



The Shepherd Centre

Giving deaf children a voice



Putting it all together

The role of functional listening and objective testing in infants

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8th Australasian Newborn Hearing Screening Conference (ANHSC 2015)
SCREENING FOR THE FUTURE
19-20 June 2015
Sydney, Australia



Australasian Newborn
Hearing Screening
Committee



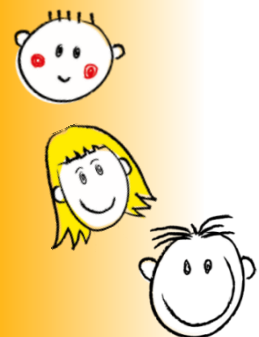


The Shepherd Centre

Giving deaf children a voice

Quantifying what infants can hear?

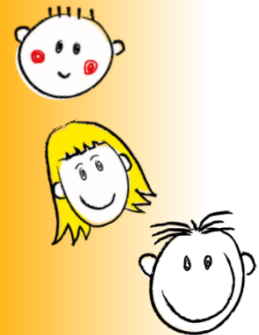
- UNHS (AABR)
- Diagnostic ABR
(hearing level and basis of device fitting)
- Hearing aid fitting
- Verifying & optimising access to sound
(behavioural/subjective measures)
- Maximising opportunity
(early diagnosis, early fitting, early intervention)



Cortical Auditory Evoked Potentials (CAEP'S)

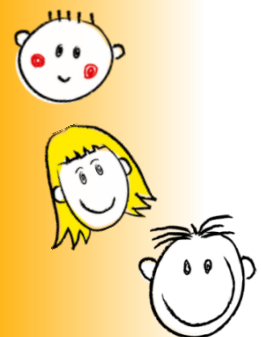
- Evoked potentials are small electrical signals that are produced by the hearing pathways in the brain. The response is measured from the brain.
(NAL Hearlab information sheet, <http://hearlab.nal.gov.au/pdf/CAEP%20parent%20handout.pdf>)
- HEARLab[®] system designed to make objective audiological assessment easy and efficient. It includes in-built statistical procedures to determine whether a response is present or absent, allowing testing to be conducted by clinicians who are not expert electrophysiologists
- Researched & developed through NAL & CRC
- Objective verification of hearing aid fitting

Provides **Detection Response** at level of the cortex



Functional Listening

- **Real world** listening skills
- Provides an indication of **what a child can do with a sound** in addition to what they may be able to detect
- Trained professionals that see infants on a regular basis have a **very good understanding** of what functional listening skills each child has
- The core of a specialized early intervention auditory focused program
 - From the earliest point (skills begin to show from a few weeks of age)
 - Pre-requisite for speech and language
 - Picture built over a period of time
 - Involves combination of measures – no one test stands alone
 - Every child is different, so individual focus impacting factors to functional listening development



How to measure functional listening?

Variety of current tools

- Functional Listening Index (tracking auditory devt skills from 0 – 6years)
- Categories of Auditory Performance – Revised
- Ling sounds/ Seven Sounds (*ah, oo, ee, mm, sh, s, or*)
- Auditory Skills Checklist
- St Gabriel's Curriculum
- Integrated Scales of Development (Cochlear Ltd))

Amongst others...

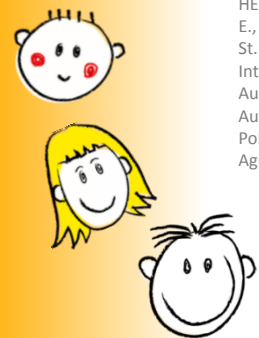
In quiet and
noise

Close and from
a distance

Individual and
separate ears

Live and digital
signals

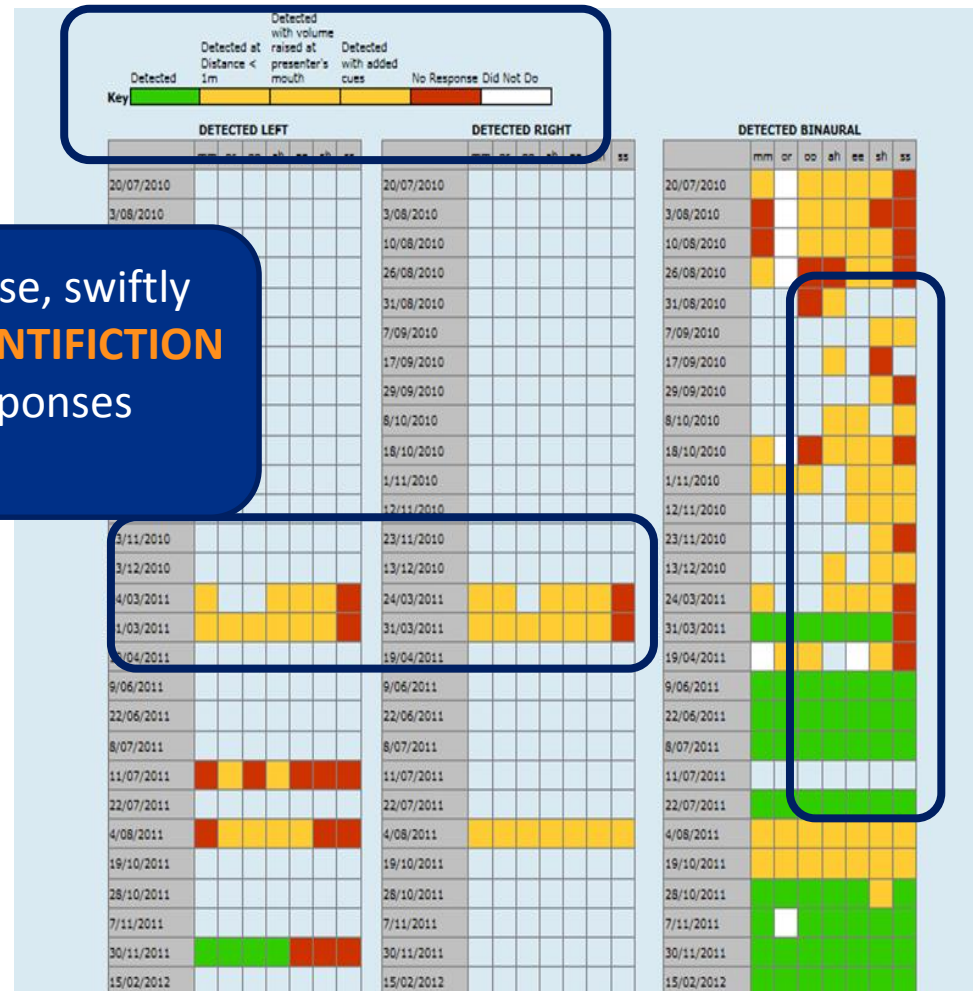
Ling, D. and Ling, A. 1978, Aural Habilitation: The Foundations of Verbal Learning in Hearing-Impaired Children, AG Bell, Washington DC, U.S.A.
Romanik, S. 1990, Auditory Skills Program for Students with Hearing Impairment, NSW Department of School Education, Sydney, NSW, Australia
Archbold, S., Lutman, M. E., & Marshall, D. H. (1995). Categories of Auditory Performance. Annals of otology, rhinology & laryngology. Supplement, 166, 312.
Cole, E. B., & Flexer, C. A. (2007). Children with hearing loss: developing listening and talking birth to six: Plural Pub.
Estabrooks, W. (1998). Cochlear implants for kids: Alexander Graham Bell Association for the Deaf.
HEARING, J. C. O. I., Muse, C., Harrison, J., Yoshinaga-Itano, C., Grimes, A., Brookhouser, P.
E., Martin, B. (2013). Supplement to the JCIH 2007 Position Statement: Principles and Guidelines for Early Intervention After Confirmation That a Child Is Deaf or Hard of Hearing. Pediatrics, 131(4)
St. Gabriel's Curriculum for the Development of Audition, Language, Speech, Cognition, Second Edition (2005). Compiled by J. Tuohy, J. Brown, & C. Mercer-Moseley
Integrated Scales of Development, Cochlear Limited
Auditory Skills Checklist, (2004) Adapted by Karen Anderson, from Auditory Skills Checklist by Nancy S. Caleffe-Schneck, M.Ed., CCC-A (1992).
Auditory Learning Guide, Beth Walker, (2009)
Pollack, D., Goldberg, D. M., & Caleffe-Schenck, N. (1997). Educational audiology for the limited-hearing infant and preschooler: An auditory-verbal program: Charles C Thomas Pub Ltd.
Agung, K. B., et al. (2005). "The Ling sound test revisited." Australian and New Zealand Journal of Audiology, The 27(1): 33.



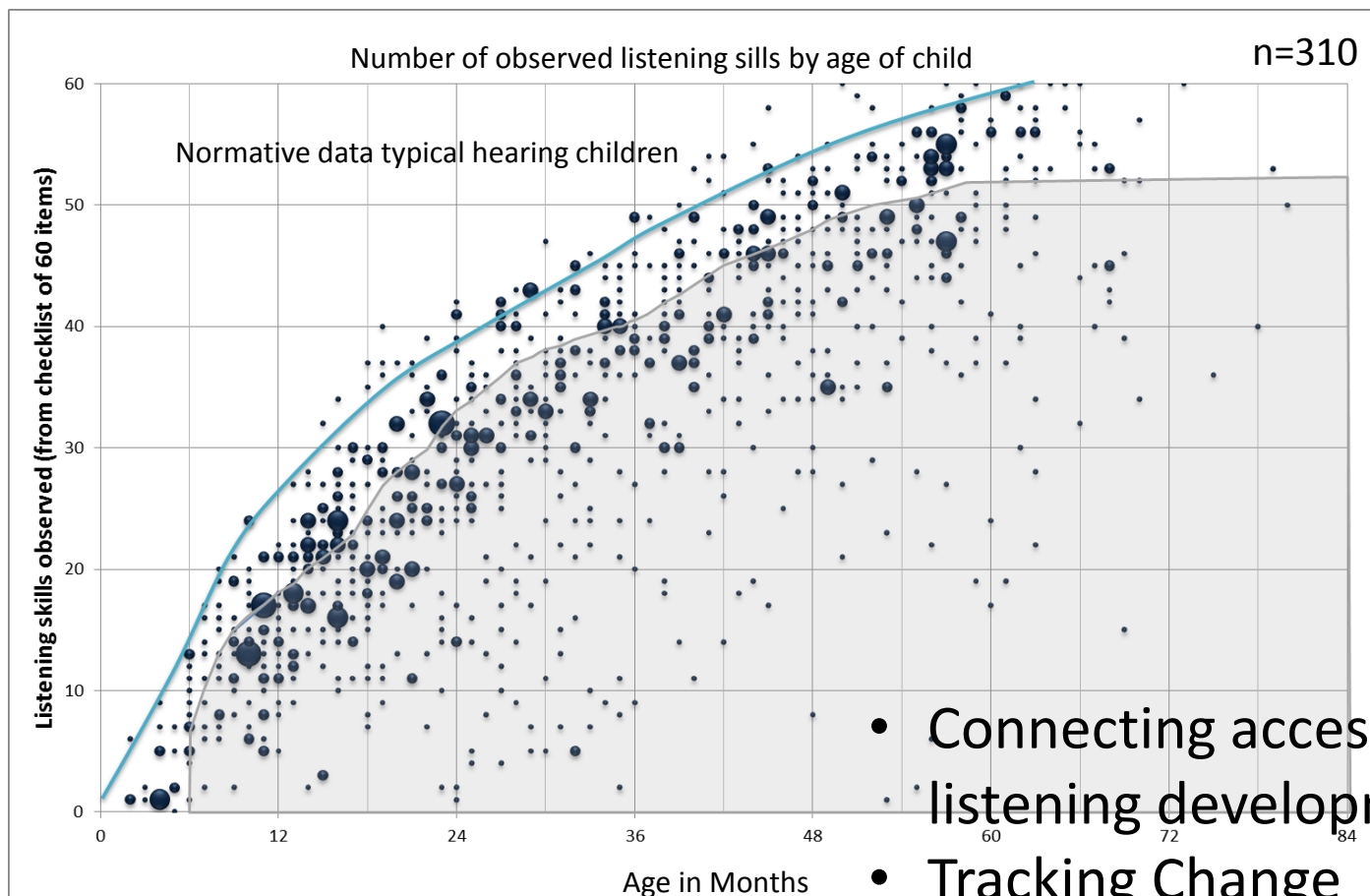
Functional Listening



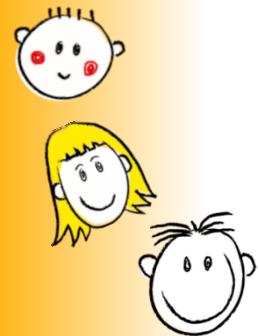
What starts as a **DETECTION** response, swiftly becomes **DISCRIMINATION** and **IDENTIFICATION** responses so **COMPREHENSION** responses become possible



Translation into Functional Listening



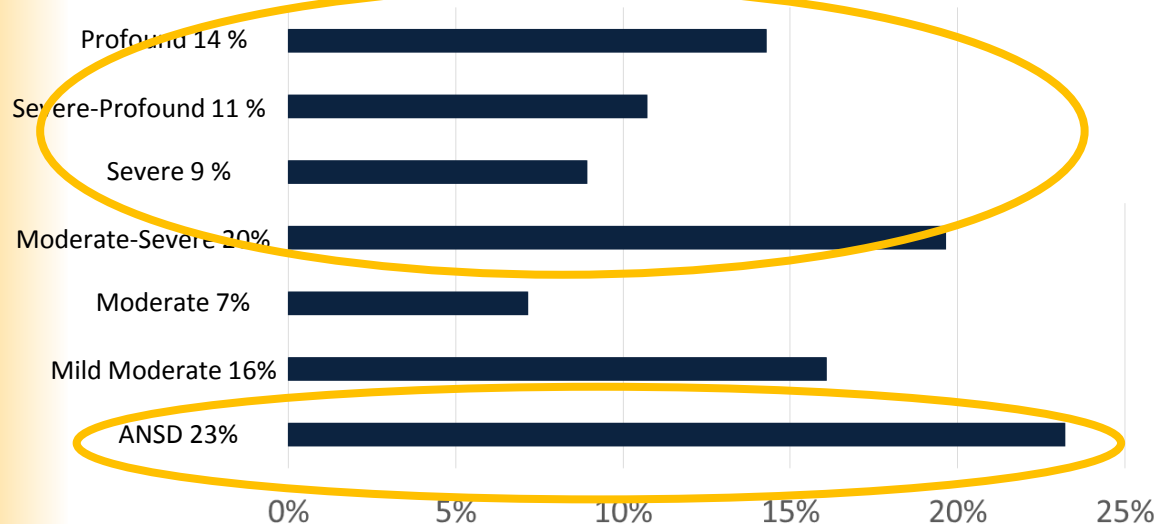
- Connecting access to listening development
- Tracking Change
- Guiding management



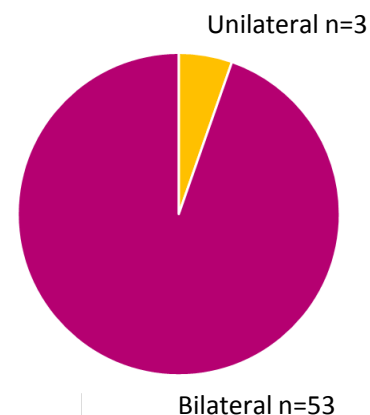
Design and demographics

Retrospective review of cortical reports
(HEARLab®) and functional listening responses
recorded in clinical database n=56 (23 females, 33
males)

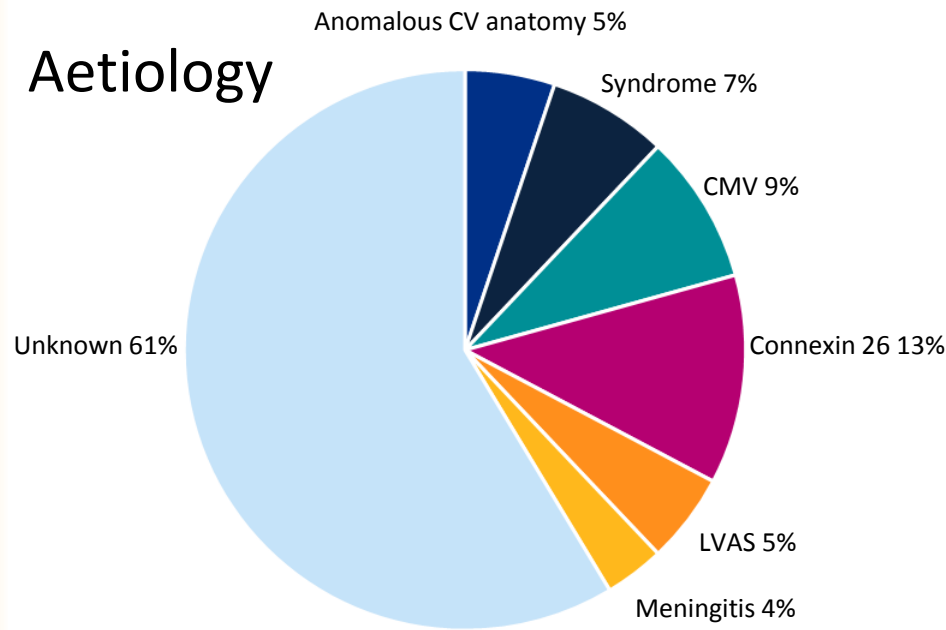
Hearing Thresholds (mean 4FA poorer ear)
at time of testing



Symmetry



Design and demographics



15/56 Diagnosed with Additional needs

n=56

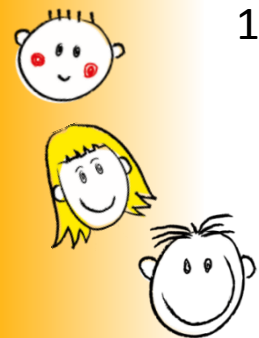
Age at CAEP assessment

Mean = 9.75 months

Median t = 5 months

Range = 1 -54 months

- 53/56 aided testing
- 3/56 unaided testing
- Testing levels 55,65 & 75dB SPL
- Comparison time locked & correlated to recorded responses



Apples with apples

CAEPs & Functional Detection

**/mae/
200-500Hz**

mmm: **F1 250-350Hz** (F2 1-1500Hz, F3 2500-3500Hz)

ooo: **F1 250-400Hz** (F2 8-900Hz)

eee: **F1 125-400Hz** (F2 2200-2600Hz)

**/gae/
800-1600Hz**

ah: **F1 700-900Hz** (F2 1300-1600Hz)

or: **F1 400-600Hz** (F2 800-1100Hz)

shh: **F3 1500-2000Hz** (F4 4500-5500Hz)

**/tae/
2-8000Hz**

eee: **F1 125-400Hz** (F2 2200-2600Hz)

shh: **F3 1500-2000Hz** (F4 4500-5500Hz)

sss: **F4 5-6000Hz**

HearLab manual <http://hearlab.nal.gov.au/pdf/HEARLab-Manual.pdf>

Estabrooks, W. (2006) Auditory Verbal Therapy and Practice

Ling, D. and Ling, A. 1978, *Aural Habilitation: The Foundations of Verbal Learning in Hearing-Impaired Children*, AG Bell, Washington DC, U.S.A.

Romanik, S. 1990, *Auditory Skills Program for Students with Hearing Impairment*, NSW Department of School Education, Sydney, NSW, Australia.

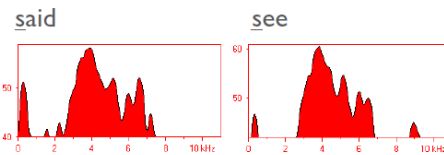


A word about speech acoustics

/s/=5-6000Hz

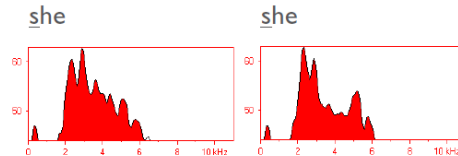
/ʃ/=F1 1500-2000Hz, F2 4500-5500Hz

MALE



Peak = 3,865 Hz

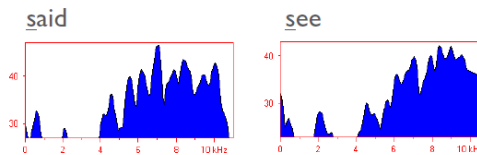
Peak = 3,865 Hz



Peak = 2,890 Hz

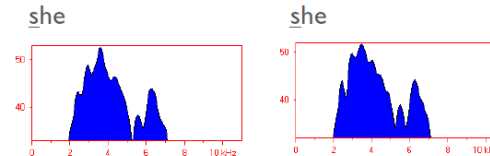
Peak = 2,320 Hz

FEMALE



Peak = 7,040 Hz

Peak = 8,420 Hz

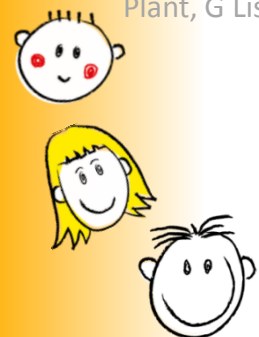


Peak = 3,580 Hz

Peak = 3,460 Hz

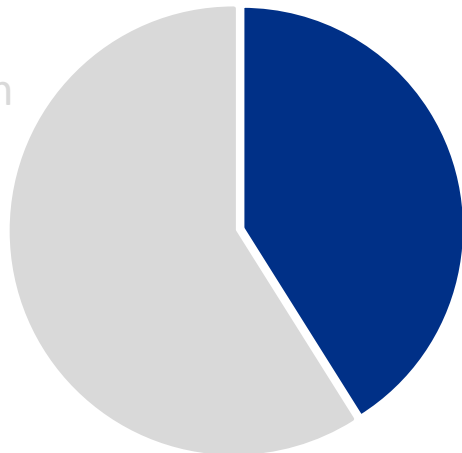
Estabrooks, W. (2006) Auditory Verbal Therapy and Practice

Plant, G Listen, Hear! Issue No. 23 http://s3.medel.com/downloadmanager/downloads/bridge/listen_hear/nl-NL/Listen-Hear-23.pdf



What does a match look like?

Mismatch
n=33



Match n=23



	/mae/	/gae/	/tae/
Aided at 65dB SPL	yes	yes	yes
Aided at 55dB SPL	yes	yes	yes

	/mae/	/gae/	/tae/
Aided at 65dB SPL	no	no	no
Aided at 75dB SPL	no	no	no

/mm/	/or/	/oo/	/ah/	/ee/	/sh/	/ss/
yes	yes	yes	yes	ac	ac	ac

/mm/	/or/	/oo/	/ah/	/ee/	/sh/	/ss/
yes	yes	yes	yes	ac	yes	yes

/mm/	/or/	/oo/	/ah/	/ee/	/sh/	/ss/
yes	yes	yes	yes	yes	yes	yes

/mm/	/or/	/oo/	/ah/	/ee/	/sh/	/ss/
no	no	no	no	no	no	no

/mm/	/or/	/oo/	/ah/	/ee/	/sh/	/ss/
no	no	no	no	no	no	no

/mm/	/or/	/oo/	/ah/	/ee/	/sh/	/ss/
no	no	no	no	no	no	no



The Sydney
children's
Hospitals Network
care, advocacy, research, education

first sounds
cochlear implant program

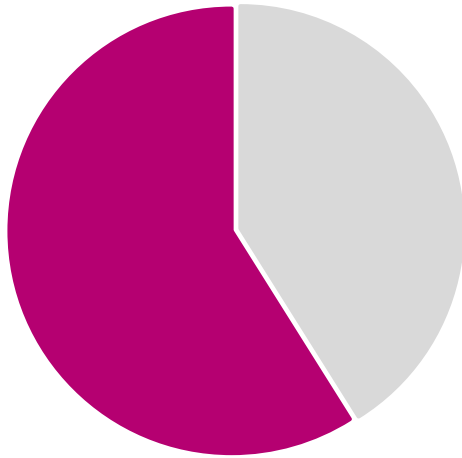


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What does a mismatch look like?

Mismatch
n=33



Match n=23

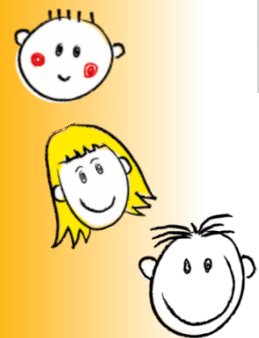


	/mae/	/gae/	/tae/
Aided at 65dB SPL	yes	yes	yes

	/mae/	/gae/	/tae/
Aided at 65dB SPL	no	yes	yes
Aided at 55dB SPL	no	yes	yes

/mm/	/or/	/oo/	/ah/	/ee/	/sh/	/ss/
no	no	yes	no	no	no	no
/mm/	/or/	/oo/	/ah/	/ee/	/sh/	/ss/
no	ac	no	no	no	no	no
/mm/	/or/	/oo/	/ah/	/ee/	/sh/	/ss/
ac	ac	no	no	no	no	no

/mm/	/or/	/oo/	/ah/	/ee/	/sh/	/ss/
yes	yes	yes	yes	no	no	no
/mm/	/or/	/oo/	/ah/	/ee/	/sh/	/ss/
yes	yes	yes	yes	ac	no	no
/mm/	/or/	/oo/	/ah/	/ee/	/sh/	/ss/
yes	yes	yes	yes	ac	no	no

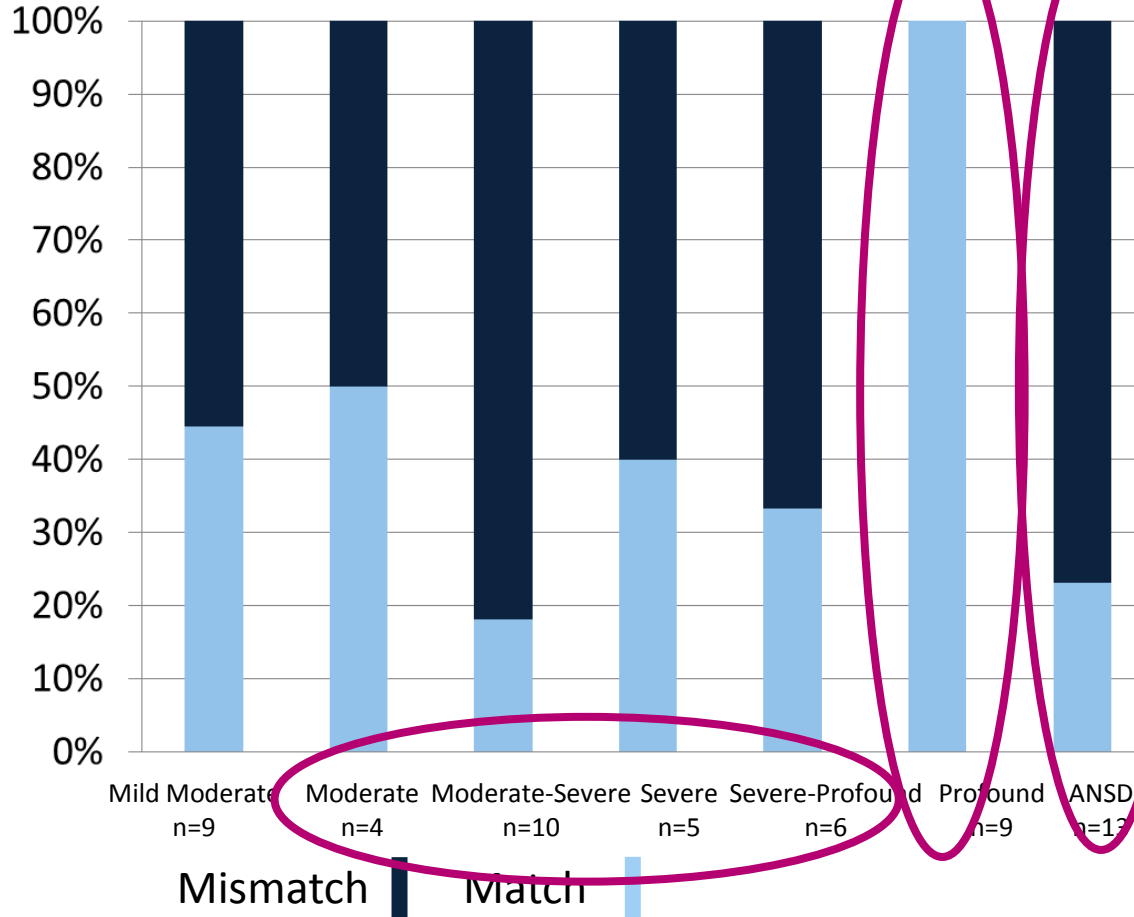


/tae/
2-8000Hz

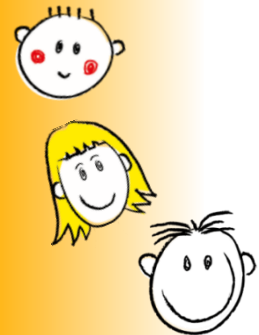
eee: F1 125-400Hz (F2 2200-2600Hz)
hh: F3 1500-2000Hz (F4 4500-5500Hz)
ss: F4 5-6000Hz

Matching the match and mismatch

3000Hz



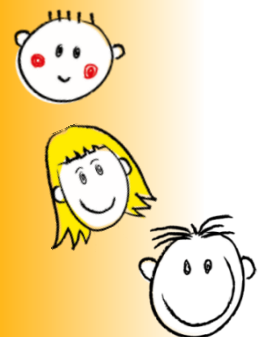
- Hearing thresholds
- Aetiology
- Middle ear pathology
- Complex medical picture



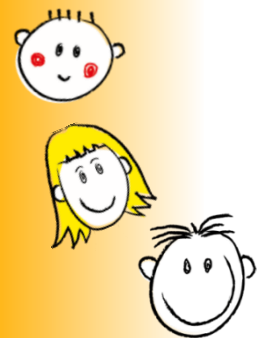
Match or mismatch?

- 41% (n=23) match with cortical responses and behavioural responses to phonemes.
- 59% (n=33) mismatch with cortical responses and behavioural responses to phonemes.
- 19/33 (58%) had all cortical responses present but a mismatch with functional listening.

What happens next?

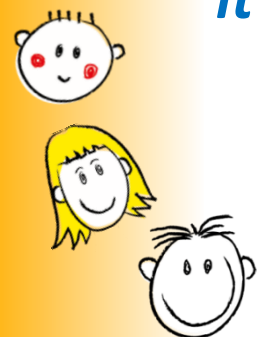


- 3/33 hearing aid optimization lead to matched results
- 21/33 have gone on to have at least 1 CI
- 4/33 CI evaluation
- 3/33 transferred to other programs
- 1/33 significant additional needs
- 1/33 with ongoing middle ear



What does CAEP testing mean for families?

- **18** recalled having the testing and could recall the results
- **4** families had a good understanding of the purpose
“to get brain response to see if getting any benefit from the aids”
- **5** families had a poor understanding of the purpose
“confirmation of diagnosis” , “to see if the inner ear is functioning & the hearing levels”
 - **6** understood implications
 - **3** had limited/poor understanding
“it’s really confusing, this is saying he can hear everything”



Impact of interpretation

“confirmed what I had been seeing and what I was feeling”

“at the time, we had passed the emotional part and into acceptance “

“always had hope never minded do another test”

“Overall – 100% beneficial sitting down and reviewing results much needed and necessary for me to hear and understand”

“For me yes, for my husband not so much, he was in denial wanting something 100% concrete”

“Yes a more technical result”

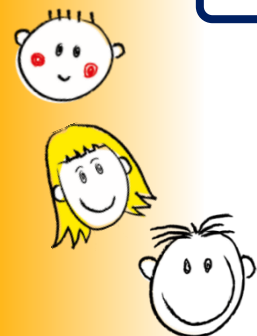
“ “Yes but also confusing”

“when we got a positive result, it gave us hope that with time maybe the hearing would get better”

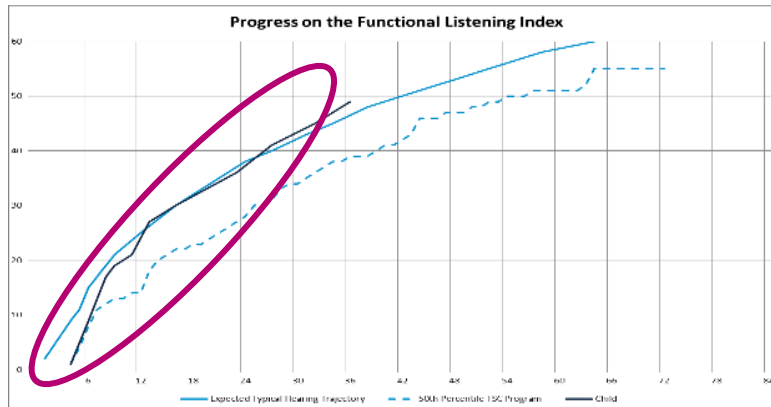
” Hard to take. Felt like getting the news of a HL all over again”

“Very nervous, much more meaning attached”

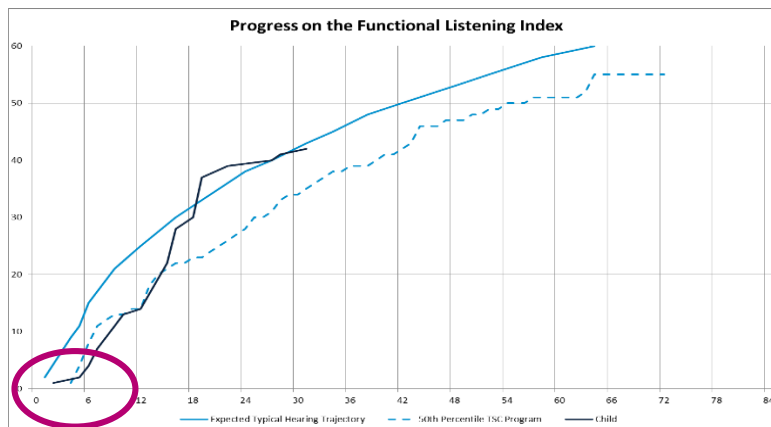
“struggling said can hear but not seeing this. Made us doubt everything”



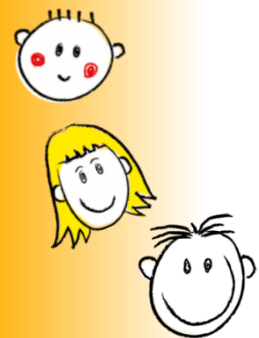
Impact of match on listening development



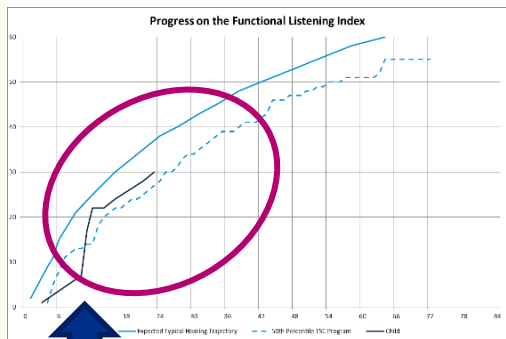
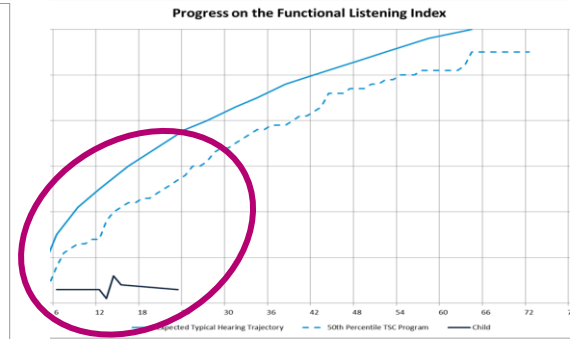
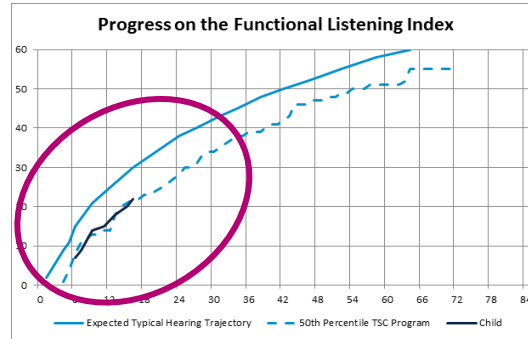
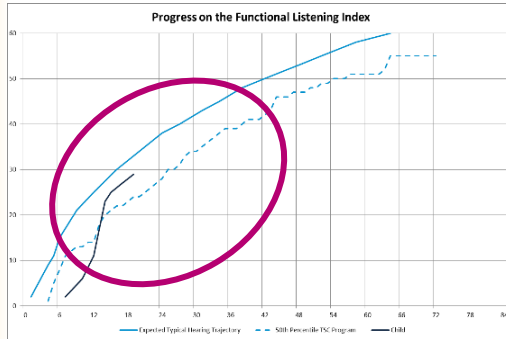
Match =
Starting and staying on the same
listening trajectory



Match =
Initially poor trajectory
Rapid change with improved access



Impact of mismatch on listening development



Mismatch =
Poorer than
expected
trajectory

Mismatch=
Complex audiology
Conflicting information
Complex psychosocial
Complex co-morbid
medical complications

Mismatch =
Poor early trajectory
Rapid change with improved access



Detection in the landscape of communication

Comprehension

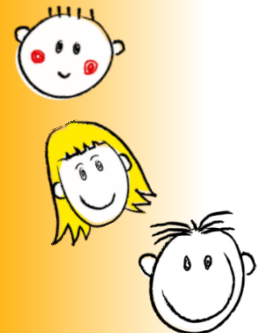
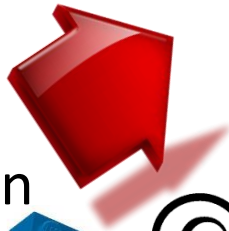
Identification



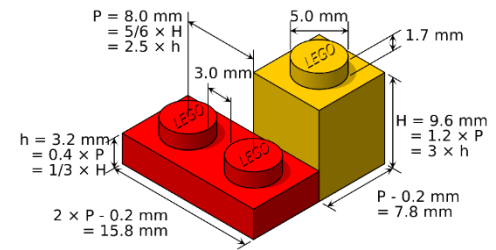
Discrimination



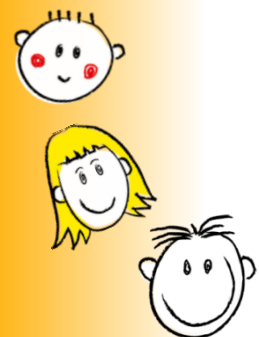
Detection



Building communication



- A present cortical response indicates detection of something at the cortex
- An absent cortical response may be present but not measureable
- There is no 100% correlate between a speech signal and the CAEP stimulus
- It's beneficial to take time with families to clearly and simply explain what additional information CAEPs might provide. This needs flexible delivery of services and information (written and verbal)
- To fully understand hearing, consider all of the available evidence in the context of the whole child
- Anything that add to the picture of understanding what a child might be hearing is useful



The Shepherd Centre team

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Dr. Phillip Chang

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Clinical Programs Admin

Sharon Hill

Tal Aronstam

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Katherine Saunders

Georgina McPherson

Dee Zamprogno

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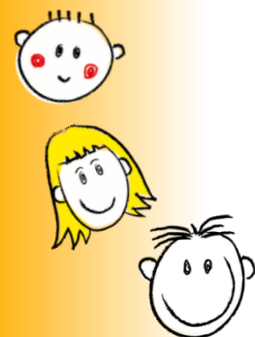
Katie Neal

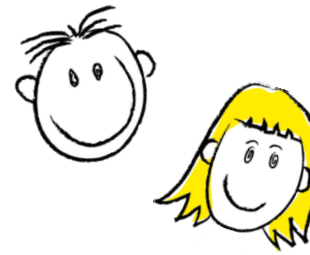
Information & Analysis

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Yeeka Yau

Heidi Shaw

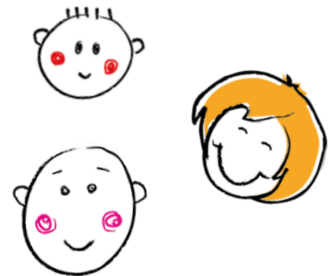




Thank you to the children
and families that share their
journey with us

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