The Ling-6(HL): Instructions

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Overview

Assistive hearing technologies, such as cochlear implants and hearing aids are provided to children with hearing losses in order to provide access to speech sounds. One common measure that is used to assess access to speech sounds across the speech frequency range is the Ling-6 sounds (/m/, /u/, /a/, /i/, /ʃ/, and /s/). The live voice method of administering Ling-6 sounds was originally proposed by Daniel Ling (Ling, 1989) and is often used to assess whether a child can detect sounds that lie within the speech spectrum of hearing. Recently, the Ling-6 sounds have been recorded, calibrated, and used within a bracketed threshold measurement procedure in hearing aid research studies. Such studies have demonstrated that calibrated Ling-6 sounds can be used to reliably bracket speech sound detection thresholds, and are sensitive to change across different hearing aid treatments (Glista et al., 2009; Wolfe et al., 2011).

The Ling-6(HL) test was developed as a speech sound detection measure for use in aided and unaided testing conditions. Measurement of detection thresholds incorporates pre-recorded, calibrated Ling-6 sounds in dB(HL). Six sound files, spoken by a female talker, are provided for measurement of bracketed hearing thresholds, per sound. The chosen sounds correspond to those previously published for use in validating hearing aid fitting across the range of frequencies important for speech understanding (Ling, 1989). These sounds have been prepared as a compact disk, with full instructions for administration. Continuous repetitions (64 each) of the following sounds are provided as audio files arranged in separate tracks on the CD: /m/ ("mmm"), /u/ ("ooo"), /a/ ("aah"), /i/ ("eee"), /ʃ/ ("shh"), and /s/ ("sss").

Details on the development and evaluation of this test can be found in the accompanying manuscript (Scollie et al., in review). Initial testing was completed on a group of normal hearing adult listeners to determine typical responses and testing reliability. Follow-up testing was completed with twenty-seven adults and five children with hearing losses. Stimulus preparation and shaping resulted in a recorded, calibrated set of Ling-6(HL) stimuli that provide flat normal thresholds in HL for normally hearing listeners. Typical aided performance may vary with hearing level and hearing aid prescription. More data are required to fully characterize performance trends in the pediatric population. The following factors may contribute to adult-child performance differences: (a) hearing loss range and configuration; (b) hearing aid prescription (i.e., children will likely be fitted with higher gain in their hearing aids than adults); and (c) test performance due to age alone, if younger children respond to Minimum Response Levels rather than true threshold when completing VRA and CPA procedures. Such data will be made available for future versions of the test.

This document contains details pertaining to the testing setup and calibration procedures needed to run the Ling-6(HL) test (for standard, conditioned play audiometry (CPA), and a standard/modified visual reinforcement audiometry (VRA) testing set-ups), in addition to details on instructing the listener, stimulus presentation, and scoring. Data collection tables/forms are provided along with an illustrative case example.

Testing Setup and Calibration Procedure

This test is meant to be used with audiometric equipment that has been calibrated according to ANSI S3.6 (2004), using a sound booth that complies with requirements for Maximum Permissable Ambient Noise Levels. For European equivalent standards, see Appendix 1. Please review the following testing set-up scenarios and corresponding calibration procedures (pages 5 through 8), as these can vary depending on the age category you are interested in testing and corresponding sound booth set-up:

1. Standard sound field testing at 0° azimuth
2. Sound field testing using conditioned play audiometry at 0° azimuth
3. Sound field testing using visual reinforcement audiometry (VRA) (standard set-up) at 45° azimuth
4. Sound field testing using VRA (modified set-up) at 0° azimuth

Comparison of a standard versus modified VRA set-ups:

Set-up	Advantages	Disadvantages
Standard VRA	Consistent with standard VRA set-up. Allows for a two-tester paradigm.	Normative data for this type of a set-up is needed. Assumes an ear-specific testing set-up.
Modified VRA	Consistent with standard/CPA testing procedures.	Requires a modified set-up: limited to one tester, repositioning of centering/reinforcement toys.

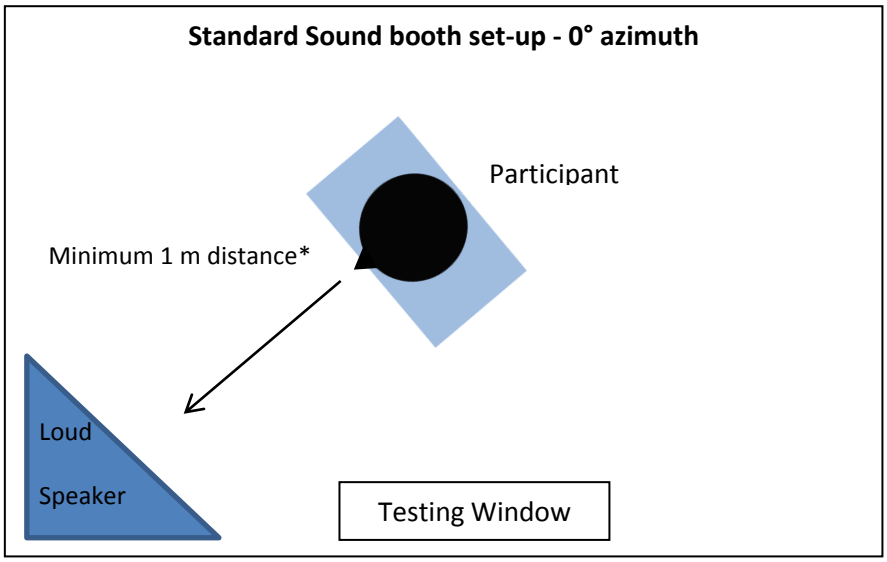
The calibration procedures outlined in this document enable the use of pre-determined stimulus-specific correction values in the scoring process. In the case where your calibration check provides values differing from those recommended, collection of site-specific normative data is recommended according to the steps below.

Collection of site-specific normative data:

Test ten normally hearing adults who have no concerns about their hearing, no history of hearing loss, and no history of significant noise exposure. Please ensure good reliability during the testing procedures.

1. Measure pure-tone thresholds (dB HL) using warble tones and record that data for each listener in Table 1. Ensure a normal hearing level for each listener.
2. Measure a speech sound detection threshold for each Ling sound and record the data for each listener in Table 2 (use the uncorrected dial levels). Calculate the mean threshold value per sound in the final row of Table 2.
3. Use Table 3 to calculate site-specific correction values. For example, the mean dial levels + site-specific corrections should equal 0 dB HL across all Ling sounds. Therefore, if the mean dial level for /m/ was equal to 10, a site-specific correction of -10 would be needed for the sound /m/. Correction values should be calculated per sound and used in place of pre-determined correction values (Form B).

Ling-6(HL): Standard Testing Set-up and Calibration Procedure



*head positioning consistent with the center-of-head reference used during standard sound field calibration

Sound Field Calibration Procedure:

Step 1: Route CD player output to external inputs of your audiometer.

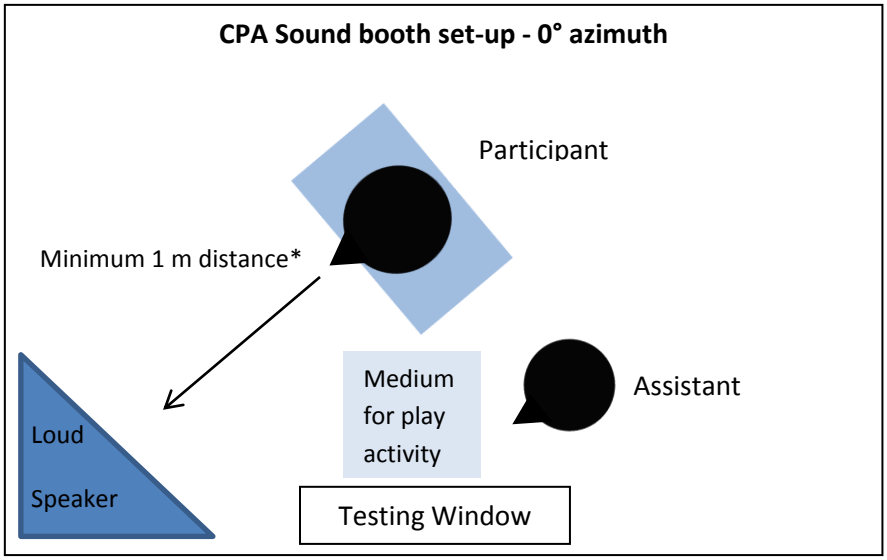
Step 2: Adjust the VU meter of your audiometer to a central position while playing the calibration tone provided on **Track 1** of the CD.

Step 3: Position a sound-level meter (SLM) at a **center-of-head reference facing 0° azimuth** to the loudspeaker. (Do not sit in chair when taking measurements)

Step 4: Set your audiometer dial reading to **65 dB HL**.

Step 5: Play **Track 2** (broadband noise) from the CD. The SLM reading for the 65 dB HL audiometer dial reading should equal **60 dB(A) ± 2.**

Ling-6(HL): Conditioned **Play Audiometry (CPA) Set-up and Calibration**



*head positioning consistent with the center-of-head reference used during standard sound field calibration

Sound Field Calibration Procedure:

Step 1: Route CD player output to external inputs of your audiometer.

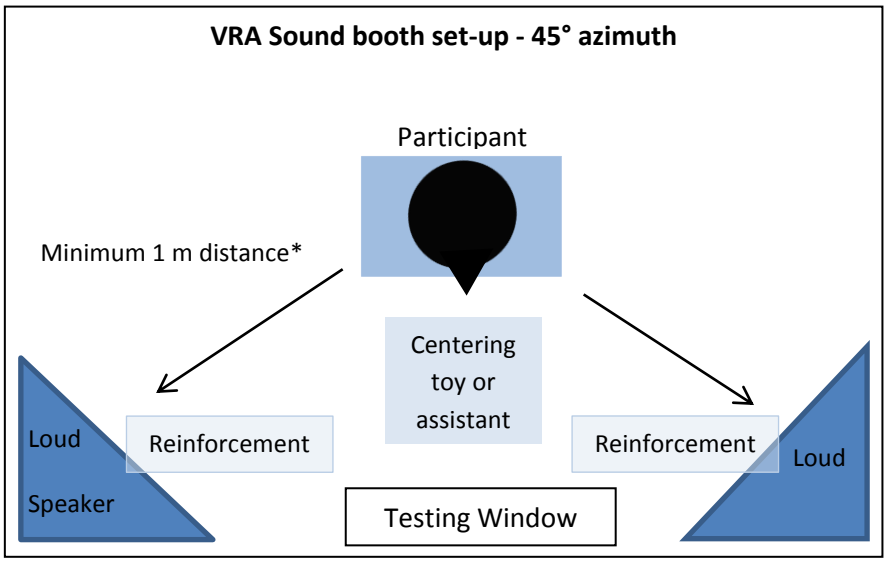
Step 2: Adjust the VU meter of your audiometer to a central position while playing the calibration tone provided on **Track 1** of the CD.

Step 3: Position a sound-level meter (SLM) at a **center-of-head reference facing 0° azimuth** to the loudspeaker. (Do not sit in chair when taking measurements)

Step 4: Set your audiometer dial reading to **65 dB HL**.

Step 5: Play **Track 2** (broadband noise) from the CD. The SLM reading for the 65 dB HL audiometer dial reading should equal **60 dB(A) ± 2.**

Ling-6(HL): Visual Reinforcement Audiometry (VRA) (Standard) Set-up and Calibration



*head positioning consistent with the center-of-head reference used during standard sound field calibration

Sound Field Calibration Procedure:

Step 1: Route CD player output to external inputs of your audiometer.

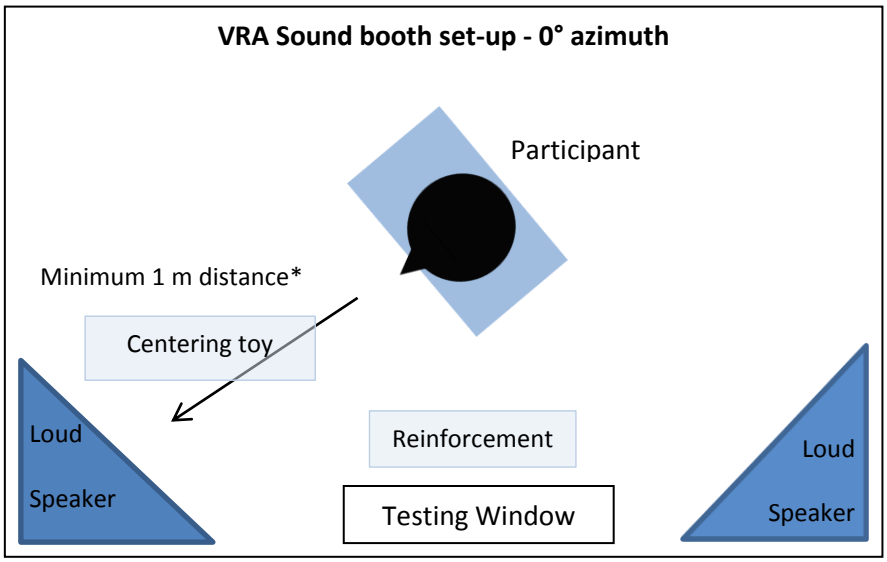
Step 2: Adjust the VU meter of your audiometer to a central position while playing the calibration tone provided on **Track 1** of the CD.

Step 3: Position a sound-level meter (SLM) at a **center-of-head reference facing 45° azimuth** to the loudspeaker that you will be using for test purposes. (Do not sit in chair when taking measurements)

Step 4: Set your audiometer dial reading to **65 dB HL**.

Step 5: Play **Track 2** (broadband noise) from the CD. The SLM reading for the 65 dB HL audiometer dial reading should equal **60 dB(A) ± 2.**

Ling-6(HL): Visual Reinforcement Audiometry (VRA) (Modified) Set-up and Calibration



*head positioning consistent with the center-of-head reference used during standard sound field calibration

Sound Field Calibration Procedure:

Step 1: Route CD player output to external inputs of your audiometer.

Step 2: Adjust the VU meter of your audiometer to a central position while playing the calibration tone provided on **Track 1** of the CD.

Step 3: Position a sound-level meter (SLM) at a **center-of-head reference facing 0° azimuth** to the loudspeaker. (Do not sit in chair when taking measurements)

Step 4: Set your audiometer dial reading to **65 dB HL**.

Step 5: Play Track 2 (broadband noise) from the CD. The SLM reading for the 65 dB HL audiometer dial reading should equal 60 dB(A) ± 2.

Testing Instructions

"You are going to hear six different speech sounds from the speaker in front of you. The sounds will get louder and quieter. It is your job to tell us whether or not you can hear them. If you hear a sound, raise your hand [substitute the use of a response button here]. Remember that some sounds will be too soft to hear, and everyone has trouble hearing them. Do you have any questions?"

Stimulus Presentation

Set the audiometer to an appropriate HL starting level; this starting level should correspond to a suprathreshold testing level, and will vary based on the listener's degree of hearing impairment. Set the audiometer such that the sound does not play until you press the signal presentation button (this is usually called "interrupt" or "reverse" depending on the model of audiometer). Choose a sound track (e.g., /m/) and play it from the CD. Bracket the thresholds using an established clinical threshold estimation procedure (i.e., modified Hughson-Westlake, or paired with VRA or CPA procedures as appropriate). Sounds can be presented once or twice, at each stage of the bracketing procedure.

Scoring Instructions

For each sound, bracket the listener's threshold. Note the dial level in the first row of the table of correction values (Form B). Corrected thresholds are obtained by adding the pre-determined correction values (or site-specific correction values) to the measured thresholds (according to dial level) to equal the corrected threshold in dB HL. These values can be plotted on a standard audiogram or on the scoring sheet provided (Form C). The shaded region on the Ling-6(HL) scoring sheet depicts the normal hearing range according to binaural sound field testing at zero degrees azimuth.

Form A: Collection of Site-Specific Normative Data (optional)

New data collection for 10 normal hearing adults:

1. Record pure-tone thresholds (dB HL) measured using warble tones in Table 1.
2. Record speech sounds detection thresholds according to the dial level in Table 2.

Table 1:

Audiogram	250	500	750	1000	1500	2000	3000	4000	6000	8000
Adult 1										
Adult 2										
Adult 3										
Adult 4										
Adult 5										
Adult 6										
Adult 7										
Adult 8										
Adult 9										
Adult 10										

Table 2:

Ling-6	m	u	a	i	ʃ	s
Adult 1						
Adult 2						
Adult 3						
Adult 4						
Adult 5						
Adult 6						
Adult 7						
Adult 8						

Adult 9						
Adult 10						
Mean						

Table 3:

Ling-6 (HL)	**m**	**u**	**a**	**i**	**ʃ**	**s**
Mean dial level						
	+	+	+	+	+	+
Site-specific correction						
	=	=	=	=	=	=
Corrected level (dBHL)	0	0	0	0	0	0

Form B: Table of Correction Values

Pre-determined correction values were devised from data provided by the University of Western Ontario for a group of normal hearing adult listeners.

	Condition 1						**Condition 2**					
Ling-6 (HL)	**m**	**u**	**a**	**i**	**ʃ**	**s**	**m**	**u**	**a**	**i**	**ʃ**	**s**
Measured dial level												
Correction **Note: replace with site-specific values if these have been developed**	-5	-5	-5	-5	-10	-15	-5	-5	-5	-5	-10	-15
Corrected level (dBHL)												

Form C: Ling-6(HL) Scoring Sheet

Name: _____ D.O.B:_____

Date: _____ Respondent: _____

Notes on testing conditions: _____

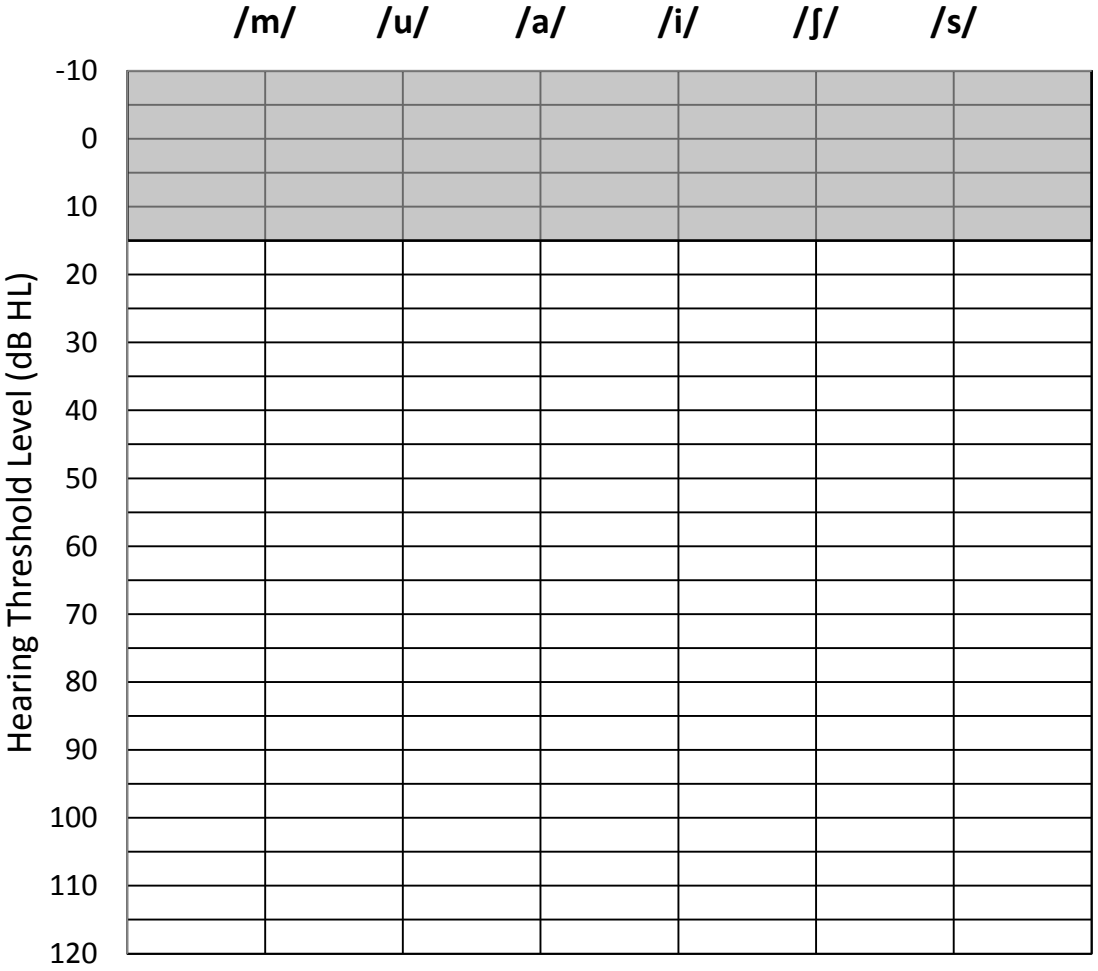
Test method: ❑ Standard ❑ CPA ❑ VRA

Reliability: ❑ Good ❑ Fair ❑ Poor

Test type: ❑ Aided ❑ Unaided ❑ CI ❑ Bone conducted ❑ BAHA

Masking (unaided ear)? ❑ n/a ❑ Yes ❑ No

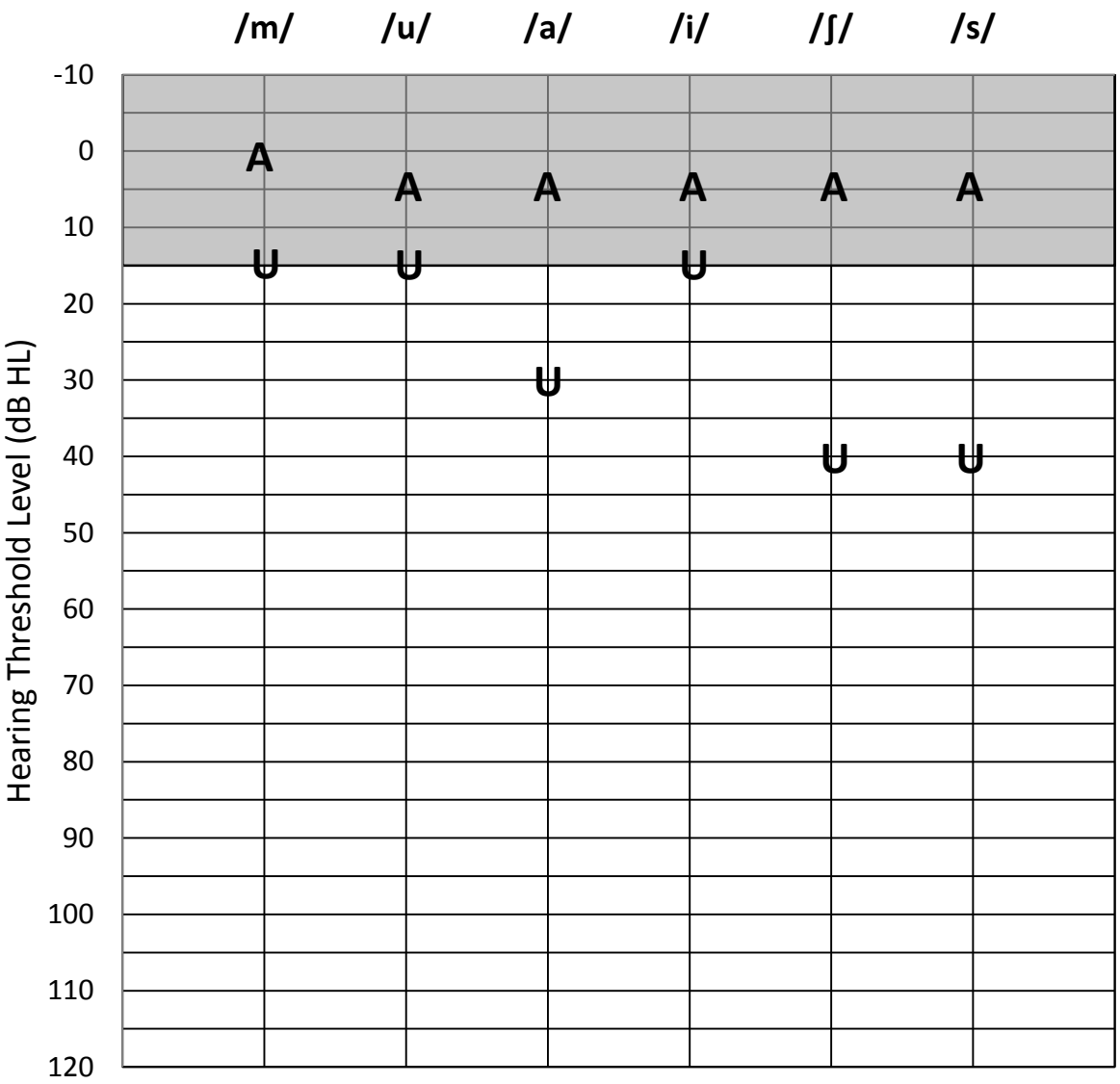
Plot the corrected threshold values in dB HL below:



Grey region shows the normal hearing range. Values assume binaural sound field testing at zero degrees azimuth.

Illustrative Case Example

This 8 year old child presents with sloping sensorineural hearing loss, ranging from a mild to moderate level of impairment. She is currently wearing conventional amplification fitted to DSL v5.0 prescriptive targets. Ling-6(HL) hearing threshold values were measured in two testing conditions: unaided (**U**) and aided (**A**) using standard set-up procedures. The corresponding corrected threshold values are plotted below.



Frequently Asked Questions

I am testing a child who wears a hearing aid only on one side. What should I do with the other ear during testing with the Ling-6(HL) sounds?

If the other side is non-responsive or has significantly poorer hearing than the aided side, you can proceed with measuring aided Ling-6(HL) thresholds as usual.

If the unaided side has normal hearing, or has significantly better hearing than the aided side, the listener may respond using that side when tested in sound field. Masking may be necessary to prevent the better ear from participating in the test. You may measure a masking plateau to demonstrate that each sound has been measured in the poorer ear. If you wish to measure benefit in a unilateral fitting, masking the better ear during both unaided and aided testing is recommended.

References

Glista, D., Scollie, S., Bagatto, M., Seewald, R., Parsa, V., & Johnson, A. (2009). Evaluation of nonlinear frequency compression: Clinical outcomes. *International Journal of Audiology, 48*(9), 632-644.

Ling, D. (1989). *Foundations of spoken language for hearing-impaired-children*. Washington DC: Alexander Graham Bell Association for the Deaf, Inc.

Scollie, S., Glista, D., Tenhaaf Le Quelenec, J., Dunn, A., Malandrino, A., & Folkheard, P. (in review). Stimuli and normative data for detection of Ling-6 sounds in Hearing Level.

Wolfe, J., John, A., Schafer, E., Nyffeler, M., Boretzki, M., Caraway, T., & Hudson, M. (2011). Long-term effects of non-linear frequency compression for children with moderate hearing loss. *International Journal of Audiology, 50*(6), 396-404.

Appendix

Comparable American National Standards Institutes and International Standards audiometric standards

	ANSI Standard	ISO Standard
Audiometer Calibration	S3.6-1996 Specifications for Audiometers	ISO 8253-3:2012 Acoustics — Audiometric test methods Part 3: Speech audiometry ISO 8253-2:2009 Acoustics = Audiometric test methods Part 2: Sound field audiometry with pure-tone and narrow-band test signals IEC 60645-2 (1993). Electroacoustics — Audiological equipment Part 2: Equipment for speech audiometry