

The Situational Hearing Aid Response Profile (SHARP), version 7

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TABLE OF CONTENTS

Introduction:.....	3
SHARP Installation:	3
SHARP Interface:.....	3
Estimation of the Hearing-Aid Output:	4
Computation of HL to SPL:.....	5
Speech Spectra:	5
References:.....	7
Appendix.....	8

Introduction:

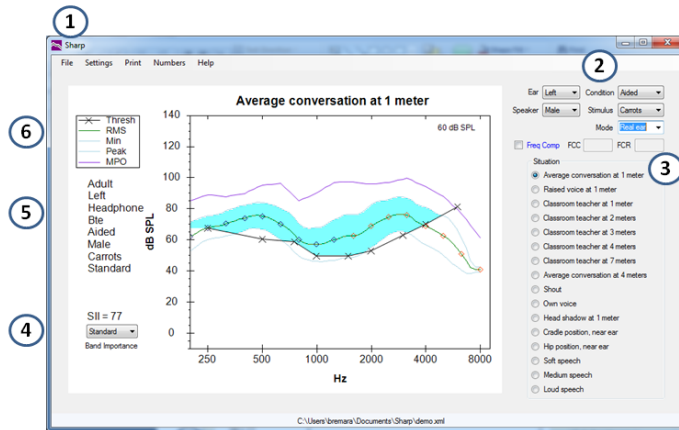
The Situational Hearing Aid Response Profile (SHARP) was originally developed by Pat Stelmachowicz and colleagues at Boys Town National Research Hospital to characterize the audibility of speech signals across a wide range of realistic listening situations with varying acoustics (Stelmachowicz et al., 1994, 1996). Version 7 represents the first update of SHARP in over a decade. Version 7 will run on Windows XP and 7. It has not been tested on Windows 8. Major updates include:

- Integration with Audioscan Verifit to read .XML data files directly into SHARP
- Prediction of input/output function in 1/3 octave bands from verification data

Installation:

- 1) Copy SHARP.zip file to Desktop of computer that SHARP will be installed on.
- 2) Double click on SHARP.zip and unzip the file into the desired location. We recommend creating a folder called C:\SHARP (or other local drive).
- 3) After unzipping, click on set-up. A window will open briefly.
- 4) SHARP will open following installation.

Interface:



1. Menu System

a. File:

- i. New: use to manually enter threshold and real-ear data.
 1. Threshold data are entered in dB HL and RECD values in dB. You must enter thresholds for at least two frequencies
 2. Enter real-ear or simulated real-ear dB SPL for each available input level (50 to 75 dB SPL, MPO). If you enter real-ear data, you must enter the dB SPL for at least two frequencies at two input levels.
 3. RECD values are not used in any of the calculations and serve only for informational purposes.
- ii. Open: use to select the location of a Verifit .XML file. This can be either a local drive or network location.

- b. Settings: Use to select how the figure is displayed. Select *show SII points* so that you can “see” the frequency lowering. You can also select to show the filename and whether the audible portion of speech is hatched or unfilled.
 - c. Print: use to print the figure to a printer or to disk.
 - d. Numbers: use to see a table of the predicted output levels.
 - e. Help: location of this manual.
2. Option selection –
- a. Ear: Selects the *left* or *right* ear from the Verifit file.
 - b. Speaker: Toggle between *male*, *female* and *child* speaker.
 - c. Condition: Toggle between *unaided* and *aided* speech spectra.
 - d. Stimulus: Selects the stimulus (Carrots, Ear, ISTA, Female) used from the Verifit file.
 - e. Freq Comp: Select if you used nonlinear frequency compression from Phonak or Unitron. Then enter the start frequency (FCC) in Hz and the compression ratio (FCR), both of which are available in the fitting software. Frequencies above the start frequency are shown in orange and frequencies below are shown in green on the SPLoGram. Click on a diamond and a popup display will show the input frequency in square brackets, output frequency and SPL at the output frequency.
 - f. Mode: Select real ear if you want to use the real-ear data that is stored in the Verifit. If you want to use the coupler data choose simulated.
3. Situation – Allows selection of different input speech spectra (See Speech Spectra section for a description of each spectrum).
4. SII – Speech Intelligibility Index. The SII represents the proportion of the speech signal that is above the listener’s threshold. The SII was modified from the ANSI (1997) standard to incorporate the dynamic range of speech after amplification. The user can select the band importance function used to compute the SII. The band importance function defaults to the ANSI (1997) standard band importance function for calculating audibility. Nonword and sentence importance weights can also be selected. *Standard* should be used for everyday listening situations. *Nonword* or *sentence* importance weights should be used when interested in predicting performance with tests that use nonwords or sentences. The SII is automatically recalculated each time you change the band importance function. Note that the value will not always change. With NFC, the SII was further modified to account for audibility with the frequency-lowered signal. Specifically, the band importance function is based on the input frequency but the sensation level is based on the output frequency. See Brennan et al. (2013) and Brennan (2014) for more details.
5. Displays the current settings.
6. Figure legend.

Estimation of the Hearing-Aid Output:

The hearing-aid output for the different listening situations is estimated using the following procedure:

- The input spectra for the different listening situations were interpolated from $1/3$ to $1/12$ octave bands.
- If the real ear data are entered manually, the user enters the RMS hearing-aid output levels, MPO, and RECD for octave bands. For the hearing-aid output levels, output levels for a minimum of two input levels must be entered. For each input level, a minimum of two data points are required. For example you could enter thresholds at 500 and 2000 Hz, along with hearing-aid output levels for input levels of 55 and 65 dB SPL and MPO at 500 and 2000. These data are then interpolated to $1/12$ octave bands from 200 to 8000 Hz.
- If the real ear data are imported from the Verifit, SHARP imports the minimum, RMS, and peak hearing-aid output levels. The levels are specified in $1/12$ octave bands from 200 to 8000 Hz.

- For each $1/12$ octave band SHARP conducts a linear regression where the independent variable is the input level and the dependent variable is the output level. With NFC, the input frequency defines the input level and the output frequency defines the output level.
- The y-intercept and slope are used to predict the hearing-aid output for each $1/12$ octave band. The independent variable is the input level for the selected listening situation and the dependent variable is the output level.
- Accuracy of the estimated hearing-aid output using SHARP was described in Brennan et al. (2013) and this conference proceeding is available for download from <http://audres.org/rc/>.

Computation of HL to SPL:

The conversion from HL to SPL depends on the method used to enter the real-ear data. For real-ear data that are entered via the Verifit, the dB SPL values computed by the Verifit are used. For real-ear data that are entered manually the dB SPL values are computed using the following procedure:

TDH. The same procedure is used to convert HL to SPL for children and adults. Thresholds in dB HL are converted to dB SPL by adding the values from the Verifit.

Inserts. First thresholds in dB HL are converted to dB SPL in a 2 cc coupler, using values obtained from the Verifit. If RECD values are entered, then these values are used to convert to real-ear levels. Otherwise, the levels in the 2 cc coupler are converted to real-ear levels by use of the same values in the Verifit. These values differ by age.

Thresholds for frequencies not entered are interpolated or extrapolated using linear regression. SHARP uses the surrounding pair of thresholds for interpolation (e.g. 2 and 4 kHz to interpolate 3 kHz). For extrapolation SHARP uses the first or last pair of thresholds (e.g. 2 and 4 kHz to extrapolate threshold for 6 kHz).

Speech Spectra:

In SHARP version 7.0 16 different speech spectra are available, as described below. The number in parentheses indicates the rms level of the signal. The 1/3-octave band levels associated with these spectra are shown in Table A of the Appendix.

- 1) Average conversation at 1 meter (60 dB SPL) - from Cox and Moore (1988).
- 2) Raised voice at 1 meter (70 dB SPL) – spectrum from Cox and Moore (1988) but adjusted to an overall level of 70 dB SPL.
- 3) Classroom teacher at 1 meter (72 dB SPL) - from Pearsons et al (1977). "Loud speech" was averaged across males and females (Figs. 16 & 17) and rescaled to an overall level of 72 dB SPL.
- 4) Classroom teacher at 2 meters (66 dB SPL) - as above from Pearsons et al (1977).
- 5) Classroom teacher at 3 meters (63 dB SPL) - as above from Pearsons et al (1977).
- 6) Classroom teacher at 4 meters (61 dB SPL) - as above from Pearsons et al (1977).
- 7) Classroom teacher at 7 meters (61 dB SPL) - as above from Pearsons et al (1977).

- 8) Average conversation at 4 meters (48 dB SPL) – spectrum from Cox and Moore (1988) but scaled down 12 dB from the 1 meter values (#1), representing a change from 1 meter to 4 meters based on the inverse square law. This assumes conversation in a non-reverberant field such as outdoors or in a large indoor area (gymnasium).
- 9) Shout (82 dB SPL) - from Pearsons et al (1977).
- 10) Own voice (70 dB SPL) - from Cornelisse et al (1991). Values represent mean of adult male, adult female, and children.
- 11) Head shadow at 1 meter (60 dB SPL) - from Studebaker et al (1980). Data represent the relative difference between 90 and 270 degrees as applied to the Cox and Moore (1988) spectrum at 1 meter.
- 12) Cradle position, near ear (68 dB SPL) - from Stelmachowicz et al (1993).
- 13) Hip position, near ear (76 dB SPL) - from Stelmachowicz et al (1993).
- 14) Verifit Soft (Soft Speech) – (55 dB SPL) Long-term average speech spectrum for the “carrot” passage from the Audioscan Verifit.
- 15) Verifit Average (Medium Speech) – (65 dB SPL) Long-term average speech spectrum for the “carrot” passage from the Audioscan Verifit.
- 16) Verifit Loud (Loud Speech) – (75 dB SPL) Long-term average speech spectrum for the “carrot” passage from the Audioscan Verifit.

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Appendix:

Table A. 1/3 octave band levels (in dB SPL) of various LTASS.

	Frequency (kHz)								
	.25	.5	.75	1.0	1.5	2.0	3.0	4.0	6.0
Avg conv (1m)	50.0	52.0	46.5	45.0	42.0	39.0	36.5	36.0	35.5
Raised voice (1m)	60.0	62.0	56.5	55.0	52.0	49.0	46.5	46.0	45.5
Classroom (1m)	55.5	61.8	61.8	60.8	61.3	55.8	53.8	51.8	45.8
Classroom (2m)	49.5	55.8	55.8	54.8	55.3	49.8	47.8	45.8	39.8
Classroom (3m)	46.0	52.3	52.6	51.3	51.8	46.3	44.3	42.3	36.6
Classroom (4m)	44.5	50.8	50.8	49.8	50.3	44.8	42.8	40.8	34.8
Classroom (7m)	44.5	50.8	50.8	49.8	50.3	44.8	42.8	40.8	34.8
Avg conv (4m)	38.0	40.0	35.0	33.0	30.0	27.0	25.0	24.0	24.0
Shout	58.0	69.0	73.8	75.0	76.3	71.5	68.5	65.8	58.8
*Own voice	60.9	63.3	58.9	53.3	46.6	44.7	36.7	34.0	34.8
*Head shadow	44.1	47.5	40.9	39.0	32.8	26.7	19.7	21.1	19.5
*Cradle position	56.1	60.5	56.4	50.2	46.5	42.4	37.8	39.6	40.6
*Hip position	63.6	69.0	62.9	58.0	55.3	52.2	49.2	47.6	45.0