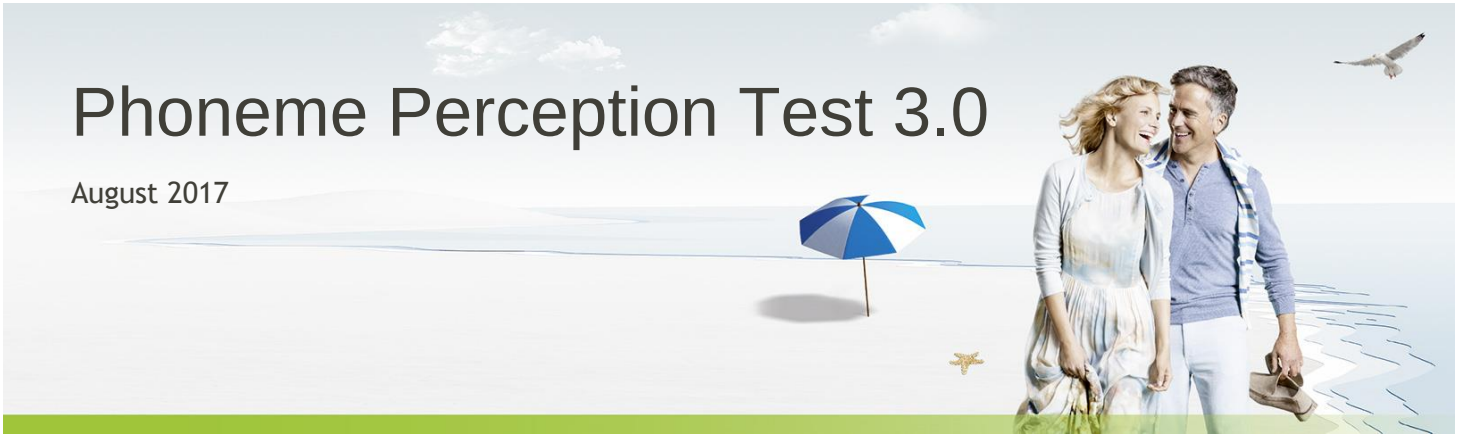


Phoneme Perception Test 3.0

August 2017

Desktop Fitting Guide

The Phoneme Perception Test is a NOAH-compatible software, designed for assessing your clients' hearing abilities. The Phoneme Perception Test is a new speech test, independent of language, that works similar to typical free field speech audiometry. However, unlike standard speech audiometry principles, the Phoneme Perception Test provides fitting advice on how to optimize your client's hearing aid settings for gain and frequency lowering. The goal is to improve your client's speech intelligibility while evaluating high frequency audibility and distinction by directly assessing hearing aid settings. A properly calibrated free-field-sound-system is a prerequisite for conducting this test.

The software provides guidance to ensure your computerized sound system is properly calibrated. The use of the external input of your audiometer in your sound booth is also possible, if your fitting computer does not contain a calibrated stereo or surround sound system. For details on how to setup and calibrate the sound system, please refer to the "Calibration guideline" chapter of this document.

Content

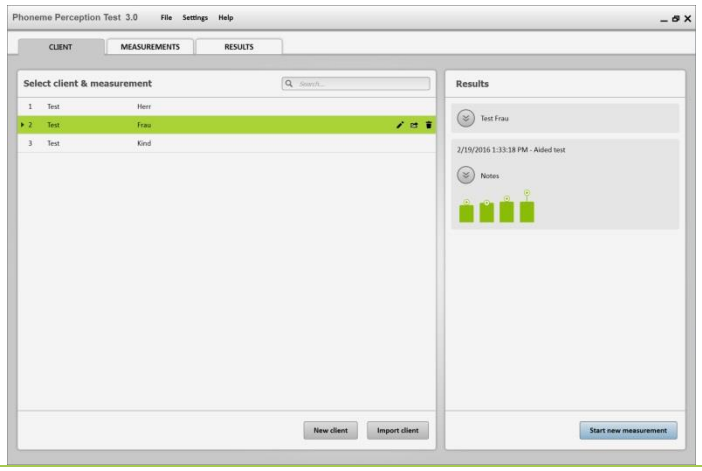
Calibration reminder

At the beginning of a test session, the Phoneme Perception Test will start with a welcome screen and the calibration reminder. Calibration is an essential part of a reproducible test and valid test results. It is recommended to run the calibration whenever you are not sure whether a preceding calibration is still valid or when some components of your sound system have been changed or moved. Please consult the Calibration guideline on how to run a calibration. Click [Continue] in the right lower corner of the screen to proceed with the Phoneme Perception test, when you have confirmed that your sound system is properly calibrated.

Client

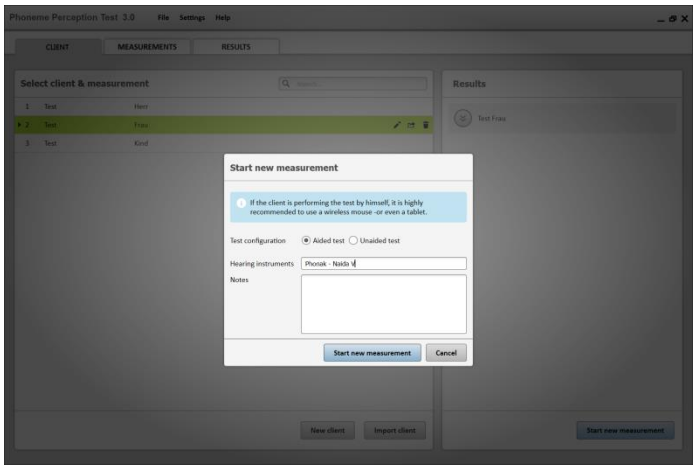
Select the client you want to work with or create a new client.

You can review or create new sessions for the assessment of your client's abilities in detecting, recognizing and distinguishing high frequency speech sounds.

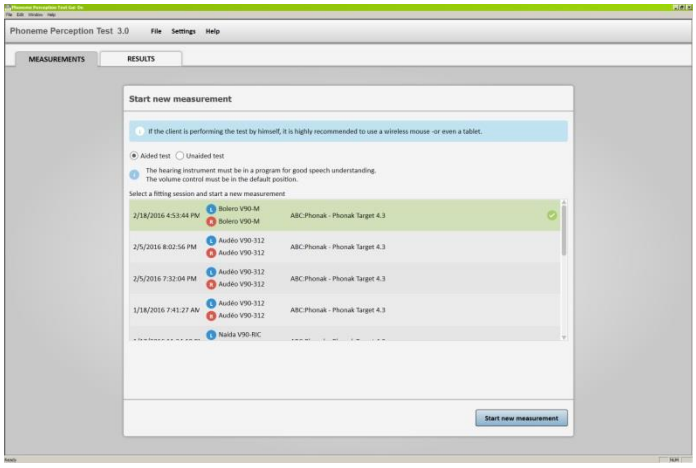


Measurements

Click on [Measurements] to start a new measurement. At the beginning of a new measurement, you will be asked whether the test will be done with your client wearing hearing instruments (aided) or not (unaided).

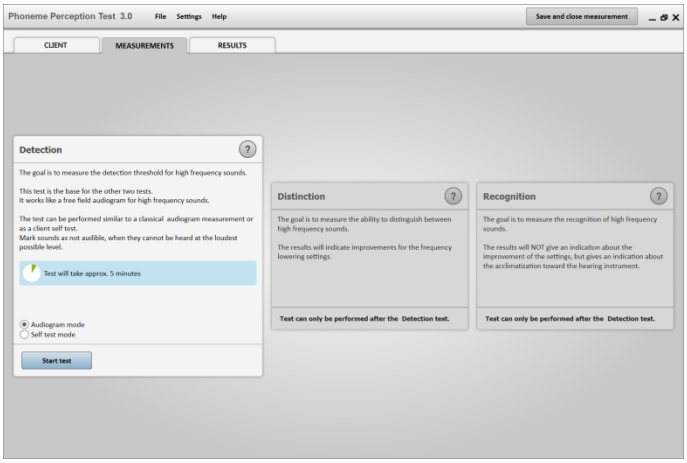


If you are using the Phoneme Perception Test within NOAH, you can directly select from the list of fitting sessions. When completing an aided measurement, select the session with the hearing instrument fitting that you want to test. When completing an unaided measurement, select the according audiogram.



Every test displays its objective and the expected duration to complete. Clicking **[?]** in the right upper corner of each test-box will provide information about the used stimuli.

Upon completion of each section of the Phoneme Perception Test, the results can be shown by clicking on the **[Show Results]** icon in the test overview.



We highly recommend using a tablet with WLAN capabilities when performing the Detection Self test, the Distinction Test, or the Recognition Test. Alternatively a wireless mouse is recommended to allow you to pass the mouse to your client.

Detection test

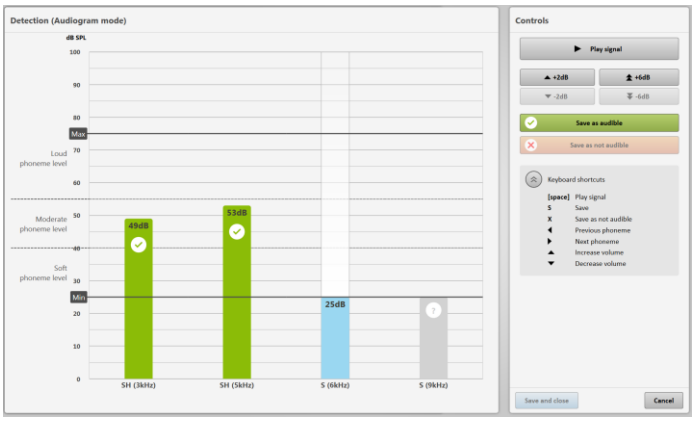
The Detection test works similarly to free field audiometry.
To measure manually, select **[Audiogram mode]** and for the detection threshold procedure performed by the client, select **[Self test mode]**.

Audiogram mode

Use the cursor keys or the according buttons to change the level of the presented speech-like sounds.

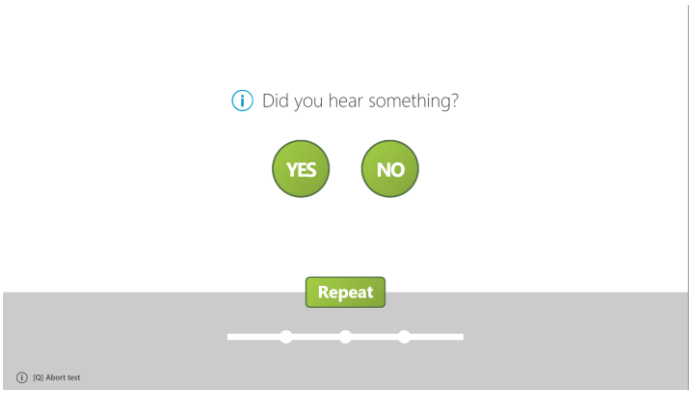
Press the SPACE bar or click **[Play signal]** to present the sound.

Depending on whether your client hears or doesn't hear the sound, click **[Save as audible]** or **[Save as not audible]** or press the keyboard shortcuts **[S]** or **[X]** to store the detection threshold values of your client.
Click on [Save and Close] after testing all frequencies.



Self test mode

This test runs with interaction of the client. The presentation pauses after each presentation and the client answers the question "Did you hear something?" by selecting **[Yes]** or **[No]**. The following presentation level is dependent upon the client's answer.
Pressing the **[D]** extends the window with an overview of the played signals together with the client's responses.



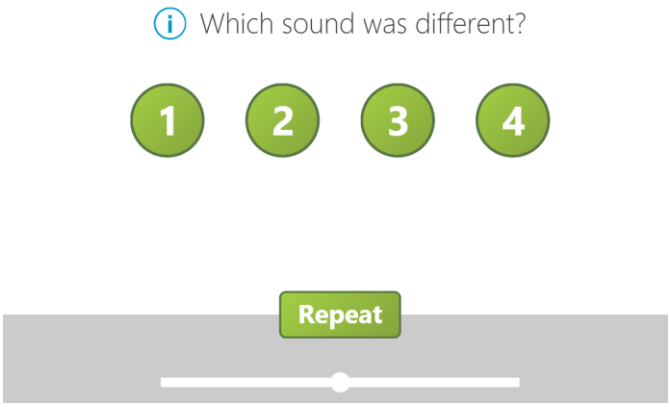
Distinction test

Use the distinction test to assess your clients' ability to distinguish high frequency speech sounds /sh/ and /s/.
Hand over the tablet or the mouse to your client and instruct her/him to listen to the presented sounds and to click the button which was highlighted when the differing sound was heard.

If you do not want to pass the tablet or mouse to your client, please detach the answer-sheet provided at the end of this document and laminate it. Hand this sheet to your client to let her/him point at the correct answers, and click the reported answers yourself. Or - just simply let your client repeat what he has heard confirming the position-number of the differing sound.

The distinction test will begin with training, allowing your client to adapt to the sounds and the way the test works. You can skip the training by un-checking the option in the test overview screen. The default can be set in the test settings options.

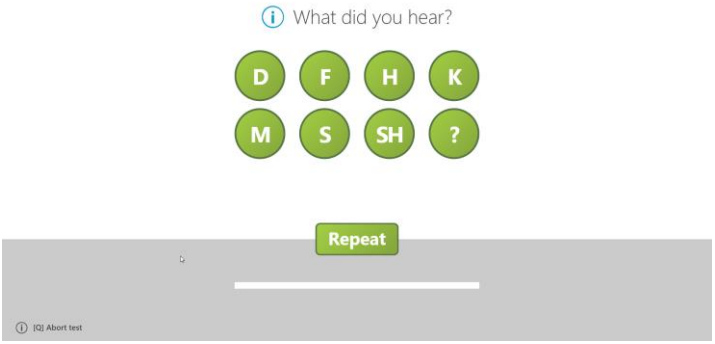
You can control the flow of the test via keyboard, while your client is operating the test on the tablet or on a second screen with a wireless mouse.



Recognition test

Use the Recognition test to assess your clients' ability in recognizing high frequency speech sounds like */sh/ or /s/*. The speech sounds are embedded within a pair of vowels, forming non-sense words like */a-sh-a/*. Hand over the tablet or wireless mouse to your client and tell her/him to listen to the presented words and to click the button with the letter which is in the middle of a presented word.

The Recognition test will start with training, allowing your client to adapt to the sounds and the way the test works. You can skip the training by un-checking the according option in the test overview screen. Or in general, by un-checking the test setting options: Start tests in training mode by default.
You can control the flow of the test via keyboard, while your client is operating the test with the tablet or a second screen.



Results

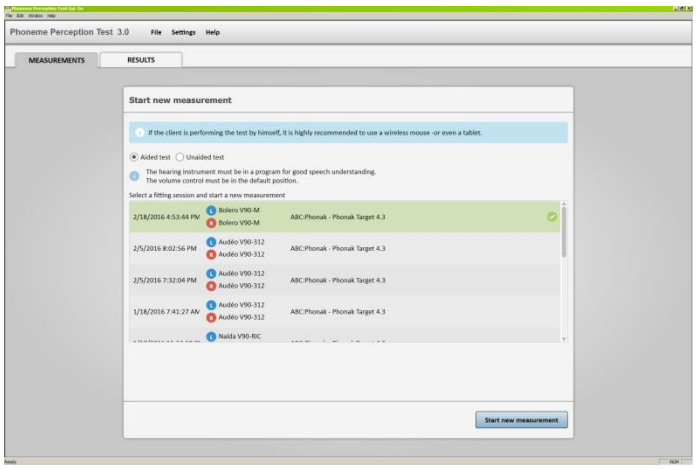
Clicking **[RESULTS]** will guide you to the results screen, showing a detailed overview of the test results of the currently selected session (1).

Click the box **[Show expected range]** (2) and select the appropriate hearing loss (3) (with this example: Mild) for your client to display the normative data (7) on the results screen. This will enable you to judge whether the results fall within the expected result ranges for your client – for the detection results (solid bars) (4) as well as for recognition scores (spheres) (5). The lower the results are in the shaded normative area indicates better results. After clicking on **[Compare measurements]**, you can click on the pictogram (6) of another session on the left side of the screen. It will display the current session's results and the previous session's results side-by-side.

Show and apply the test result in Phonak Target

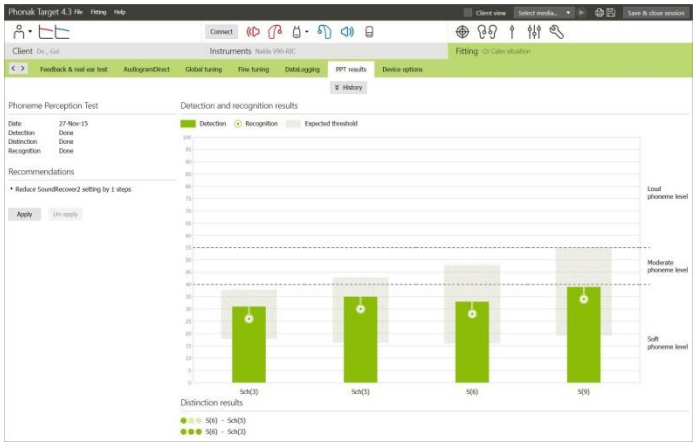
Phonak Target provides an interface to show and apply the results of a preceding Phoneme Perception Test to improve your client's fitting. To use this functionality it is required to run both Phonak Target and the Phoneme Perception Test under NOAH.

When starting a new measurement in the Phoneme Perception Test, select **[Aided test]** and the session with the hearing instrument fitting that you want to test.



After the measurement has been done **[Save and close]**, open the fitting session in Phonak Target. The screen **[PPT results]** will be accessible.

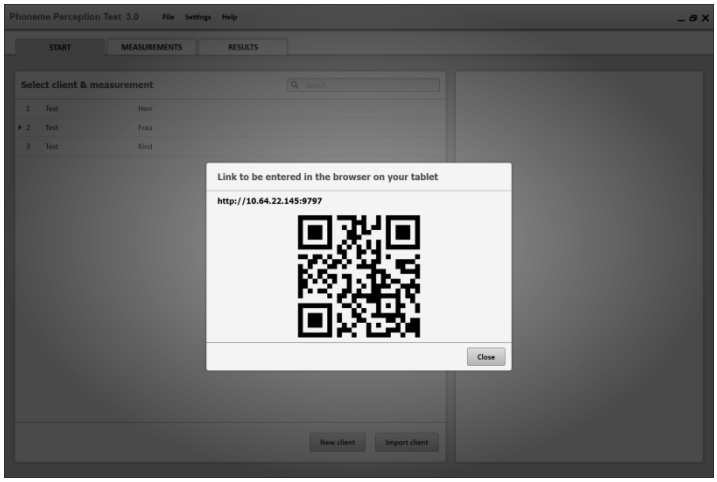
If desired, **[Apply]** the fine tuning recommendations to the fitting.



Connecting the tablet

The Phoneme Perception Test allows using a Tablet as a second screen and input device during the tests.

1. Make sure the Phoneme Perception Test 3.0 is installed on a computer with MS Windows 7 or higher.
2. Connect your tablet to the same WiFi network as your computer
3. Click on **[Help]** > **[Show link for tablet]**
4. Take the tablet and scan the QR code with a QR code reader or enter the displayed link in your tablet browser. (QR code readers can be downloaded for free in the App-Stores for iOS and Android)
   If you experience problems with the connection, please use another browser on your tablet.
5. The tablet is now ready for use

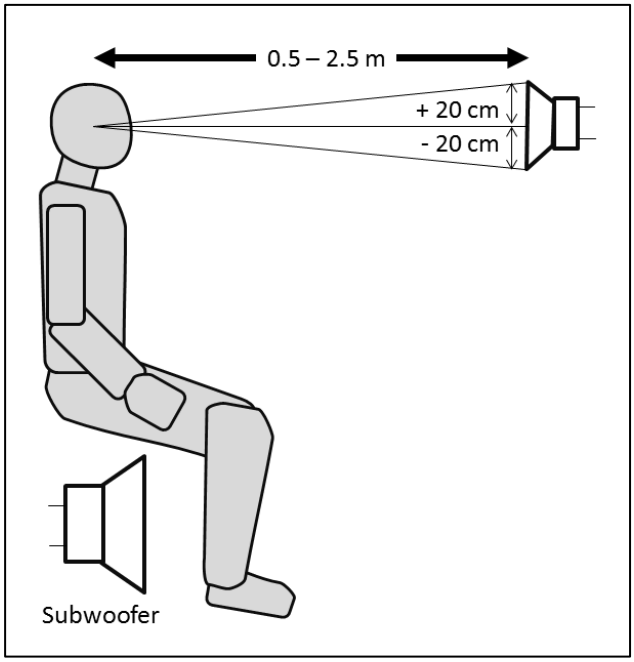


Calibration guideline

This chapter will guide you through the process of manually calibrating your sound system for the Phoneme Perception Test.

Definitions

A-Weighting:	A frequency-dependent energy weighting of spectral signals used in the context of measuring the level of sound signals. The weighting has most sensitivity within the range between 1 kHz and 5 kHz. Abbreviation is dB (A)
C-Weighting:	A frequency-dependent energy weighting of spectral signals used in the context of measuring the level of sound signals. The weighting shows a flat response (3 dB corner frequencies) between 250 Hz and 8 kHz. Abbreviation is dB (C)
Sound level meter:	Equipment designed to capture sound in a sound field and calculate the sound pressure level in decibels – a commercially available sound level meter (class 2, IEC 61672-1:2003). The Sound level meter must be capable of reporting the sound pressure level (dB SPL) within an accuracy of ± 2 dB and must provide the capability of displaying sound levels in dB (A).
Calibration Components:	Sound calibration is calibration with a broad band sound. Spectral verification is a verification of narrow band sounds with dB (A)-weighting.
Reference position:	Point in the sound field where sound levels are measured or sounds are made accessible for a client. The reference position is defined by height, angle and distance towards the sound source.



Sound equipment:	The hardware used to produce sound examples to clients. This includes the computer, sound card, amplifier, and speakers.
Room:	The room which contains the sound equipment.

Noah standard speaker configuration
The number of speakers, how they are arranged and the method of assigning segments of the recording to different speakers may vary.

Examples include two speaker system (front-back) (see figure 1), and surround 5.1 sound (see figure 2).

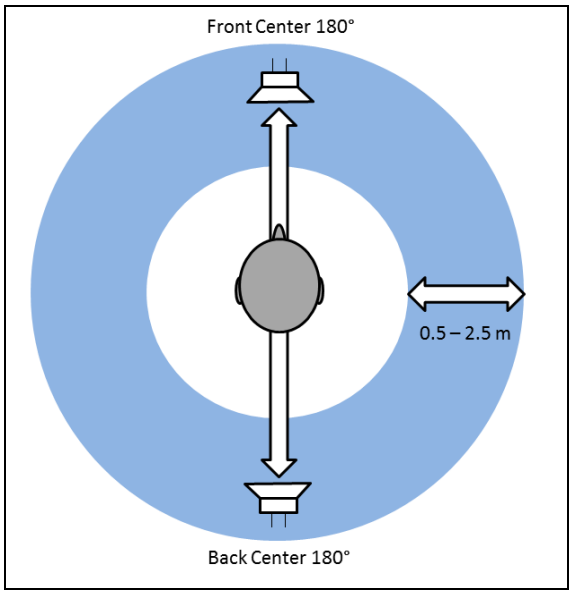


Figure 1

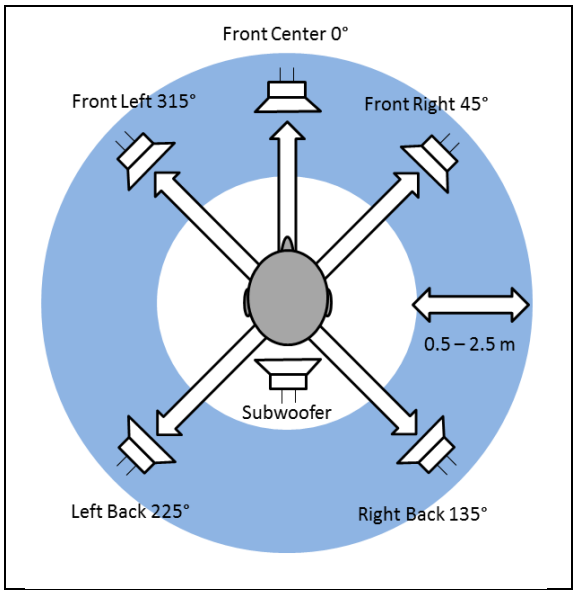


Figure 2

Importance of calibration
The Phoneme Perception Test delivers results which reliably help you in assessing the hearing capabilities of your clients. The more precise the results are the better the assessment will be. Therefore it is recommended to regularly check whether the used sound equipment in providing the correct levels at the relevant frequencies. The Phoneme Perception Test is especially sensitive for high frequencies. Therefore providing proper adjustment of the loudness for high frequencies of your sound equipment is essential for meaningful results. Once you have successfully calibrated your sound equipment it is recommended that you do not change the level settings of your sound equipment or computer volume except for the purpose of re-calibration.

How often should I calibrate?
The calibration procedure (overall level and separate adjustments of different high frequency signals) must be done prior to the first assessment session with a client. It is highly recommended to repeat the procedure whenever any component of the used sound system (e.g. loud speakers, amplifier, sound card, and computer) had been changed, replaced, or moved, or when the client's reference position has been changed.
It is also recommended to redo the entire calibration procedure from within the Phoneme Perception Test every 1-2 months to ensure correct, reproducible, and useful results.

How to calibrate

To start the calibration, open the Settings Menu and click [Start Calibration]. This will open the Calibration function of the Phoneme Perception Test. To do a proper calibration follow the steps described below:

1. Select the sound card from the choices offered in the Phoneme Perception Test calibration screen.
2. Setup the audio equipment you are using
    a. Stereo (left speaker)
    b. Surround 5.1 (enter speaker)
    c. Aurical / Aurical Plus (for the display of the Aurical-Controls)

3. Sound calibration
    a. Click [Play / stop sound] to present the overall calibration signal (broadband noise)
    b. Measure the level at the client's reference position (see previous page) using a sound level meter (class 2, IEC 61672-1:2003). The presentation level shall be 70 dB (A).
    c. Adjust the sound level of your sound equipment until it matches 70 dB (A).

4. Spectral verification
    a. Click every button from **[Play 0.5 kHz]** to **[Play 8.0 kHz]**, one after the other to play the frequency specific calibration signals (spectrally shaped noises).
    b. Measure the output at the client's reference position (see previous page) using a sound level meter (class 2, IEC 61672-1:2003). The presentation level should be 70 dB (A) for each signal.

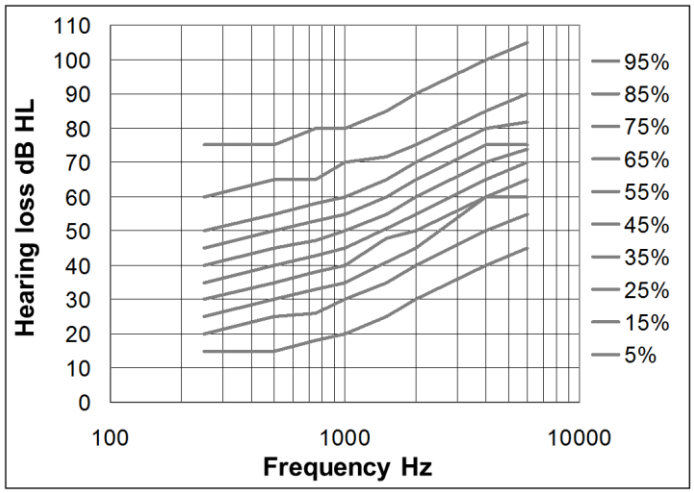
       If some of the played frequency specific signals do not match 70 dB (A) within ± 2 dB tolerance, the sound system is not spectrally flat and needs frequency specific adjustment.
    c. If this is the case your sound system should be equipped with a graphic equalizer allowing specifically adjusting the levels around the denoted center frequencies of the frequency specific calibration sounds.

       After the adjustment procedure the tolerance for all sounds (broadband signal and separate high frequency signals) should be within this ± 2 dB tolerance for one setting of your sound equipment

    d. Click **[Calibration completed]** and **[Continue]** to accept the new configuration of your Audio equipment

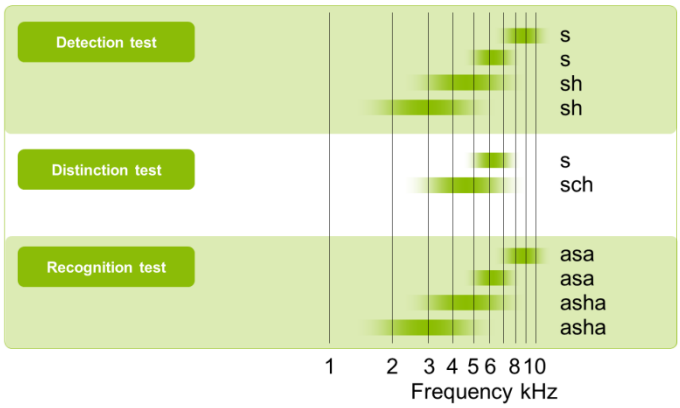
Background information

Speech intelligibility in quiet and in noisy situations is most important within the process of fitting hearing instruments.
The figure shows more than 8000 audiograms of Phonak clients divided in percentile clusters. The figure suggests that most hearing-impaired people need high frequency amplification from hearing aids more than they need low frequency amplification. This shows the importance of verifying hearing aid fittings, especially at high frequencies.



The test features a lower and a higher frequency /sh/ as well as a lower and a higher frequency /s/. This covers the variation of different male and female speakers. The four /sh/- and /s/-sounds cover the frequency range between 2 and 10 kHz.

The graphic shows the test on the left side and the according test signals on the right side. Each test signal is shown with the spectral energy maximum of the fricative sound.



The changes to sounds, such as amplification or frequency lowering, which are performed by the hearing aid, will affect the audibility of and distinction between high frequency speech sounds / phonemes. The Phoneme Perception Test therefore strongly focuses on the audibility of and distinction between– speech sounds. A recognition test is offered in addition.

Purpose of different sub-tests within the Phoneme Perception Test

- **Detection**
  The detection test will assess if the client can hear a sound or not. The Audiogram mode follows the measurement principles of a pure tone audiometry in free-field.
  The [Self test mode] allows the client to actively participate in the measurement process of the hearing threshold, increasing motivation and acceptance of the tested person.

- **Distinction**
  The distinction test will assess the ability to distinguish between audible phonemes which are similar to one another. The methodology of this test in based on the signal detection theories and is called 4-Alternative-Forced-Choice (4AFC) Method. 4 Stimuli are being presented, 3 are the same, and one is different to the others.

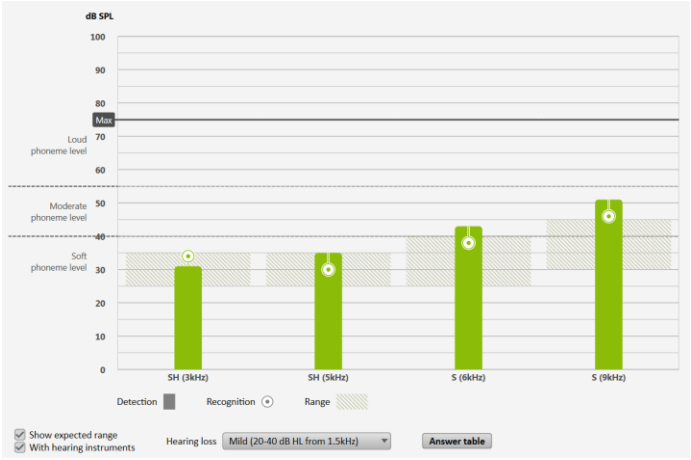
- **Recognition**
  The recognition test checks if the audible sounds can be recognized correctly. Complete words are more adequate for recognition tests than isolated fricatives, such as /sh/ and /s/. The sounds used for the recognition test are therefore vowel-consonant-vowel combinations like /asha/ and /asa/. The results are recognition thresholds for the 4 test sounds in the range between +15dB and -5dB in relation to the phoneme detection threshold.

Inadequate high frequency hearing – consequences for speech intelligibility
Unknown names, abbreviations, or in noisy or reverberant conditions may lead to uncertainties, misunderstandings or lack of speech intelligibility.

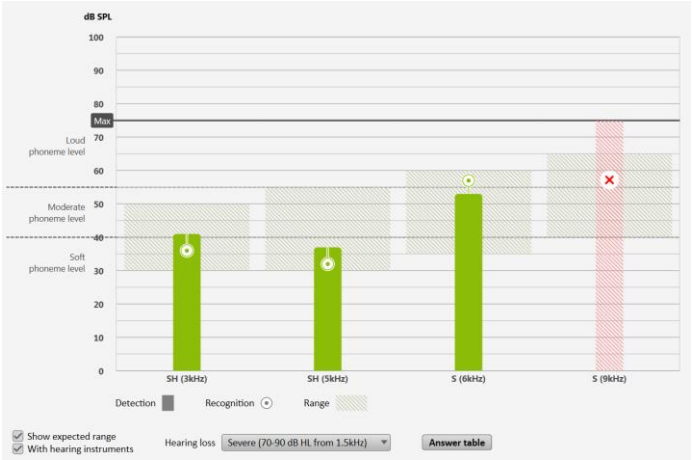
Why would a phoneme based speech test be useful?
Many languages share phonemes. Therefore, it is appropriate to create a test that is applicable across several different languages. Phonemes may be pronounced differently for different languages and phonemes are used differently in words and sentences. Nevertheless, frequency, amplitude, duration and temporal structure remain the same.

Using this test with different degrees of hearing loss

The phoneme perception test is applicable for all degrees of hearing loss – with and without hearing aids. However, the test outcome and the expectations for detection thresholds depend on the client's hearing loss. The illustrations below show the expected ranges (grey area) for two different levels of hearing loss – with hearing aids.



Mild hearing loss

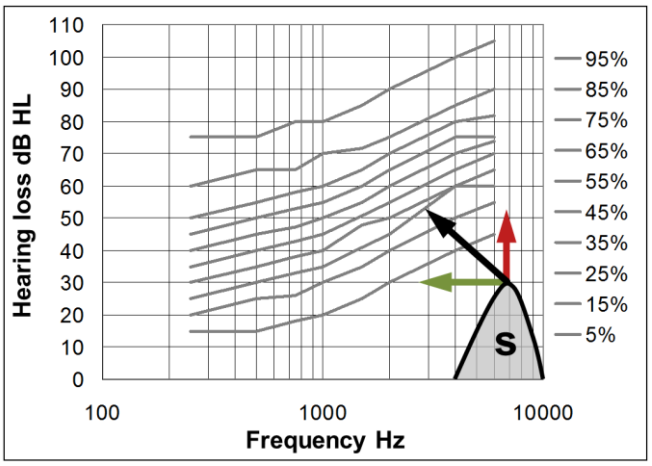


Severe hearing loss

How to use the Phoneme Perception Test results to improve your fitting

The Phoneme Perception Test delivers results which show hearing abilities and deficits of your client together with the strengths and weaknesses of their current fitting.
Positive results of the test can be used as indication that further optimization may not be necessary, whereas negative results show the weaknesses of the current hearing aid fitting. You can tell positive results from negative, when all bars and spheres are within the normative shaded areas of the expected ranges. Whenever values are out of the denoted ranges, please, read the chapters below on how to improve with these situations.

How much gain and how much frequency lowering (e.g. SoundRecover) should I add?
Gain/amplification is the most effective parameter to increase audibility for high frequencies if the hearing loss within this frequency range is below 60 dB HL. For hearing losses above 60 dB or for hearing losses with small dynamic ranges (residual ranges between thresholds of audibility and discomfort), frequency lowering or a combination of frequency lowering and increased amplification may be the right approach. However, the specific amount of each component you should add strongly depends on the hearing loss and the hearing instrument used as well as the amount of gain you can apply before feedback occurs.



Percentile levels of over 8000 audiograms

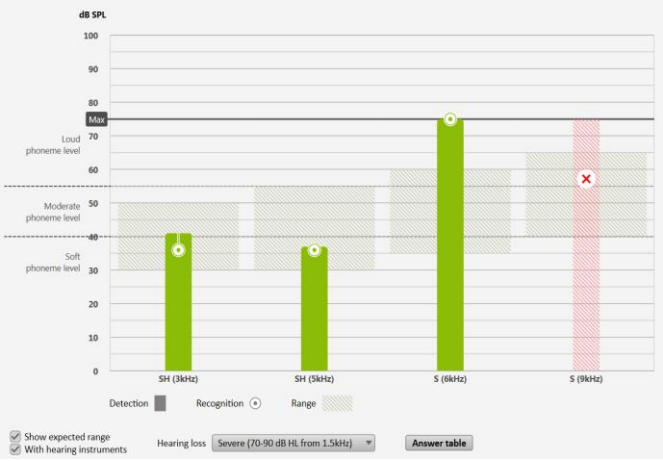
Amplification
Frequency lowering
Combination of amplification and frequency lowering

Applicable gain

Applying more gain in the high frequency regions of a hearing instrument often is the most appropriate means to regain audibility in these frequency ranges. As the phonemes, used by the Phoneme Perception Test, are always displayed with their center frequencies (e.g. /sh/ 5 kHz), it is easy to identify the frequencies that are not audible.

The example shows a lack of amplification at 6 kHz and at 9 kHz. This suggests increasing the gain to improve audibility for speech sounds between 6 kHz and 9 kHz to reach the expected range.

The normative data targets, which depend on the client's hearing loss, can be displayed by selecting the appropriate hearing loss shown in the drop-down box within the session overview.



However, take care not to over amplify denoted expected frequencies ranges, since this will lead to adverse effects like increased feedback tendency and bad clients' acceptance of the hearing aids.

Since the available additional gain of the hearing aids depends on its feedback threshold, it is recommended go to try an occluded fitting whenever available gain headroom does not suffice to restore clients' high frequency audibility.

Applicable frequency lowering

If your client's hearing aids are equipped with a frequency lowering feature (e.g. Spectral iQ™, Audibility Extender, SoundRecover™) these functions are an alternative or supporting methods to restore the clients' audibility for high frequency fricative sounds (/s/, /sh/). Frequency-lowering techniques offer the ability to map inaudible sounds back into your client's residual hearing, when your client has a hearing loss which is sloping to higher frequencies.

Applying frequency lowering – when available – provides two major advantages:

1. The high-frequency fricatives are shifted/transposed/compressed into a frequency area, where clients' hearing usually is much better than in the original frequency area of the according speech sounds
2. The hearing instruments usually provide much more gain in the shifted/transposed/compressed area than in the original areas of high-frequency speech sounds which adds extra gain advantage

Though this may suggest that the more lowering you apply the better, there may be adverse effects.

- Applying too much of frequency lowering will make the sound of the hearing aids strange and adverse.

Clients with high-frequency sloping hearing losses also suffer from impaired frequency resolution capabilities. Increasing the strength of frequency-lowering settings in frequency regions with reduced resolution may make this worse. This may result in reduced distinguishability of similarly sounding fricatives as e.g. /s/ and /sh/.

Regarding the distinction – be cautious

The Phoneme Perception Test proposes to run a distinction test whenever there is clear indication, that reduced distinguishability might be the root cause for bad recognition scores. The outcome of the distinction test will indicate whether

a) lack of acclimatization to a hearing instrument setting
b) Reduced distinguishability is the reason for bad recognition scores of your client.

The indicators show whether distinction capabilities are generally good while acclimatization is missing, or whether wrong hearing instrument settings and/or physiological reasons of your client are the root cause for poor distinction capabilities

.


= distinction good, maybe lack of acclimatization (give client some time to acclimatize to instruments)


= distinction OK (hearing instrument, client's hearing loss)

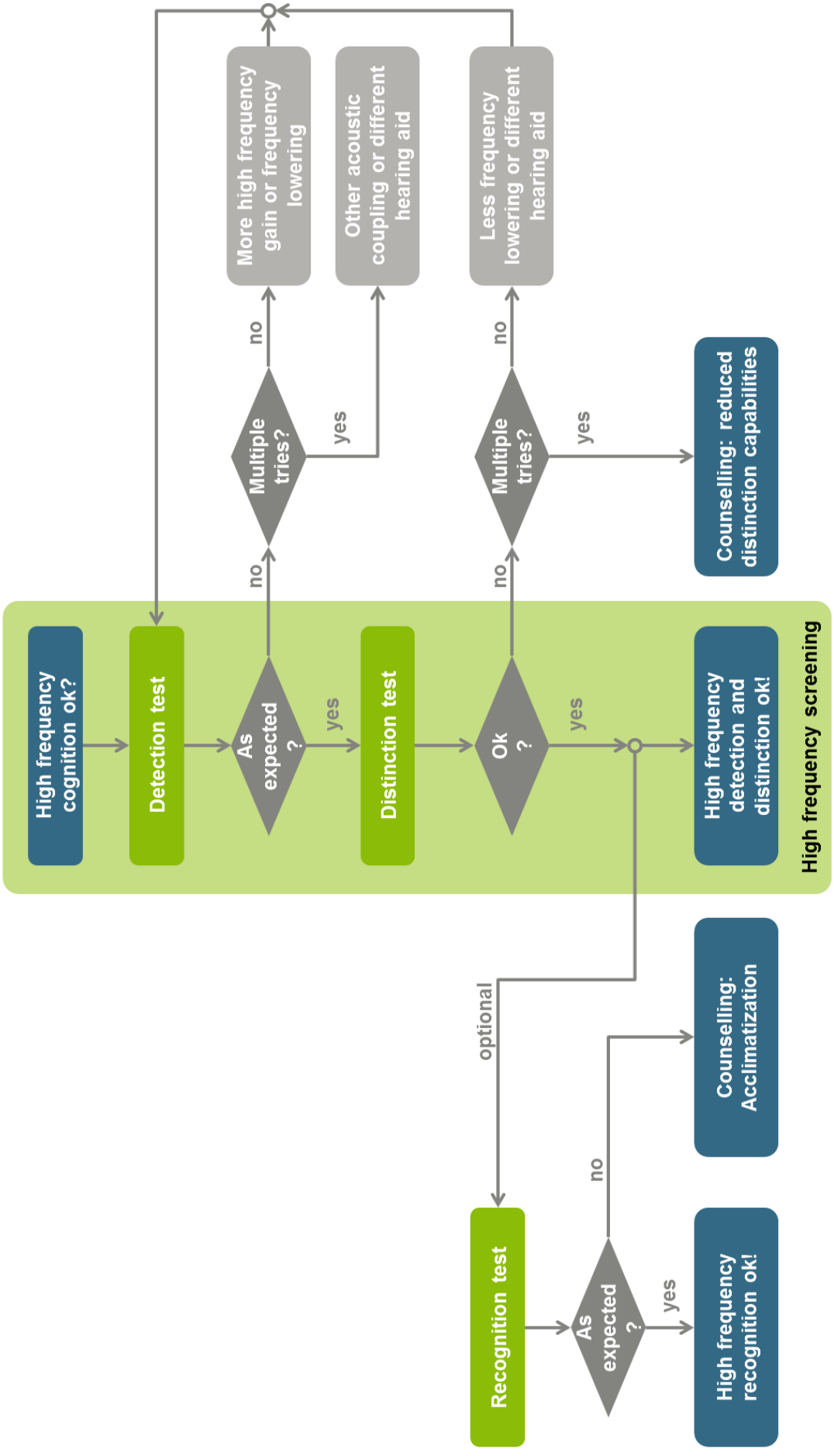

= distinction reduced (hearing instrument, client's hearing loss)

In the case of OK or reduced distinction it is not beneficial to apply stronger frequency-lowering settings, as this may worsen the recognition score as well as the distinction score. In this case, you may consider reducing the strength of frequency lowering of the hearing instruments to provide better phoneme distinction capabilities for your client.

Otherwise –stronger frequency lowering may help in restoring the audibility of /s/ and /sh/ sounds, as long as your client is capable of distinguishing similarly sounding fricatives while wearing hearing instruments.

Frequency-lowering features can change the perception of sounds more than expected and therefore may require your client to acclimatize to these new frequency-lowering settings.

Flow chart for actions and decisions



4
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1

K
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SH
F
S
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M

System requirements

Processor	Pentium IV, 2 GHz or faster
RAM	2 GB or more
Hard disk space	200 MB or more
Operating system	• MS Windows Vista, 32 bit / 64 bit, latest SP • MS Windows 7, 32 bit / 64 bit • MS Windows 8, 32 bit / 64 bit • MS Windows 10
Operation system for tablet synchronization	• MS Windows 7, 32 bit / 64 bit • MS Windows 8, 32 bit / 64 bit • MS Windows 10
Screen resolution	1280 x 1024 pixels or more
Graphic card	• 16 Million (24bit) screen colors or more • DirectX 9 capable / Premium Ready PC
Drive	DVD-Rom or CD-ROM
Sound card	Surround 5.1 or stereo
Playback system	200Hz–10kHz(±-2dB), 93dB 50Hz–14kHz(± 5dB)

CE mark applied 2016

CE

Manufacturer:
Sonova AG
Laubisrütistrasse 28
CH-8712 Stäfa
Switzerland