Aided corticals: bridging the gap between early hearing aid fitting and behavioural assessment
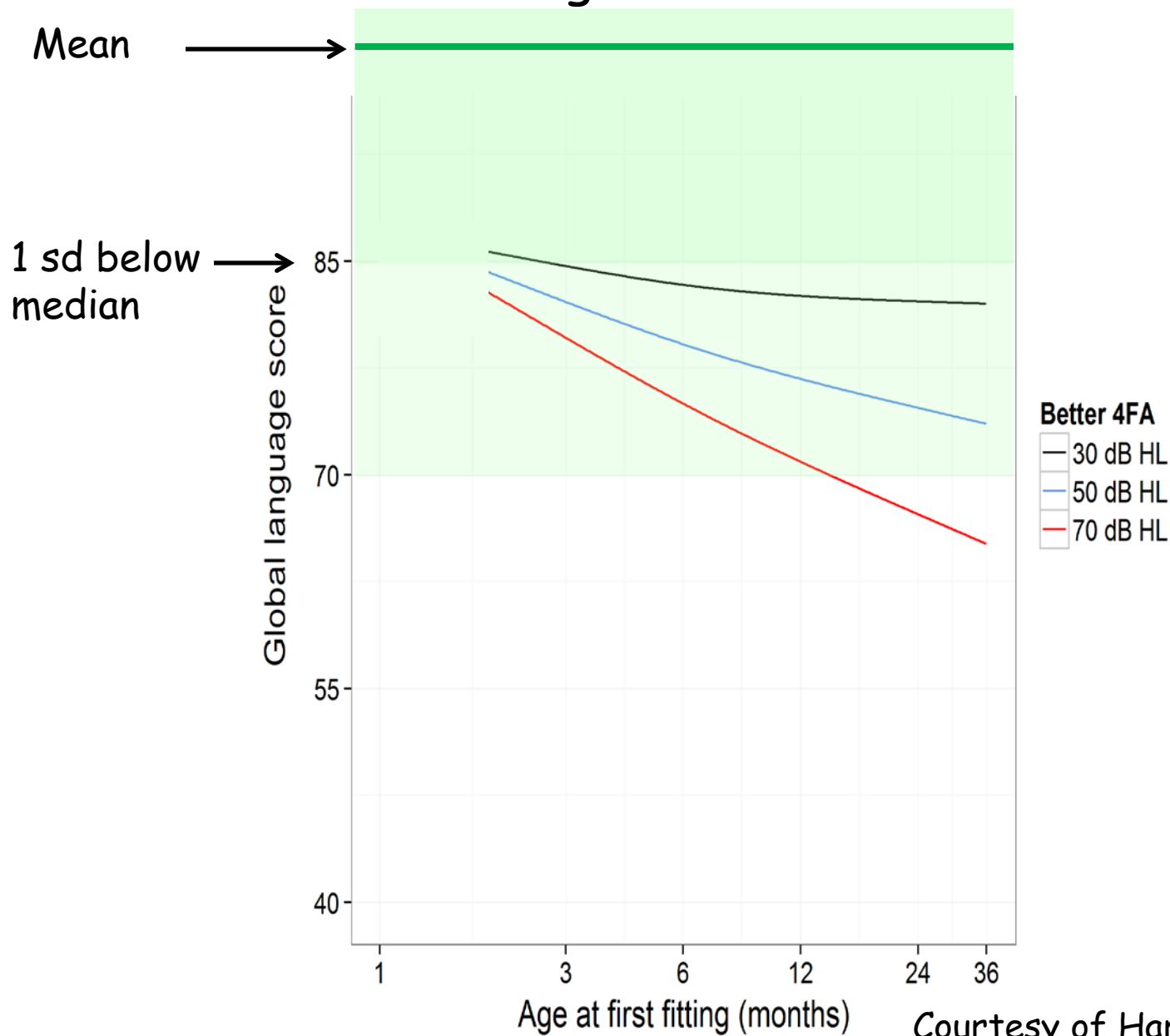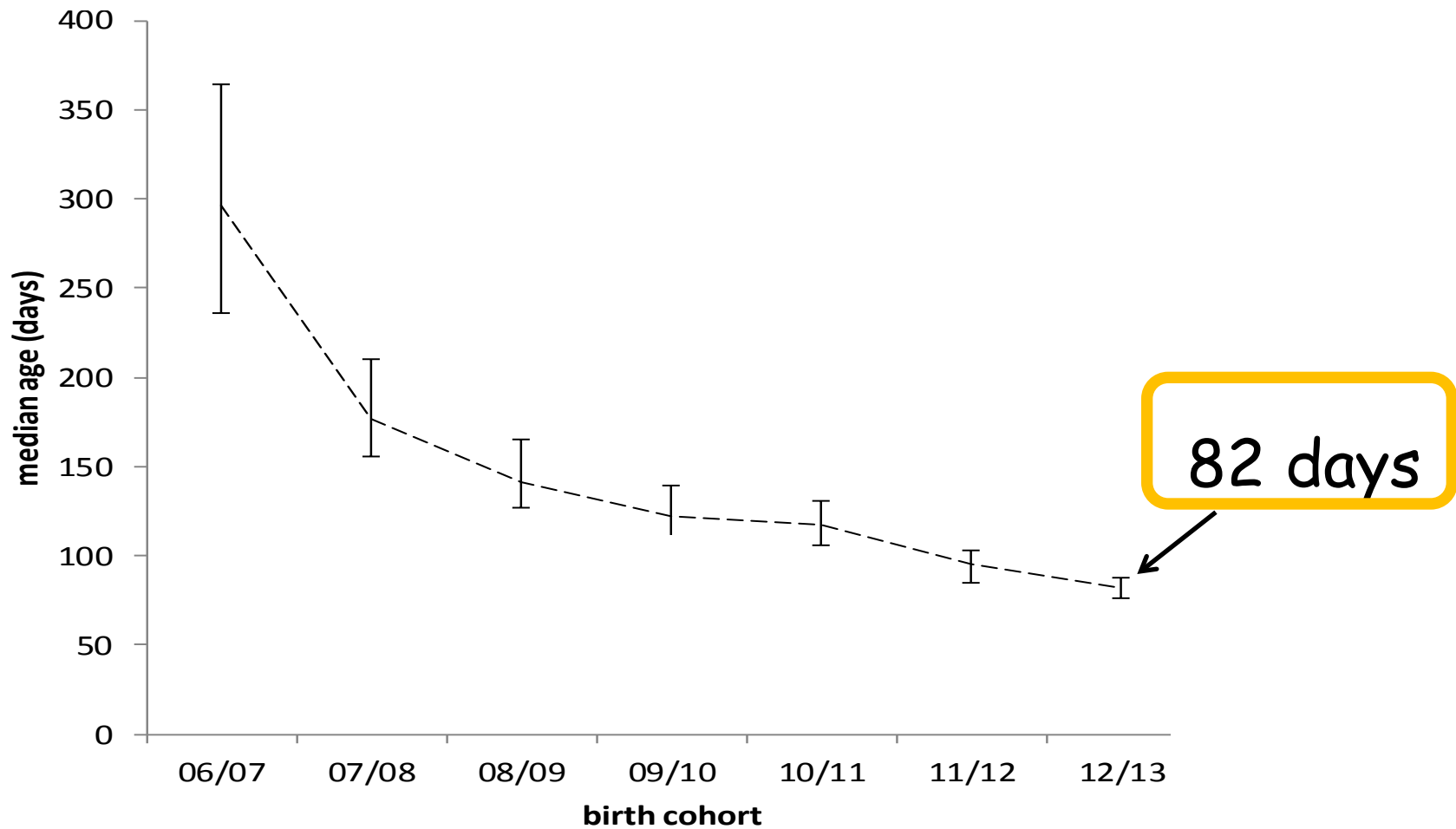
Kevin J Munro

MANCHESTER 1824

The University of Manchester

Central Manchester University Hospitals **NHS**
NHS Foundation Trust

Manchester Academic Health Science Centre

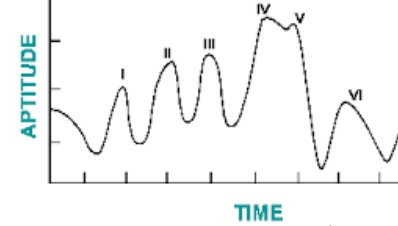# Language outcomes at age 5 years – hearing aid children

Courtesy of Harvey Dillon, May 2014

AGE AT HEARING AID FITTING

(Wood et al, 2015)

Frequency-specific ABRs provide an accurate prediction of hearing thresholds but ……

- behavioural thresholds often deviate from predicted threshold by 10 dB, and occasionally by 20 dB (Stapells, 2011)

- in severe hearing loss, no ABR (Stelmachowicz, 2008)

- middle-ear disease and concomitant medical problems can complicate (Stelmachowicz, 2008)

- ABR typically absent in some populations e.g., auditory neuropathy (Roush et al, 2011)

Bridging the gap

Hearing aid fitting (e.g., 2-3 mths)

Behavioural assessment (e.g., 8-9 mths)

Wrexham, Wales

5
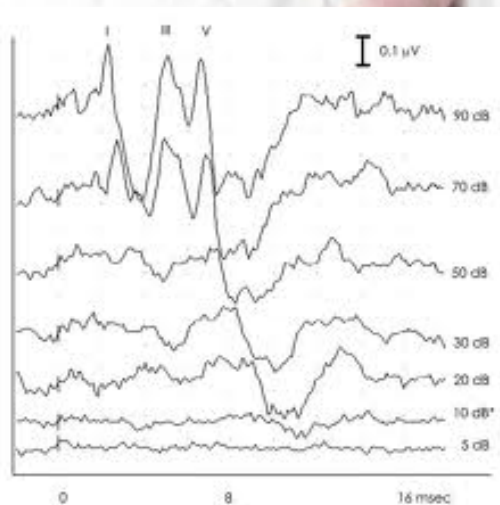
Improving the early care pathway

PARENTS:

- an aided response (of some sort) will provide reassurance

- motivate and encourage consistent hearing aid use

HEARING PROFESSIONAL:

- alert when current fitting may not be appropriate

- expedite alternative strategies e.g., frequency lowering devices, cochlear implant
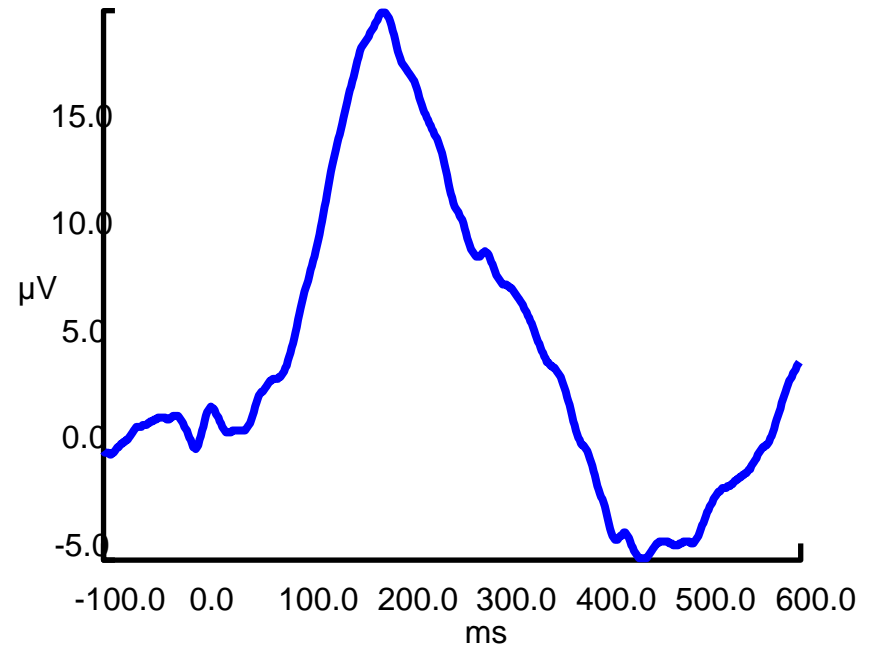
Supplementing existing measures

- Behavioural assessment

  — eye tracking??

- Physiological assessment

  — verify **physiological detection** e.g., using CAEPs

  — investigate **physiological discrimination** e.g., using acoustic-change-complex

Cortical Auditory Evoked Potential
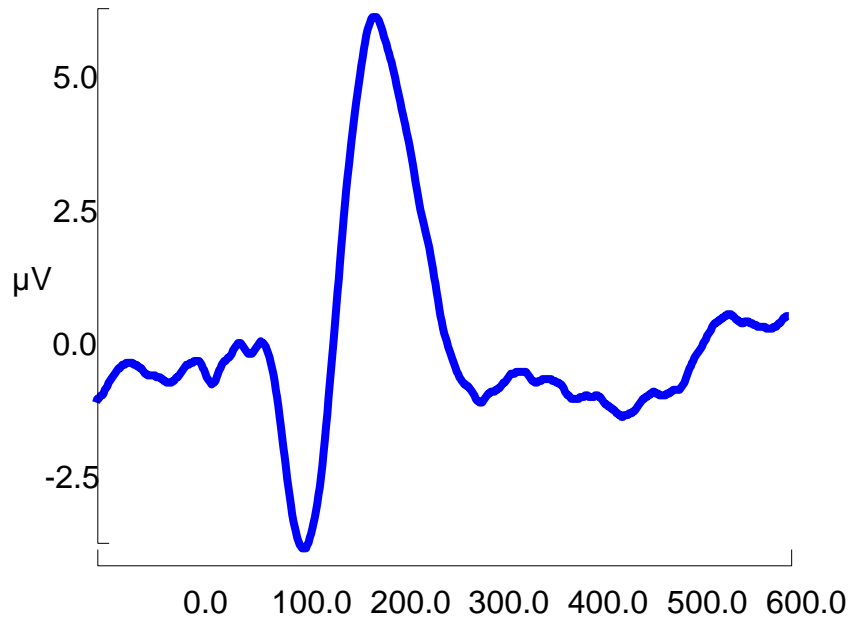
Using CAEPs to <u>SUPPLEMENT</u> existing measures
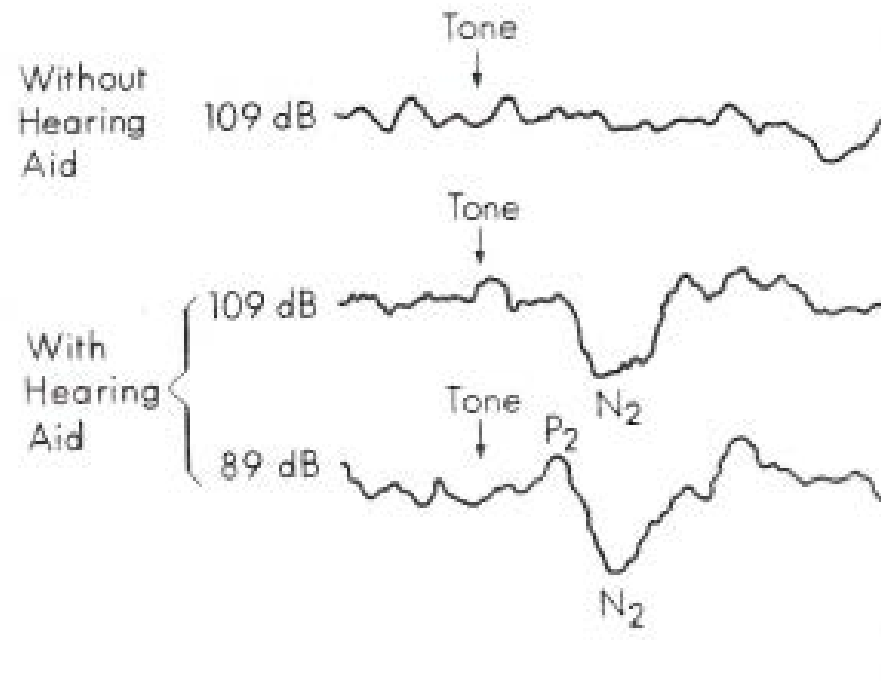
Verifying physiological response

Source: Fig 4 from Rapin & Graziani [1967]

Gravel et al. Case Studies, *Sem Hear*, 1989, 10, 272-87

CASE ONE (7 mths): SEVERE SNHL & HA
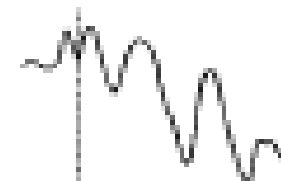
UNAIDED

AIDED

10 uV
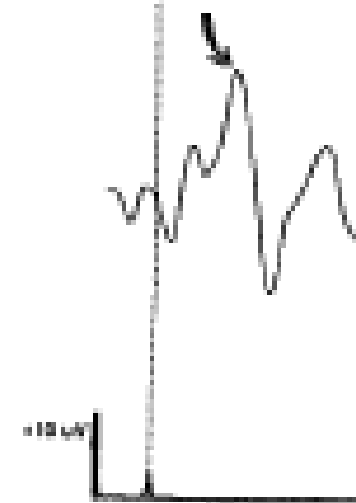
200 msec/div.
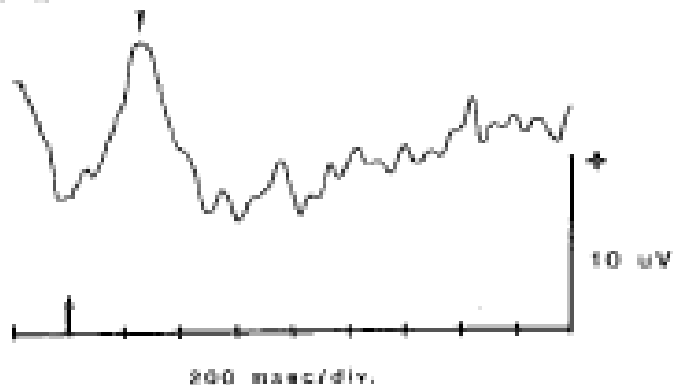
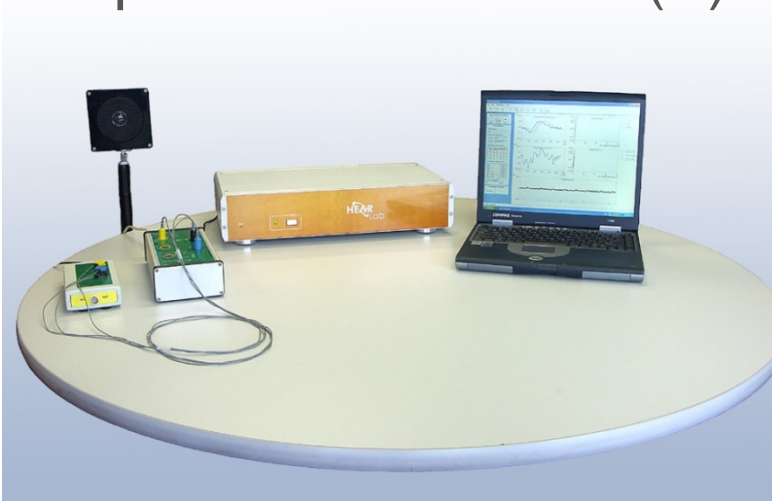**CASE TWO (11 mths): CHL & BCHA**

WITHOUT HEARING AIDS

WITH HEARING AIDS

1000 msec

NAL/Frye HEARLab

Examples of useful features: (i) residual noise (ii) automated response detection & (iii) sound field calibration procedure

Detection of CAEPs in children with HL

Chang et al (2012)

- n=18 (3-15 mths)

- NAL/Frye HEARLab

- Audibility estimated from behavioural data with **different** stimuli

- no CAEP detected 30-40%

Van Dun et al (2012)

- n=25 (8-30 mths)

- NAL/Frye HEARLab

- CAEP and VRA at same time in **older** children

- no CAEP detected 22-28%

Preliminary CAEP study in infants

- HearLab clinical system: three conversational level speech stimuli (/m/, /g/, /t/, short duration ~20-30 ms)
- 150 accepted runs recorded for each stimulus
- recording Cz/Fpz to mastoid
- Analysis
    i. clinically feasible (duration, completion rates)
    ii. response detection
    iii. acceptable to families

| Recruited	104 infants age 5-39 weeks (passed newborn screen and no family concern)
Analysis: Completion rates Test duration Acceptability CAEP analysis	sample size: 104 100 100 83 (tymp abnormal/not tested)

'TYPICAL' INFANT RESPONSE
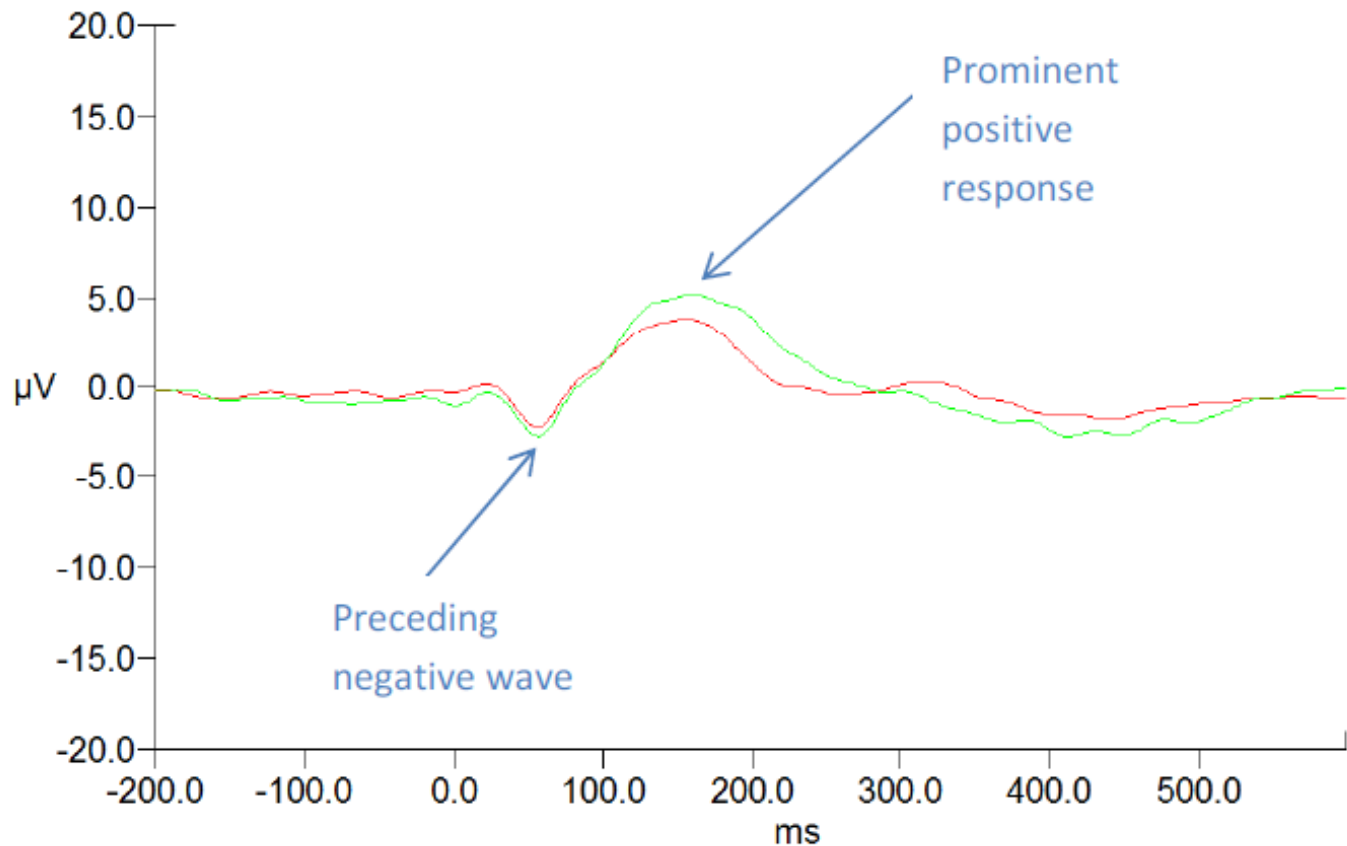
RESULTS

- Completion rate >95%

  - behaviour state vital: 4 restless or asleep

- Test duration 27 mins (range 17-89)

  - preparation time 13 mins

  - data acquisition 13 min

- Parents reported all aspects of test acceptable

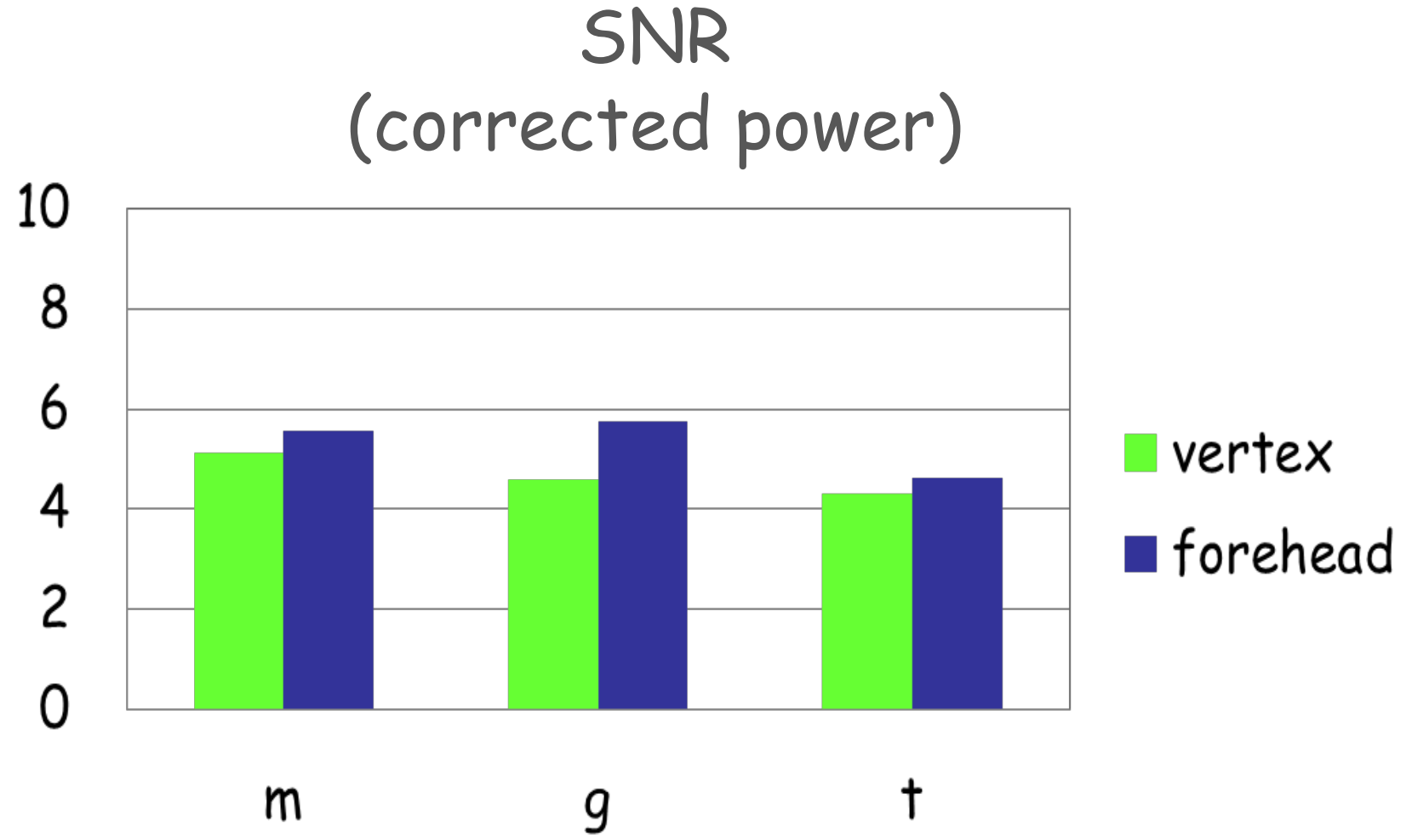- Interviews revealed positive experience
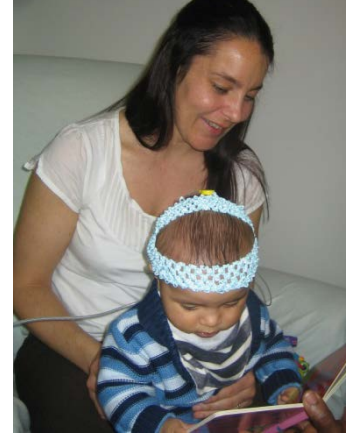
Objective response detection
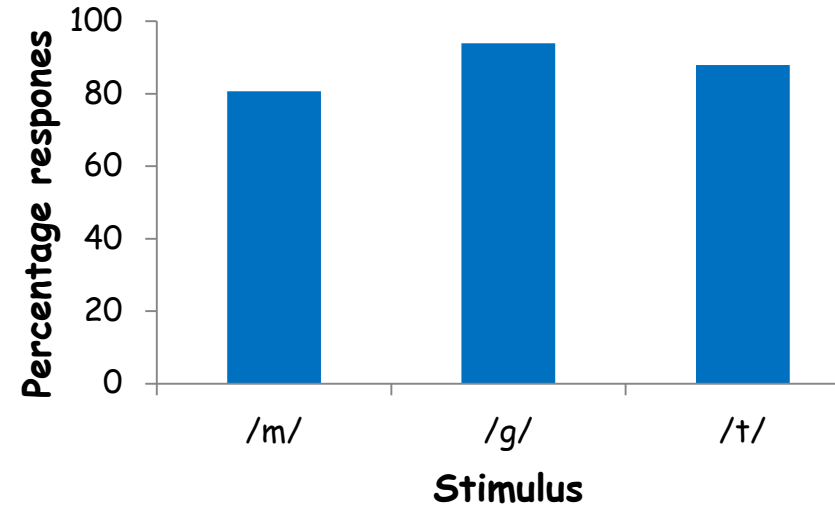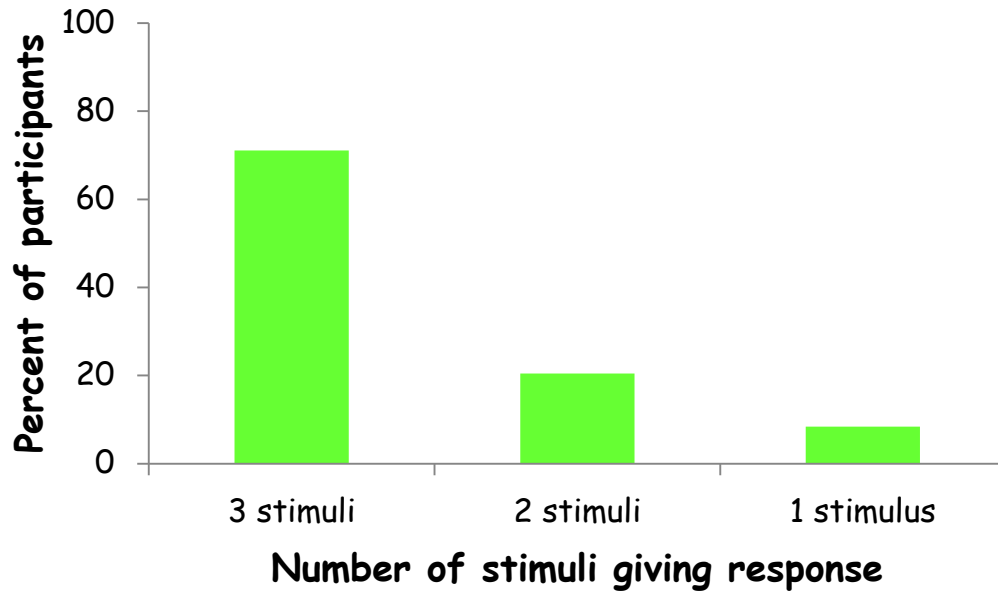
- All participants showed a response to at least one, and most to at least two, stimuli

No difference in SNR at vertex v high forehead

SNR
(corrected power)

Next steps: babies with hearing aids

- **Phase One: finalise methodology**
  - What are appropriate stimuli?
  - What is the optimal automated CAEP detection method?

- **Phase Two: defining performance characteristics**
  - In what proportion is a CAEP present when stimuli audible/inaudible?
  - In what proportion of absent cases is there a response on retest?

- **Phase Three: clinical feasibility & caregiver acceptability**
  - Feasibility measured in terms of completion rates and test time
  - Is the procedure acceptable to caregivers

Excitation patterns of CAEP stimuli
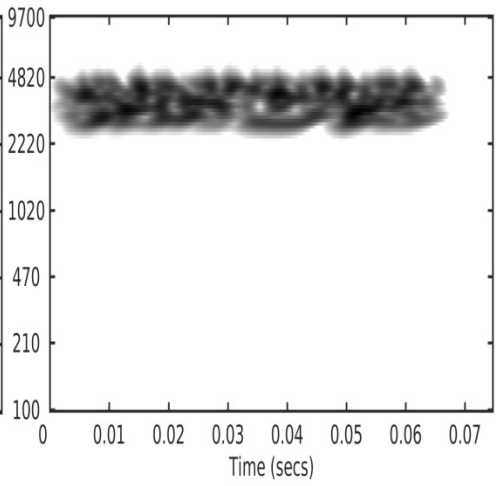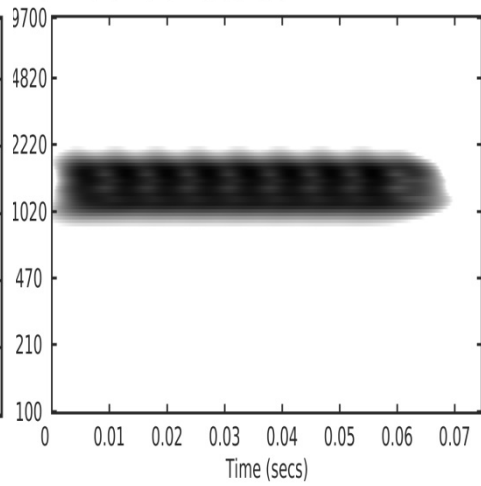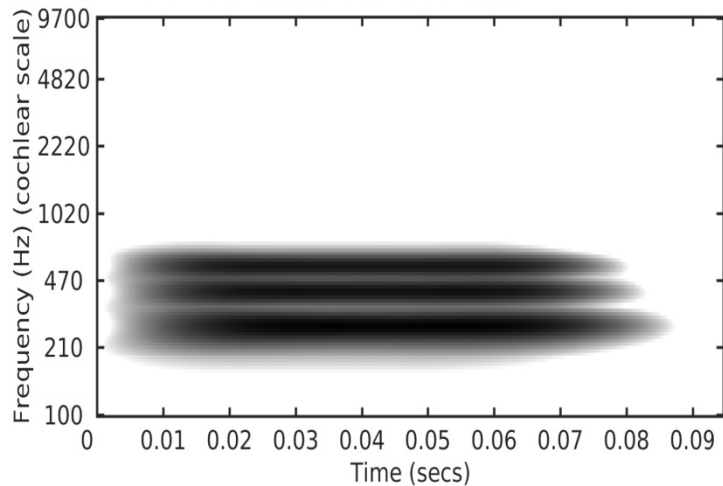
HEARlab : /m/ /g/ /t/
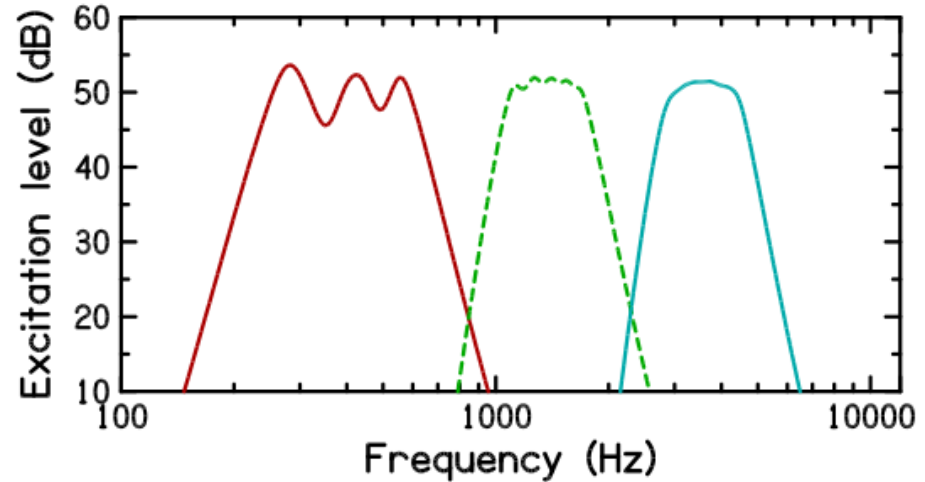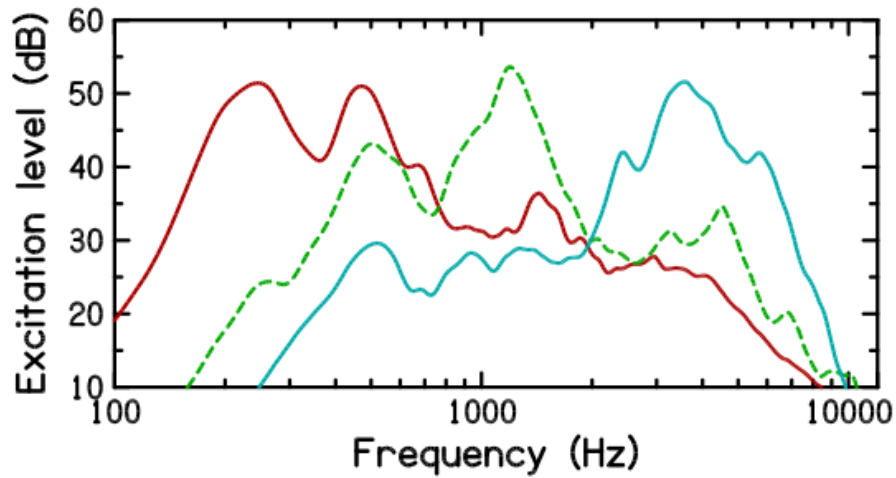
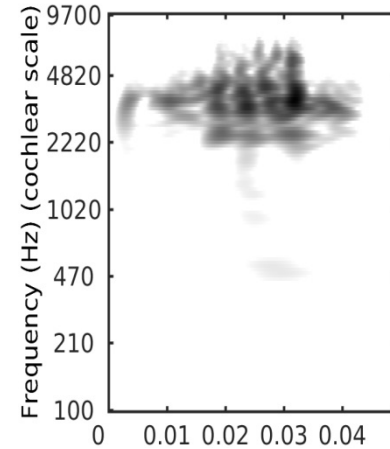Synthetic : 'm' 'g' 't'

(Adult : 33 mm meatus+concha length)

Erbograms of CAEP stimuli

HEARlab : **/m/**   **/g/**   **/t/**
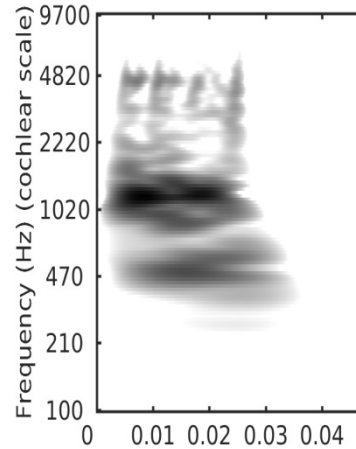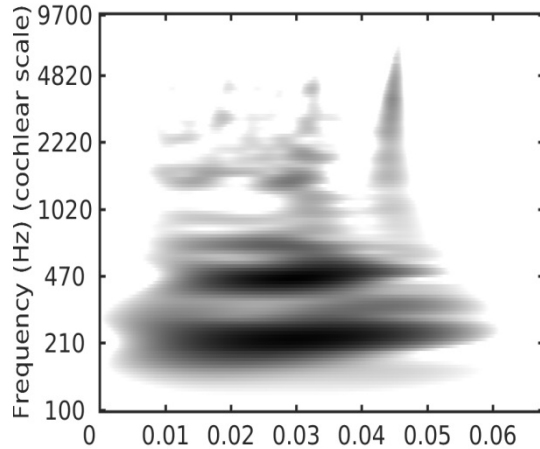
Synthetic :   **'m'**   **'g'**   **'t'**

(Adult length meatus+concha (Keefe et al., JASA1994). Greyscale normalised for each plot to a 30 dB dynamic range)

Does hearing aid treat stimuli as speech?

Unaided

CAEP | VRA stim | Embedded stim

Low freq

Mid freq

High freq

HA2 (moderate loss)

CAEP | VRA stim | Embedded stim

Low freq

Mid freq

High freq
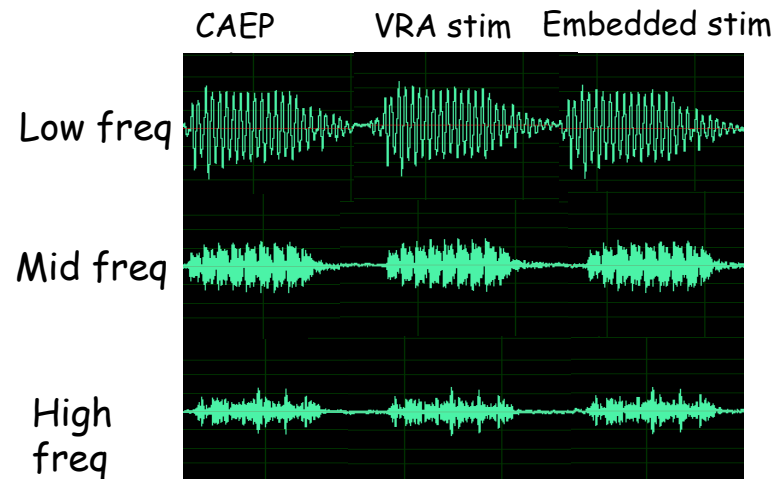
Next steps cont'd

- **Phase Two: defining performance characteristics**

  – In what proportion is a CAEP present when stimuli audible/inaudible?

  – In what proportion of absent cases is there a response on retest?
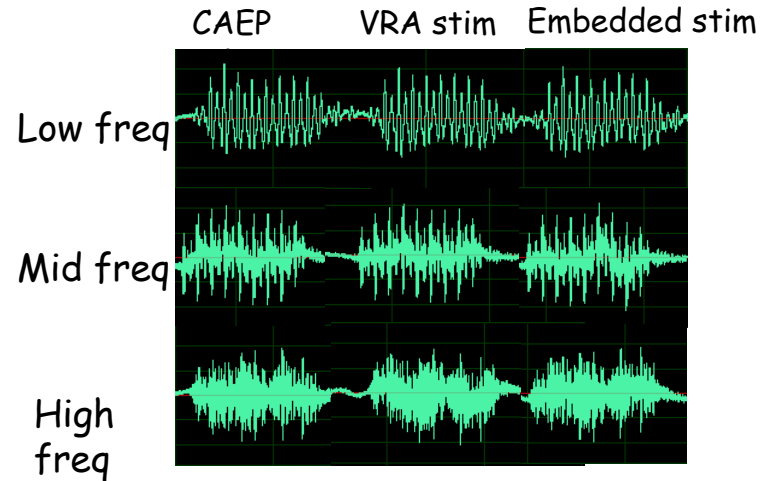
- **Phase Three: clinical feasibility & caregiver acceptability**

  – Feasibility measured in terms of completion rates and test time

  – Is the procedure acceptable to caregivers

Babies with hearing aids

- Recruiting 200 hearing-impaired babies

- Age 3-7 months at initial test (CAEP)

- Behavioural testing aged 8-9 months (VRA)

- CAEP and VRA use the same speech-like stimuli, for direct comparison

Mobile Hearing Unit

- **Convenience** - van visits families at their homes
- **Enthusiasm** from families/clinicians for mobile unit
- **Controlled environment** - sound-treated and electrically-isolated booth. Fully battery-operated

TAKE HOME MESSAGE

High completion rate	High response detection	Acceptable test duration	Acceptable to parents

- Infant CAEPs are clinically feasible, and theoretically useful for indicating physiological response to a range of sounds

- The current study seeks to validate the measure for use in clinical populations, 3-7 months, for whom behavioural data are limited

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No difference in SNR at vertex v high forehead