Auditory Brain Stem Response IMPC_ABR_001

Purpose

Auditory brainstem response test determines hearing sensitivity and other physiological parameters using evoked potential recordings in anesthetized mice.

Ontological description: MP:0004738 - abnormal brainstem auditory evoked potential.

Experimental Design

- **Minimum number of animals :** 4 mutant animals of the same zygosity but of any sex
- **Age at test:** Week 14
- **Sex:** We do not expect the results of this test to show sexual dimorphism

Equipment

1.Audio signal generators, amplifiers and loudspeakers

2.Calibration equipment (microphone, etc)

3.EEG Needle electrodes

4.Biological amplifier & headstage

5.Data acquisition hardware

6.Software to control signal presentation and data acquisition

7.Data Analysis software/database application

8.Sound Attenuating chamber

9.Heating blanket

Procedure

1. Test mouse with click box. Is the Preyer Reflex present? Optional.
2. Anesthetize the mouse.
3. Place mouse on heating blanket in sound chamber and insert sub dermal needle electrodes; active electrode on vertex; reference electrode overlying left bulla; ground electrode overlying right bulla (See Figure 1).

4. Place mouse unrestrained in a prone position, nose forward, at the calibrated distance from the leading edge of the speaker to the mouse's interaural axis, on a thermostatically controlled blanket, inside a sound attenuating booth.
5. Record a click-evoked ABR (70dB SPL) to ensure a good ABR is present (in non-impaired mice). Optional.
6. ABRs are recorded to clicks (10µs duration, positive transient) presented from 0-85 dB SPL in 5dB steps, presented 256 times at 42.6/sec.
7. ABRs are recorded to the following frequencies and levels; 6kHz (0-85dB SPL), 12kHz (0-85dB SPL), 18kHz (0-85dB SPL), 24kHz (0-85dB SPL) and 30kHz (0-85dB SPL), presented in 5dB intervals. Tone pips are 5ms in duration, with a 1ms rise/fall time, presented 256 times at 42.6/sec (optional values). Tone stimuli are presented in decreasing frequency order for a particular sound level and from low to high stimulus level.
8. If deafness/hearing impairment is suspected for a particular mutant line (e.g. by elevated thresholds or absence of ABR waveforms at any stimulus level), all stimulus presentation levels should be, instrument permitting, extended to 95dB SPL.
9. Record a final click-evoked ABR (70dB SPL), to check for any deterioration of the click-evoked response during recordings. Optional.

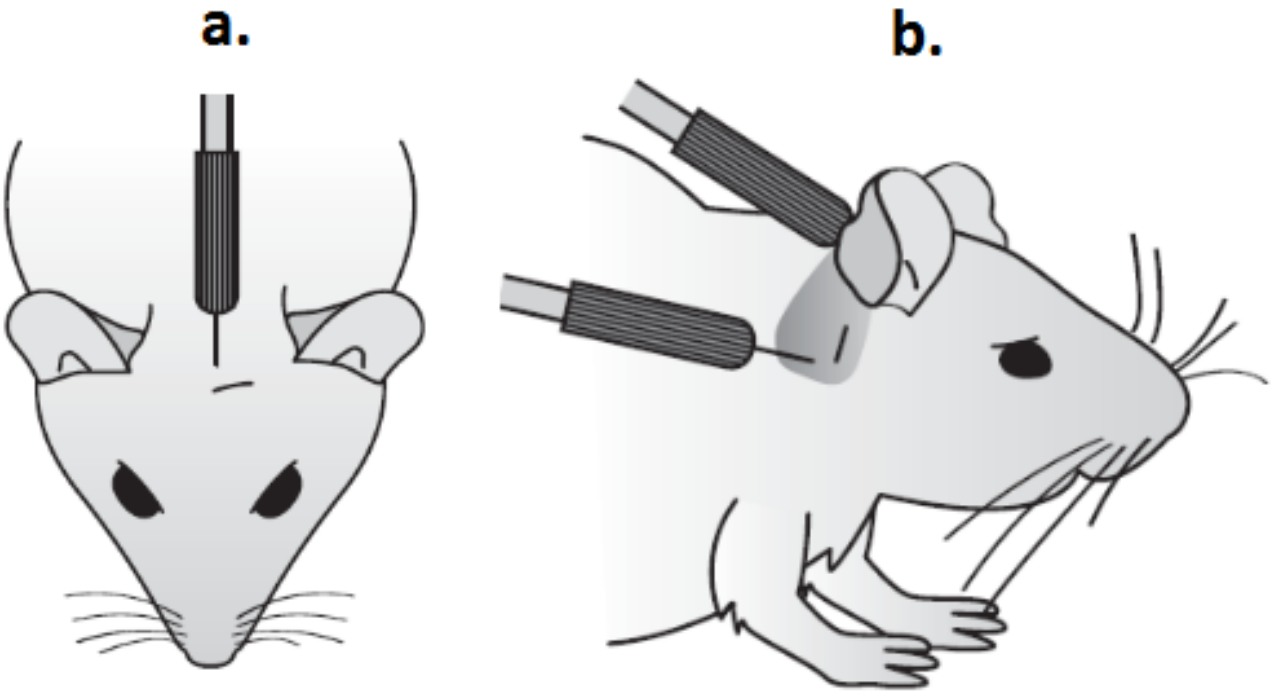

Figure 1. To indicate positioning of sub-dermal needle electrodes for ABR recording. a. Active electrode in position on the vertex. b. Reference/Earth electrode positioned behind the ear.

Notes

If other tests are being performed under the same anesthetic regime, it is advised to perform the ABR first.

Raw data is uploaded to a database for display of waveforms and threshold allocation for each mouse (See Figure 2) and for display of plots of threshold for each frequency and click for each individual mouse and for each mutant line.

Detailed methodology can be found in Ingham, Pearson & Steel (2011) Current Protocols in Mouse Biology 1: 279-287.

The information about the date of the experiment, that is the date when the measurement is performed, is an important parameter which is to be submitted in the Experiment xml file (dateOfExperiment="2013-02-28").

Threshold Analysis (Phase 1). Thresholds are defined for each mouse and for each stimulus as the lowest intensity at which any part of the ABR waveform can be visually recognized by a trained operator. Calls are made on data from each line based on a set of rules. For each stimulus, over 60% or more of thresholds must fall outside of a 95% reference range (based on a large population of wildtype data) for that result to be classed as significant. A manual call option can be used by an experienced operator to include or not include a particular dataset, to override the rules-based call. A line is called as significant if any one of the click or frequency stimuli are called as significant.

Waveform analysis (Phase 2 - Optional). Overlay plots of click-evoked waveforms recorded at threshold +20dB and +50dB are viewed by experienced operators to determine if there are any obvious abnormalities in waveform shape.

Input-Output functions (Phase 3 - Optional). If the waveforms appear abnormal, plots of P1-N1 and P3-N3 amplitude, P1, N1, P3 and N3 latency and P1-P3 and N1-N3 interpeak interval for click stimuli against dB sensation level (dB above click threshold) are generated. For each parameter, if 60% or more of values fall outside a 95% reference range for 5 adjacent sensation levels, the parameter is called as significant. Again, a manual override option allows operator discretion in judging calls made by these fixed rules.

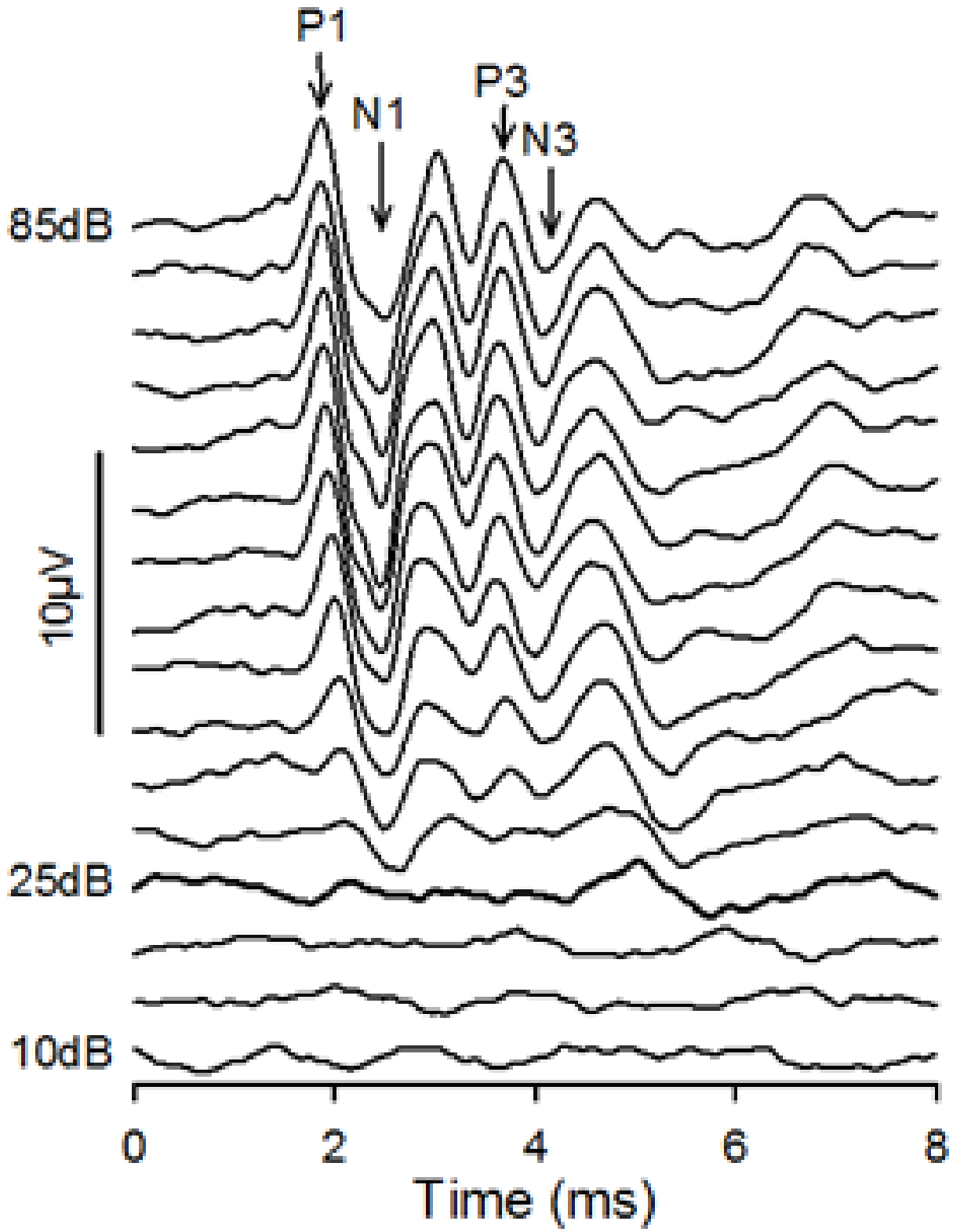
P1
N1
P3
N3
85dB
25dB
10dB
10μV
0
2
4
6
8
Time (ms)

Figure 2. Click-evoked ABRs. In this case, threshold was determined to be 25dB SPL. The points on the waveform defined as P1, N1, P3 and N3 are indicated by arrows.

Data QC

1. **Sound System Calibration.** Optionally a calibration curve is recorded at the start of each experimental day. These can be used to check the consistency of the sound delivery system over time. Once or twice annually, the calibration of this microphone used for sound delivery should be checked using a Bruel & Kjaer PULSE system with a Type 4231 calibrator calibrator or other equivalent calibration instrumentation suitable for use with high frequencies.
2. **Test Click ABR.** Optionally the amplitude of the responses to the 70dB SPL click recorded at the start and end of the protocol can be compared to ensure there is no significant physiological deterioration of response.
3. **ABR thresholds.** Thresholds are allocated to each stimulus for each mouse by a trained & skilled operator recording the data. A random selection of thresholds is checked by a second skilled operator.

Metadata Parameters examples

Metadata	**Example**
Range of test stimuli used	The array of stimuli used to record ABRs. E.g. Click; 6,12,18,24,30kHz.
Range of stimulus levels used - Click	The range of stimulus levels used for click. E.g. 0-85dB SPL.

Range of stimulus levels used - 6kHz	The range of stimulus levels used for tone at 6kHz. E.g. 20-85dB SPL.
Range of stimulus levels used - 12kHz	The range of stimulus levels used for tone at 12kHz. E.g. 0-85dB SPL.
Range of stimulus levels used - 18kHz	The range of stimulus levels used for tone at 18kHz. E.g. 0-85dB SPL.
Range of stimulus levels used - 24kHz	The range of stimulus levels used for tone at 24kHz. E.g. 10-85dB SPL.
Range of stimulus levels used - 30kHz	The range of stimulus levels used for tone at 30kHz. E.g. 20-85dB SPL.
Extension of stimulus levels	The extension of the stimulus level used if any, due to suspected hearing impairment. E.g. 95 dB SPL.
Stimulus level step size	The frequency increase step size of the stimulus level. E.g. 5dB.
Tone Pip Duration	The duration of the tone pip. E.g. 5ms.
Tone Pip rise/fall	The rise/fall time of the tone pip. E.g. 1ms.
Repetition Rate	The rate of the stimuli presentation. E.g. 42.6/s
Number averages	The number of times the tone is presented. E.g. 256.
Recording Environment	The mouse environment during the recording. E.g. In sound attenuating booth on thermo-statically controlled heating pad (@ 37°C).
Anesthetic agent 1	Anesthetic 1 used to sedate the mouse. E.g. Ketamine.
Anesthetic agent 2	Anesthetic 2 used to sedate the mouse. E.g. Xylazine.

Anesthetic agent 1 dosage	Dosage for anesthetic 1. E.g. 1mg/g.
Anesthetic agent 2 dosage	Dosage for anesthetic 2. E.g. 0.01mg/g
Anesthetic administration route	The route of anesthetic administration. E.g. Intraperitoneal (i.p.).
Date of Test	Date of test execution.
Time of injection	Time of anesthetic injection.
Equipment ID	When more than 1 machine having same model and manufacturer is used, e.g. machine 1, machine 2, machine Minnie, machine Mickey Mouse, etc.
Equipment manufacturer	Manufacturer of the equipment. E.g. TDT (Tucker Davis Technologies).
Equipment model	Model of the equipment. E.g. RP2.1 based system, RA4PA Medusa Preamplifier.
Software	The software used to control signal presentation and data acquisition. E.g. Sanger bespoke averager software.
Experimenter ID	An ID of any format to be used coherently both inside the same procedure and for all procedures. E.g. Harw_001, or 1/2/3.
Date equipment last calibrated	Most recent date in which the equipment (or any part of) used in the procedure was subject to a calibration event.

Parameters and Metadata

Body weight IMPC_ABR_001_001 | v1.4

simpleParameter

Req. Analysis: false **Req. Upload:** false **Is Annotated:** false

Unit Measured: g

Description: body_weight

Click-evoked ABR threshold IMPC_ABR_002_001 | v1.3

simpleParameter

Req. Analysis: false **Req. Upload:** false **Is Annotated:** true

Unit Measured: dB SPL

Description: click_evoked_abr_threshold

Click-evoked ABR waveforms (numerical format) IMPC_ABR_003_001 | v1.0

seriesParameter

Req. Analysis: false **Req. Upload:** false **Is Annotated:** false

Description: click_evoked_abr_waveforms_numerical_format_

6kHz-evoked ABR Threshold IMPC_ABR_004_001 | v1.3

simpleParameter

Req. Analysis: false **Req. Upload:** true **Is Annotated:** true

Unit Measured: dB SPL

Description: 6khz_evoked_abr_threshold

6kHz-evoked ABR waveforms (numerical format) IMPC_ABR_005_001 | v1.0

seriesParameter

Req. Analysis: false **Req. Upload:** false **Is Annotated:** false

Description: 6khz_evoked_abr_waveforms_numerical_format_

12kHz-evoked ABR Threshold IMPC_ABR_006_001 | v1.3

simpleParameter

Req. Analysis: false **Req. Upload:** true **Is Annotated:** true

Unit Measured: dB SPL

Description: 12khz_evoked_abr_threshold

12kHz-evoked ABR waveforms (numerical format) IMPC_ABR_007_001 | v1.0

seriesParameter

Req. Analysis: false **Req. Upload:** false **Is Annotated:** false

Description: 12khz_evoked_abr_waveforms_numerical_format_

18kHz-evoked ABR Threshold IMPC_ABR_008_001 | v1.3

simpleParameter

Req. Analysis: false **Req. Upload:** true **Is Annotated:** true

Unit Measured: dB SPL

Description: 18khz_evoked_abr_threshold

18kHz-evoked ABR waveforms (numerical format) IMPC_ABR_009_001 | v1.0

seriesParameter

Req. Analysis: false **Req. Upload:** false **Is Annotated:** false

Description: 18khz_evoked_abr_waveforms_numerical_format_

24kHz-evoked ABR Threshold IMPC_ABR_010_001 | v1.3

simpleParameter

Req. Analysis: false **Req. Upload:** true **Is Annotated:** true

Unit Measured: dB SPL

Description: 24khz_evoked_abr_threshold

24kHz-evoked ABR waveforms (numerical format) IMPC_ABR_011_001 | v1.0

seriesParameter

Req. Analysis: false **Req. Upload:** false **Is Annotated:** false

Description: 24khz_evoked_abr_waveforms_numerical_format_

30kHz-evoked ABR Threshold IMPC_ABR_012_001 | v1.3

simpleParameter

Req. Analysis: false **Req. Upload:** true **Is Annotated:** true

Unit Measured: dB SPL

Description: 30khz_evoked_abr_threshold

30kHz-evoked ABR waveforms (numerical format) IMPC_ABR_013_001 | v1.0

seriesParameter

Req. Analysis: false **Req. Upload:** false **Is Annotated:** false

Description: 30khz_evoked_abr_waveforms_numerical_format_

Click-evoked + 6 to 30kHz tone waveforms (pdf format) IMPC_ABR_014_001 | v1.2

mediaParameter

Req. Analysis: false **Req. Upload:** false **Is Annotated:** false

Description: click_evoked_6_to_30khz_tone_waveforms_pdf_format_

Audiograms IMPC_ABR_015_001 | v1.2

seriesParameter

Req. Analysis: false **Req. Upload:** false **Is Annotated:** false

Unit Measured: dB SPL

Description: audiograms

Preyer Reflex IMPC_ABR_016_001 | v1.0

simpleParameter

Req. Analysis: false **Req. Upload:** false **Is Annotated:** true

Description: preyer_reflex

Options: Yes, No,

Click +20dB waveforms (numerical format) IMPC_ABR_017_001 | v1.0

seriesParameter

Req. Analysis: false **Req. Upload:** false **Is Annotated:** false

Description: click_20db_waveforms_numerical_format_

Click +50dB waveforms (numerical format) IMPC_ABR_018_001 | v1.0

seriesParameter

Req. Analysis: false **Req. Upload:** false **Is Annotated:** false

Description: click_50db_waveforms_numerical_format_

Click +20dB+50dB waveforms (pdf format) IMPC_ABR_019_001 | v1.2

mediaParameter

Req. Analysis: false **Req. Upload:** false **Is Annotated:** false

Description: click_20db_50db_waveforms_pdf_format_

P1-N1 amplitude (at each stimulus level) IMPC_ABR_020_001 | v1.1

seriesParameter

Req. Analysis: false **Req. Upload:** false **Is Annotated:** false

Unit Measured: uV

Description: p1_n1_amplitude_at_each_stimulus_level_

P3-N3 amplitude (at each stimulus level) IMPC_ABR_021_001 | v1.1

seriesParameter

Req. Analysis: false **Req. Upload:** false **Is Annotated:** false

Unit Measured: uV

Description: p3_n3_amplitude_at_each_stimulus_level_

P1 Latency (at each stimulus level) IMPC_ABR_022_001 | v1.1

seriesParameter

Req. Analysis: false **Req. Upload:** false **Is Annotated:** false

Unit Measured: ms

Description: p1_latency_at_each_stimulus_level_

N1 Latency (at each stimulus level) IMPC_ABR_023_001 | v1.1

seriesParameter

Req. Analysis: false **Req. Upload:** false **Is Annotated:** false

Unit Measured: ms

Description: n1_latency_at_each_stimulus_level_

P3 Latency (at each stimulus level) IMPC_ABR_024_001 | v1.1

seriesParameter

Req. Analysis: false **Req. Upload:** false **Is Annotated:** false

Unit Measured: ms

Description: p3_latency_at_each_stimulus_level_

N3 Latency (at each stimulus level) IMPC_ABR_025_001 | v1.1

seriesParameter

Req. Analysis: false **Req. Upload:** false **Is Annotated:** false

Unit Measured: ms

Description: n3_latency_at_each_stimulus_level_

P1-P3 Interval (at each stimulus level) IMPC_ABR_026_001 | v1.1

seriesParameter

Req. Analysis: false **Req. Upload:** false **Is Annotated:** false

Unit Measured: ms

Description: p1_p3_interval_at_each_stimulus_level_

N1-N3 Interval (at each stimulus level) IMPC_ABR_027_001 | v1.1

seriesParameter

Req. Analysis: false **Req. Upload:** false **Is Annotated:** false

Unit Measured: ms

Description: n1_n3_interval_at_each_stimulus_level_

Range of test stimuli used IMPC_ABR_028_001 | v1.1

procedureMetadata

Req. Analysis: true **Req. Upload:** false **Is Annotated:** false

Description: range_of_test_stimuli_used

Options: Click, 6,12,18,24,30 kHz, Tone,6,12,18,24,30 kHz, Click,6,12,18,24,30 kHz,

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Range of stimulus levels used - Click IMPC_ABR_029_001 | v1.1

procedureMetadata

Req. Analysis: false **Req. Upload:** false **Is Annotated:** false

Unit Measured: dB SPL

Description: range_of_stimulus_levels_used_click

Options: 0-85, 0-75, 0-88,

Range of stimulus levels used - 6kHz IMPC_ABR_030_001 | v1.1

procedureMetadata

Req. Analysis: false **Req. Upload:** false **Is Annotated:** false

Unit Measured: dB SPL

Description: range_of_stimulus_levels_used_6khz

Options: 20-85, 0-85, 0-95, 20-90, 0-88,

Range of stimulus levels used - 12kHz IMPC_ABR_031_001 | v1.1

procedureMetadata

Req. Analysis: false **Req. Upload:** false **Is Annotated:** false

Unit Measured: dB SPL

Description: range_of_stimulus_levels_used_12khz

Options: 0-85, 20-85, 0-95, 0-90,

Range of stimulus levels used - 18kHz IMPC_ABR_032_001 | v1.1

procedureMetadata

Req. Analysis: false **Req. Upload:** false **Is Annotated:** false

Unit Measured: dB SPL

Description: range_of_stimulus_levels_used_18khz

Options: 0-85, 20-85, 0-95, 0-90, 0-80,

Range of stimulus levels used - 24kHz IMPC_ABR_033_001 | v1.1

procedureMetadata

Req. Analysis: false **Req. Upload:** false **Is Annotated:** false

Unit Measured: dB SPL

Description: range_of_stimulus_levels_used_24khz

Options: 0-85, 20-85, 0-95, 10-90, 0-90,

Range of stimulus levels used - 30kHz IMPC_ABR_034_001 | v1.1

procedureMetadata

Req. Analysis: false **Req. Upload:** false **Is Annotated:** false

Unit Measured: dB SPL

Description: range_of_stimulus_levels_used_30khz

Options: 0-85, 20-85, 0-95, 20-90,

Extension of stimulus levels IMPC_ABR_035_001 | v1.0

procedureMetadata

Req. Analysis: true **Req. Upload:** false **Is Annotated:** false

Unit Measured: dB SPL

Description: extension_of_stimulus_levels

Options: 95, 90,

Stimulus level step size IMPC_ABR_036_001 | v1.1

procedureMetadata

Req. Analysis: false **Req. Upload:** false **Is Annotated:** false

Unit Measured: dB SPL

Description: stimulus_level_step_size

Options: 5,

Tone Pip Duration IMPC_ABR_037_001 | v1.0

procedureMetadata

Req. Analysis: true **Req. Upload:** true **Is Annotated:** false

Unit Measured: ms

Description: tone_pip_duration

Options: 5, 7, 1,

Tone Pip rise/fall IMPC_ABR_038_001 | v1.0

procedureMetadata

Req. Analysis: true **Req. Upload:** true **Is Annotated:** false

Unit Measured: ms

Description: tone_pip_rise_fall

Options: 1, 0.2,

Repetition Rate IMPC_ABR_039_001 | v1.0

procedureMetadata

Req. Analysis: true **Req. Upload:** true **Is Annotated:** false

Unit Measured: s^-1

Description: repetition_rate

Options: 42.6, 20, 10,

Number averages IMPC_ABR_040_001 | v1.0

procedureMetadata

Req. Analysis: true **Req. Upload:** true **Is Annotated:** false

Description: number_averages

Options: 256, 300, 512, 542,

Recording Environment IMPC_ABR_041_001 | v1.0

procedureMetadata

Req. Analysis: true **Req. Upload:** true **Is Annotated:** false

Description: recording_environment

Options: In sound attenuating booth on thermo-statically controlled heating pad (@ 37°C), Sound proof room, Sound proof booth, Med Associates PVC sound attenuated chamber,

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Anesthetic agent 1 IMPC_ABR_042_001 | v1.0

procedureMetadata

Req. Analysis: true **Req. Upload:** true **Is Annotated:** false

Description: anesthetic_agent_1

Options: Ketamine, Avertin, Pentobarbital,

Anesthetic agent 2 IMPC_ABR_043_001 | v1.0

procedureMetadata

Req. Analysis: true **Req. Upload:** true **Is Annotated:** false

Description: anesthetic_agent_2

Options: Xylazine, Avertin, None,

Anesthetic agent 1 dosage IMPC_ABR_044_001 | v1.0

procedureMetadata

Req. Analysis: true **Req. Upload:** true **Is Annotated:** false

Unit Measured: mg/g

Description: anesthetic_agent_1_dosage

Options: 1, 0.1, 0.8, 0.11, 0.011, 10, 0.2, 0.08,

Anesthetic agent 2 dosage IMPC_ABR_045_001 | v1.0

procedureMetadata

Req. Analysis: true **Req. Upload:** true **Is Annotated:** false

Unit Measured: mg/g

Description: anesthetic_agent_2_dosage

Options: 0.01, 0.016, 0.1, 1, 0.011, 0.02, 0,

Anesthetic administration route IMPC_ABR_046_001 | v1.1

procedureMetadata

Req. Analysis: false **Req. Upload:** true **Is Annotated:** false

Description: anesthetic_administration_route

Options: Intraperitoneal, Intramuscular, Subcutaneous,

Date of Test IMPC_ABR_047_001 | v1.1

procedureMetadata

Req. Analysis: false **Req. Upload:** true **Is Annotated:** false

Description: date_of_test

Time of injection IMPC_ABR_048_001 | v1.2

procedureMetadata

Req. Analysis: false **Req. Upload:** true **Is Annotated:** false

Description: time_of_injection

Equipment ID IMPC_ABR_049_001 | v1.0

procedureMetadata

Req. Analysis: false **Req. Upload:** true **Is Annotated:** false

Description: equipment_id

Equipment manufacturer IMPC_ABR_050_001 | v1.0

procedureMetadata

Req. Analysis: true **Req. Upload:** true **Is Annotated:** false

Description: equipment_manufacturer

Options: TDT (Tucker Davis Technologies), Intelligent Hearing Systems,

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Equipment model IMPC_ABR_051_001 | v1.0

procedureMetadata

Req. Analysis: true **Req. Upload:** true **Is Annotated:** false

Description: equipment_model

Options: RP2.1 based system, RA4PA Medusa Preamplifier, III, Smart EP,
RZ6-A-P1 bioacoustic system, RA4PA pre-amp / Digitizer, RA4LI headstage, MF1-S multi field speaker,
RZ6, Z-series 2-DSP bioacoustic system, Medusa PreAmp/Digitizer, Medusa LI headstage, Multi field speaker/Stereo,

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Software IMPC_ABR_052_001 | v1.0

procedureMetadata

Req. Analysis: false **Req. Upload:** true **Is Annotated:** false

Description: software

Options: Sanger bespoke averager software, Cambridge Electronic Design, HIS Smart, BioSigRZ, SmartEP, Tucker Davis Technologies,

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Experimenter ID IMPC_ABR_053_001 | v1.0

procedureMetadata

Req. Analysis: false **Req. Upload:** true **Is Annotated:** false

Description: experimenter_id

Date equipment last calibrated IMPC_ABR_054_001 | v1.2

procedureMetadata

Req. Analysis: false **Req. Upload:** false **Is Annotated:** false

Description: date_equipment_last_calibrated