

 **National Acoustic Laboratories**
A division of Australian Hearing



Longitudinal Outcomes of children with hearing impairment (LOCHI)

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National Acoustic Laboratories, Australian Hearing; HEARing CRC

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Motivation

- 1-2 children/1000 have a permanent hearing loss (Russ et al, 2003; Ching et al, 2006)
- Hearing loss impacts negatively on children's development
 - Language and Literacy (Moeller et al, 2007)
 - Speech recognition and production (Eisenberg, 2007)
 - Perceptual processing (Jerger, 2007; Rudner et al, 2007)
 - Psychosocial development (Watson et al, 1990; Moeller, 2007)
 - Educational attainment (Punch et al, 2004)
- Early detection makes early treatment possible (USPSTF, 2001; 2007).
- No clear evidence on efficacy of early intervention (USPSTF 2001; Wolff et al., 2010)

Current evidence					
Study	n	Entry to EI / HA fitting	Age at Evaluation	Outcomes measured	Effect of Age of Intervention
Yoshinaga-Itano et al. 1998	150	0 - 34 mo (72 < 6 mo)	13 – 36 mo	Parent report (CDI)	√
Moeller 2000	112	1 - 54 mo (24 < 11 mo)	5 yrs	Receptive vocab (PPVT)	√
Wake et al, 2004	89	5 to 54 mo (11 < 6 mo)	7 – 8 yrs	Language Sp. production	X
Kennedy et al, 2006	120	10 - 40mo (57 < 9 mo)	5.4 – 11.7 yrs, mean =7.9 yrs	Receptive language Expressive language Speech (Parent report)	√ X X
Fitzpatrick et al, 2007	65	6.6 - 18mo (15 < 6 mo)	3 – 5 yrs	Receptive vocab (PPVT) Language (PLS-4) Speech prod (GF2)	X
Vohr et al, 2009	30	13 =< 3 mo 16 > 3 mo	12 – 16 mo	Words (parent report) gestures (parent report)	√
Sininger et al, 2010	44	1 to 72 mo (23 < 6 mo)	60 – 100 mo	Speech perception, Speech production, Language	√

*No prospective study that directly compared
Outcomes of early and later-identified children
on a population basis*

In 2005, we commenced

Longitudinal
Outcomes of
Children with
Hearing
Impairment



Aims

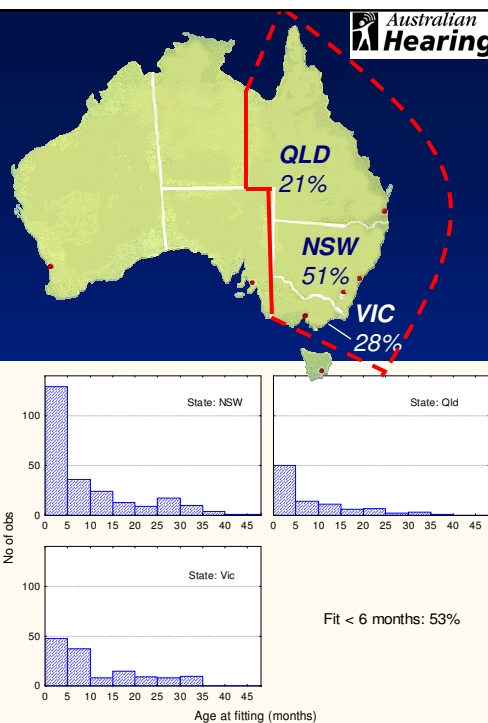
- Directly compare outcomes of early- and later-identified children;
- Examine the effect of a range of factors, including child, family, intervention, device setting and etiology, on different outcomes.
- Examine factors affecting individual development prospectively.

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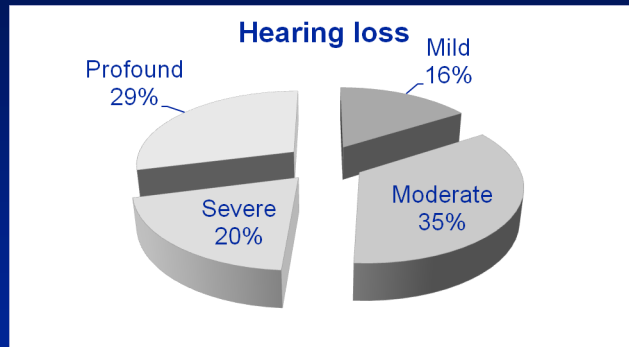
Participants

YOB: 2002 – 2007
475 children in New South Wales (NSW), Queensland (QLD) and Victoria (VIC).

- Gender: 54% M
- Add disabilities: 25%
- Fit age < 6 mo: 53 %



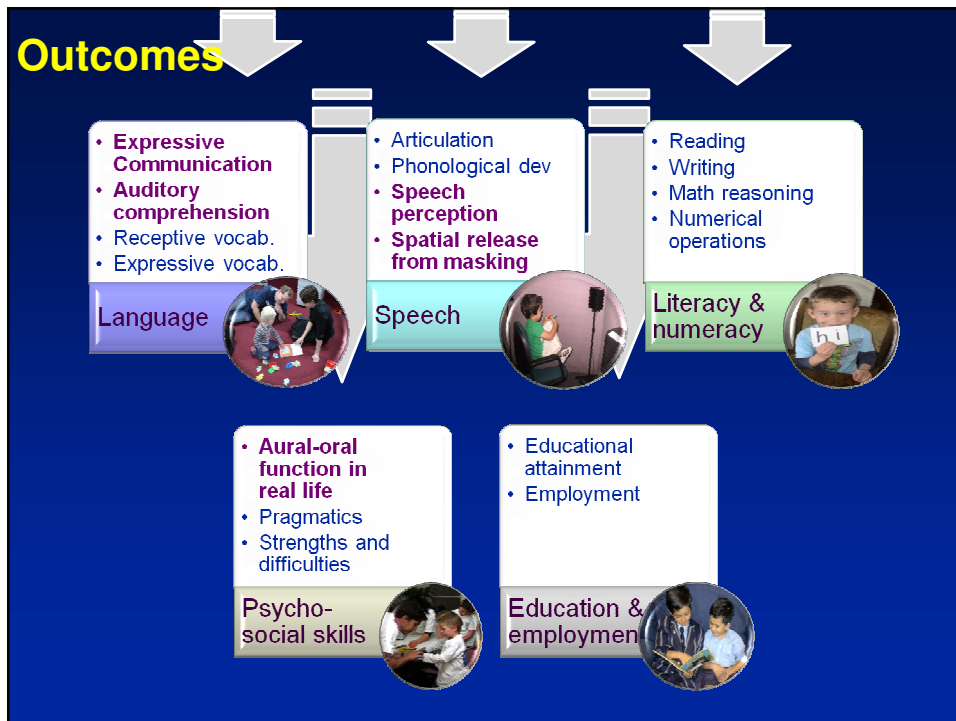
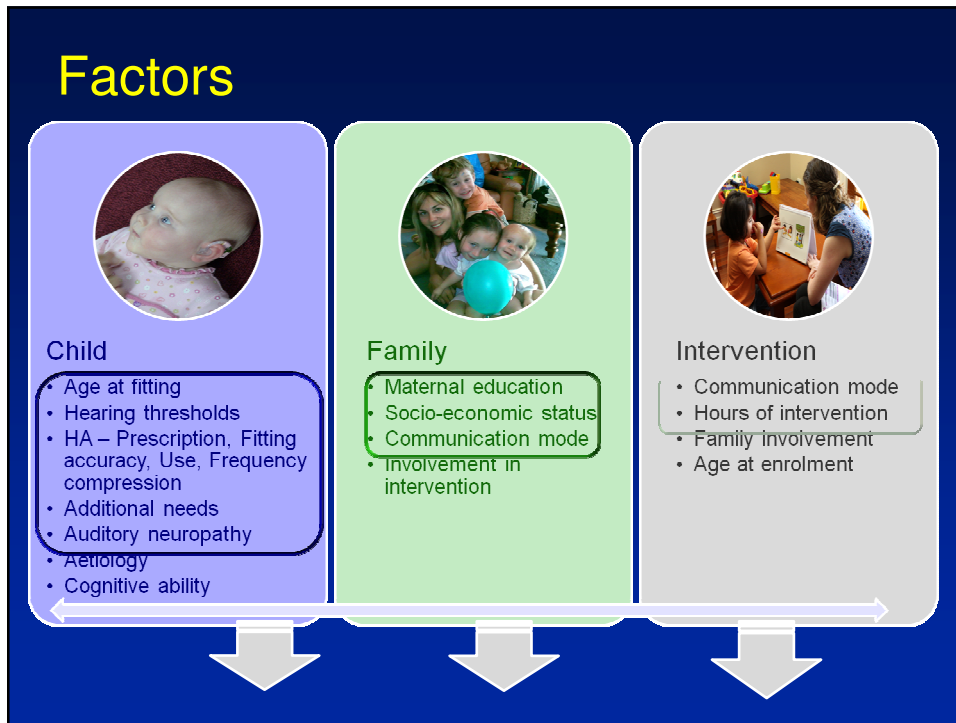
Degree of hearing loss



Hearing aids: 69%

Test intervals





Pre-school Language Scale (PLS-4) (Zimmerman et al, 2002)

- 0 to 6 yrs 11 m
- Examiner presents different activities and observes
 - What the child understands
 - What the child says
- Total Language scale, 2 subscales
 - Auditory comprehension
 - Expressive communication

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Parent's Evaluation of Aural/oral performance of CHildren (PEACH) (Ching & Hill,2007)

- Parents observe and record children's functioning in real-world situations in a diary
- Examiner interviews parents
- 1 m to 16 yrs
- Total score, 2 subscale scores
 - Quiet
 - Noise

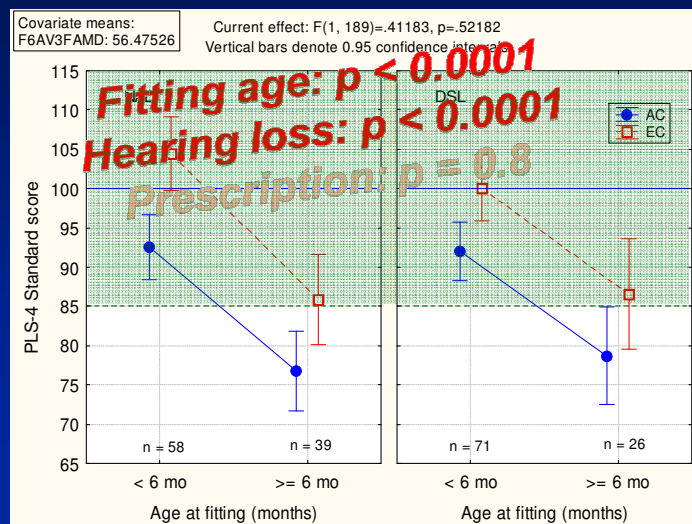
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RESULTS: HEARING AIDS

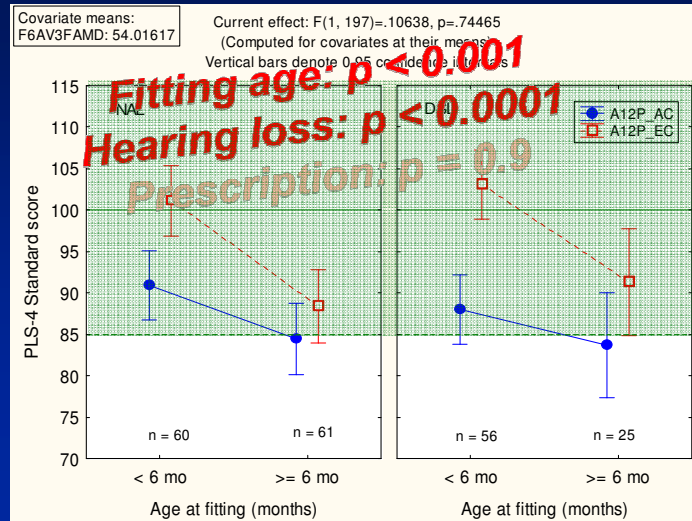


Language at 6 months after intervention (n=194)





Language at 12 months after intervention (n=202)



To examine factors affecting language outcomes,

1. For each outcome,



2. Repeat for other outcomes

3. Compile set of all significant variables (20)

4. Perform standard regression against each outcome for each imputation

5. Averaged Beta across imputations, ...

At 6 and 12 months post-fitting,

	Age fit (log)	Birth weight	Aud Neuro pathy	Carer - com diff	Carer - NESB	Home - only spkn	EIA hours	Use of HA	Add Disabilities	HTL
AC (6 m)	-0.30	0.17	0.20					0.21	-0.36	-0.31
AC (12m)	-0.13		0.23			0.14	0.19		-0.21	-0.17
EC (6 m)	-0.31	0.24	0.21						-0.25	-0.21
EC - (12m)	-0.34	0.15	0.22			0.13			-0.31	-0.20
Comp (12m)		0.17			-0.16		0.21		-0.25	-0.25
Exp (12m)		0.18			-0.16				-0.42	-0.42
Comp W&G		0.21		0.24				-0.16	-0.22	-0.33
Prod W&G	-0.39			0.19		-0.25				-0.32

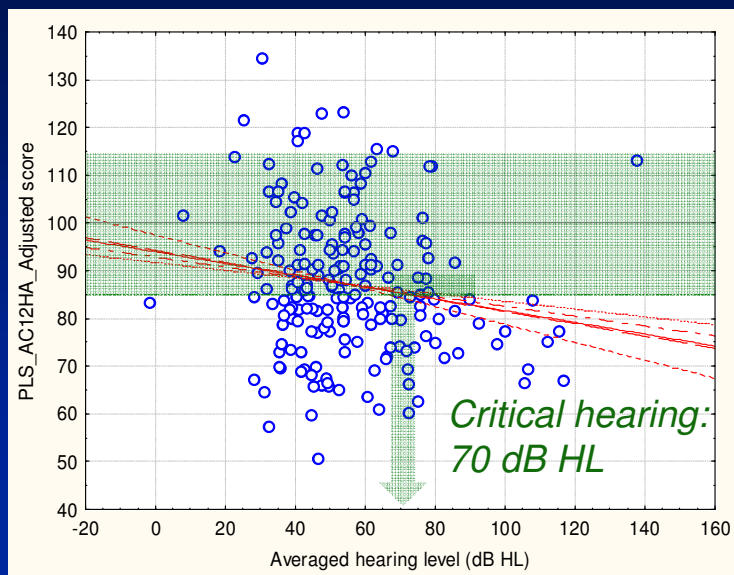
Calculate residuals and perform ANOVA to examine effect of:

- Communication mode in intervention
 - Levels: Spoken only vs Sign or combination
 - Results: **Main effect not significant**
- Maternal education
 - Levels: University vs Diploma/certificate vs School
 - Results: **significant (p<0.05) only for CDI Expressive Language at 12months post-fitting.**

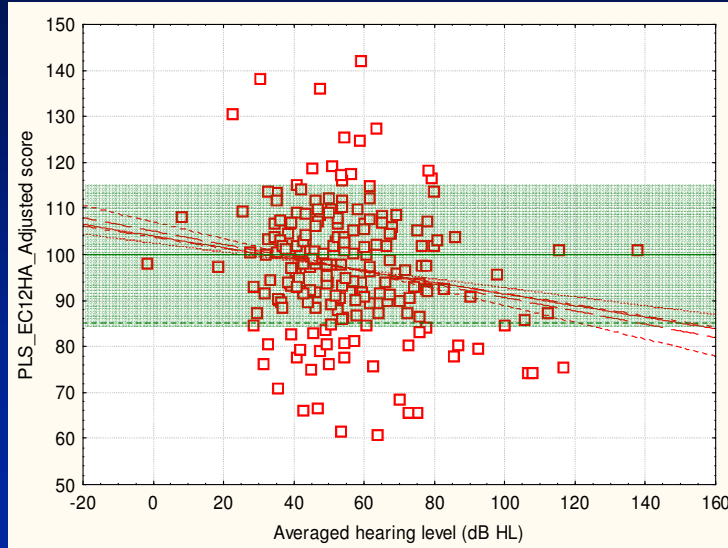
After adjusting scores for the effect of all significant variables, we examined

- hearing level
- age at fitting

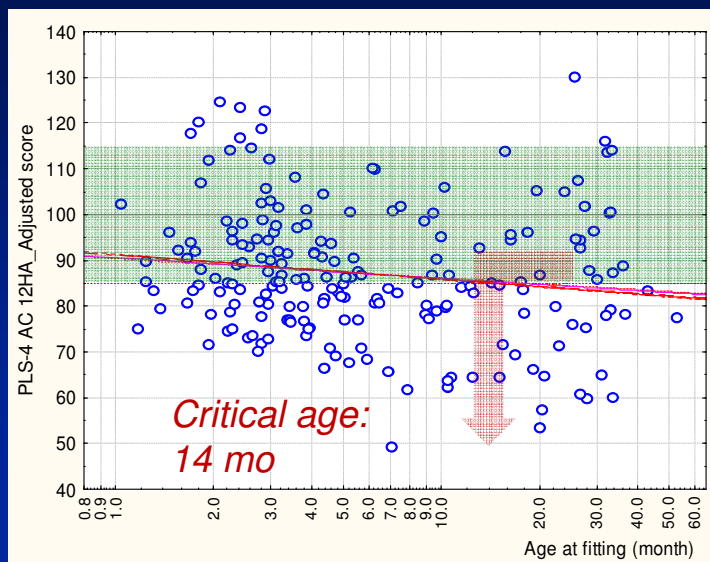
Hearing level affects Auditory comprehension,
but ...



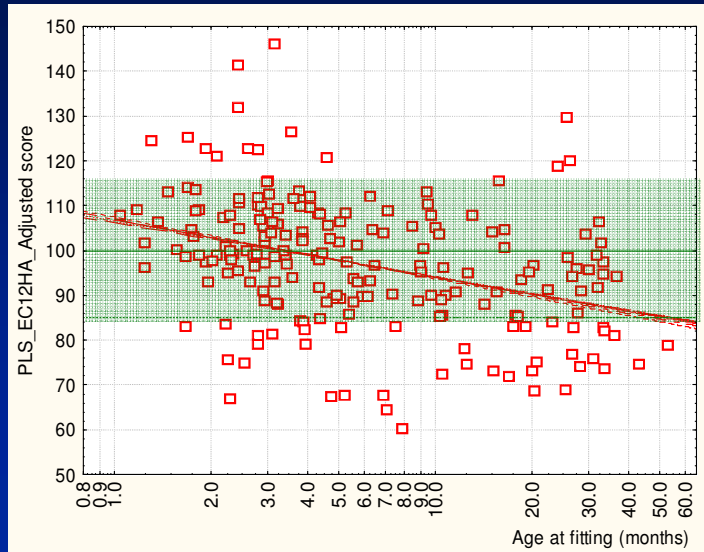
But less so for expressive communication



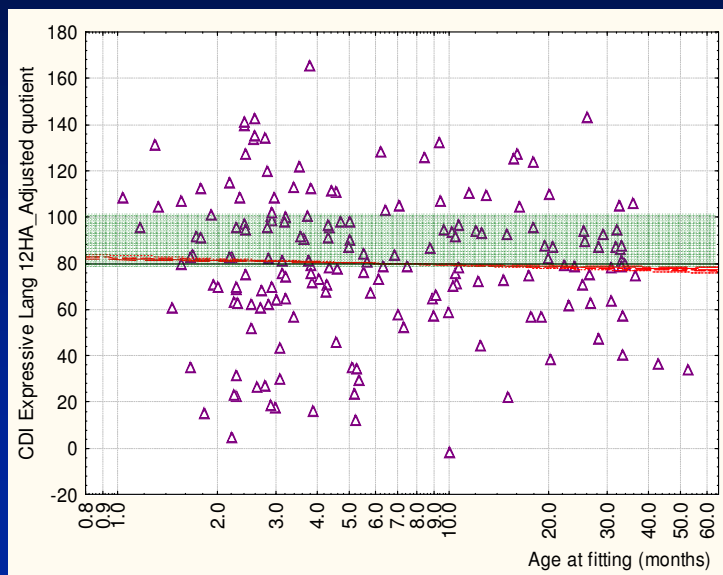
Fitting age affects Auditory comprehension, but ...



But less so for expressive communication

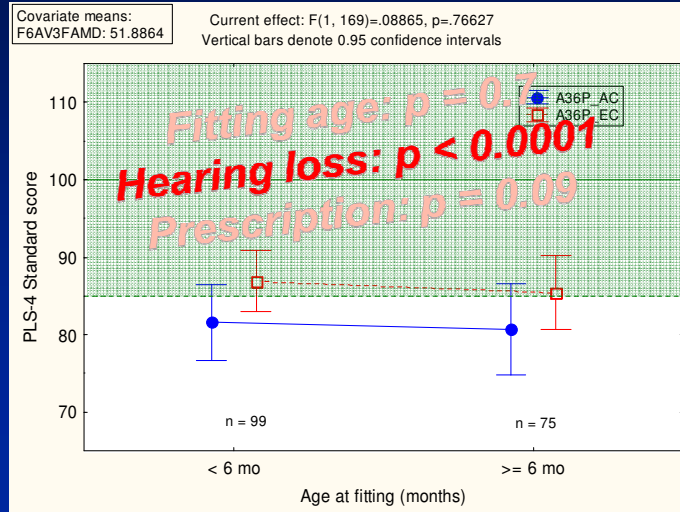


But not Expressive language, ...





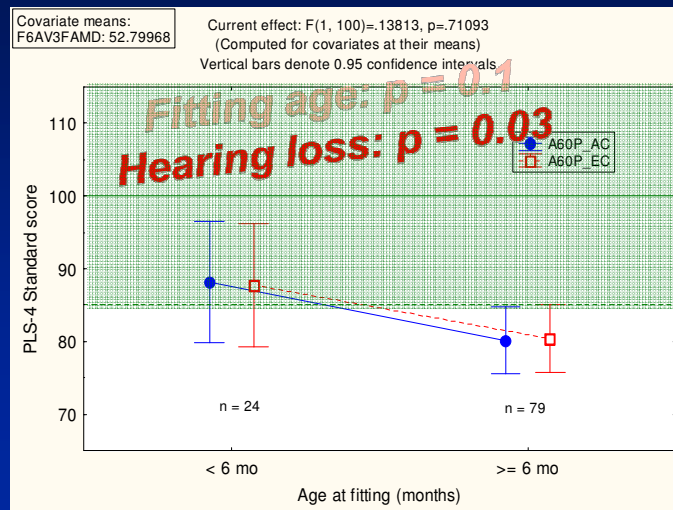
Language at 3 years of age



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Language at 5 years of age



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Multi-linear regression

Yr 3 Axs	Gender	Age fit	Pres	Hearing Level	Maternal Education	SES (IRSAD)
Auditory comprehension (n=173)			Beta = 0.15 p = 0.03	Beta= -0.26 P < 0.0001	Beta=-0.25 P < 0.001	Beta= 0.16 P = 0.02
Expressive communication				Beta =-0.28, p < 0.0001	Beta=-0.31 P < 0.0001	
Speech production (n = 114)				Beta =-0.20, p = 0.03		
Receptive vocabulary (n = 131)			Beta = 0.18 p = 0.03	Beta =-0.18, p = 0.024	Beta =-0.21 P = 0.008	Beta= 0.23 P = 0.005
CDI -Language (n=159)				Beta =- 0.25 P = 0.001	Beta =-0.29 P < 0.001	
PEACH (n=121)			Beta = 0.3 P < 0.001		Beta= -0.30 P < 0.001	

In summary,

- At 6 and 12 months post-fitting,
 - Better outcomes were associated with earlier fitting, lesser hearing loss, greater birth weight, and absence of auditory neuropathy or additional disabilities
 - Choice of prescription, Socio-economic status, hearing status of carer, gender, communication mode in intervention did not affect outcomes
 - Accuracy of fitting did not affect outcomes, provided that achieved gain was within 5 dB of prescribed gain

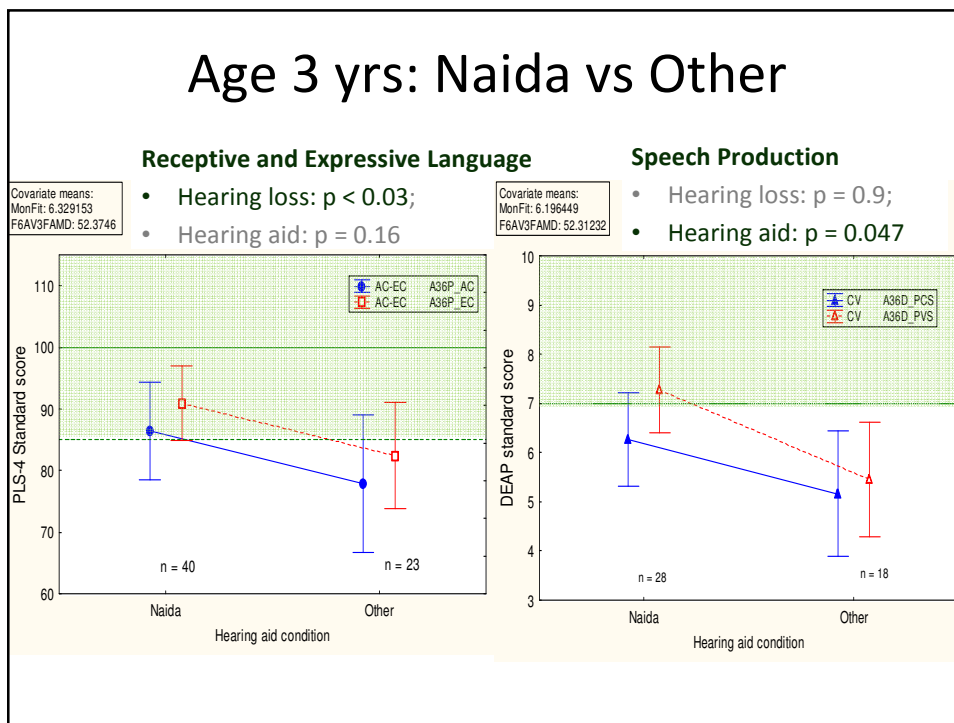
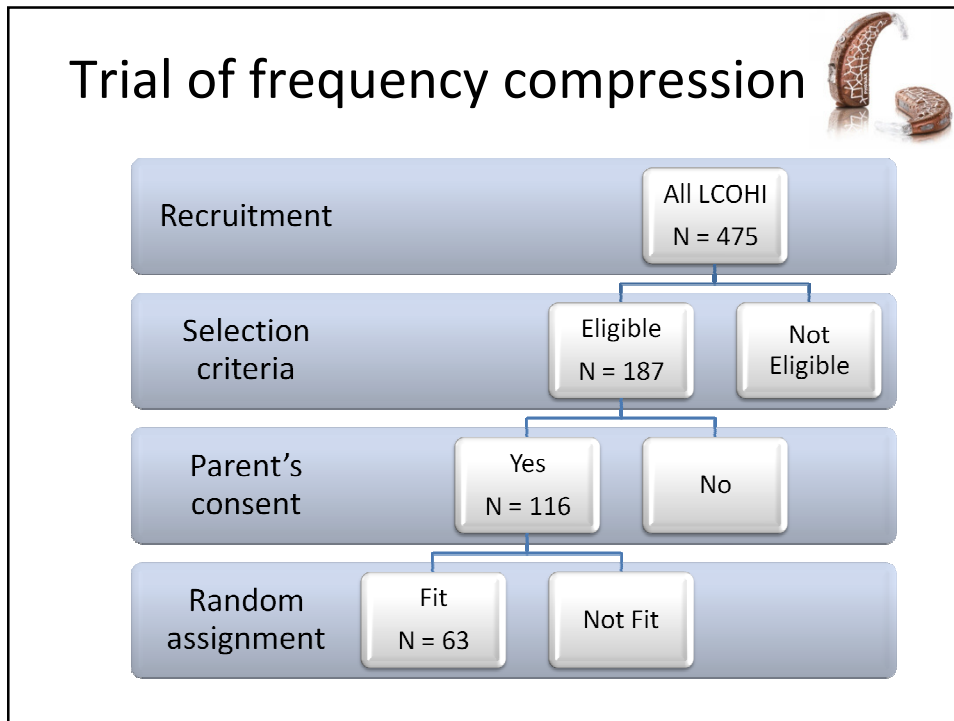
At 3 years of age,

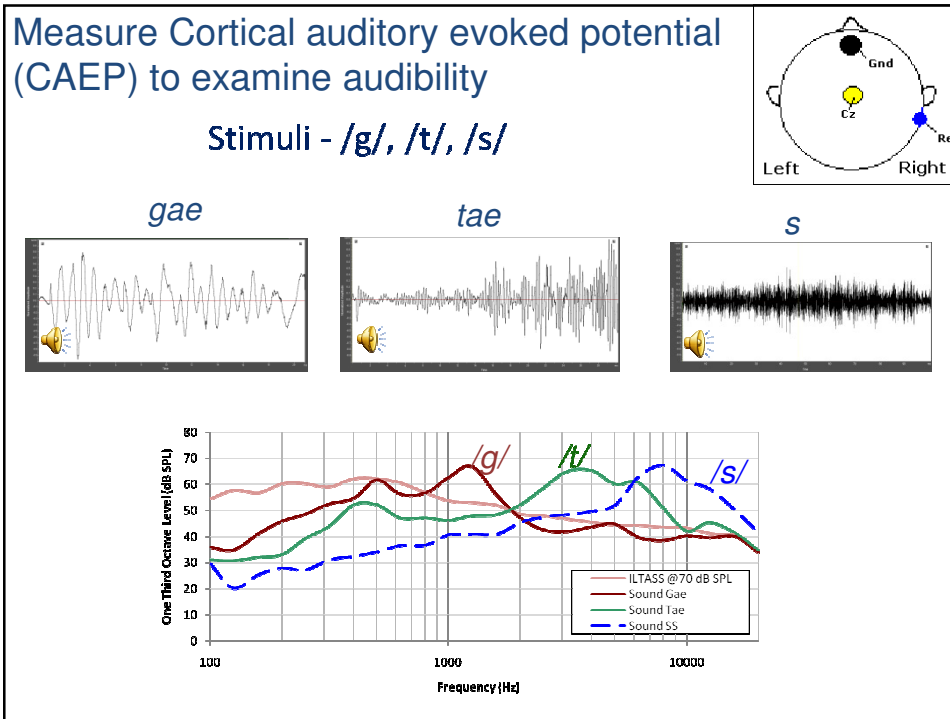
- Age of fitting did not have a significant effect, but,
- Hearing loss and maternal education significantly affected outcomes.
- Many confounding factors still to be allowed for, when all data become available.



As part of the LOCHI study, we also examined

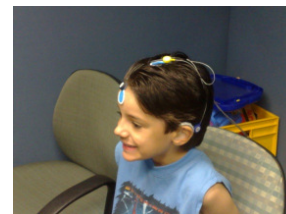
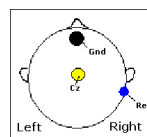
EFFECT OF FREQUENCY COMPRESSION

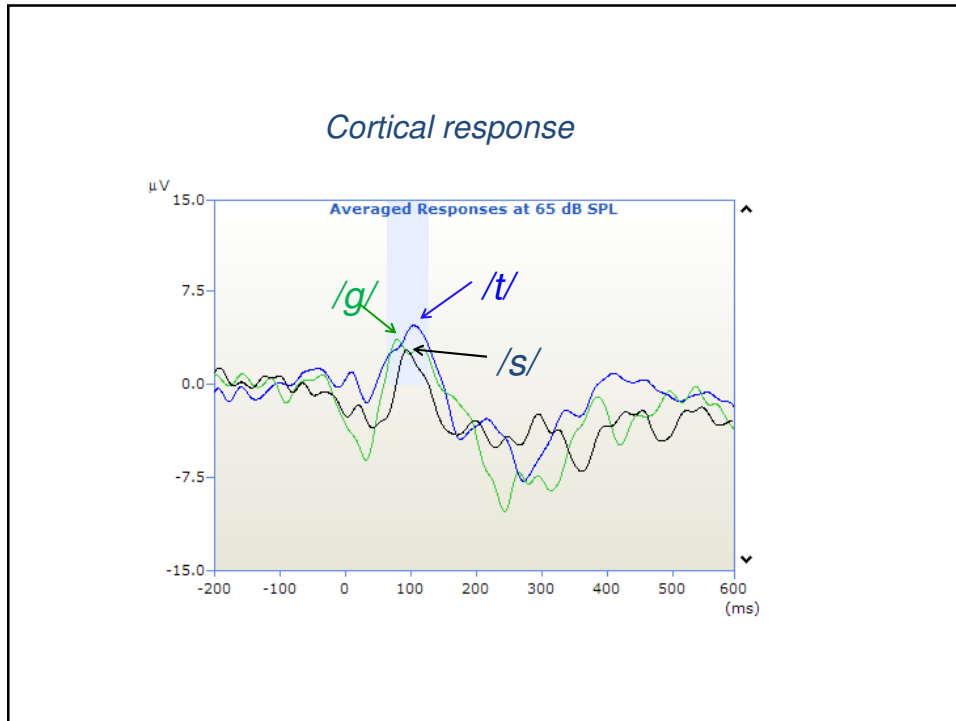




Methods: CAEP

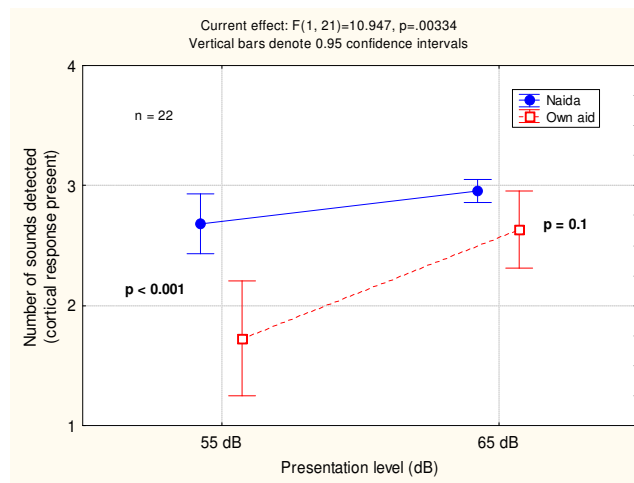
- Presentation level: 55, 65, or 75 dB SPL via loudspeaker at 0° azimuth
- Cortical responses were recorded by using the HEARLab equipment developed at National Acoustic Laboratories.
- Recording electrodes at Cz, C3, C4



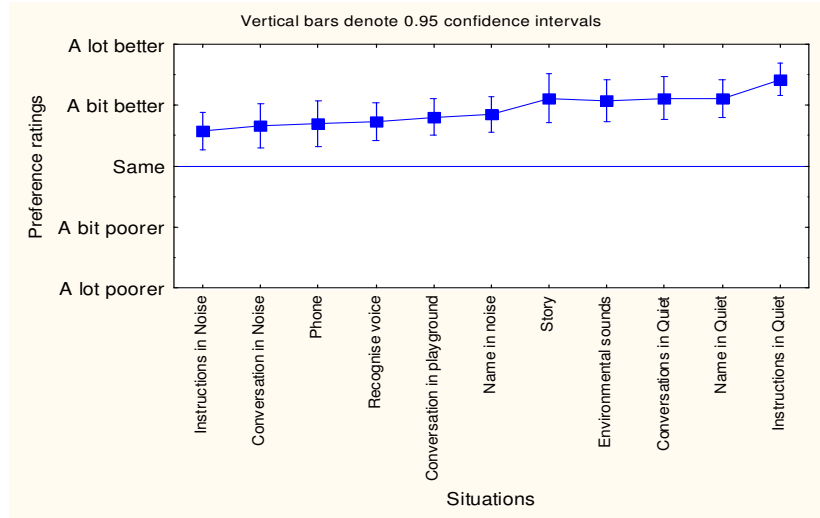


Results: Cortical responses at 55 and 65 dB input level

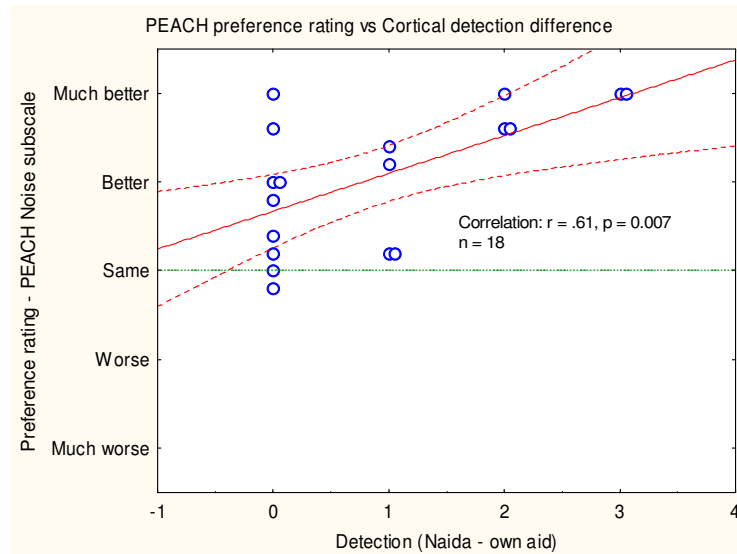
Naida vs own aid



Parents' Preference rating (PEACH)



Correlation between Peach and cortical detection



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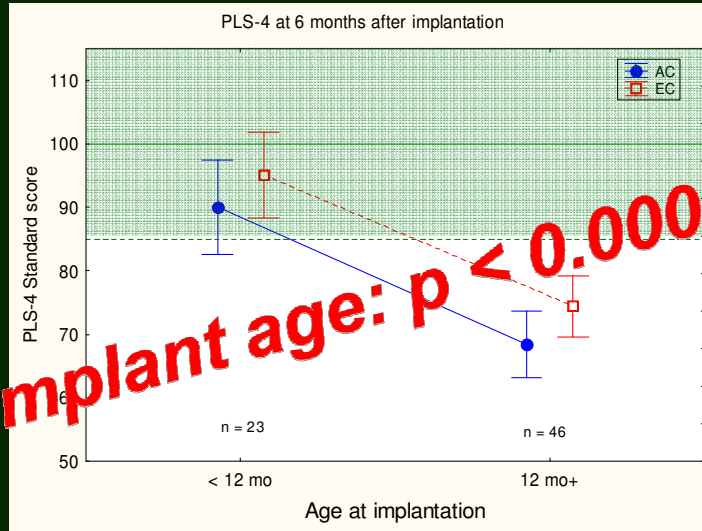
In summary,

- On average, choice of frequency compression did not significantly affect auditory comprehension or expressive communication.
- On average, speech production was better (just significant).
- On average, the use of frequency compression improved audibility of sounds at low input level.
- Increased audibility was associated with improved everyday functional performance.



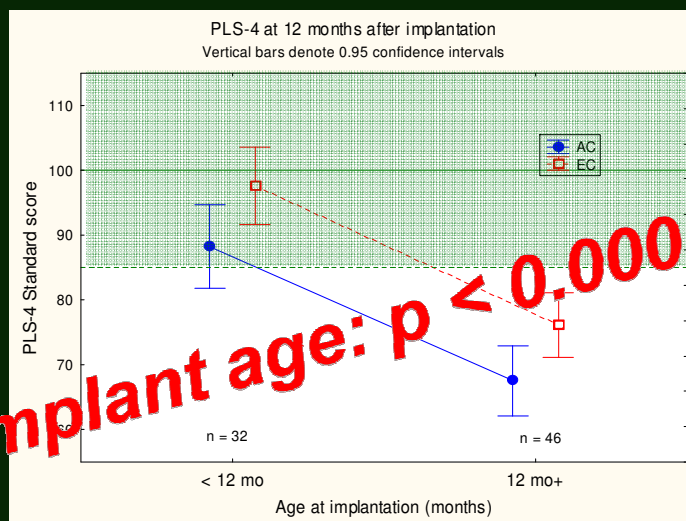
COCHLEAR IMPLANTS

Language at 6 months after implantation



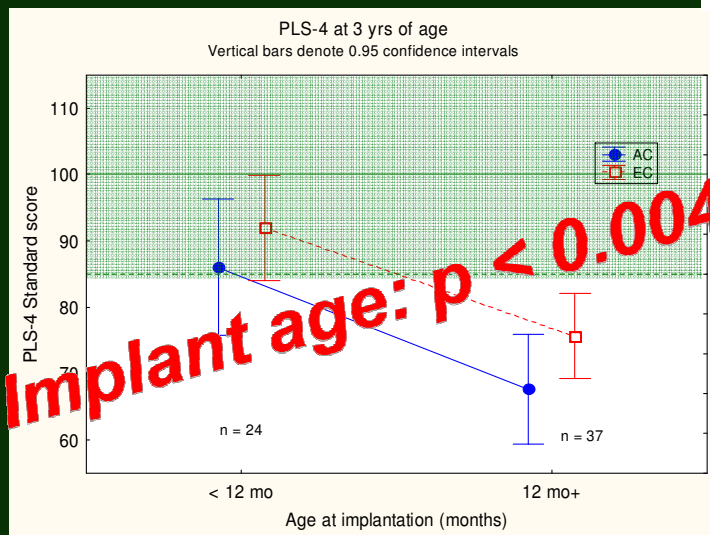
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Language at 12 months after implantation



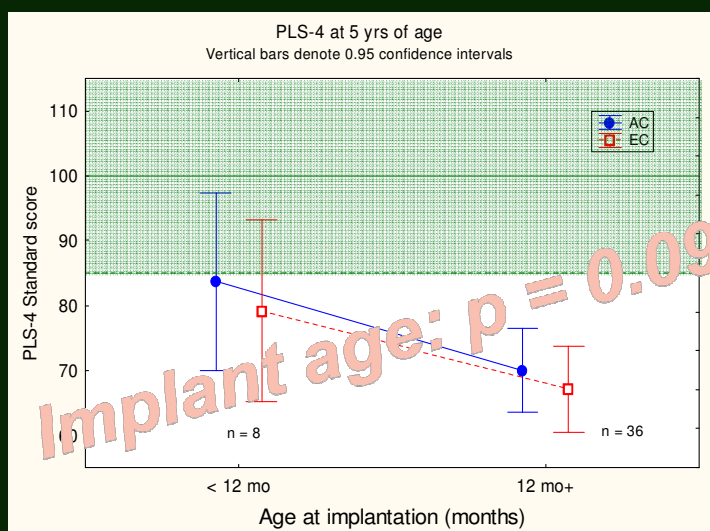
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PLS-4 at age 3 years



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PLS-4 at age 5 years



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Multi-linear regression



Yr 3 Axs	Gender	Mat Edn	Age at implantation	Bimodal experience
Auditory comprehension (n = 61)			Beta=-0.32 P=0.01	Beta = -0.22 P = 0.07
Expressive communication			Beta=-0.37 P=0.002	Beta = -0.16 P = 0.2
CDI Language Quotient (n=51)			Beta = -0.38 P = 0.006	Beta = - 0.14 P = 0.3
PEACH (n=43)	Beta=0.3 P = 0.02	Beta = -0.14 P = 0.3	Beta = -0.25 P = 0.06	Beta = -0.45 P = 0.001

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In summary,

- Better outcomes were associated with implantation before 12 months of age
- Bimodal experience was associated with better outcomes
- Multiple confounding variables need to be allowed for, when all data become available.

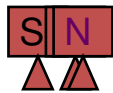
When children in the LOCHI study turn 5 years of age, we also evaluated

SPEECH PERCEPTION AND SPATIAL RELEASE FROM MASKING

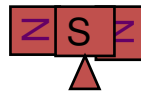
Speech perception

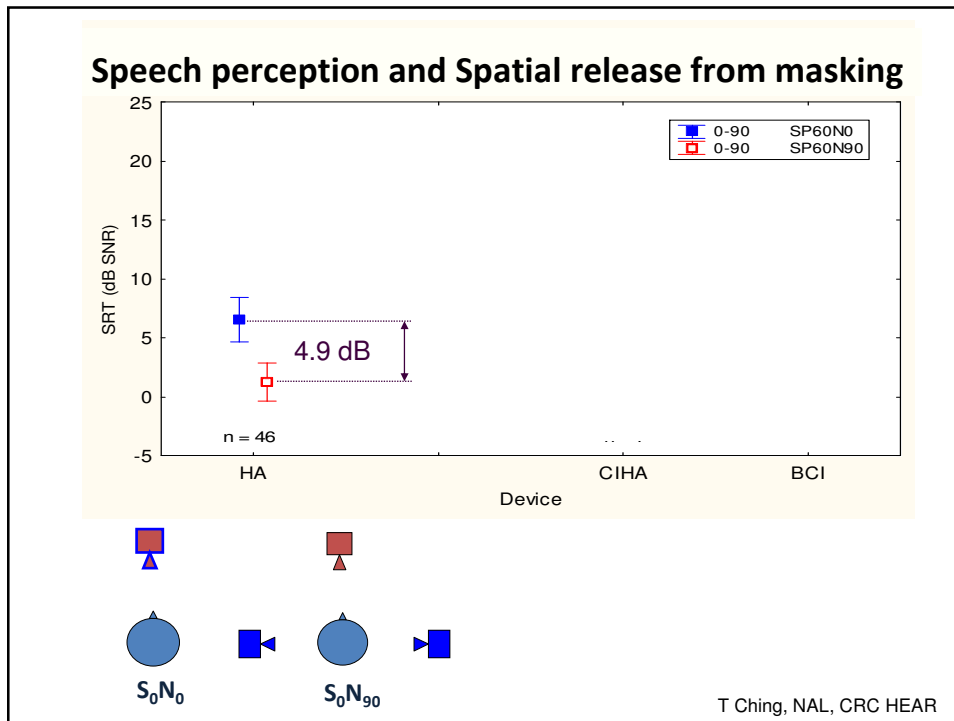


S_0N_0



$S_0N_{\pm 90}$





OVERALL SUMMARY

Summary of interim findings:

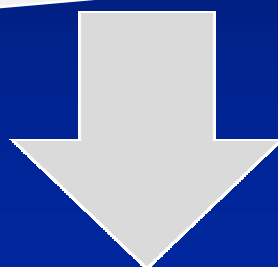
- Early detection and intervention enabled children to make a good head start in language development.
- Implantation < 12 months was associated with better outcomes.
- Longer term effects of early intervention will be investigated when all data are available.
- Some children demonstrate deficits in spatial masking release.
- Multiple factors affect level of attainment and rate of development.



At 6 and 12 months post-fitting,



Early amplification
More intervention hours
Spoken communication at home
More device use



Low birth weight
Additional disabilities
Auditory neuropathy
Greater hearing loss
Non-English speaking background
Caregiver has communication difficulties

Message for rehabilitationists

- Fit hearing aids early
- Fit hearing aids accurately
- Encourage hearing aid use consistently
- Encourage spoken communication at home
- Provide more intervention early



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Sanna Hou, Gerrie Krynda, Jessie Sjahalam-King, Vivienne Martin, Vicky Zhang, Iva Djula,
Patricia van Buynder, Julia Day, Nicole Mahler, Julia Day, Cassie Cook, Laura Street, Angela Wong.

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