If you are viewing this course as a recorded course after the live webinar, you can use the scroll bar at the bottom of the player window to pause and navigate the course.

This handout is for reference only. It may not include content identical to the powerpoint. Any links included in the handout are current at the time of the live webinar, but are subject to change and may not be current at a later date.
The use of cortical auditory evoked potentials (CAEPs) to assist in the management of infants with sensorineural hearing loss & auditory neuropathy spectrum disorder, presented in partnership with Seminars in Hearing

AudiologyOnline Webinar – 23rd March 2017
Presenters: Dr Kirsty Gardner-Berry & Ms Simone Punch

Learner Outcomes

As a result of this course, participants will be able to:
1. Describe both the benefits, limitations and complimentary nature of CAEP testing when used to help manage infants with hearing loss.
2. Describe the relationship between stimulus audibility and the likely presence of a cortical auditory evoked potential in infants with hearing loss.
3. Describe the clinical protocols implemented in Australian Hearing for the use of cortical auditory evoked potential testing for hearing aid fitting and evaluation in young children.
Overview

1. **Introduction**: Clinical need for objective tools to manage infants with hearing loss, and how CAEPs together with functional auditory evaluations can help meet this need (K. Gardner-Berry)

2. **Research**: Research findings on the use of CAEPs & functional auditory evaluations in infants with normal hearing, sensorineural hearing loss (SNHL), and auditory neuropathy spectrum disorder (ANSD) (K. Gardner-Berry)

3. **Clinical applications**: Clinical use & protocols in place for the use of CAEPs & functional auditory evaluations at Australian Hearing (S. Punch)

4. **Case studies**: Clinical case studies integrating CAEP & functional auditory evaluation results in infants with SNHL, ANSD, and referral for cochlear implantation (S. Punch & K. Gardner-Berry)

5. **Q&A**
1. **Introduction:** Clinical need for objective tools to manage infants with hearing loss, and how CAEPs together with functional auditory evaluations can help meet this need

(K. Gardner-Berry)
Impact of UNHS on audiological practice

Screening early  Diagnosing early  Fitting early  Validating the fitting early

Why choose CAEPs as a testing tool for infants with hearing loss?

**Existing option:**
Behavioral Observation Audiometry (BOA)

- Infant needs to be in a specific state for testing (ideally a light sleep).
- Presenting at specific stimulus intensity levels requires good clinician control & experience.
- Interpretation of the infant’s response is subjective, and responses from the infant can be very subtle.
- If a parent doesn’t agree with the clinician’s judgement that a response was present or absent the parent may lose confidence in the process.
- Infants can habituate to the stimuli more rapidly making repeat stimuli for confirmation of a response more challenging.

**New option:**
CAEPs

- Reliably present in awake infants.
- Can be elicited by a range of frequency-specific speech phonemes
- Stimuli can be longer in duration compared to ABR, which allows the hearing aid more time to react to the sound in a manner similar to what it does for an ongoing speech signal.
- Response is generated by cortical levels under the scalp, making them much larger in amplitude compared to ABR which is deep in the brainstem. This means fewer stimuli are needed before a response can be seen (very important when testing awake babies!).
- Response originates from neurons towards the end of the hearing pathway (i.e. beyond the cochlea, nerve & brainstem), & therefore closer to other brain centres where speech & language processing occurs.
What are Cortical auditory evoked potentials (CAEP)?

CAEPs are a series of waves recorded on the scalp that represent the summed neural activity in response to sound at the level of the auditory cortex.

**Adult CAEP**

**Infant CAEP**

Not yet developed mature P1 & N1

Maturational effects on CAEP waveform

How do we measure CAEPs?

Speech sounds
- 55 dB SPL
- 65 dB SPL
- 75 dB SPL

3 electrodes:
- Forehead
- Vertex
- Behind the ear

Free Field Speaker

HEARLab stimuli

<table>
<thead>
<tr>
<th>/m/</th>
<th>/f/</th>
<th>/t/</th>
<th>/s/</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Frequency</td>
<td>Mid Frequency</td>
<td>High Frequency</td>
<td>Very High Frequency</td>
</tr>
<tr>
<td>500Hz</td>
<td>1kHz</td>
<td>4kHz</td>
<td>6kHz</td>
</tr>
</tbody>
</table>

/m/ (30 ms)
/f/ (30 ms)
/t/ (20 ms)
/s/ (50 ms)
HEARLab demonstration video

Automated response detection:
- Hotelling’s $T^2$

Calculates the probability that a mean value of any linear combination of the 9 variables was significantly different from zero.

• Each response* is divided into 50 ms time bins (50 – 500 ms)
• The data points are averaged within each time bin to form 9 variables

* Each response
CAEPs – potential scenarios

Using a 65 dB SPL speech stimulus

**Scenario 1**
- Unaided CAEPs present.
- Test at 55 dB
- Hearing likely to be normal-mild

**Scenario 2**
- Unaided CAEPs absent.
- Aided CAEPs present.
- Hearing loss around moderate-severe
- Change/check something now
- Demonstrated aided benefit

**Scenario 3**
- Unaided CAEPs absent.
- Aided CAEPs absent.

OR
- Under fitted
- Poor speech discrimination (ANSD)
- Or
- One of 20% with absent CAEP

How can a CAEP be present when the ABR is absent in ANSD?

Stimulus rate for ABR is fast
Stimulus rate for CAEP is slow

Hair cells, synapse or nerve fibers may struggle to keep up with the stimulus

ABR is not clearly visible unless the hair cells & nerves are firing rapidly & consistently

Stimulus rate for CAEP is slow

NAL

Continued
Tests of functional auditory behavior
- Parent Evaluation of Aural/oral performance in Children with Hearing loss (PEACH)

So we only need to test CAEPs to verify the fitting right?

- Observational tests of functional auditory behavior are still very important as part of an infant test battery. Like everything in audiology, we want to make sure all test results are consistent with one another.
- Parents have a greater opportunity to observe their baby during the day in different behavioral states and environments.
- Engaging parents in the observational process can empower them rather than make them feel like they only have a passive role in the assessment & management process.
- Validated tests such as the PEACH allow us to compare the progress of each infant against normative data.

Parents’ Evaluation of Aural/Oral performance of Children (PEACH)

Potential scenarios

- Increasing PEACH score
- Mean
- +2 SD
- -2 SD
- Concerns arise if the score is >2 SD below the normative mean for age

Increasing age

4 months 8 months Age (months) Increasing age

Significant delay

Progress

Plateau
Relationship between CAEPs & PEACH

N=12 infants with ANSD
- Measured CAEPs to 3 stimuli in each ear separately
- Measured PEACH score

Examples

1. /m/ 44 Present 46 Absent
   /l/ 61 Absent 61 Absent
   /t/ 55 Absent 57 Present

2. /m/ 33 Absent 35 Absent
   /l/ 36 Absent 48 Present
   /t/ 33 Present 42 Absent

3. /m/ 40 Present 45 Present
   /l/ 40 Present 50 Present
   /t/ 30 Absent 36 Present

4. /m/ 17 Present 16 Absent
   /l/ 41 Absent 34 Absent
   /t/ 24 Absent 24 Present

5. /m/ 7 Absent 27 Absent
   /l/ 25 Absent 29 Absent
   /t/ 25 Absent 11 Absent

N=12 infants


Relationship between CAEPs & PEACH

Infants with a greater proportion of CAEPs present had higher PEACH scores.

Increasing CAEP score

Increasing PEACH score

Normative mean

+2 SD

-2 SD

% PEACH score

Summed left & right aided CAEP score /6

Increasing CAEP score
Detection rates of CAEPs at different sensation levels in infants with sensory/neural hearing loss and ANSD

Objectives:
1. To investigate the relationship with stimulus audibility & CAEP detection rate in infants with sensory/neural hearing loss (SNHL) and ANSD.

Design:
- Retrospective HEARLab data collected from Australian Hearing centres & Children’s Hearing Foundation in Taiwan.
- Hearing aid coupler gain used at the time of CAEP testing & subsequent VROA thresholds were used to calculate stimulus audibility.
Results
- CAEP detection rate at different sensation levels

- The CAEP detection rate increased with increasing stimulus sensation level for infants with SNHL & ANSD.
- There was no difference in detection rates between infants with SNHL & ANSD.
- The results differed from the earlier study published in IJA which showed a decrease in the detection rate at higher sensation levels in infants with ANSD (not using HEARlab).

Considerations: Even at sensation levels of >20 dB
CAEPs were not present in approximately 25% of cases.

i.e. an absent CAEP does not mean the stimulus is inaudible to the infant.
Overall Conclusions & Considerations (both studies)

1. CAEP detection rates increase with increasing audibility.
   - The use of CAEPs in the infant test battery provides us with the opportunity to identify infants with ANSD who require aiding and those who may only need to be monitored.

2. An absent CAEP does not mean the stimulus is inaudible.
   - Clinicians need to be cautious when interpreting absent CAEP results before deciding whether to increase the gain of hearing aids.
   - This emphasizes the need to use a test battery, which should include feedback regarding parental observations.

3. Clinical applications: Clinical use & protocols in place for the use of CAEPs & functional auditory evaluations at Australian Hearing (S. Punch)

Semin Hear 2016; 37(01): 036-052
DOI: 10.1055/s-0035-1570331

Thieme Medical Publishers 333 Seventh Avenue, New York, NY 10001, USA

Clinical Experience of Using Cortical Auditory Evoked Potentials in the Treatment of Infant Hearing Loss in Australia

Simone Punch1, Bram Van Duij3, Alison King3, Lyndal Carter2, Wendy Pearce2

1Australian Hearing, Sydney, Australia
2The HRECig CRC, Melbourne, Australia
3National Acoustic Laboratories, Sydney, Australia

Simone Punch
Context

Australian Hearing is funded by the Australian Government to provide Hearing Services to children with permanent hearing loss. There is no fee for our services, except for a small annual maintenance fee if hearing aids are fitted.

- Australian Hearing provides services over 23,000 children with hearing aids and cochlear Implants across Australia
- Australia has had universal coverage of Newborn Hearing Screening (UNHS) since the beginning of 2011
- Initially rolled out 16 specialised Infant Fitting Centres to provide services to babies identified via UNHS- now services in >35 centres across Australia
- Cortical Auditory Evoked Potential (CAEP) assessment (using HEARLab™) introduced into the infant clinical pathways during 2011.
- Since this time we have reviewed the clinical application of CAEPs within our infant fitting program

Australian Hearing clinical pathway for infant aided evaluation

- Sensorineural Hearing Loss
  - Fitting aids based upon ABR, ASSR.
  - Match targets for all 3 input levels
- Auditory Neuropathy Spectrum
  - Fitting for ANSD based on behavioral tests, PEACH and unaided CAEPs.
- Follow up
  - Aided Corticals + aid adjust if req'd
  - PEACH initiated at first or second follow up when appropriate
Infant hearing aid fitting

ABR HTLs (dBnHL) – eHL correction (dB) = Estimated Behavioral Threshold (dBHL)

Australian Hearing chooses to use the below correction factors based on Small & Stapells 2016

<table>
<thead>
<tr>
<th>Frequency (Hz)</th>
<th>ABR</th>
<th>AC</th>
<th>BC</th>
<th>AC</th>
<th>BC</th>
<th>AC</th>
<th>BC</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>35</td>
<td>20</td>
<td>35</td>
<td>N/A</td>
<td>30</td>
<td>30</td>
<td>25</td>
</tr>
<tr>
<td>1000</td>
<td>-5</td>
<td>10</td>
<td>N/A</td>
<td>5</td>
<td>5</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>2000</td>
<td>10</td>
<td>10</td>
<td>N/A</td>
<td>10</td>
<td>N/A</td>
<td>10</td>
<td>N/A</td>
</tr>
<tr>
<td>4000</td>
<td>35</td>
<td>N/A</td>
<td>30</td>
<td>N/A</td>
<td>40</td>
<td>40</td>
<td>30</td>
</tr>
</tbody>
</table>

Where a range of ABR correction and normal maximum values and eHL corrections was provided, we have chosen to follow the corrections recommended by the British Columbia Early Hearing Program (BCEHP, 2015).

Aid adjustment per speech stimulus.
Clinical Review - 2013

• The Clinical review looked at babies born in 2012- in this year 386 infants were fitted with their first with hearing aids before 6 months of age.

• Files of all children fitted between October and December 2012 & aged< 6mths at time of fitting
  • 4 clients excluded - no data available

• Sample size = 83
  • 5 (6%) Aboriginal/Torres Strait Islander
  • 32 (39%) 3FAHL<45dBHL in the better ear
  • 64 (77%) Bilaterally aided

• Most children had completed their initial fitting program at time of review

55 (66%) Infants tested using HEARLab during initial fitting program

<table>
<thead>
<tr>
<th>Interval between hearing aid fitting and first CAEP assessment</th>
<th>No of Children</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weeks from fitting date</td>
<td></td>
</tr>
<tr>
<td>Pre-amplification</td>
<td>2</td>
</tr>
<tr>
<td>0-4 weeks</td>
<td>18</td>
</tr>
<tr>
<td>5-8 weeks</td>
<td>15</td>
</tr>
<tr>
<td>9-12 weeks</td>
<td>4</td>
</tr>
<tr>
<td>12+ weeks</td>
<td>11</td>
</tr>
</tbody>
</table>
Reason for no CAEP’s (n=28, 34%)

- Mild/Unilateral Loss, 15
- Couldn’t complete test, 3
- Did not attend, 4
- Test equipment not available, 3
- OME, 3
- Family priorities/complex needs, 2
- No reason given, 1
- OME, 3

How often were CAEPs used?

Number of times children tested

<table>
<thead>
<tr>
<th>Number of times tested</th>
<th>Number of children</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>38</td>
</tr>
<tr>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>3+</td>
<td>8</td>
</tr>
</tbody>
</table>
Conclusions from clinical review

- The majority of children were able to be assessed in their initial fitting program
- Most commonly done within 8 weeks of fitting
- Main reason for non-assessment related to mild/unilateral hearing loss
- 70% of children only needed one CAEP assessment in initial program
- When children are able to condition for behavioural assessment this becomes the focus.
- CAEPs can be effectively integrated into the infant fitting program

 Pediatric Audiologist Survey

- 32 of 48 Infant fitting audiologists responded
- Indicated that CAEP testing influenced their approach to rehabilitation, was well received by parents, and that they were satisfied by the technique.
- Some audiologists reported, however, that parents were frustrated with inconclusive results, or results that did not match expectations.
  - This frustration can be addressed by appropriate explanation of the limitations of the testing, and clear explanation of the next steps, e.g. CAEP retesting or a different assessment technique. Conversely, clinical experience shows as well that parents experience similar frustration when behavioural test results are inconclusive.
4. Case studies: Clinical case studies integrating CAEP & functional auditory evaluation results in infants with SNHL, ANSD, and referral for cochlear implantation (S. Punch & K. Gardner-Berry)

Case study 1: Cochlear Implant candidacy
Case study 2: Ensuring audibility
Case study 3: Decision to fit hearing aids in the case of ANSD

<table>
<thead>
<tr>
<th>Frequency (in Hz)</th>
<th>500</th>
<th>1000</th>
<th>2000</th>
<th>4000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right</td>
<td>&gt;95</td>
<td>&gt;95</td>
<td>&gt;95</td>
<td>&gt;95</td>
</tr>
<tr>
<td>Left</td>
<td>&gt;95</td>
<td>&gt;95</td>
<td>&gt;95</td>
<td>&gt;95</td>
</tr>
</tbody>
</table>

Note: For conversion purposes, >95 dB nHL is taken equal to 100 dB nHL, a lower limit of the estimated hearing loss.

Resulting estimated behavioural audiogram (in dB HL)

<table>
<thead>
<tr>
<th>Frequency (in Hz)</th>
<th>500</th>
<th>1000</th>
<th>2000</th>
<th>4000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right</td>
<td>90</td>
<td>95</td>
<td>100</td>
<td>105</td>
</tr>
<tr>
<td>Left</td>
<td>90</td>
<td>95</td>
<td>100</td>
<td>105</td>
</tr>
</tbody>
</table>

Note: Using dB nHL to dB HL correction at the time of CAEP testing were derived from Vander Werff et al. 2009

The infant was fitted with hearing aids at 6 weeks of age based on the estimated behavioural audiogram.
Case study 1: Cochlear Implant candidacy

Absent responses to speech stimuli /m/, /g/ and /t/ at 65 and 75 dB SPL via a loudspeaker when bilaterally aided. Statistical p-values for every speech sound are provided (p ≤ 0.05 indicates a high likelihood of a CAEP being present).

No p values of <0.05 obtained = no CAEP response detected

<table>
<thead>
<tr>
<th></th>
<th>/m/</th>
<th>/g/</th>
<th>/t/</th>
</tr>
</thead>
<tbody>
<tr>
<td>75 dB SPL</td>
<td>0.268</td>
<td>0.779</td>
<td>0.360</td>
</tr>
<tr>
<td>65 dB SPL</td>
<td>0.609</td>
<td>0.704</td>
<td>0.687</td>
</tr>
</tbody>
</table>

Responses to speech stimuli /m/, /g/ and /t/ at 65 and 55 dB SPL via freefield loudspeaker when bilaterally aided - Statistical p-values for the aided 3 speech sounds at 2 stimulus levels.

<table>
<thead>
<tr>
<th></th>
<th>/m/</th>
<th>/g/</th>
<th>/t/</th>
</tr>
</thead>
<tbody>
<tr>
<td>75 dB SPL</td>
<td>0.617</td>
<td>0.418</td>
<td>0.705</td>
</tr>
<tr>
<td>65 dB SPL</td>
<td>0.639</td>
<td>0.505</td>
<td>0.318</td>
</tr>
</tbody>
</table>

The child was reassessed at age 3mths

Estimated audiogram adjusted for CAEP results.

<table>
<thead>
<tr>
<th>Frequency [in Hz]</th>
<th>500</th>
<th>1000</th>
<th>2000</th>
<th>4000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right</td>
<td>105</td>
<td>110</td>
<td>115</td>
<td>220</td>
</tr>
<tr>
<td>Left</td>
<td>105</td>
<td>110</td>
<td>115</td>
<td>220</td>
</tr>
</tbody>
</table>

Hear the sounds you love
Case study 1: Cochlear Implant candidacy

Results were explained to the parents and CI agency referral was suggested as the next step in this child’s program management.

Reports were sent to the family’s early intervention service and CI centre.

The child went on to receive bilateral CIs at 5 months of age. The child’s parents emailed the audiologists to say:

“Thank you so much for the information you gave us on the previous testing as it helped us with our decision to proceed with the implants.”

Case study 2: Ensuring audibility

This child was referred to Australian Hearing via the UNHS program. Diagnostic ABR results were used to estimate a bilateral mild sloping to moderately severe sensorineural hearing loss.

The child was fitted with bilateral hearing aids at 5 weeks of age based on the estimated hearing thresholds.

**Auditory brainstem response (ABR) testing results at diagnosis (in dB nHL).**

<table>
<thead>
<tr>
<th>Frequency (in Hz)</th>
<th>500</th>
<th>1000</th>
<th>2000</th>
<th>4000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right</td>
<td>40</td>
<td>DNT</td>
<td>60</td>
<td>70</td>
</tr>
<tr>
<td>Left</td>
<td>40</td>
<td>DNT</td>
<td>70</td>
<td>80</td>
</tr>
</tbody>
</table>

Note: DNT= Did not test, thresholds at 1 kHz are interpolated from the hls at 0.5 & 2 kHz.

**Resulting estimated behavioural audiogram (in dB HL)**

Note: Using $dB$ nHL to $dB$ HL correction, derived from Vander Werff et al. 39.

<table>
<thead>
<tr>
<th>Frequency (Hz)</th>
<th>500</th>
<th>1000</th>
<th>2000</th>
<th>4000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right</td>
<td>30</td>
<td>45</td>
<td>60</td>
<td>75</td>
</tr>
<tr>
<td>Left</td>
<td>30</td>
<td>50</td>
<td>70</td>
<td>85</td>
</tr>
</tbody>
</table>
Case study 2: Ensuring audibility

First CAEPs: Present responses to speech stimuli /m/, /ɡ/ and /t/ at 65 dB SPL, & to /t/ stimulus at 55 dB SPL via a loudspeaker when bilaterally aided.

<table>
<thead>
<tr>
<th></th>
<th>/m/</th>
<th>/ɡ/</th>
<th>/t/</th>
</tr>
</thead>
<tbody>
<tr>
<td>55dB SPL</td>
<td>0.265</td>
<td>0.342</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>65dB SPL</td>
<td>0.050</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Statistical p-values for each speech sound (those in bold indicate p ≤ 0.05).

Red = /m/
Green = /ɡ/
Blue = /t/
Case study 2: Ensuring audibility

Second visit: Present responses to speech stimuli /m/ /g/ and /t/

Statistical p-values for the 3 aided speech sounds at 2 stimulus levels.

<table>
<thead>
<tr>
<th></th>
<th>/m/</th>
<th>/g/</th>
<th>/t/</th>
</tr>
</thead>
<tbody>
<tr>
<td>65 dB SPL</td>
<td>0.007</td>
<td>0.014</td>
<td>0.005</td>
</tr>
<tr>
<td>55 dB SPL</td>
<td>0.301</td>
<td>0.014</td>
<td>0.001</td>
</tr>
</tbody>
</table>

The parents were reassured about appropriateness of hearing aid settings and a resulting email was sent by the mother to the audiologists where she commented: “We feel very relieved, as our faith has been restored in the hearing aids as a result of what we discovered from the results.”
Case study 3: Decision to fit hearing aids in the case of ANSD

- This child was referred to Australian Hearing via the UNHS program.
- Diagnostic audiology assessment showed clear cochlear microphonics on reversal of click stimulus polarity during ABR, and distortion product otoacoustic emissions (DPOAEs) were present in both ears, indicating ANSD.

### Statistical p-values for the 3 aided speech sounds at 2 stimulus levels.

<table>
<thead>
<tr>
<th></th>
<th>/m/</th>
<th>/g/</th>
<th>/t/</th>
</tr>
</thead>
<tbody>
<tr>
<td>65 dB SPL</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>55 dB SPL</td>
<td>0.116</td>
<td>0.016</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>
Case study 3: Decision to fit hearing aids in the case of ANSD

Latest audiogram obtained using play audiometry at the age of 2 years and 10 months (incomplete as testing had to be discontinued due to child’s attention).

Case study 3: Decision to fit hearing aids in the case of ANSD

Parents reported no hearing difficulties

Monitoring continued via functional questionnaires, speech testing when appropriate, and behavioral hearing assessment.

The family were advised to consider the use of a wireless remote microphone system if the child showed hearing difficulty in noise at a later stage.

CAEP testing was useful in confirming the parents’ initial observations of responses to soft sounds and in supporting the decision not to proceed with hearing aid fitting.
Summary

• Clinical protocols for Australian Hearing’s use of CAEPs in infant fitting programs have been outlined

• Findings from a clinical review and Audiologist surveys indicate that CAEPs can be effectively integrated into infant fitting programs and provide valuable information where behavioral testing is unreliable or impossible.

• The three case studies highlighted four main situations where CAEP testing can be useful, more specifically to evaluate hearing aid fittings, indicate unaided audibility in ANSD cases, provide additional objective information when deciding on CI candidacy, and assist with parent counselling.

Clinical Verification still ongoing

• Questions requiring formal research verification still remain, for example:
  – To what extent does fine-tuning of a hearing aid fitting using the Australian Hearing clinical CAEP protocol result in a significant increase of CAEP presence at the second assessment?
  – Does CAEP assessment contribute to a hearing aid fitting which is significantly closer to hearing aid target fitting than without?
  – Does CAEP assessment result in a significantly earlier decision to proceed with cochlear implantation?

Questions & Answers

Seminars in Hearing – special issue
“The use of cortical auditory evoked potentials in diagnosis & treatment of hearing disorders”
Vol. 37, No. 1, February 2016

SemHear 2016; 37(01): 053-061
DOI: 10.1055/s-0035-1570330

Thieme Medical Publishers 333 Seventh Avenue, New York, NY 10001, USA.
Detection Rates of Cortical Auditory Evoked Potentials at Different Sensation Levels in Infants with Sensory/Neural Hearing Loss and Auditory Neuropathy Spectrum Disorder

Kirsty Gardner-Berry1, Hsiiwen Changi, Teresa Y. C. Chinór2, Sanna Hau1

1National Acoustic Laboratories, Melbourne, Australia
2Department of Audiology and Speech Language Pathology, Macquarie Medical College, Taiwan
SemHear 2016; 37(01): 036-052
DOI: 10.1055/s-0035-1570331

Thieme Medical Publishers 333 Seventh Avenue, New York, NY 10001, USA.
Clinical Experience of Using Cortical Auditory Evoked Potentials in the Treatment of Infant Hearing Loss in Australia

Simone Pinnun, Bram Van Duijn2,3, Alison King1, Lyndal Carter4, Wendy Pearcie5

1Australian Hearing, Sydney, Australia
2The VERTigo CRC, Melbourne, Australia
3National Acoustic Laboratories, Sydney, Australia

CONTINUED