INFANT HEARING AID ASSESSMENT USING CORTICAL AUDITORY EVOKED POTENTIALS

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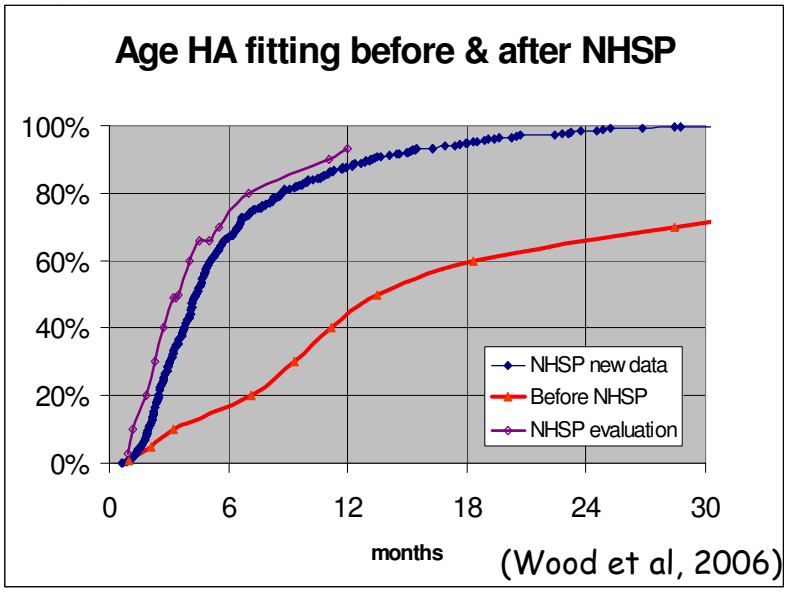

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SEQUENTIAL STEPS

1. HEARING SCREEN
   - e.g., using fixed-level ABR
2. ASSESSMENT
   - e.g., freq-specific ABR or ASSR
3. SELECT & FIT AMPLIFICATION
   - based on good-quality & comprehensive data
4. AUDIBILITY OF SPEECH
5. DISCRIMINABILITY OF STIMULI
6. MONITOR & PREDICT OUTCOME

CAEPs??

WHY OBLIGATORY CAEPS?

1. Originate at end of auditory chain so assessing more of hearing system (& probably more likely to correlate with performance-see later)

2. Corticals work well on awake babies: large amplitude response & easily detected with relatively little repetition

3. Stimuli (such as speech) can be long duration so hearing aid has time to react to real life sounds

(Dillon, 2005)

THE IDEA IS NOT A NEW ONE

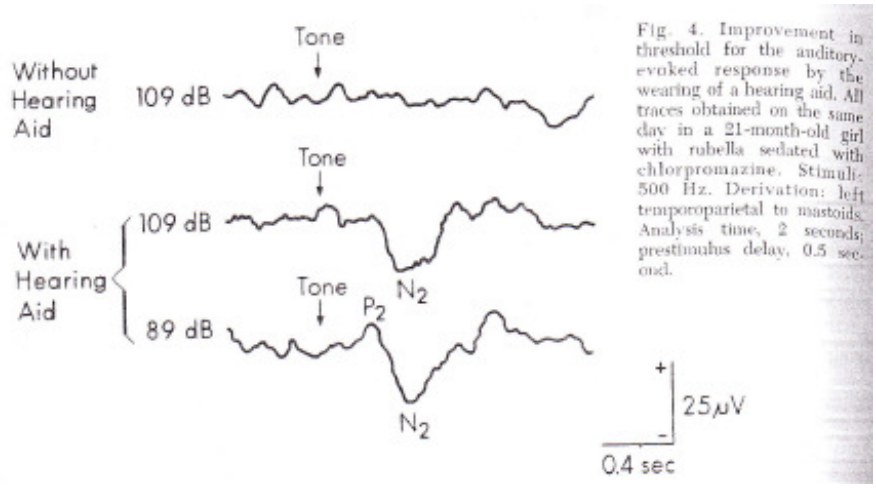
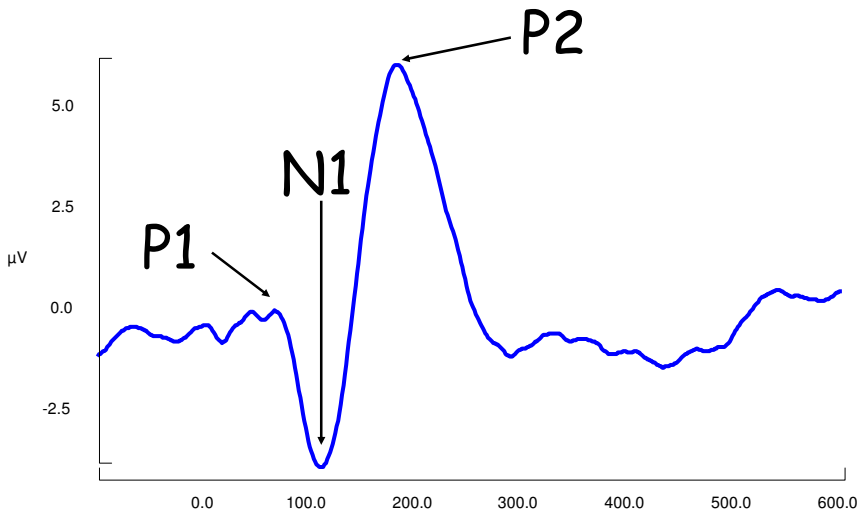
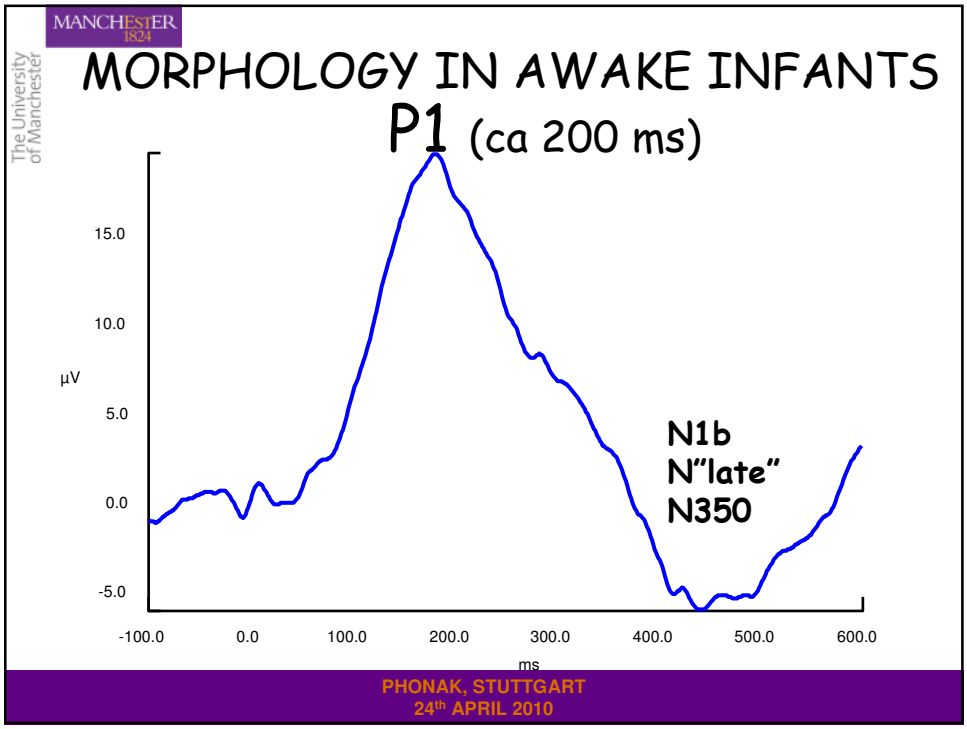


Fig. 4. Improvement in threshold for the auditory-evoked response by the wearing of a hearing aid. All traces obtained on the same day in a 21-month-old girl with rubella sedated with chlorpromazine. Stimuli: 500 Hz. Derivation: left temporoparietal to mastoids. Analysis time, 2 seconds; prestimulus delay, 0.5 second.

[Source: Fig 4 from Rapin & Graziani [1967)]

MORPHOLOGY IN ADULT

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MORPHOLOGY IN AWAKE INFANTS
P1 (ca 200 ms)
15.0
10.0
µV
5.0
0.0
-5.0
N1b
N"late"
N350
-100.0
0.0
100.0
200.0
300.0
400.0
500.0
600.0
ms
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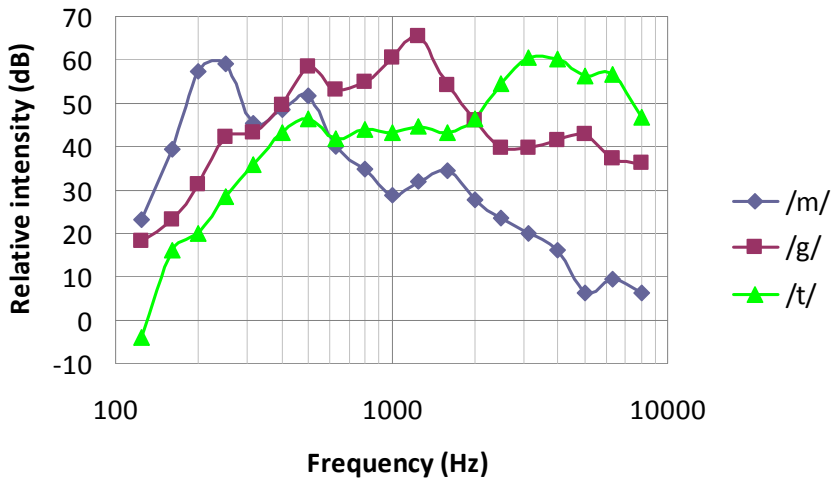
METHODOLOGY

1. Infant awake on parents lap or in high chair
2. Distracters e.g., toys with lights, mirrors, DVD
3. Snap-on leads so easy to have break e.g. feeding
4. Natural speech stimuli from loudspeaker (m, g, t)
5. 50-100 responses per average
6. Inter-stimulus interval ca 1125 ms
7. Artifact reject at +/- 100 μV
8. Recording window -100 to +500 ms
9. baseline correct, 30 Hz low pass filter

SPEECH STIMULI



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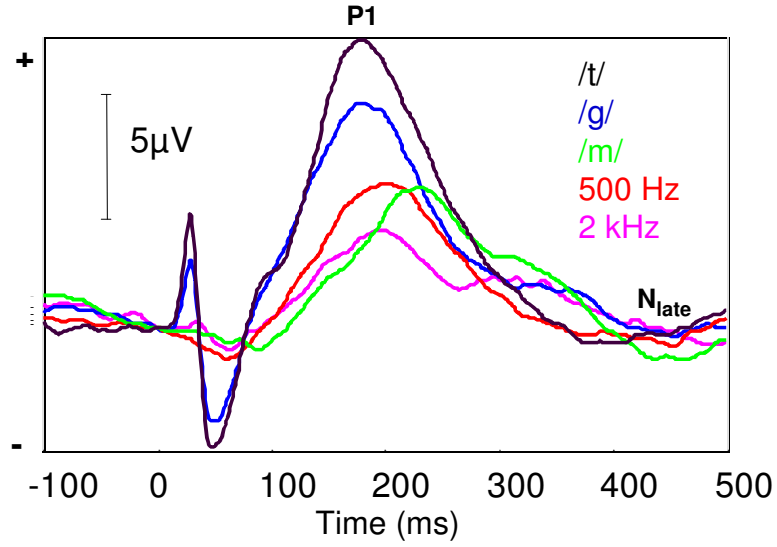
Infants (n=20; 3.5-7 mths) at Cz



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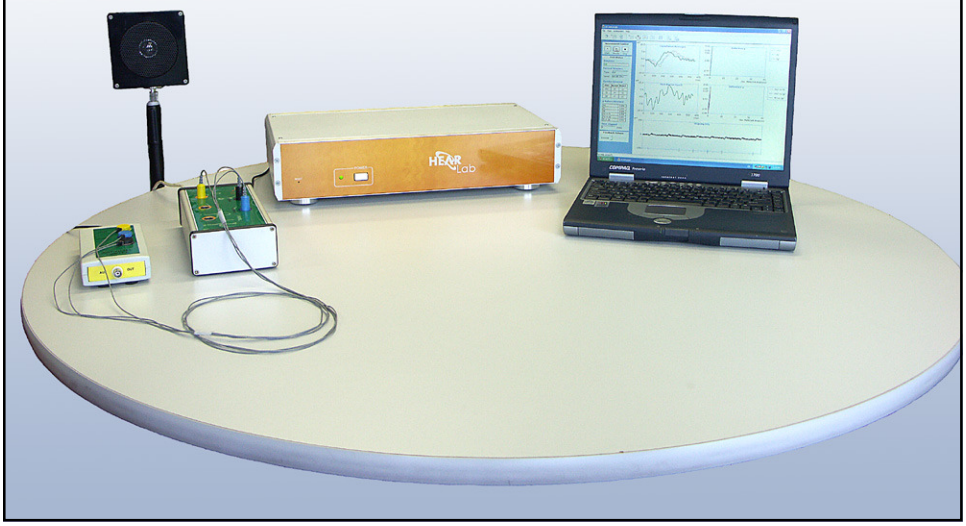
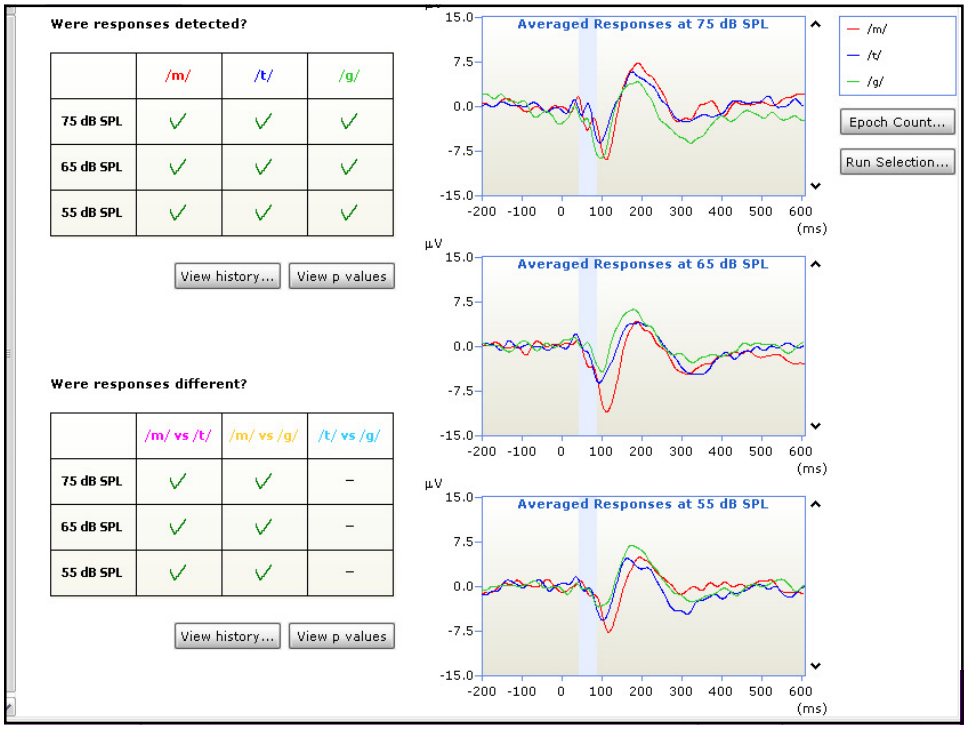
NAL HearLAB

(speech stimuli & statistical analysis)





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AUTOMATED WAVEFORM DETECTION & DIFFERENTIATION

(Munro et al, Under Revision)

- n=24 adult listeners
- with and without earplugs to simulate HL
- /m/, /g/ & /t/ at 55, 65 & 75 dB SPL

DETECTION OF CAEP (Automated Hotelling T^2 analysis)

	/m/	/t/	/g/
	Normal		
75 dB SPL	24 (100%)	23 (96%)	23 (96%)
65 dB SPL	24 (100%)	23 (96%)	24 (100%)
55 dB SPL	23 (96%)	23 (96%)	23 (96%)
	Simulated conductive impairment		
75 dB SPL	24 (100%)	24 (100%)	24 (100%)
65 dB SPL	21 (88%)	21 (88%)	23 (96%)
55 dB SPL	16 (67%)	12 (50%)	18 (75%)

DIFFERENTIATION OF CAEP (Automated MANOVA analysis)

	/m/ v /t/	/m/ v /g/	/t/ v /g/
	Normal		
75 dB SPL	18/23 (79%)	14/23 (61%)	3/22 (14%)
65 dB SPL	18/23 (79%)	14/24 (58%)	3/23 (14%)
55 dB SPL	16/23 (69%)	15/23 (65%)	5/23 (22%)
	Simulated conductive impairment		
75 dB SPL	8/24 (33%)	13/24 (54%)	5/24 (21%)
65 dB SPL	7/20 (35%)	14/20 (70%)	11/21 (52%)
55 dB SPL	4/11 (11%)	8/14 (60%)	5/11 (46%)

EVIDENCE SUPPORTING LINK BETWEEN CAEPS & PERFORMANCE

1. hearing aids
2. cochlear implants
3. auditory neuropathy
4. listening training
5. 'central deafness'

RELATIONSHIP BETWEEN OBLIGATORY CAEPS & FUNCTIONAL MEASURES IN YOUNG INFANTS (Golding et al, 2007)

- Function measured using PEACH questionnaire (in good hearing aid users). Involves parents reporting frequency of aural/oral behaviour
- Quality of CAEP on simple grading
  - 0= no response
  - 1= clear response to one stimuli
  - 2= clear response to 2 stimuli
  - 3 = clear responses to three stimuli

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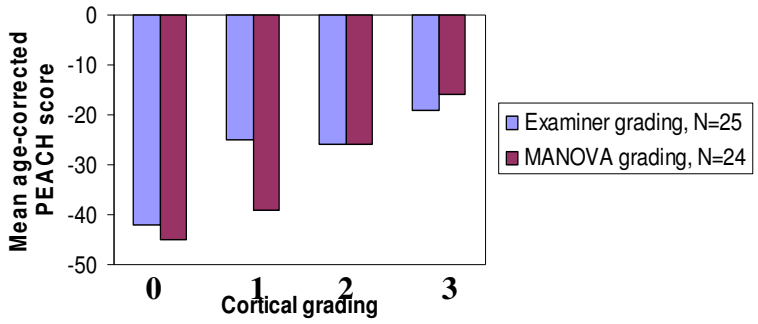
Age-corrected PEACH score by cortical grading (aided infants/children, mean age 8 mth)



(Sig correlation: Examiner grading r_s=0.45, p=0.01; MANOVA grading r_s=0.60, p=0.001)

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Central Auditory Maturation and Babbling Development in Infants With Cochlear Implants

Anu Sharma, PhD; Emily Tobey, PhD; Michael Dorman, PhD; Sneha Bharadwaj, PhD; Kathryn Martin, MA; Phillip Gilley, MS; Fereshteh Kunkel, MS

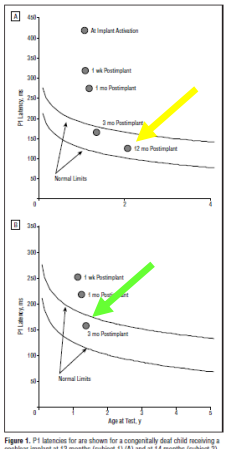

Figure 1. P1 latencies for are shown for a congenitally deaf child receiving a cochlear implant at 13 months (subject 1) (A) and at 14 months (subject 2) (B). The solid lines represent the 95% confidence intervals for normal development of P1 latencies. The circles represent the child's P1 latencies at different postimplantation intervals.

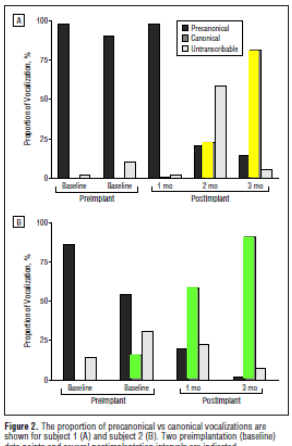

Figure 2. The proportion of precanonical vs canonical vocalizations are shown for subject 1 (A) and subject 2 (B). Two preimplantation (baseline) data points and several postimplantation intervals are indicated.

(Modified from Sharma et al, 2004)

SPEECH PERCEPTION & CAEP IN CHILDREN WITH AUDITORY NEUROPATHY

(Rance et al, 2002)

- Speech recognition & CAEP (measured around the same time) from 15 children with AN who wore HAs
- Around 50% had CAEP and some degree of speech recognition (but wide range of performance)
- The remaining 50% had very poor speech recognition and no CAEP

POSSIBLE CLINICAL PROCEDURE

1. To demonstrate audibility
   - /m/, /t/ & /g/ at 65 dB SPL, unaided & aided
2. To evaluate adequacy of frequency response
   - If no response to /m/, /t/ & /g/ consider increasing low, high and mid-frequency gain, respectively
3. To gauge degree of audibility of speech sounds
   - If no response at 65 dB SPL, retest at 75 dB SPL
   - If response at 65 dB SPL, retest at 55 dB SPL

(Adapted from Dillon, 2005)

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EXAMPLES

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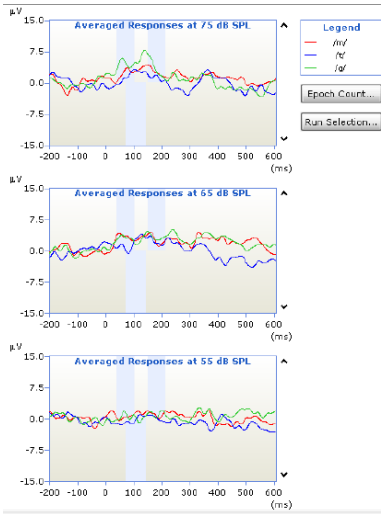
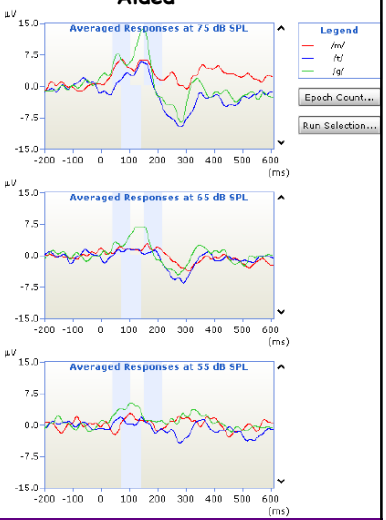
Girl with severe hearing-impairment Attends Grammar School for the Deaf

Unaided



Aided



Courtesy of Tracy Draper, April 2010 (id: 7)

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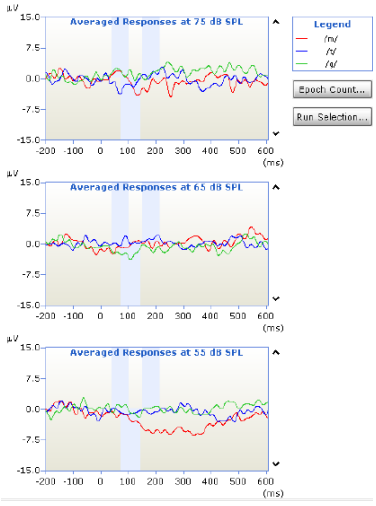
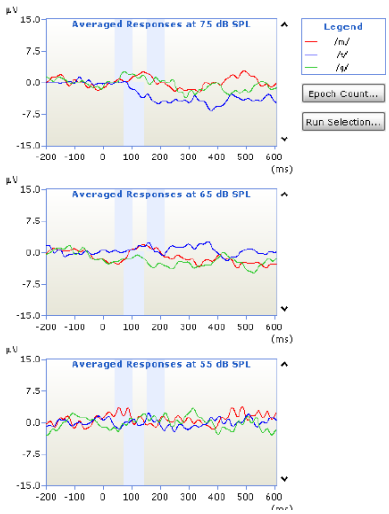
Boy with severe hearing-impairment
Attends Grammar School for the Deaf
Late fitting & poor speech/language skills

Unaided



Aided



Courtesy of Tracy Draper, April 2010 (id: 6)

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Male age 14 years
CHARGE syndrome: severe LD & visual impairment
Tangible reinforcement audiometry: ca 80 dB HL ?? unaided, 60 dB HL?? aided

	/m/	/g/	/t/
Unaided	RESPONSE [Used info to reduce low frequency gain]	NO RESPONSE	NO RESPONSE
Aided	RESPONSE	RESPONSE	RESPONSE

Courtesy of Vanessa Salisbury, Feb' 2010

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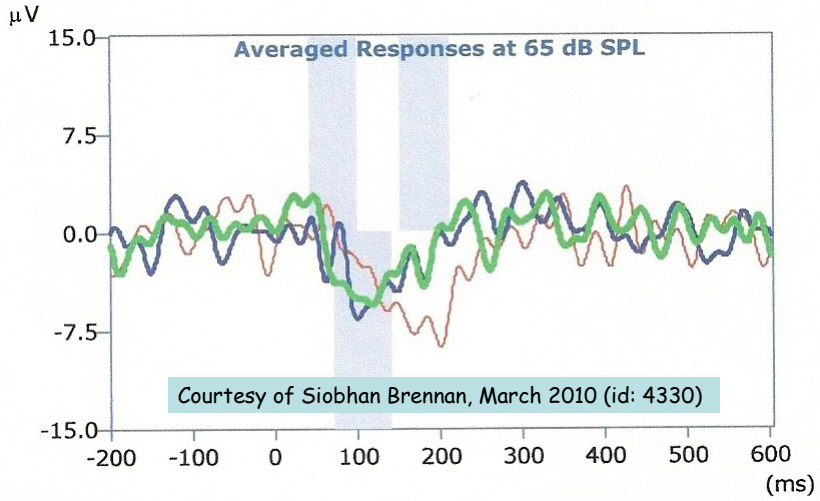
Aided CAEP
Male (64 years) severe LD
Previously diagnosed with severe SNHL



Courtesy of Siobhan Brennan, March 2010 (id: 4330)

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TAKE-HOME MESSAGE

1. Infants are provided with HAs before good quality behavioural information is available
2. It is possible to measure speech-evoked CAEPs (aided & unaided) in infants
3. There may be a role for speech-evoked CAEPs in HA assessment