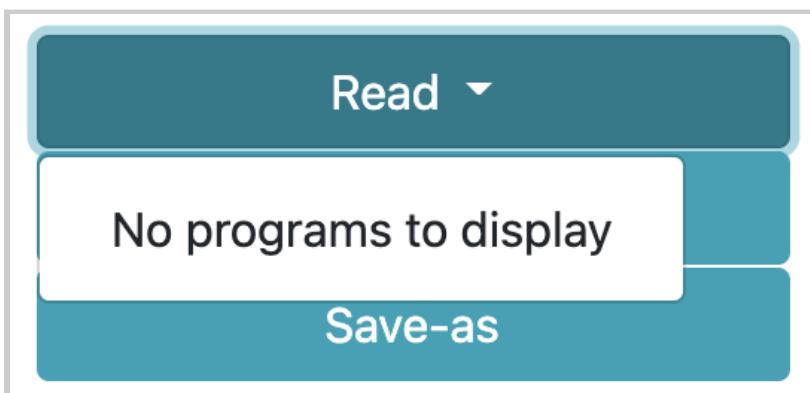
Values entered into the tables within the researcher page for a given listener can be saved as a new program or overwrite existing values from an existing program. Programs were built into the software to enable you to later retrieve the values for a given listener.

Located at the upper right-hand corner of the screen, there is a set of three buttons that enable you to switch between or save programs. Each is explained below.

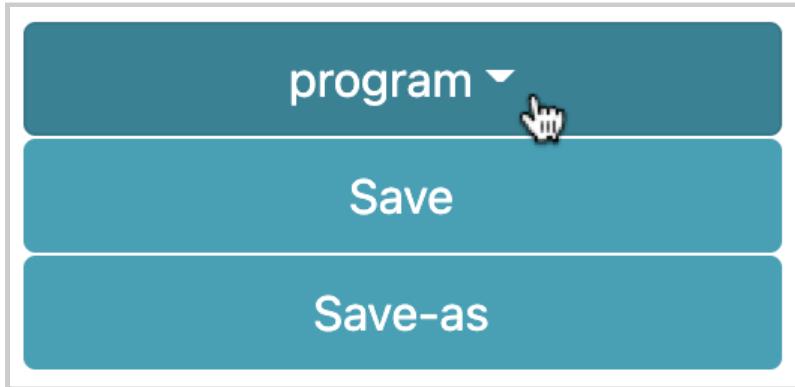


Program button

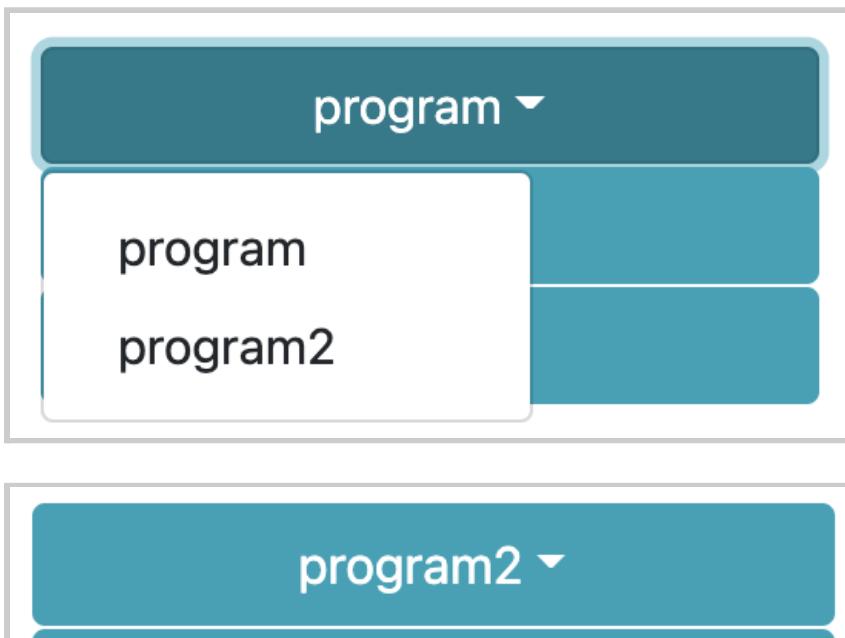
By default, if there is no program available and assigned to the selected listener, the button label will show “Read”. When you select it, it will show “No programs to display”, meaning that you will have to select the “Save-as” button to save the values for the parameters and bands as a new program.



Once you save at least one program and have it selected, the button will change to show the currently selected program. The example image below shows “program” as the selected program.



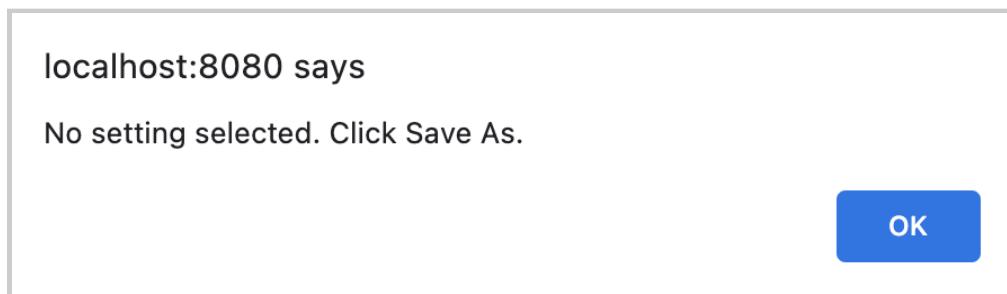
When selected, you would see a list of previous programs saved that can be selected instead (from the image, “program” and “program2” are shown).



“Save” button



By default, if you select this button while there is no program available and assigned to the selected listener, this pop-up message will appear: “No setting selected. Click Save As.”



You will have to select the “Save-as” button to save the values for the parameters and bands as a new program. Otherwise, this pop-up message appears whenever you save your values: “Program saved.”

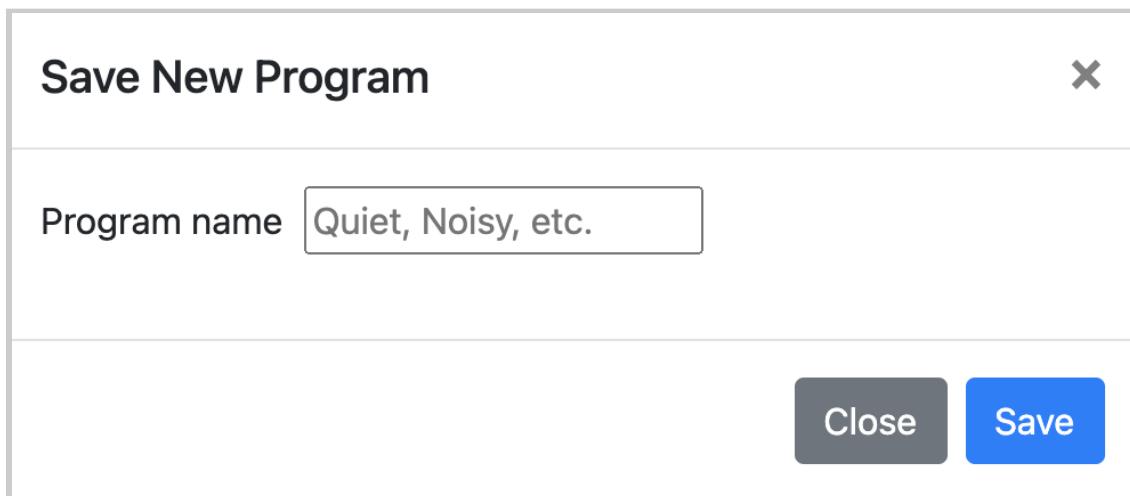


“Save-as” button



When selected, this allows you to create a new listener program that saves all current values for the parameters and bands as well as the current settings shown in the Researcher Page.

Simply enter a new name for the new listener program and select the blue “Save” button to confirm. Otherwise, you may cancel saving the new program by selecting the “Close” button, the “X” button, or clicking anywhere else on the screen.

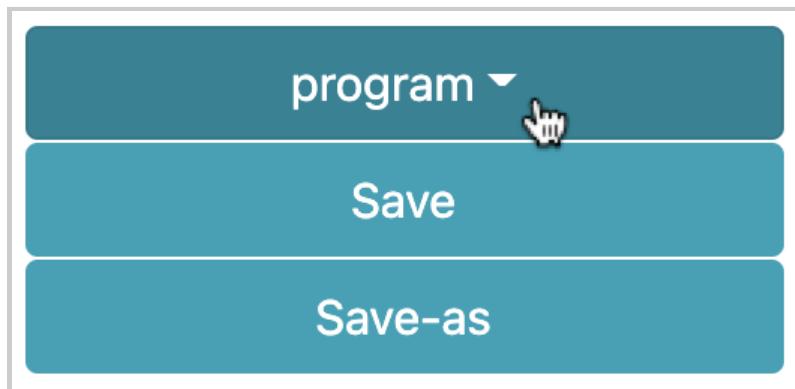


Once you select “Save”, you’ll see this pop-up message confirming that your program is saved: “New program saved. Refreshing the web page.”.

The browser page will reload to load the program that you just saved.

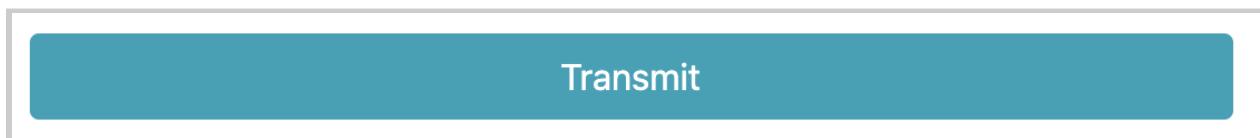


You will also notice that the *Program button* will change its label to show the name of the program that you just saved.



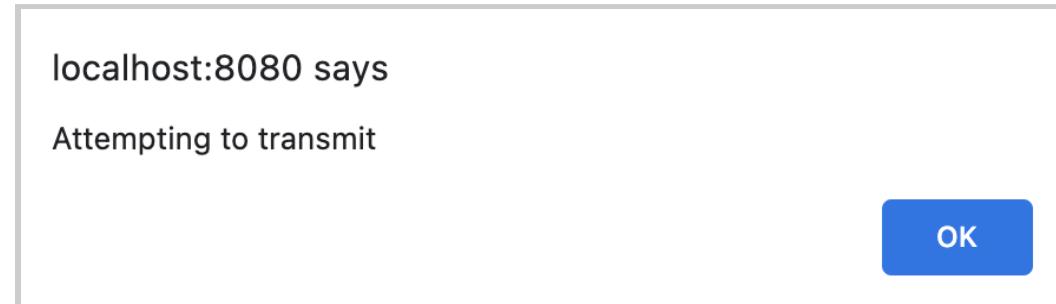
4.14.10 - Researcher Page: “Transmit” and “Continue” buttons

“Transmit” button



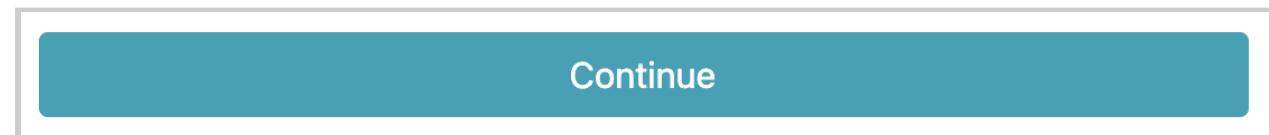
When selected, this takes all the current values from the parameters and bands and sends them to RTMHA.

This pop-up message also appears. “Attempting to transmit”



It is recommended to also save the program by selecting the “Save” button.

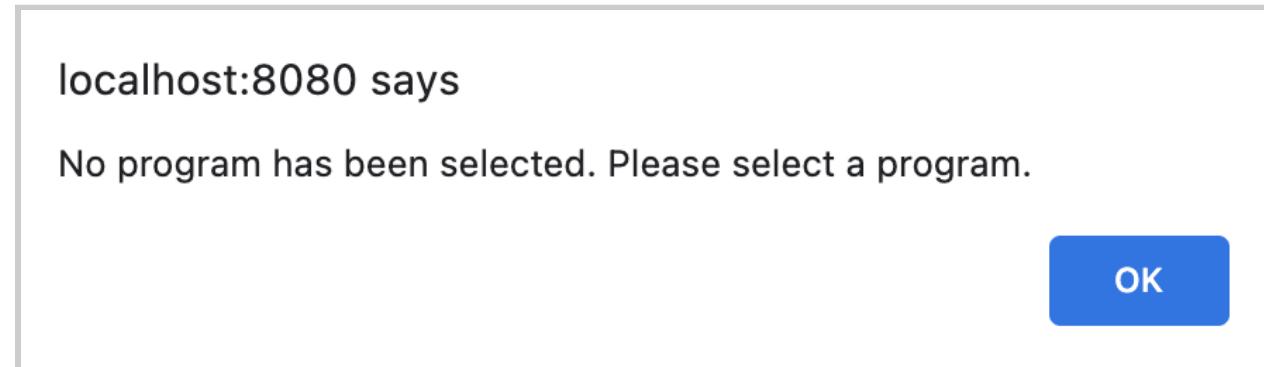
“Continue” button



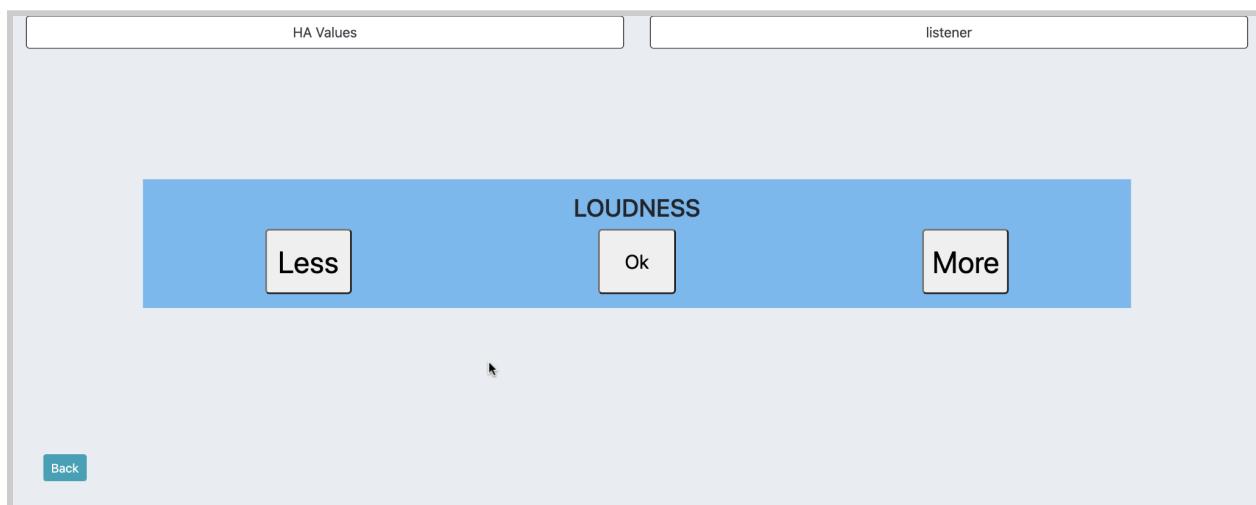
With a selected program, when this button is selected, you will navigate to a preview of the [listener interface](#).

By default, if there are no listener programs available or currently selected for a given listener profile, you will see this pop-up message: “No program

has been selected. Please select a program". You will need to select the "Save-as" button to create a new listener program.



Depending on the selected settings within “Adjustments”, the previewed button controls and behavior in the [listener interface](#) will be different. You should see the [listener interface](#) somewhat similar to the example image below.



4.15 - Goldilocks: Self Adjustment

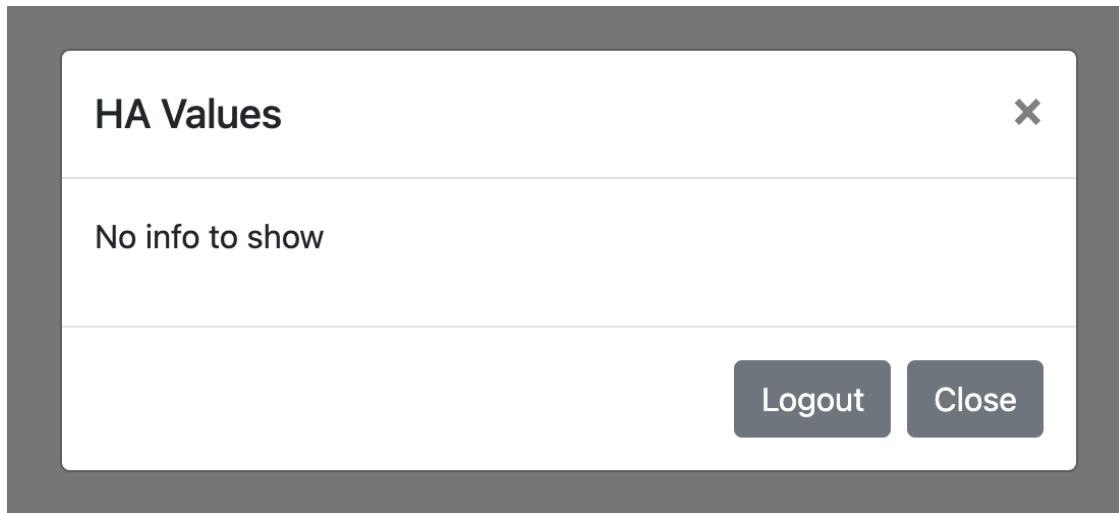
How to navigate:

- Select “Goldilocks”, then “Self Adjustment”.
- From the [Researcher Page](#), you can also preview this listener interface by selecting the corresponding listener program from the [program button](#) and selecting the [“Continue” button](#).

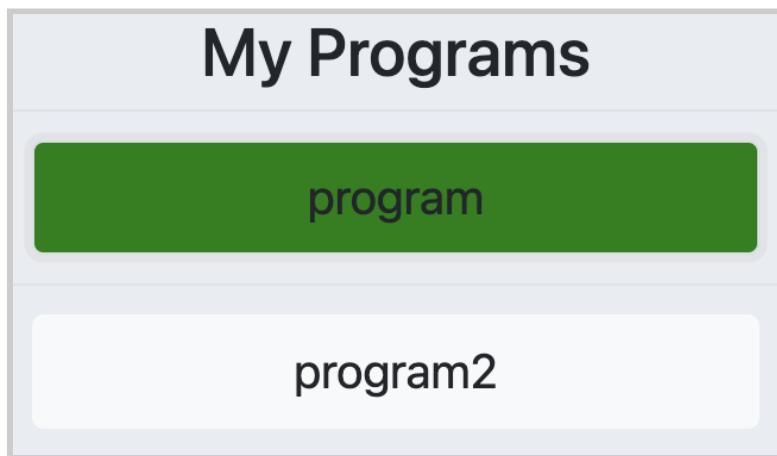
Once you have one or more [listener programs](#) created, Most recently selected listener profile, as a button with the profile name shown (this is also shown for other parts of Goldilocks Listener).



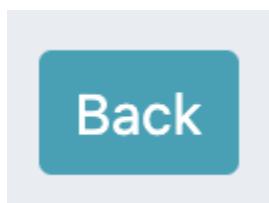
When selecting this button, a modal popup appears.



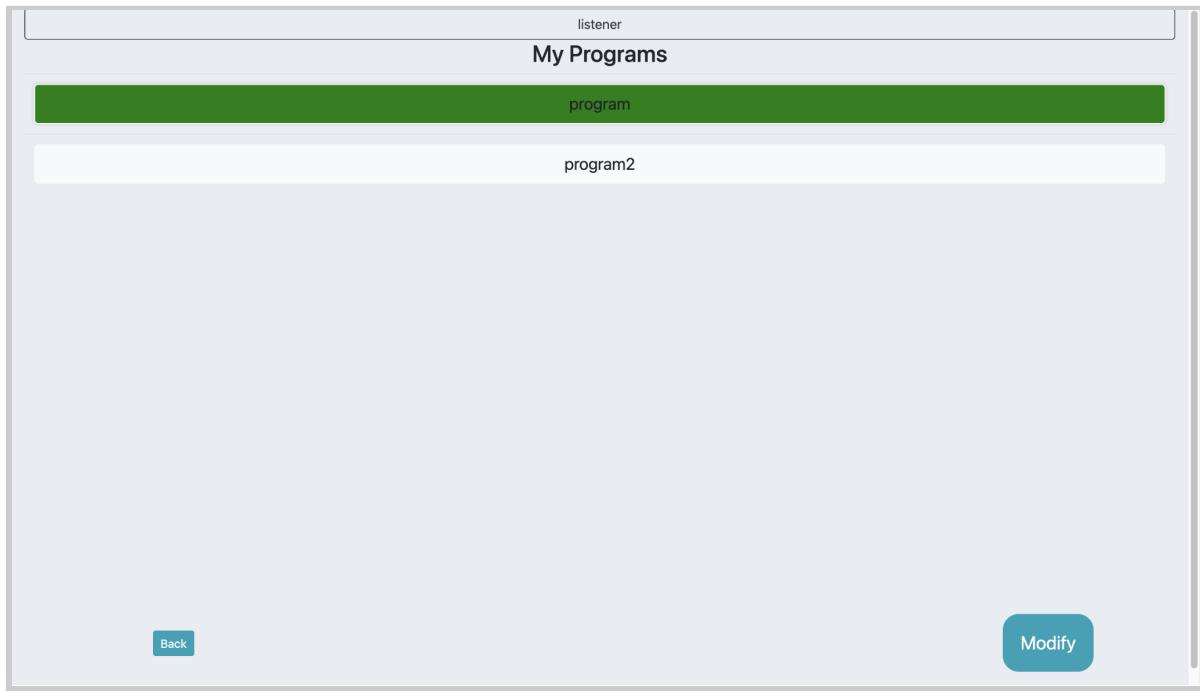
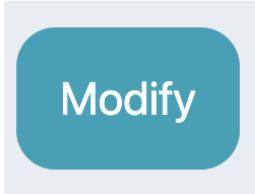
- The “Logout” button will redirect you back to the selection for the listener programs.
- The “Close” button and “X” icon will close the popup.
- At least one available program is associated with the listener, shown as one or more buttons. By default, the most recently selected program from the Researcher Page would have a dark green background color. Any program that has this background color would be used later on in the next part of the listener interface.



- A “Back” button in the lower-left corner that navigates back to the main page for Goldilocks.



- A “Modify” button in the lower-right corner. When selected, this would show one or more sets of button controls based on the settings created for the selected listener program.



Default desktop interface with selected listener profile and programs.

When you open this page for the very first time, you may instead see this interface with no available listeners. This is because you need to have created at least one researcher profile (covered in section “[4.3.1 -](#)

[Researchers](#)”), and at least one listener profile (covered in section “[4.3.2 - Listeners](#)”).

GOLDILOCKS

No listeners to choose from.

If you have created a listener profile, but no listener program, you will see the message “No programs to display”.

listener

My Programs

No programs to display

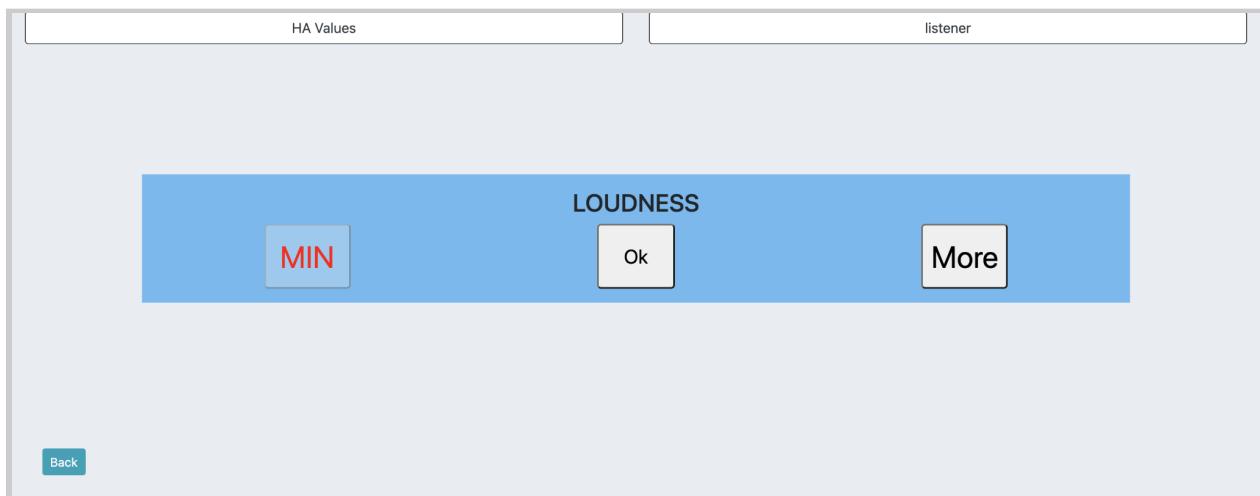
If you try to select the “*Modify*” button without selecting a listener program, you will see this error message “Please select a program”.

Please select a program

For both cases, this means you will have to go to the [Researcher Page](#) and select the [*“Save-as” button*](#) to save the values for the parameters and bands as a new program.

4.15.1 - Self Adjustment: The Listener Interface

Once you select the “Modify” button from the main [“Self Adjustment” page](#) for a selected listener program, you will be taken to an interface that looks similar to one of the image examples below.



HA Values listener

CRISPNESS

MIN More

LOUDNESS

MIN More

Back

Finish

This screen displays two horizontal sliders for rating audio qualities. The top slider is for 'CRISPNESS' and the bottom slider is for 'LOUDNESS'. Each slider has a yellow 'MIN' button on the left and a white 'More' button on the right. The labels 'LOUDNESS' and 'CRISPNESS' are centered above their respective sliders. At the bottom of the screen are 'Back' and 'Finish' buttons.

HA Values listener

CRISPNESS

Less More

LOUDNESS

Less More

FULLNESS

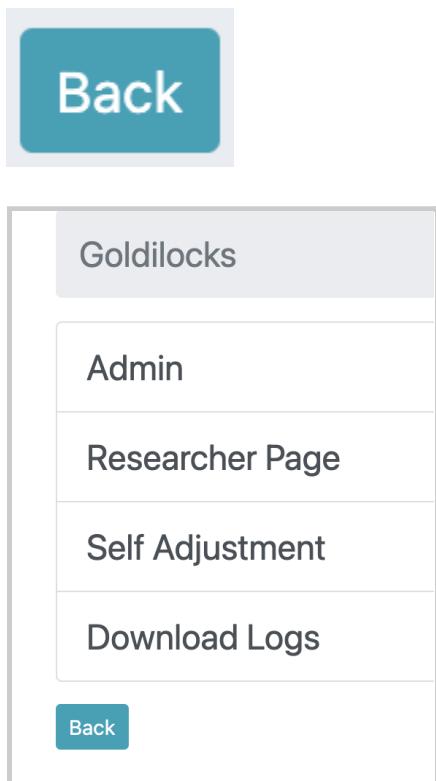
Less More

Back

Finish

This screen displays three horizontal sliders for rating audio qualities. The top slider is for 'CRISPNESS', the middle for 'LOUDNESS', and the bottom for 'FULLNESS'. Each slider has a white 'Less' button on the left and a white 'More' button on the right. The labels 'LOUDNESS', 'CRISPNESS', and 'FULLNESS' are centered above their respective sliders. At the bottom of the screen are 'Back' and 'Finish' buttons.

There is a “Back” button that takes you back to the main Goldilocks interface.



It is intended for you to use the listener interface until you see and select the “Finish” button.



4.15.2 - Self Adjustment: Crispness, Loudness, Fullness Controls

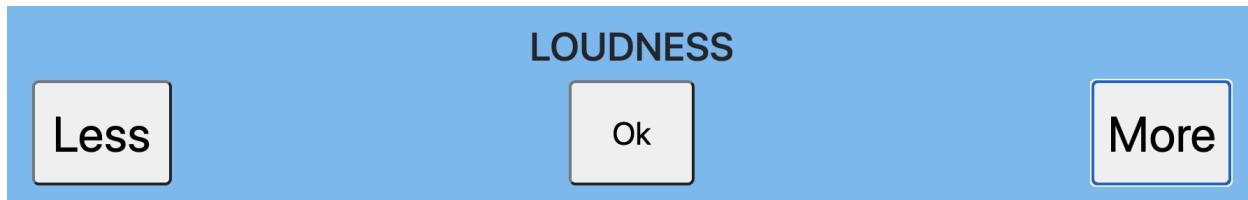
The three main button controls are grouped as “Crispness”, “Loudness”, and “Fullness”, as substitutes to the parameters “L”, “V”, and “H” respectively.

The three main button controls are labeled as:

- “Crispness” (yellow) = Low-frequency output (cut or boost)
- “Loudness” (blue) = overall output/Volume
- “Fullness” (orange) = High-frequency output (cut or boost)

Each set of button controls usually contains two buttons that a listener can select, labeled “Less” and “More”. The third one, labeled “Ok”, may or may not appear, depending on the program’s settings.

- “Less” button - decreases the low-frequency output, high-frequency output, or overall output
- “More” button - increases the low-frequency output, high-frequency output, or overall output
- “Ok” button - confirms the current low-frequency output, high-frequency output, or overall output and proceeds to the next set of button controls



“Crispness”	
Definition	Corresponding Parameter(s) in Researcher Page
High-frequency output (cut or boost)	“H” and “H Mult” H H Mult

“Loudness”	
LOUDNESS	
Less	More
overall output/Volume	“V” V

“Fullness”	
FULLNESS	
Less	More
Low-frequency output (cut or boost)	“L” and “L Mult” L L Mult

At some point, pressing the “Less” button enough times will change the button label to “MIN” and disable it, which can affect more than one set of

buttons at the same time. Once disabled, the button cannot be selected until a listener selects a “More” button one or more times.



Likewise, pressing the “More” button enough times will change the button label to “MAX” and disable it, which can affect more than one set of buttons at the same time. Once disabled, the button cannot be selected until a listener selects a “Less” button one or more times.



This behavior is affected by the “Min” and “Max” parameters for setting the minimum and maximum gain thresholds for “L”, “V”, and “H” in the [Researcher Page](#). Increasing or decreasing the values will affect the

listener's ability to keep selecting an increase or decrease in gain for the “L”, “V”, and “H” respectively.

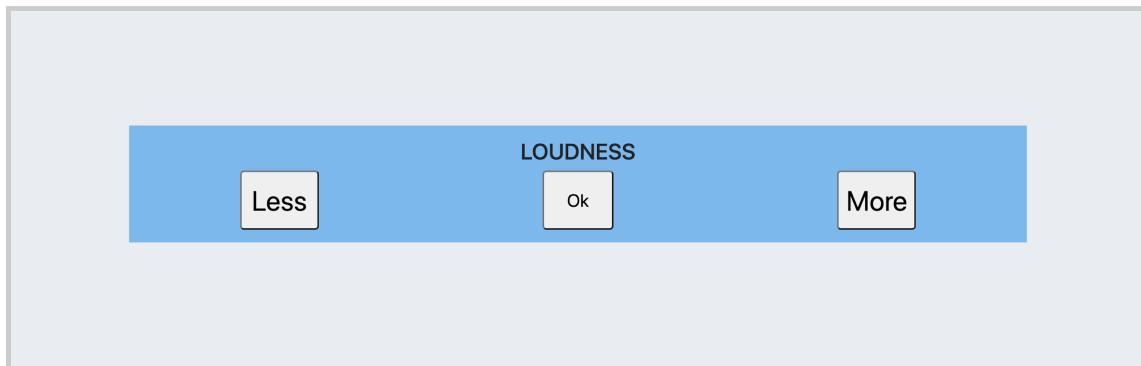
	L	V	H
Step	1	3	1
Min	-40	-40	-40
Max	40	40	40

4.15.3 - Self Adjustment: Behavior of Button Controls

Depending on how the program is set, the experience of adjusting each set of button controls will be different. You may experience one of the following behaviors:

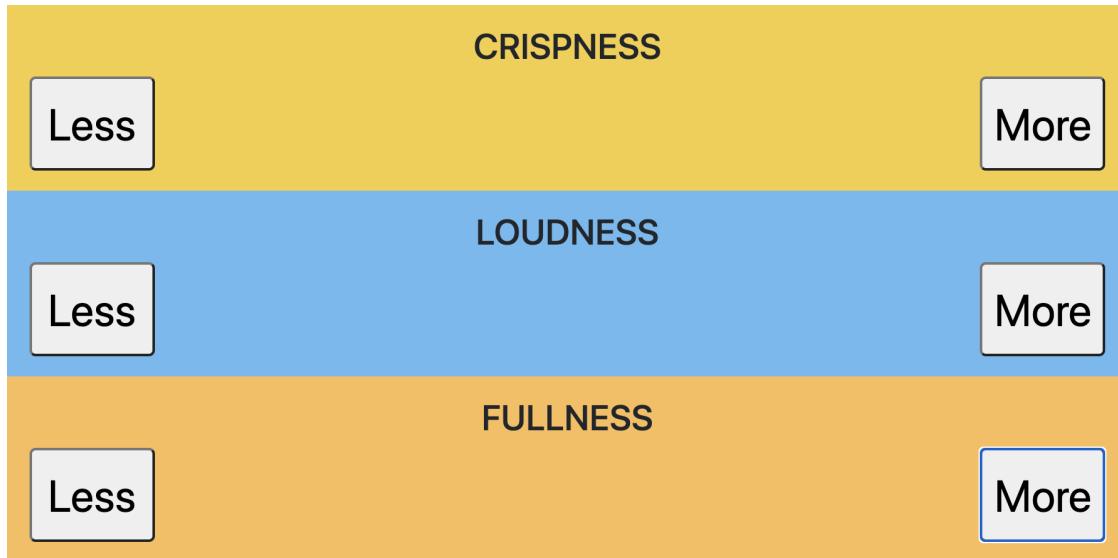
- You will see the button controls only appear one at a time. Usually, buttons for either “Crispness” or “Loudness” will appear first, followed by other button controls. In some cases, you may only see button controls for “Crispness” and “Loudness” only.





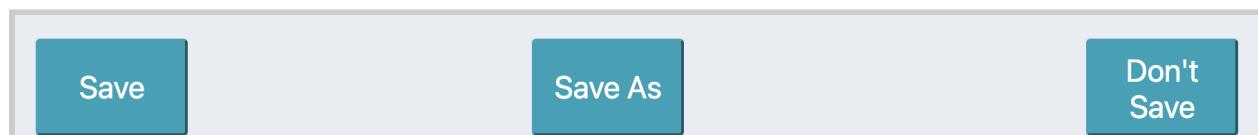
- You will be able to see and select all available button controls at once, without the “Ok” button and without having to select subsequent button controls. You may see “Loudness” only; both

“Loudness” and “Crispness”; or all three button controls.



4.15.4 - Saving Listener Programs

You would continue selecting the buttons until the “Finish” button is selected. Once it is selected, three buttons will appear for different options for (not) saving the program.

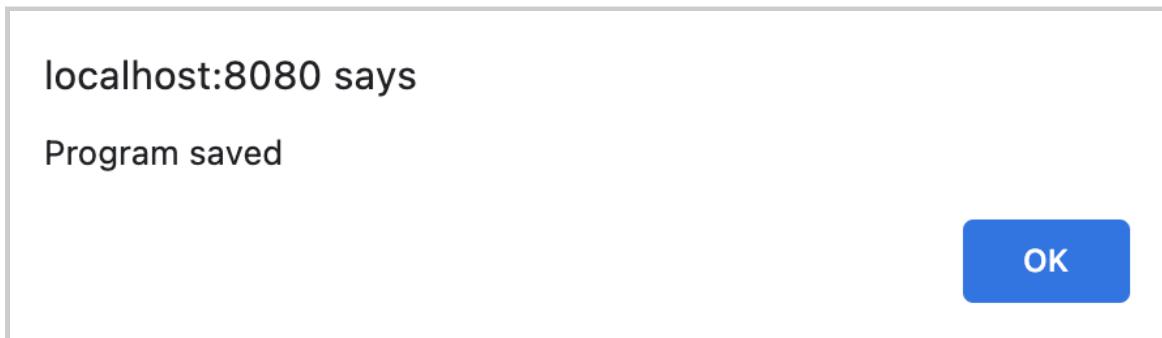


- “Save” button

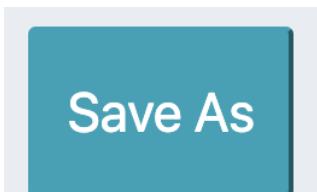


When selected, your program will be saved based on adjustments to

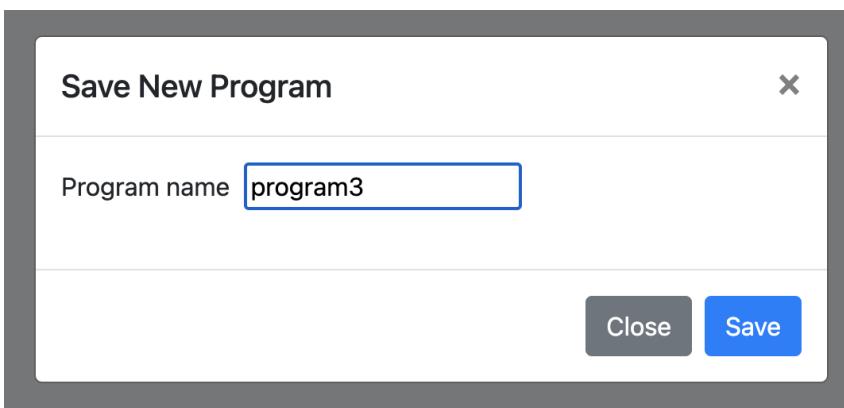
the program from selections of the button controls. An alert message will appear confirming that the adjustments to the program have been saved.



- “Save As” button

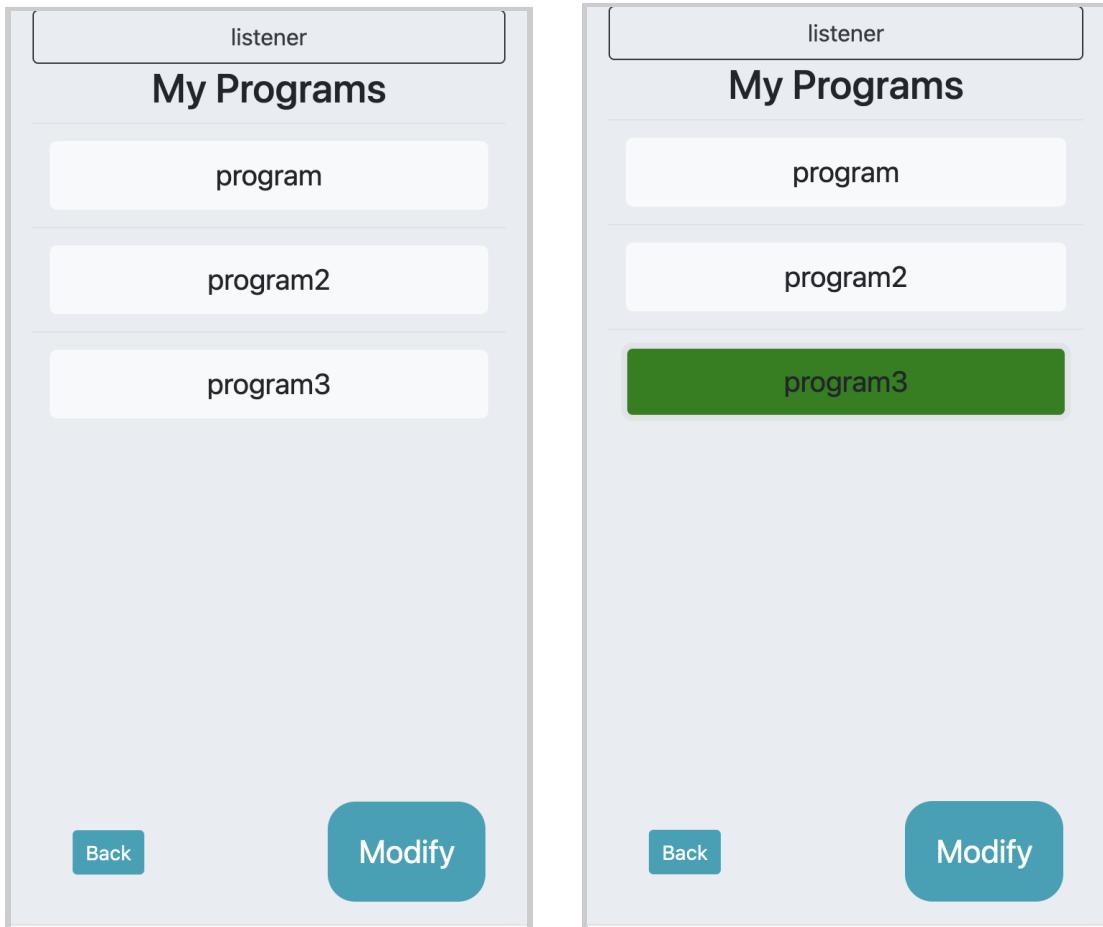


When selected, this allows you to save the program as a separate new program with a new name.



Selecting the “Save” button will take you back to the program selection interface, with the saved program selected for use (shown

in green).



Selecting the “Close” button or the “X” icon will cancel saving the new program.

- “Don’t Save” button

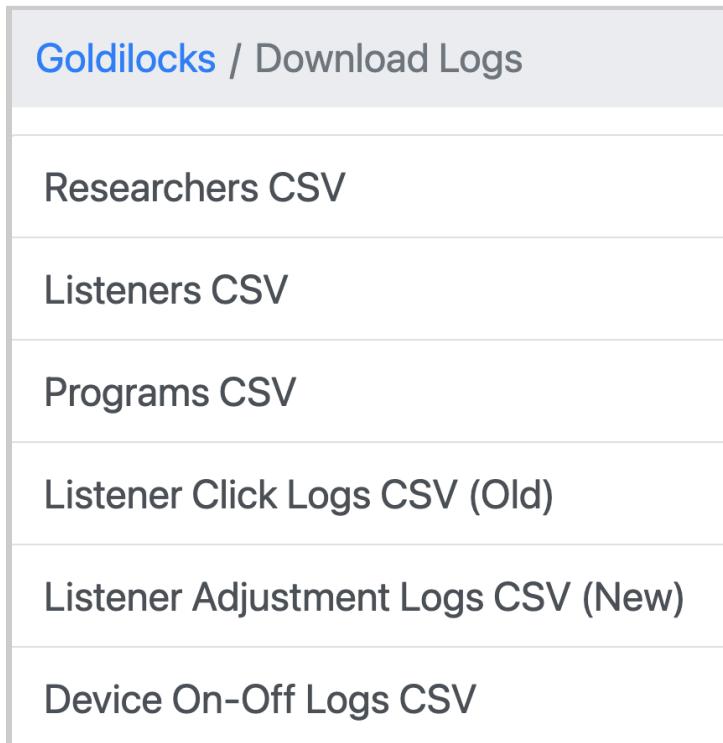


When selected, the program selection interface will be shown again with the used program selected (shown in green).

4.16 - Goldilocks: Downloadable Logs

How to navigate: Select “Goldilocks”, then “Download Logs”.

When you open this page for the very first time, you will see different types of logs available for download as .csv files.



Below explains what information is available to download, each as a spreadsheet file:

- “*Researchers CSV*” - You are able to download all researcher profiles.

id	researcher	created_at	updated_at
1	researcher	6/20/21 11:04	6/20/21 11:04

- “*Listeners CSV*” - You are able to download all listener profiles.

id	listener	pin	researcher_id	current_program_id
1	listener	4fM%	1	1
2	listener2	M*9)	1	

program_id	created_at	updated_at	mostRecent
1	6/20/21 11:22	7/20/21 22:15	1
	6/20/21 11:22	6/20/21 13:16	0

- “*Programs CSV*” - You are able to download all listener programs.

id	listener_id	name	parameters
1	1	program	{"multiplier_l": [3,3,0,0,0,0], "multiplier_h": [0,0,0,3,3,3], "gain": 0, "l_min": -40, "l_max": 40, "l_step": 1, "v_min": -40, "v_max": 40, "v_step": 3, "h_min": -40, "h_max": 40, "h_step": 1, "control_via": 0, "afc": 1, "sequence_num": 3, "sequence_order": 0, "app_behavior": 0}

created_at	updated_at	name_rank	parametersTwoChannels
20/21 12:20	6/20/21 12:20	1	{"left": {"targets": [59,61,62,73,75,64], "ltass": [44,58,57,55,56,57], "hearing_loss": [25,30,35,45,55,85], "compression_ratio": [1.4,1.4,1.4,1.4,1.4,1.4], "g50": [19.3,7.3,9.3,22.3,23.3,11.3], "g65": [15,3,5,18,19,7], "g80": [10.7, 1.3,0.7,13.7,14.7,2.7], "g50_max": [35,35,35,35,35], "g80_min": [0,0,0,0], "knee_low": [45,45,45,45,45], "mpo_band": [110,110,110,110,110], "attack": [5,5,5,5,5], "release": [20,20,20,20,20]}, "right": {"targets": [59,61,62,73,75,64], "ltass": [44,58,57,55,56,57], "hearing_loss": [25,30,35,45,55,85], "compression_ratio": [1.4,1.4,1.4,1.4,1.4,1.4], "g50": [19.3,7.3,9.3,22.3,23.3,11.3], "g65": [15,3,5,18,19,7], "g80": [10.7, 1.3,0.7,13.7,14.7,2.7], "g50_max": [35,35,35,35,35], "g80_min": [0,0,0,0], "knee_low": [45,45,45,45,45], "mpo_band": [110,110,110,110,110], "attack": [5,5,5,5,5], "release": [20,20,20,20,20]}}}

- “*Listener Click Logs CSV (Old)*” - You are able to download data associated with which interactions each and every listener has performed within the [listener interface](#).

id	listener_id	action	l_value	v_value	h_value
1	1	started_app	0	0	0
2	1	started_app	0	0	0
3	1	started_app	0	0	0
4	1	v_okay	0	0	0
5	1	h_okay	0	0	0
6	1	v_okay	0	0	0
7	1	l_okay	0	0	0
8	1	h_more	0	0	3

program_state	created_at	updated_at
{"parameters":{"multiplier":1}}	6/20/21 12:36	6/20/21 12:36
{"parameters":{"multiplier":1}}	6/20/21 12:37	6/20/21 12:37
{"parameters":{"multiplier":1}}	6/20/21 12:37	6/20/21 12:37
{"parameters":{"multiplier":1}}	6/20/21 12:37	6/20/21 12:37
{"parameters":{"multiplier":1}}	6/20/21 12:37	6/20/21 12:37
{"parameters":{"multiplier":1}}	6/20/21 12:37	6/20/21 12:37
{"parameters":{"multiplier":1}}	6/20/21 12:37	6/20/21 12:37
{"parameters":{"multiplier":1}}	6/20/21 12:37	6/20/21 12:37

- “Listener Adjustment Logs CSV (New)” - You are able to download data associated with changes that each and every listener made to their parameters within their listener program. These changes would occur from the interactions performed within the [listener interface](#).

id	timestamp	timezone	listener	researcher	starting_program	ending_program
1	7/22/21 20:57	-7	listener	researcher	program	program

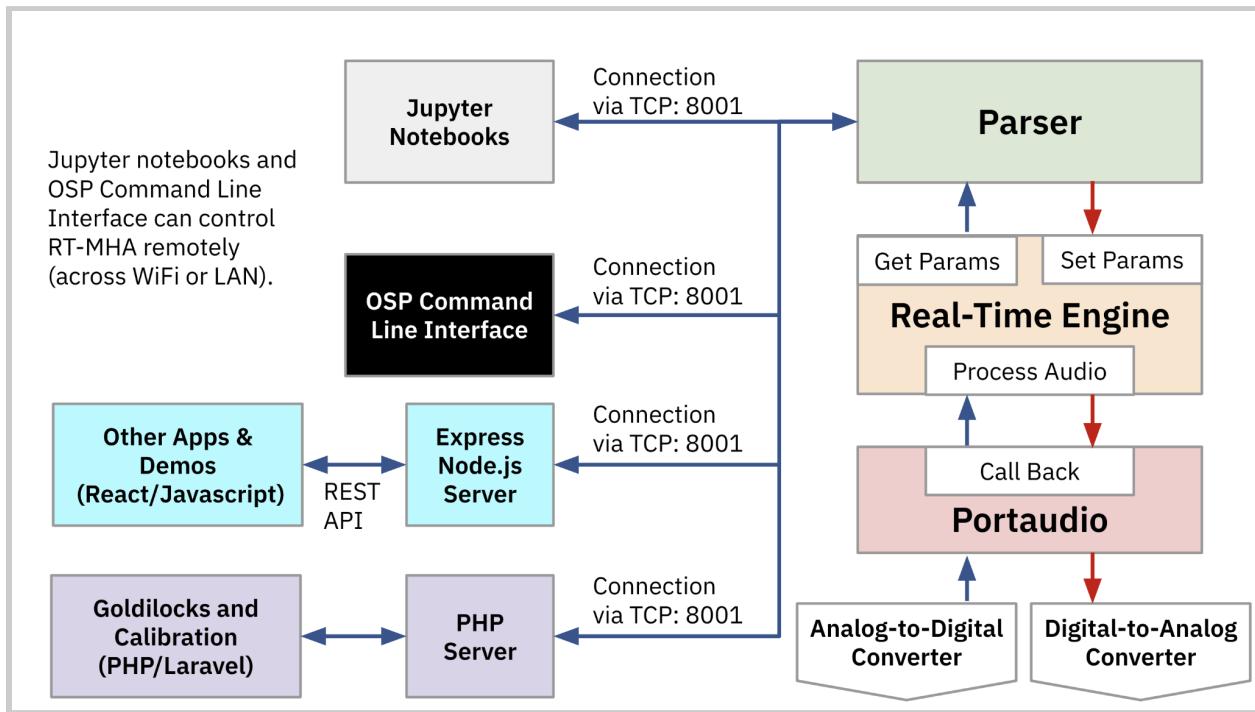
final_l	final_v	final_h	steps	seconds_elapsed
-3	9	-3	21	31

- “Device On-Off Logs CSV” - You can still download a spreadsheet, but this feature may not be operational.

5 - Command Line Interface (CLI) via Terminal

5.1 - Introduction

One main component of the OSP software is the Real-Time Master Hearing Aid (RT-MHA); it is a hearing-aid algorithm which takes the audio from the environment and modifies it for the listeners specific prescription. In addition, the OSP software features a CLI within a terminal (or Windows Powershell) that can be used to further manipulate the audio parameters within RT-MHA.



Block diagram that illustrates the different components and connections within the Real-Time Master Hearing Aid

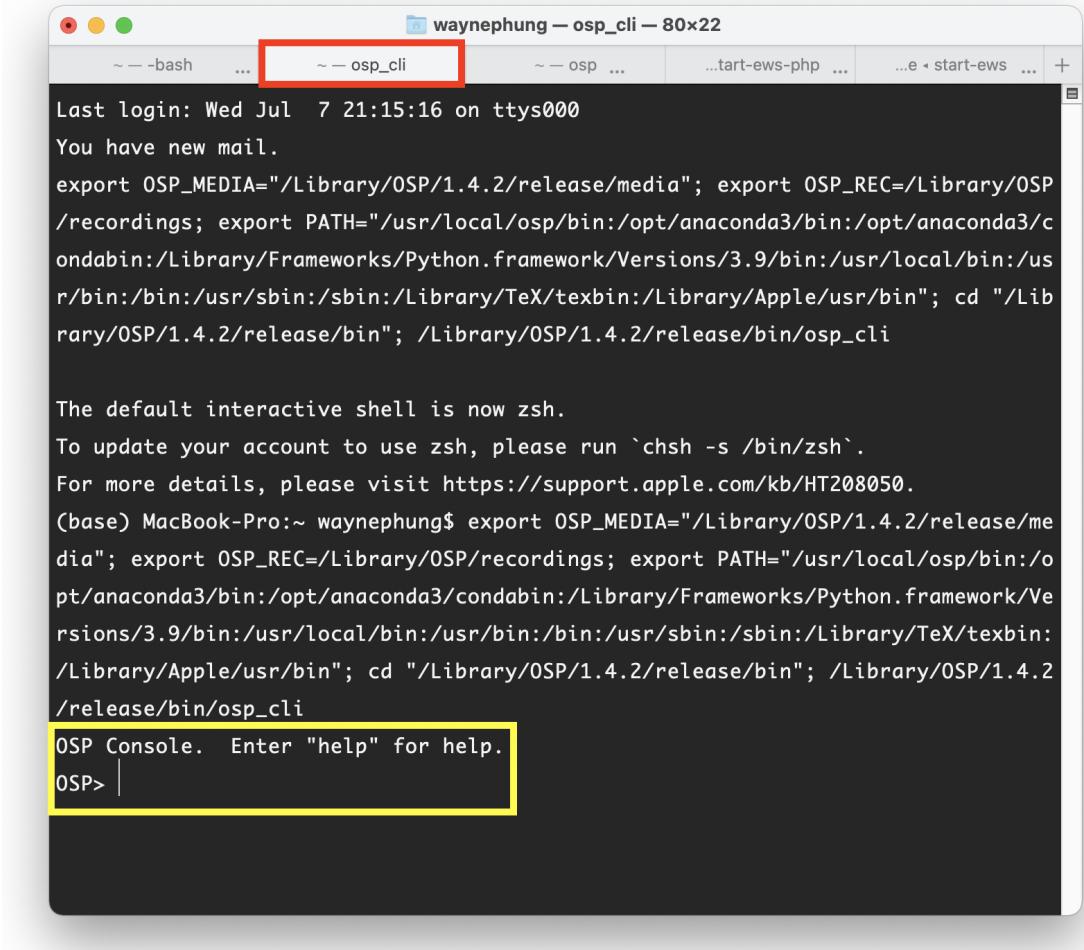
5.2 - How to Access via OSP Software Only

Skip to step 3 if you already have the software running on your terminal.

1. Open a new terminal window. For Windows, open Powershell.
2. Enter the command: **run_osp**

You should see five terminal tabs open and you will be directed to the browser when EWS launches.

3. Go to the terminal tab labeled “osp_cli”. You should now have access to the CLI and be able to enter OSP-related commands.



```
Last login: Wed Jul  7 21:15:16 on ttys000
You have new mail.

export OSP_MEDIA="/Library/OSP/1.4.2/release/media"; export OSP_REC=/Library/OSP/recordings; export PATH="/usr/local/osp/bin:/opt/anaconda3/bin:/opt/anaconda3/condabin:/Library/Frameworks/Python.framework/Versions/3.9/bin:/usr/local/bin:/usr/bin:/sbin:/sbin:/Library/TeX/texbin:/Library/Apple/usr/bin"; cd "/Library/OSP/1.4.2/release/bin"; /Library/OSP/1.4.2/release/bin/osp_cli

The default interactive shell is now zsh.
To update your account to use zsh, please run `chsh -s /bin/zsh`.
For more details, please visit https://support.apple.com/kb/HT208050.

(base) MacBook-Pro:~ waynephung$ export OSP_MEDIA="/Library/OSP/1.4.2/release/media"; export OSP_REC=/Library/OSP/recordings; export PATH="/usr/local/osp/bin:/opt/anaconda3/bin:/opt/anaconda3/condabin:/Library/Frameworks/Python.framework/Versions/3.9/bin:/usr/local/bin:/usr/bin:/bin:/usr/sbin:/sbin:/Library/TeX/texbin:/Library/Apple/usr/bin"; cd "/Library/OSP/1.4.2/release/bin"; /Library/OSP/1.4.2/release/bin/osp_cli

OSP Console. Enter "help" for help.
OSP>
```

5.3 - How to Access via OSP Hardware

1. Connect the USB cable(s) from the Processing and Communication Device (PCD) to your computer's USB port.
2. Open a new Terminal or Windows Powershell window.

3. Navigate to the folder that hosts the pcdtool(.exe) file. For example, if the name of the folder is named “pcd-2021A” or “pcd-windows-2021A” and is stored within “Downloads”.
 - a. macOS/Linux: **cd Downloads/pcd-2021A**
 - b. Windows: **cd .\Downloads\pcd-windows-2021A\pcd-windows-2021A**
4. Use pcdtool to connect to the PCD.
 - a. macOS/Linux: **./pcdtool conn**
 - b. Windows: **.\pcdtool.exe conn**
5. Press enter to see “**root@ospboard:>**”.
6. Enter the command **osp_cli** to launch the OSP CLI.
7. To exit the OSP CLI, press the control + D keys on your keyboard to close the CLI. This will navigate back to the pcdtool interface (shown as the prompt “**root@ospboard:>**”).

5.4 - CLI Commands and RT-MHA Parameters

When using the CLI, parameters are set by sending a JSON string to the osp process. The parameters are set for the left and right channels. Some parameters, such as those related to [beamforming](#), apply to both channels. The second JSON string example below shows that the right channel is ignored.

```
{"method": "set", "data": {"left": {"alpha": 1},  
"right": {"alpha": 1}}}  
  
{"method": "set", "data": {"left":  
{"audio_filename": "audio/MPEG_es01_s.wav",  
"audio_play": 1, "audio_alpha": 1}}}
```

5.4.1 - Help and Get Commands

To get familiar with the commands, you can start with these two, **help** and **get**.

help - Explains all of the available commands and capabilities that you can use in osp_cli. You should see the following output.

```
===== Commands =====  
help  
This menu.  
play [file]  
Play a file. "play ?" lists files.  
Defaults to "MPEG_es01_s.wav"  
record [file]  
Record output to a file.  
Defaults to "osp_output"  
Send "audio_record=0" to stop recording.
```

When finished use osp_convert to convert to a WAV file.

stop

Stop playing. Requires latest osp with OSP_MEDIA set.

sleep [secs]

Sleep for a number of seconds. Default 1

source <filename>

Read commands from a file.

repeat cmd num [delay]

Repeat a command "num" times with an optional delay of "delay" ms between.

time [on|off]

Enable|Disable printing the execution time for commands

exit (or control-D)

Exit this program.

===== Reading Data =====

get Get all data**?**

Print help on parameters. "{pat}?" will match all parameters

beginning with {pat}

Anything that is JSON (starts with '{') is sent directly to RT-MHA.

Type a string and all parameters that start with that string will be displayed.

Set a parameter with "[left | right] {param} = {value}

===== Setting Parameters =====

{param}={value} Set a parameter to a value.

===== Command History =====

Use up and down arrows to scroll through history.

Type some characters then use up and down arrows to scroll through matches.

get - Delivers all of the audio parameters and values from RT-MHA, which are modifiable from the commands given from the **help** command.

```
Sending {"method": "get"}  
num_bands          6  
-----  
afc                1                  1  
afc_delay          4.6875            4.6875  
afc_mu              0.005            0.005  
afc_rho              0.9                0.9  
afc_type             3                  3  
aligned             0                  0  
alpha               1.                1.  
amc_forgetting_factor 0.8            ---  
amc_thr              2.                ---  
attack              5,5,5,5,5,5,5      5,5,5,5,5,5  
audio_alpha          0.                ---  
audio_filename        ---
```

audio_playing	0	---
audio_record	0	---
audio_repeat	0	---
audio_rfile		---
bf	0	---
bf_alpha	0.	---
bf_amc_on_off	0	---
bf_beta	150.	---
bf_c	0.001	---
bf_delay_len	160	---
bf_delta	0.	---
bf_fir_length	319	---
bf_imu_on_off	0	---
bf_mu	0.01	---
bf_nc_on_off	0	---
bf_p	1.3	---
bf_power_estimate	0.	---
bf_rho	0.985	---
bf_type	3	---
cal_mic	23.3,25.8,17.5,15.8,15.7,15.7	23.3,25.8,17.5,15.8,15.7,15.7
cal_mpo	0.5,1,0.5,1,-7,4.5	0.5,1,0.5,1,-7,4.5
cal_rec	0.5,1,0.5,1,-7,4.5	0.5,1,0.5,1,-7,4.5
en_ha	1	1
freping	0	0
freping_alpha	0,0,0,0,0,0	0,0,0,0,0,0
g50	9.5,4.5,15,22.5,32,18	14.5,9.5,17,22.5,34,21
g80	-9.5,-14.5,-5,2.5,14,2	-4.5,-9.5,-3,2.5,16,4
gain	0.	0.
global_mpo	120.	120.
knee_low	45,45,45,45,45,45	45,45,45,45,45,45
min_phase	0	0
mpo_band	110,110,110,110,110,110	110,110,110,110,110,110
nc_thr	1.	---
noise_estimation_type	0	0
release	20,20,20,20,20,20	20,20,20,20,20,20
spectral_subtraction	0.	0.
spectral_type	0	0

The values on the left closest to each audio parameter name are designated for the left channel. The values on the farthest right of the terminal are designated for the right channel.

However, if you notice three dashes “---” as values for the right channel, that means that the audio parameter may not be dependent on which channel it designates the value to.

Tip: You can copy the text `{"method": "get"}` and enter it as a command, which will deliver the raw JSON string of data values for all of the parameters.

```
{  
    "left": {  
        "afc": 1,  
        "afc_delay": 4.6875,  
        "afc_mu": 0.00499999888241291,  
        "afc_rho": 0.8999999761581421,  
        "afc_type": 3,  
        ...  
        more parameters and values  
        ...  
        "spectral_subtraction": 0.0,  
        "spectral_type": 0  
    },  
    "num_bands": 6,  
    "right": {  
        "afc": 1,  
        ...  
    }  
}
```

```
"afc_delay": 4.6875,  
"afc_mu": 0.004999999888241291,  
"afc_rho": 0.8999999761581421,  
"afc_type": 3,
```

If you need to recall your memory on what each audio parameter does, just enter the command: **[AUDIO_PARAMETER]**?

Example commands: `num_bands?` `afc?` `cal_mpo?` `attack?`

OSP> num_bands?
num_bands Sets the number of bands to 6
or 10. Changing the number of bands resets all the
parameters

Below is a series of tables that describes all of the audio parameters.

5.4.2 - Global Parameters

parameter name	default value	description
alpha	0.0	The mixer of virtual sound (file playback) and actual sound (from the microphones) 0 = complete actual sound 1 = complete virtual sound
en_ha	1	Enables/disables the hearing aid

		algorithm. 0=off, 1=on
gain	0.0	The gain in dB
global_mpo	120.0	Set the global maximum power output (MPO) limit.

5.4.3 - AFC (Adaptive Feedback Cancellation)

Parameters

parameter name	default value	description
afc	0	Enables AFC. 0=off, 1=on
afc_delay	4.6875	Loopback delay in millisecond to adjust for device to device variation in feedback path.
afc_mu	0.005	Adjust the step size for feedback management
afc_reset	0	Reset the taps of the AFC filter to default values. A signal, not a state!
afc_rho	0.9	Adjust the forgetting factor for feedback management.
afc_type	3	Adaptation type for AFC. 0 = disable adaptation 1 = FXLMS (Filtered-X Least Mean Squares) 2 = IPNLMS (Improved Proportionate

		Normalized Least-Mean-Square) 3 = SLMS (Signed Least Mean Square)
--	--	--

5.4.4 - Audio Playback and Recording Parameters

parameter name	default value	description
audio_alpha	0.0	Temporarily set the alpha value for the next file played. alpha is restored to previous level when play is finished
audio_filename	""	Audio file to play
audio_play	0	0 = stop (playing) audio, 1 = play audio
audio_repeat	0	Repeat the audio file 0 = disable repeat, 1 = enable repeat
audio_rfile	""	Record file name
audio_record	0	0 = stops recording 1 = records inputs 2 = records outputs

5.4.5 - Beamforming Parameters

parameter name	default value	description
amc_forgetting_factor	0.8	Adjust the forgetting factor of the power estimate for GSC beamforming. Range: 0-1
amc_thr	2.0	Adjust the threshold of the AMC for GSC beamforming. Range: 0-10
bf	0	Enable Beamformer. 0 = off, 1 = on
bf_alpha	0.0	A number between -1 to 1 for different degrees of sparsity in IPNLMS-l_0 (Improved Proportionate Normalized Least-Mean-Square)
bf_amc_on_off	0	Enable adaptation mode control beamformer. 0=off, 1=on
bf_beta	150.0	A number indicating different degrees of sparsity in IPNLMS-l_0 (Improved Proportionate Normalized Least-Mean-Square). Range: 0-500
bf_c	0.001	A small positive number for preventing stagnation in SLMS

bf_delta	1e-6	A small positive number to prevent dividing zero.
bf_mu	0.01	Adjust the step size for GSC beamforming (Help has wrong default)
bf_nc_on_off	0	Enable norm-constrained beamformer. 0=off, 1=on
bf_imu_on_off	0	Enable toggling beamforming using IMU gestures (i.e. double-tap) 0=off, 1=on
bf_p	1.3	Defines fitting different degrees of sparsity in SLMS. Range: 1-2
bf_rho	0.985	Adjust the forgetting factor for beamforming. Range: 0-1
bf_type	3	Adaptation type for GSC beamforming. 0 = Stop adaptation 1 = Modified LMS 2 = IPNLMS 3 = SLMS
nc_thr	1.0	Adjust the threshold of the norm-constrained adaptation for GSC beamforming.

5.4.6 - Beamforming Constants Parameters

These may be set in the default config file for osp, but cannot be modified after osp is started.

parameter name	default value	description
bf_fir_length	319	The number of filter taps of adaptive filters in beamformer.
bf_power_estimate	0.0	Adjust the power estimate for beamforming. [NOT USED]
bf_delay_len	160	The length of delay line in samples for beamformer.

5.4.7 - Freping Parameters

parameter name	default value	description
freping	0	Enable freping: 0=off, 1=on
freping_alpha [num_bands]	0.0	Set the alpha parameter for freping [-0.02 to 0.02]

5.4.8 - WDRC (Wide Dynamic Range Compression)

Parameters

parameter name	default value	description
attack [num_bands]	5.0	Set the attack time for WDRC for the bands.
g50 [num_bands]	0.0	Set the gain values at 50 dB SPL input level.
g80 [num_bands]	0.0	Set the gain values at 80 dB SPL input level.
knee_low [num_bands]	45.0	Set the lower knee points for the bands.
mpo_band [num_bands]	120.0	Set the MPO (upper knee points) for the bands.
release [num_bands]	20.0	Set the release time for WDRC for the bands.
aligned	1	Enable 10 or 11-band filterbank alignment. Aligns the delays in each subband.
min_phase	1	Use minimal phase 11-band filterbank.

5.4.9 - Speech Enhancement Parameters

These commands work for 6 and 10 bands only

parameter name	default value	description
noise_estimation_type	0	Noise Estimation type: 0 = Disabled 1 = Arslan 2 = Hirsch and Ehrlicher 3 = Cohen and Berdugo
spectral_subtraction	0.0	Amount to subtract. Range: 0-1
spectral_type	0	Enable spectral subtraction: 0=Disable 1=Enable

5.4.10 - JSON String Command Parameters

These are not channel parameters where you can simply send a numerical value. Instead, they are sent as JSON strings.

```
{"method": "set", "data": {"num_bands": 10}}  
{"method": "set", "data": {"restart": 1}}  
{"method": "get", "data": {"restart": 1}}  
{"method": "get_media"}
```

parameter name	default value	description
num_bands	6	6, 10, or 11 frequency bands.

restart	1	Tells RT_MHA) to restart. May take a few seconds.
get		Gets the current parameter state
get_media		Gets the paths to the media files.

5.4.11 - Stopping OSP

An optional command to remember is **stop_osp**. This will stop all the OSP processes currently running. You may need to close the terminal tabs, depending on the terminal settings, and restart OSP. To restart, you may need to open a new terminal window and enter the command **run_osp** again.

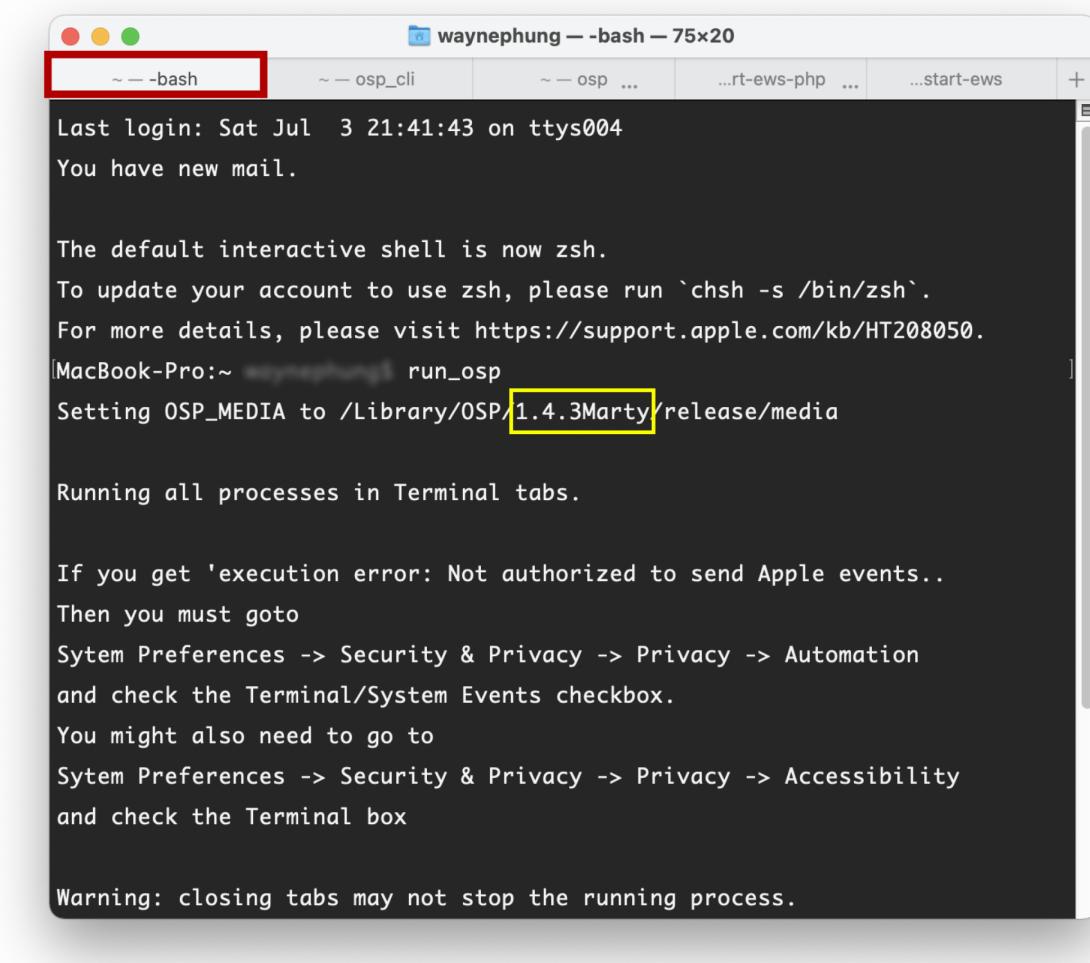
5.5 - Closing the CLI (OSP Hardware Only)

Press control + D keys on your keyboard to close the CLI. This will navigate back to the pcdtool interface (shown as the prompt “**root@ospboard:~>**”).

6 - Uninstalling OSP (Software Only for macOS)

Follow the steps below.

1. First, find the version number. Have a terminal running and enter the command **run_osp** to launch OSP. Go to the “*-bash*” terminal tab, and find the version number in the “*Setting OSP_MEDIA to /Library...*” message.



The screenshot shows a macOS Terminal window titled "waynephung — bash — 75x20". The window has multiple tabs at the top: "-bash", "osp_cli", "osp ...", "...rt-ews-php ...", "...start-ews", and a "+" button. The "-bash" tab is highlighted with a red border. The terminal output is as follows:

```
Last login: Sat Jul  3 21:41:43 on ttys004
You have new mail.

The default interactive shell is now zsh.
To update your account to use zsh, please run `chsh -s /bin/zsh`.
For more details, please visit https://support.apple.com/kb/HT208050.
[MacBook-Pro:~ [REDACTED] run_osp
Setting OSP_MEDIA to /Library/OSP/1.4.3Marty/release/media

Running all processes in Terminal tabs.

If you get 'execution error: Not authorized to send Apple events..
Then you must goto
System Preferences -> Security & Privacy -> Privacy -> Automation
and check the Terminal/System Events checkbox.
You might also need to go to
System Preferences -> Security & Privacy -> Privacy -> Accessibility
and check the Terminal box

Warning: closing tabs may not stop the running process.
```

A yellow box highlights the line "Setting OSP_MEDIA to /Library/OSP/1.4.3Marty/release/media".

2. Enter the command “**sudo bash**

/Library/OSP/1.4.3Marty/uninstall.sh”. Simply replace “**1.4.3Marty**” with the version number you found. When prompted, enter your computer login password.

3. You will be asked if you want to proceed with uninstallation. To do so, type “y” and press enter. If you change your mind, type “n” and press enter.

4. You should see the following message that the uninstall process has been finished.

```
Application uninstalling process started  
[1/3] [DONE] Successfully deleted shortcut links  
[2/3] [DONE] Successfully deleted application informations  
[3/3] [DONE] Successfully deleted application  
Application uninstall process finished
```

7 - Resources

This marks the end of the manual for explaining the OSP software.

Below are hyperlinks to other OSP-related resources:

- [OSP Website](#) - General information of OSP.

- [OpenSpeechPlatform on GitHub](#) - This is a public repository where you will find installer files and other documentation files for setting up both OSP software and hardware. Check back for future OSP release notes, updated installer files, and other updates.
 - [“Binaries” folder on GitHub](#) - This is the specific folder where you can download the software builds for either macOS or for the OSP hardware provided.
- [Google Form “OSP Feedback Form”](#) - You can complete this form if you would like to follow up regarding any topics or issues using OSP to a project staff member.

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Bibliography

1. Harinath Garudadri, Arthur Boothroyd, Ching-Hua Lee, Swaroop Gadiyaram, Justyn Bell, Dhiman Sengupta, Sean Hamilton, Krishna Chaithanya Vastare, Rajesh Gupta, and Bhaskar D. Rao, "A Realtime, Open-Source Speech-Processing Platform for Research in Hearing Loss Compensation", In Signals, Systems and Computers, 2017 51st Asilomar Conference, IEEE, 2017.
2. James M. Kates, "Principles of digital dynamic-range compression," Trends in Amplification, vol. 9, no.2, pp. 45-76, 2005.
3. Shilpi Banerjee, The compression handbook: An overview of the characteristics and applications of compression amplification, 4th Edition, Starkey Laboratories, 2017.
4. James M. Kates, Digital hearing aids, Plural publishing, 2008.
5. Toon van Waterschoot and Marc Moonen, "Fifty years of acoustic feedback control: State of the art and future challenges," Proceedings of IEEE, vol. 99, no. 2, pp. 288-327, 2011.
6. Johan Hellgren, "Analysis of feedback cancellation in hearing aids with Filtered-x LMS and the direct method of closed loop

- identification," IEEE Transactions on Speech and Audio Processing, vol. 10, no. 2, pp. 119-131, 2002.
7. Hsiang-Feng Chi, Shawn X. Gao, Sigfrid D. Soli, and Abeer Alwan, "Band-limited feedback cancellation with a modified filtered-X LMS algorithm for hearing aids," Speech Communication, vol. 39, no. 1-2, pp. 147-161, 2003.
 8. Donald L. Duttweiler, "Proportionate normalized least-meansquares adaptation in echo cancelers," IEEE Transactions on Speech and Audio Processing, vol. 8, no. 5, pp. 508-518, 2000.
 9. Jacob Benesty and Steven L. Gay, "An improved PNLMS algorithm," in Proceedings of IEEE International Conference on Acoustic, Speech, and Signal Processing (ICASSP), pp. 1881-1884, 2002.
 10. Constantin Paleologu, Jacob Benesty, and Silviu Ciochină, "An improved proportionate NLMS algorithm based on the ℓ_0 norm," in Proceedings of IEEE International Conference on Acoustic, Speech, and Signal Processing (ICASSP), pp. 309-312, 2010.
 11. Arslan, Levent, Alan McCree, and Vishu Viswanathan. "New methods for adaptive noise suppression." Acoustics, Speech, and Signal Processing, 1995. ICASSP-95., 1995 International Conference on. Vol. 1. IEEE, 1995.
 12. Hirsch, Hans-Günther, and Christoph Ehrlicher. "Noise estimation techniques for robust speech recognition." Acoustics, Speech, and

Signal Processing, 1995. ICASSP-95., 1995 International Conference on. Vol. 1. IEEE, 1995.

13. Cohen, Israel, and Baruch Berdugo. "Noise estimation by minima controlled recursive averaging for robust speech enhancement." IEEE signal processing letters 9.1 (2002): 12-15.
14. Lee, Ching-Hua, Bhaskar D. Rao, and Harinath Garudadri. "Sparsity promoting LMS for adaptive feedback cancellation". In Signal Processing Conference (EUSIPCO), 2017 25th European, pp. 226-230. IEEE, 2017.