

*Outcomes of children with hearing impairment:
a population-based, prospective study comparing
early and later-identified children*

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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
 - Communication 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)

Newborn hearing screening: early detection and diagnosis



Does early intervention really lead to better outcomes?

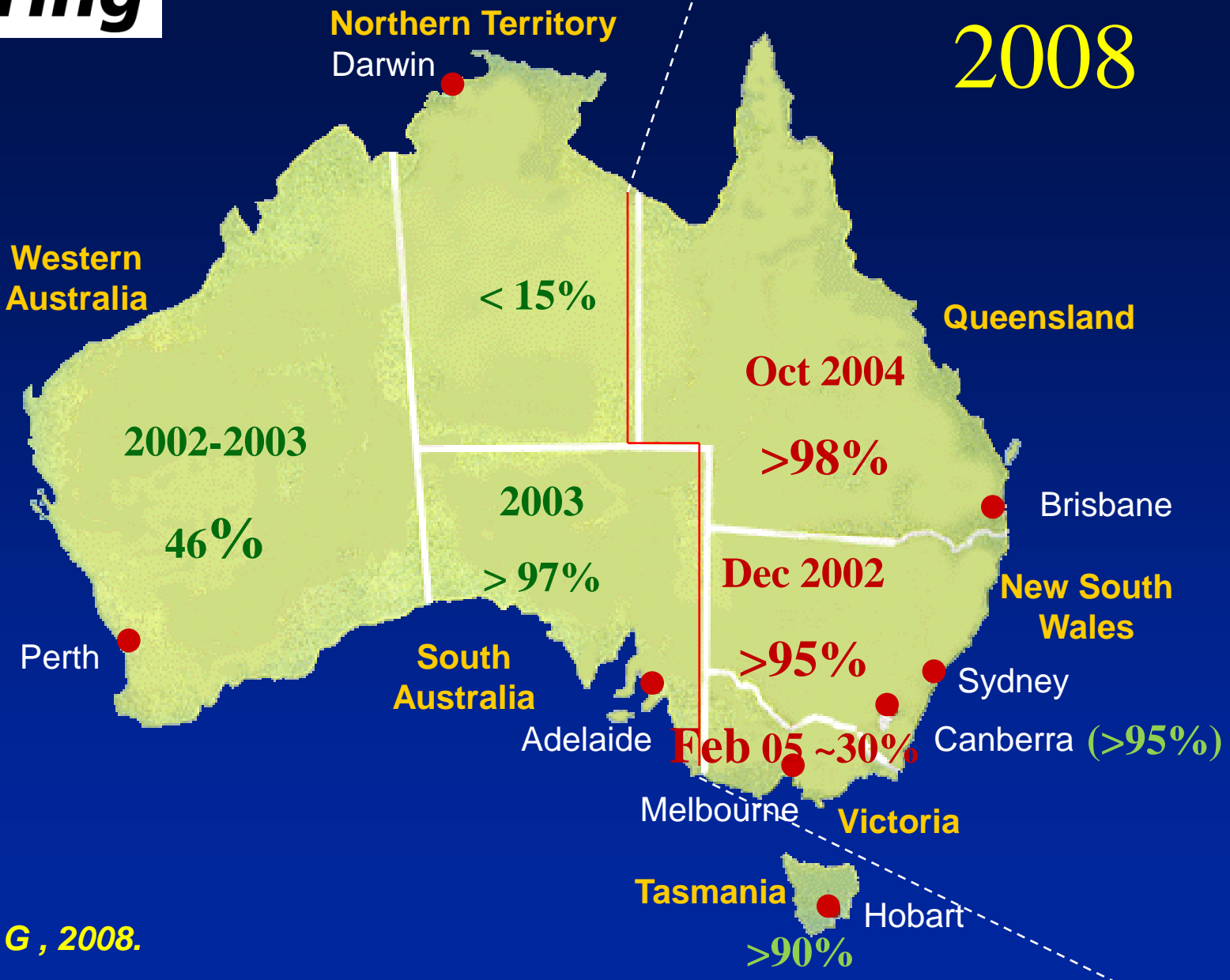
Research evidence is inconclusive

(Ching et al, 2008)

- ◆ Program-based retrospective cohort studies
(Yoshinaga-Itano et al, 1998; Moeller, 2000; Fitzpatrick et al, 2007).
✓ ✓ ✗
- ◆ Community-based retrospective cohort study
(Kennedy et al, 2006)
✓

“There were no prospective studies that directly examine whether earlier intervention result in improved speech, language, or educational development.” (USPSTF, 2001)

2008



Leigh G , 2008.

In 2005, we commenced ...

Longitudinal

Outcomes of

Children with

Hearing

Impairment ...



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Aims

- ◆ To establish an evidence base for the speech, language, functional, psycho-social and educational outcomes of children who use hearing aids and/or cochlear implants;
- ◆ To quantify the effect of a range of factors, including age of intervention, on different outcomes.
- ◆ To relate etiology to outcomes
- ◆ To track individual development of outcomes

Participants

- ◆ Born between Dec 02 and Aug 07 in NSW, Qld, Vic who first received amplification under 3 years of age

Method

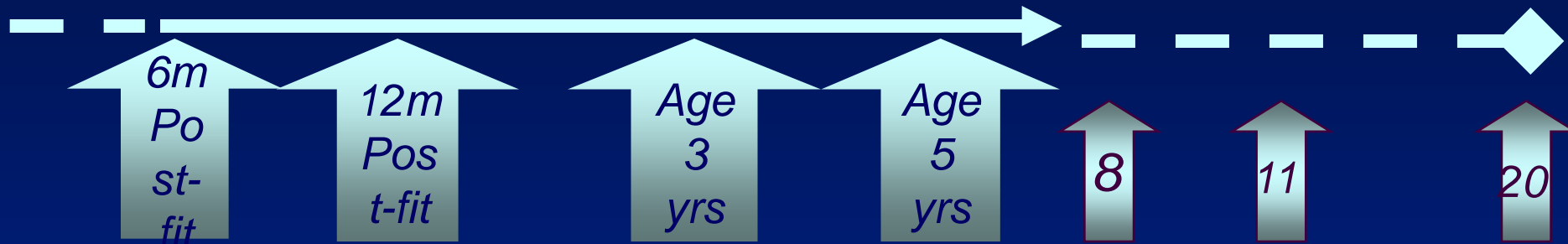
- ◆ RCT for prescription: NAL or DSL
- ◆ Collect demographic, audiological information and information about intervention for each participant.
- ◆ Assess non-verbal cognitive ability at 5 years of age
- ◆ Genetic testing

Method (etiology)

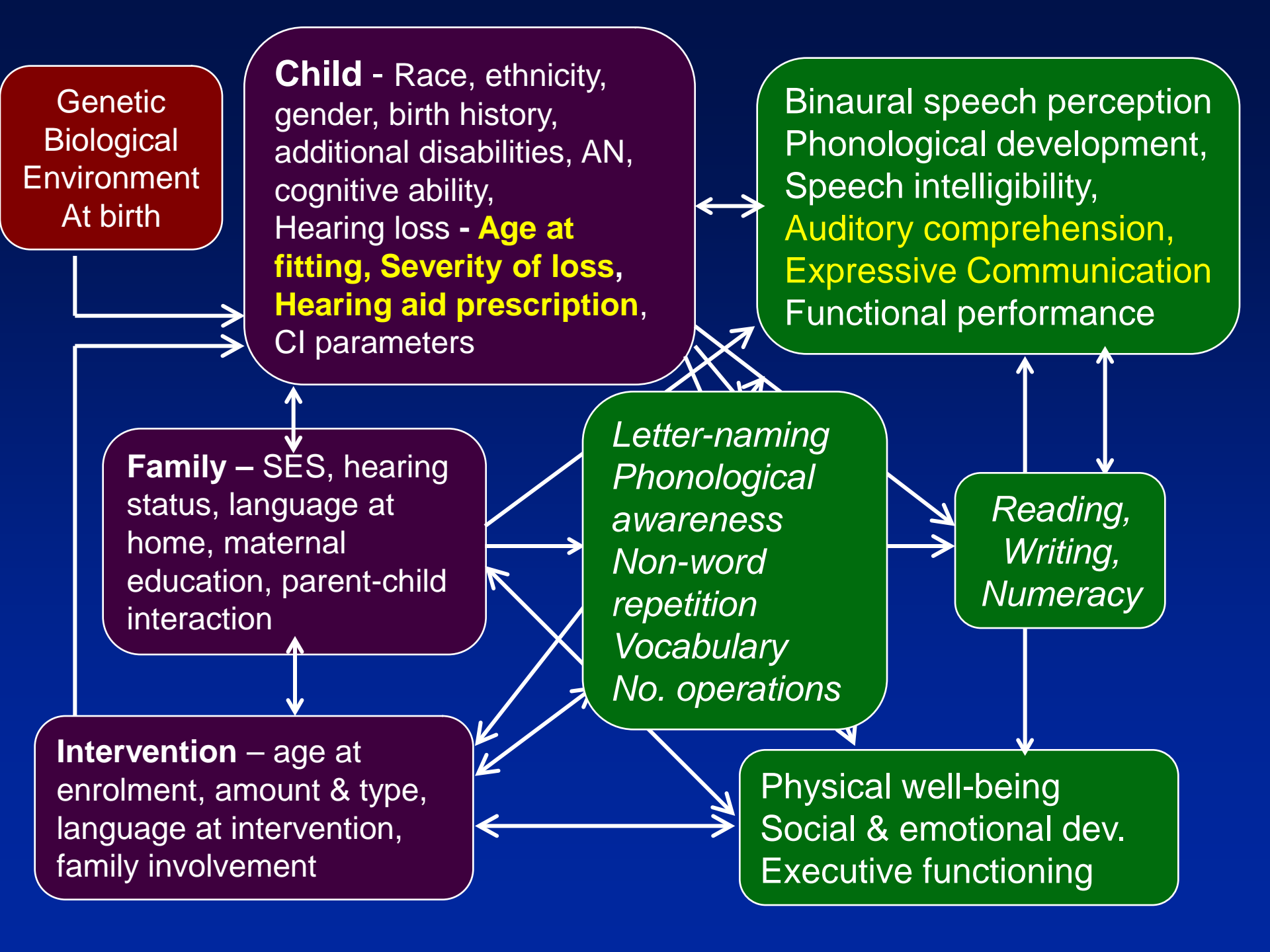
- ◆ Parental questions
- ◆ Tests of newborn blood spots
 - CMV ~ 25% (Morton & Nance, 2006)
 - mutations in GJB2 (Cx 26) ~ 15-21%
 - mutations in SLC26A4 (Pendred) ~3-7%
 - A1555G mutations (aminoglycosides ototoxicity) ~ 1%

Method

*First
Fit*



- ◆ Multiple assessments over time
 - to monitor individual development of different overcomes over time
 - To assess relative impact of different factors at different age



Measures

<i>Domains</i>	<i>Measures</i>
Speech production	DEAP
Speech intelligibility	BIT
Binaural Speech perception – release of masking	NU-CHIPS BKB/BEST lists
Language	M-BCDI <u>PLS-4</u> <u>Child Development Inventory</u> CELF-4
Reading	WDRB - Reading vocabulary, Passage comprehension
Phonological awareness	PAT – letter naming CTOPP
Phonological memory	CTOPP – memory for digits Dollaghan & Campbell – nonword repetition

Outcomes measures (cont'd)

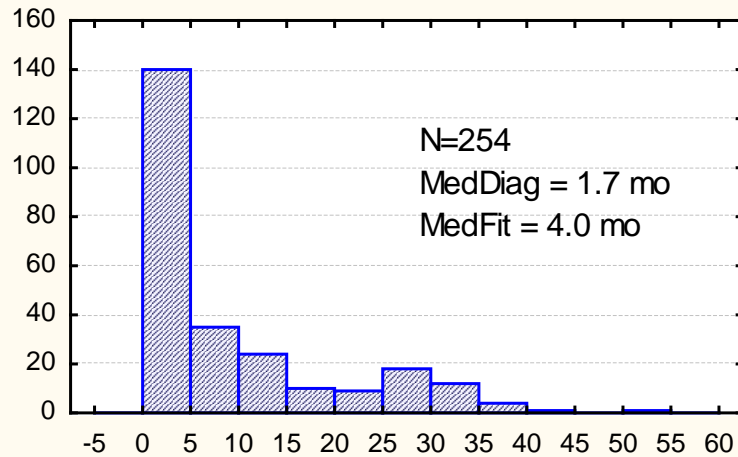
<i>Domains</i>	<i>Measures</i>
Receptive vocabulary	<u>PPVT-4</u>
Functional performance	<u>PEACH</u> , TEACH
Psychosocial skills	Child Development Inventory SDQ, PHSCS
Educational attainment	WIAT – numeracy TWS, WDRB State-wide assessments
Quality of life	Child QoL
Executive functioning	BRIEF

To date ...

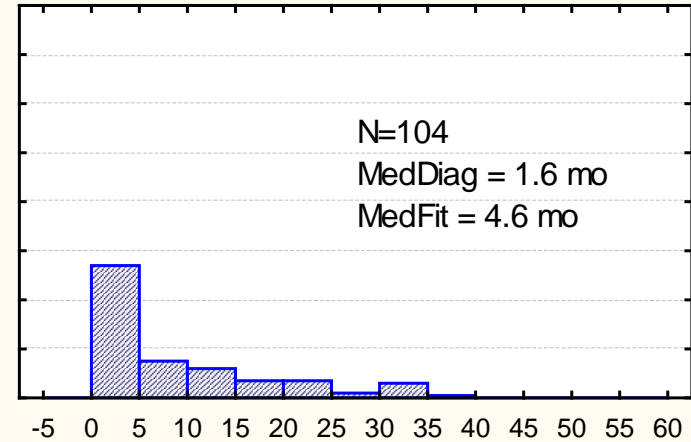
Currently enrolled

- ◆ About 471 children and families
 - 228 in NSW, 139 in Vic, 04 in Qld
 - 122 reported additional disabilities
 - 54 reported developmental delay
- ◆ 346 use hearing aids
- ◆ 125 have cochlear implants
 - 97 in one ear, 28 in both ears

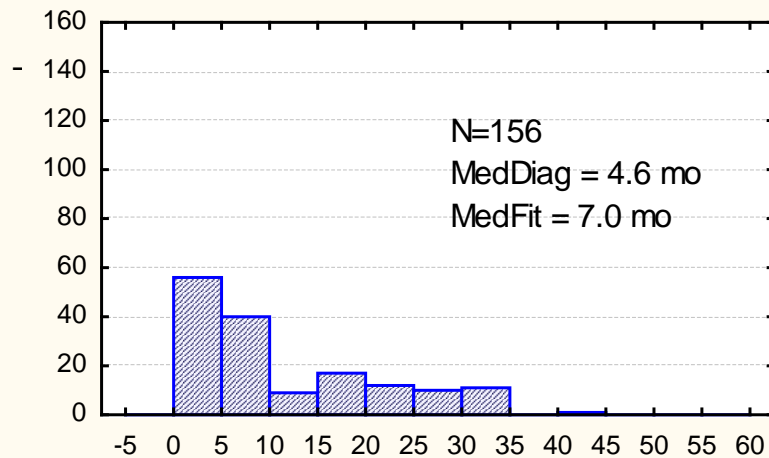
Participants



State: NSW



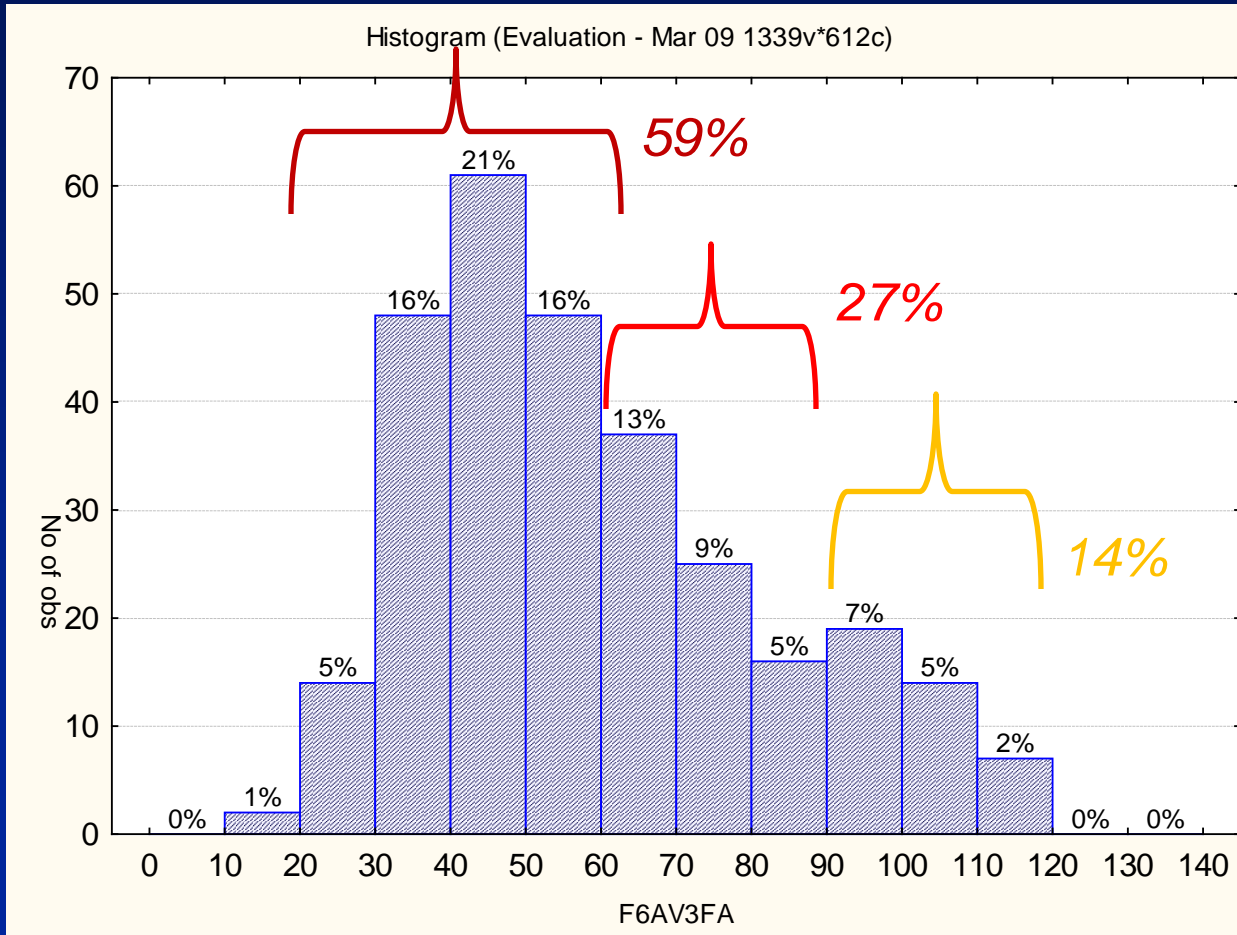
State: Qld



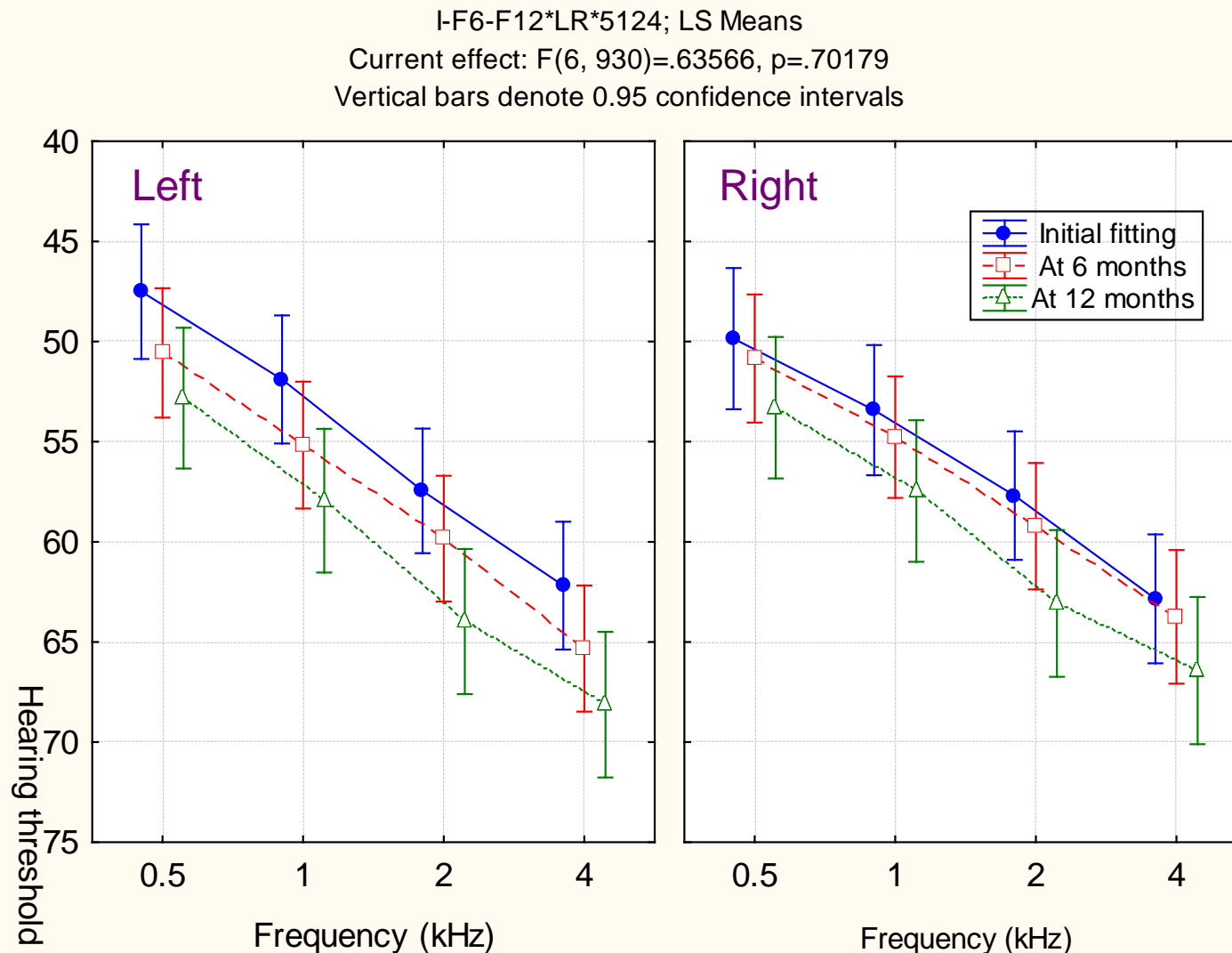
State: Vic

Fitted <6m: 54.3%
Fitted >= 6m: 45.7%

Distribution of hearing loss



Audiogram over first 12 months





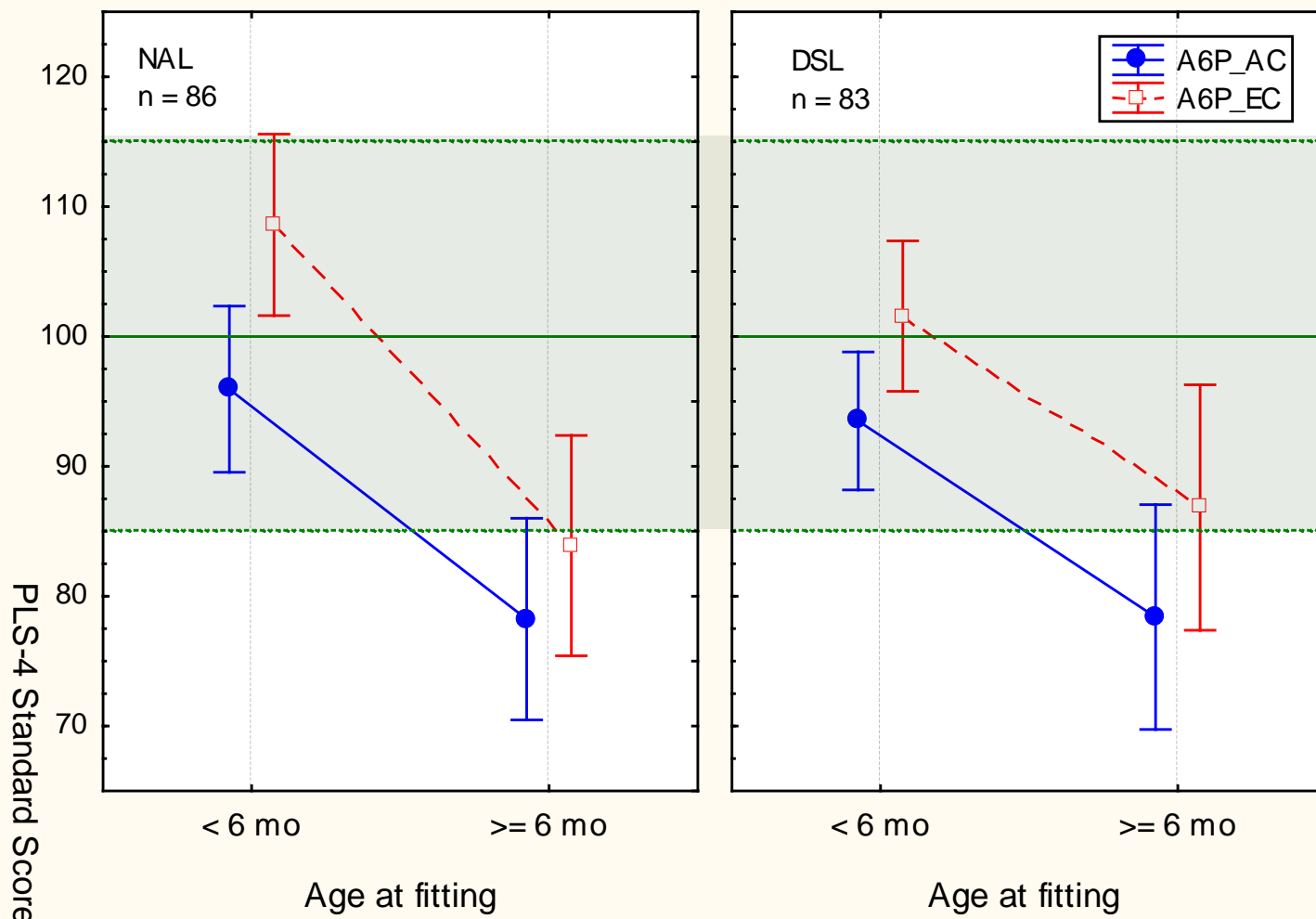


PLS-4 at 6 months after fitting

- *Effect of age of fitting: $p < 0.001$ **
- *Effect of hearing loss: $p = 0.002$ **
- *Effect of prescription: $p = 0.6$*

Covariate means:
F6AV3FA: 56.7383

(Computed for covariates at their means)
Vertical bars denote 0.95 confidence intervals

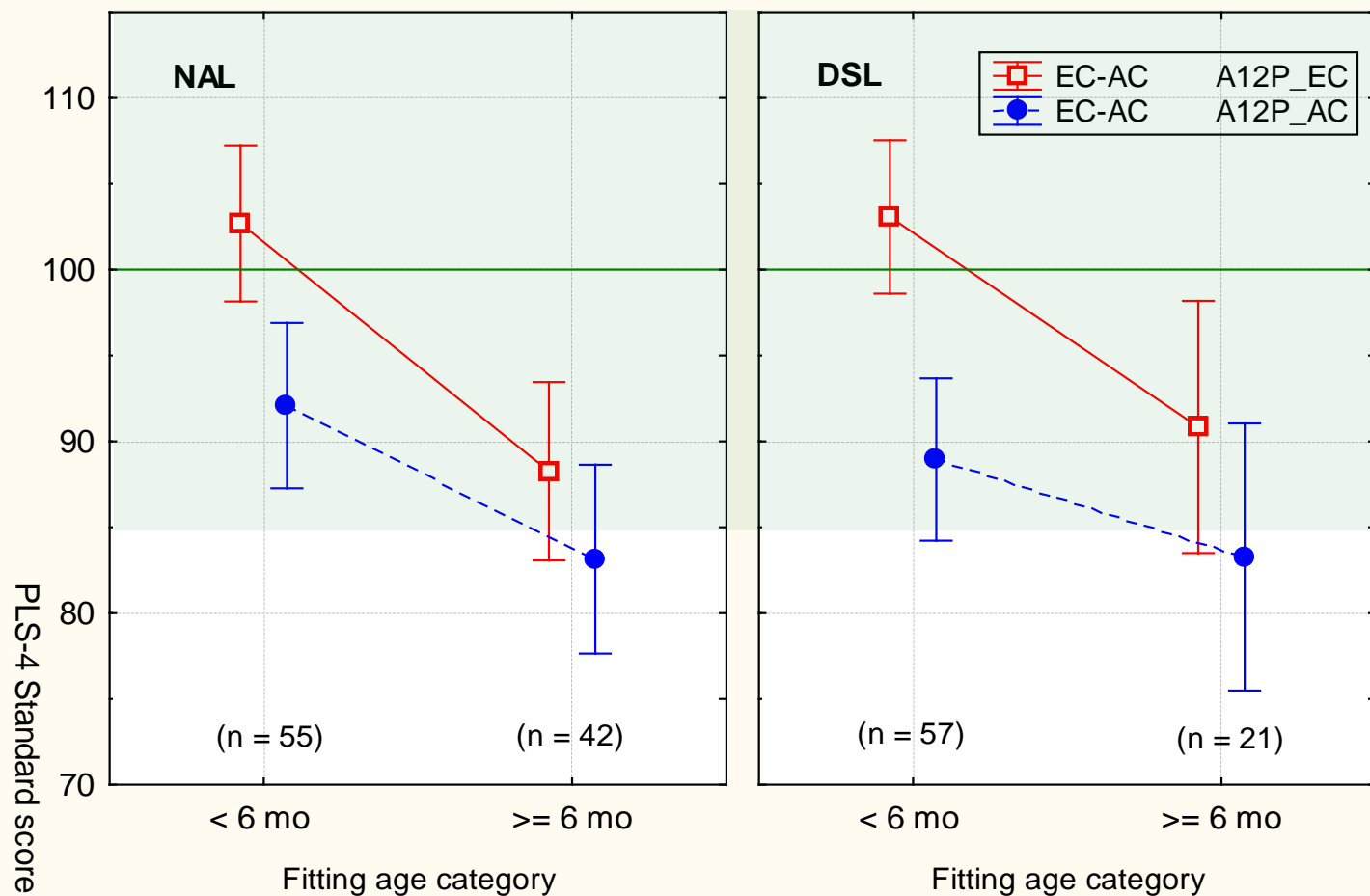


PLS-4 at 12 months after fitting

- Effect of age of fitting: $p = 0.0001^*$
- Effect of hearing loss: $p < 0.0001^*$
- Effect of prescription: $p = 0.9$

Covariate means:
F6AV3FAMD: 55.64857

EC-AC*"Cat2Fit"*"Cat2Pres"; LS Means
EC-AC * Cat2Fit: $F(1, 170)=7.741, p=.005$
Vertical bars denote 0.95 confidence intervals



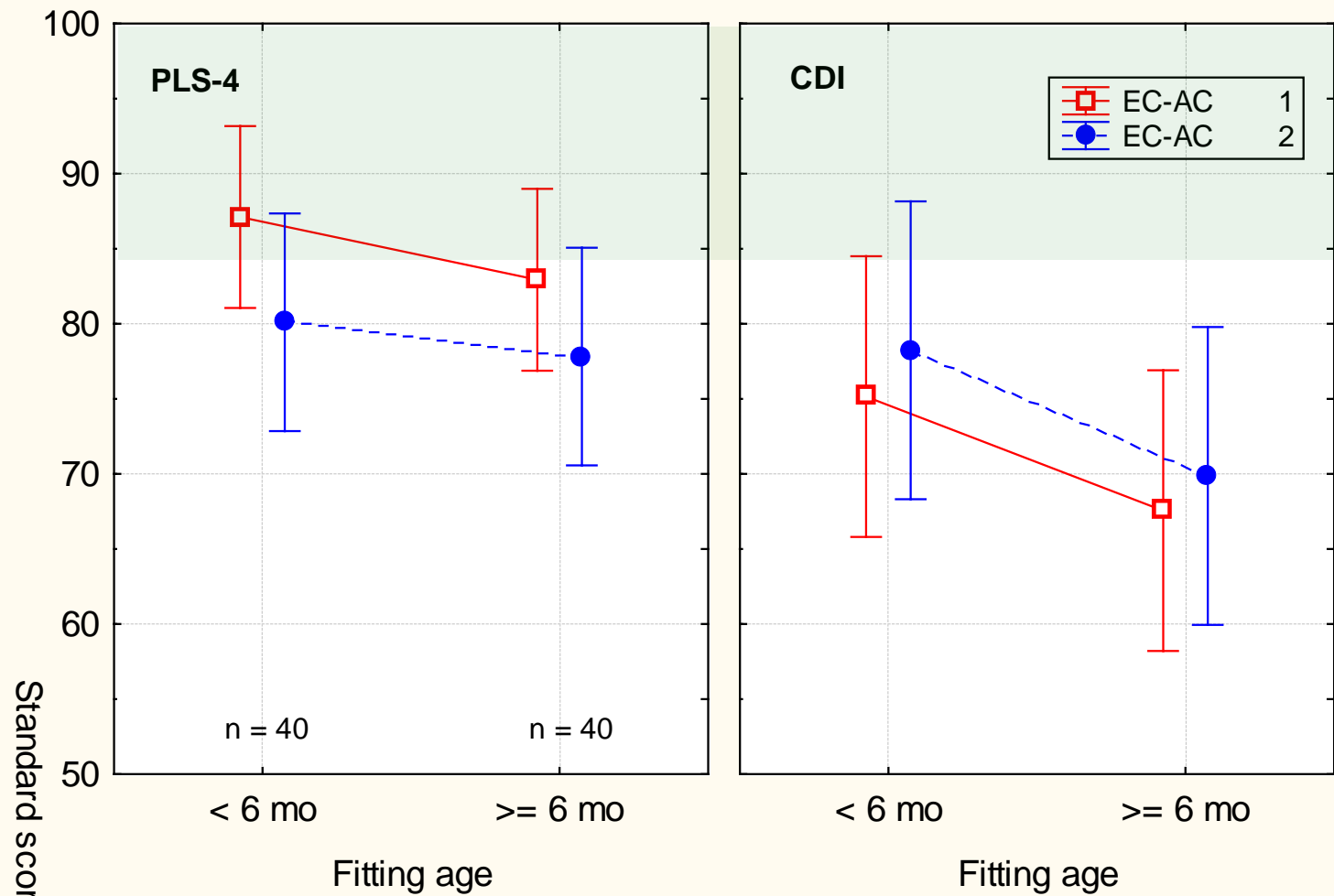
PLS and CDI at 3 yrs

Effect of hearing loss: $p < 0.001^*$

Effect of age at fitting: $p = 0.2$

Covariate means:
F6AV3FAMD: 53.73

PLS-CDI*EC-AC*"Cat2Fit"; LS Means
Current effect: $F(1, 77) = .66743, p = .41647$
Vertical bars denote 0.95 confidence intervals





Receptive vocabulary at 3 yrs



- *Effect of age of fitting: $p = 0.8$*

Covariate means:
F6AV3FAMD: 50.71733

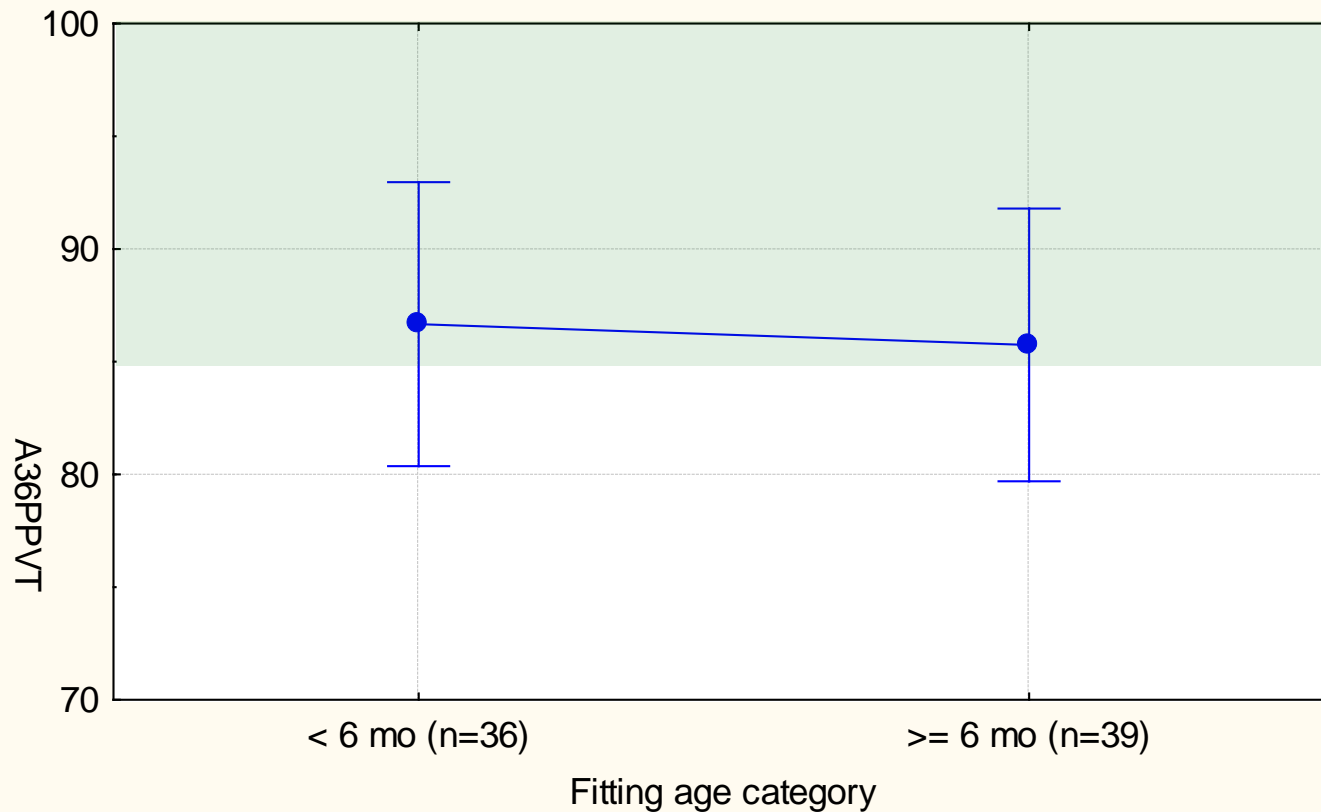
Receptive Vocabulary at 3 yrs

Current effect: $F(1, 72) = .04429, p = .83391$

Effect of 3FA: $F = 1.95, p = 0.17$

Effect of "Cat2Fit": $F = 0.04, p = 0.8$

Vertical bars denote 0.95 confidence intervals



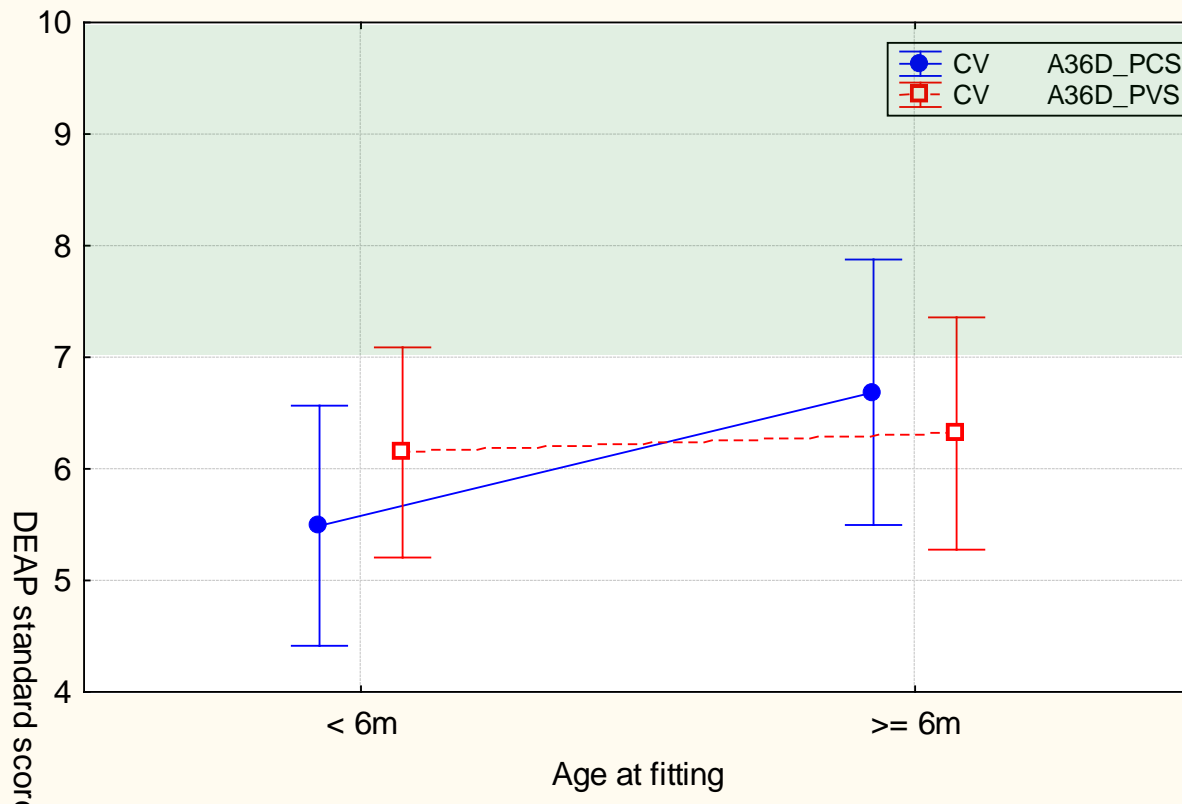


Speech production at 3 yrs



Covariate means:
F6AV3FAMD: 51.81858

CV**Cat2Fit"; LS Means
Current effect: $F(1, 56)=5.0163, p=.02910$
Vertical bars denote 0.95 confidence intervals



Psychosocial development (CDI) at 3 yrs:

3 yrs:

- Effect of age of fitting: $p = 0.1$
- Effect of hearing loss: $p = 0.027^*$

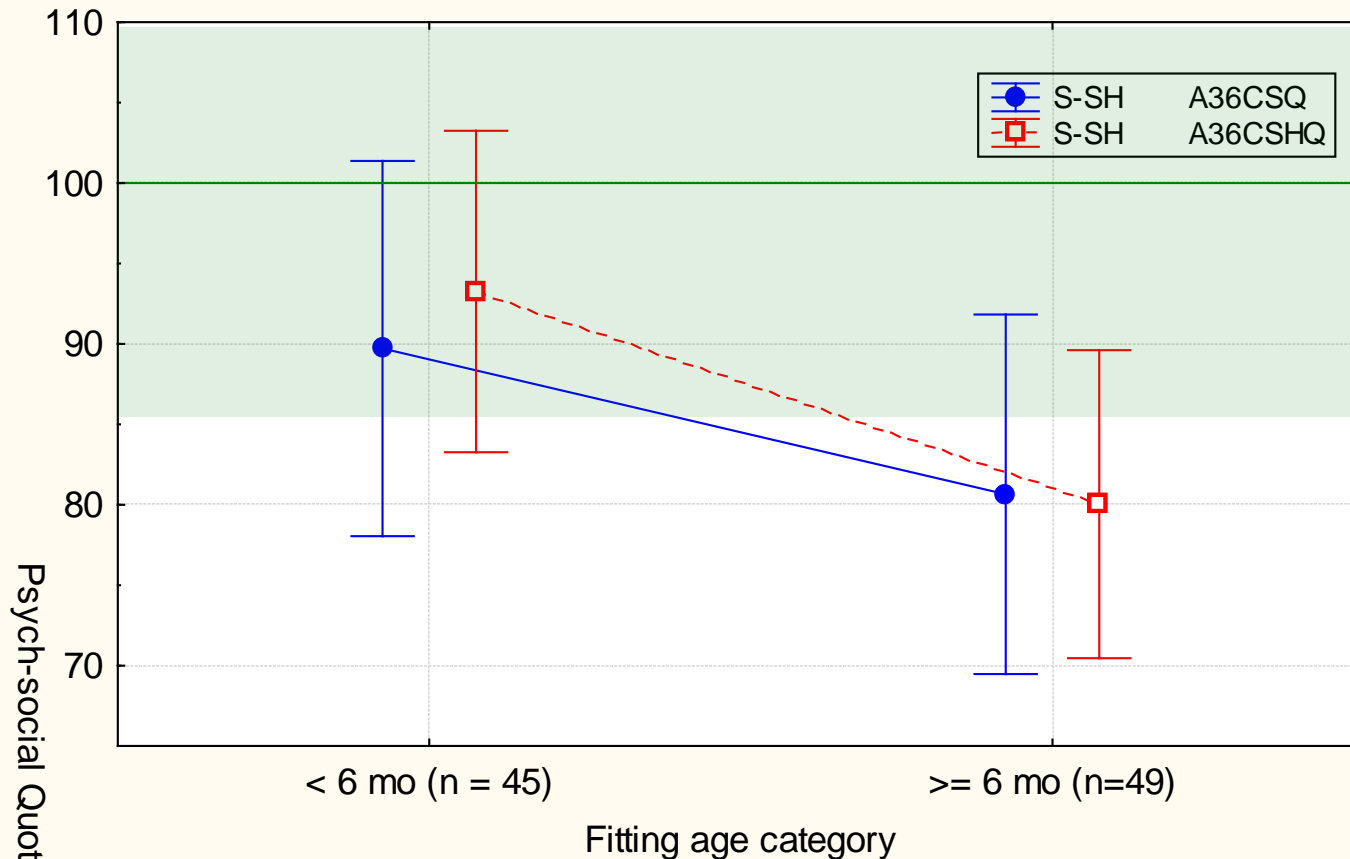
Covariate means:
F6AV3FAMD: 55.25709

S-SH*"Cat2Fit"; LS Means

Effect of hearing loss: $F(1, 91)=5.04, p=.027$

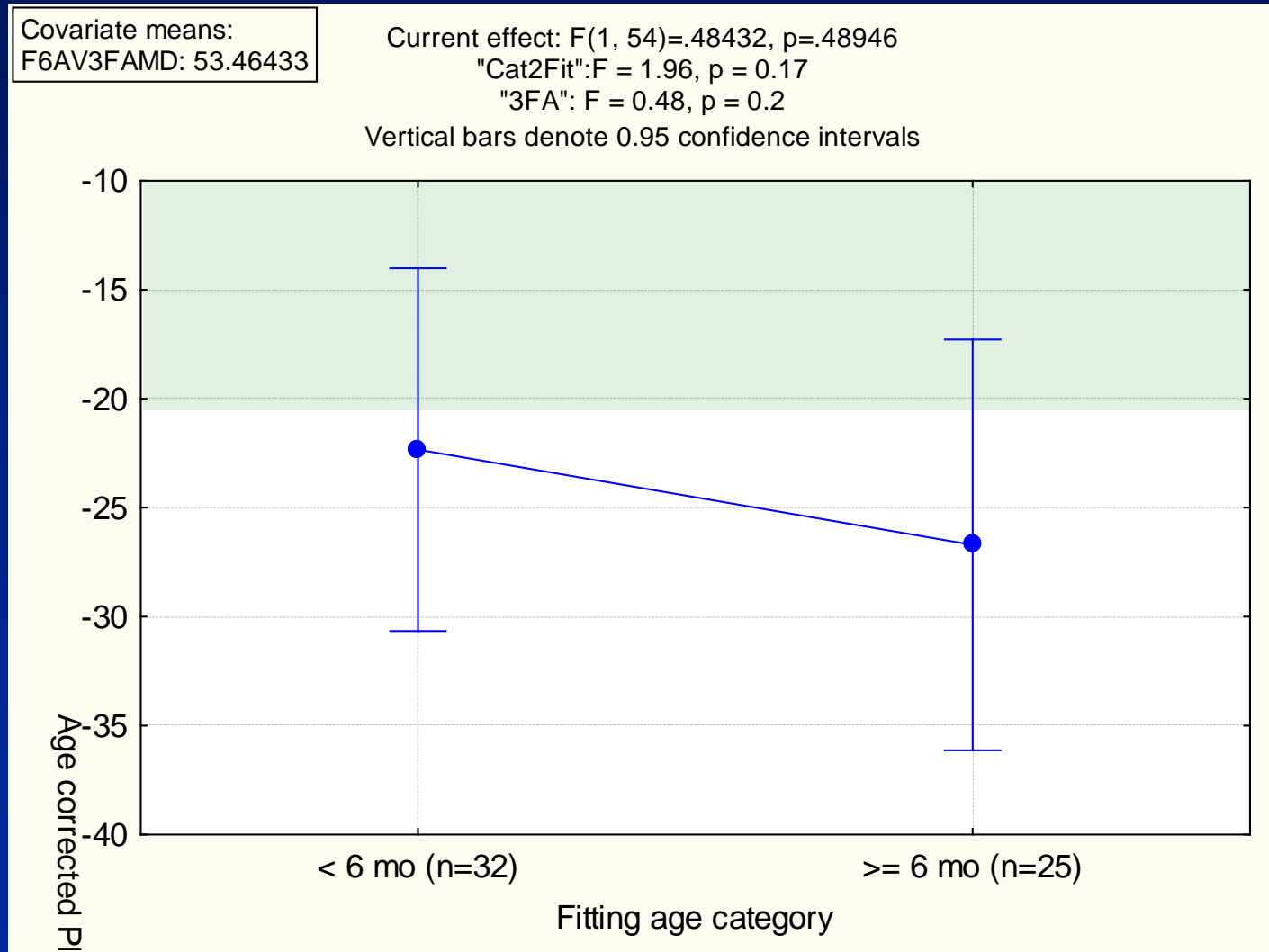
(Computed for covariates at their means)

Vertical bars denote 0.95 confidence intervals



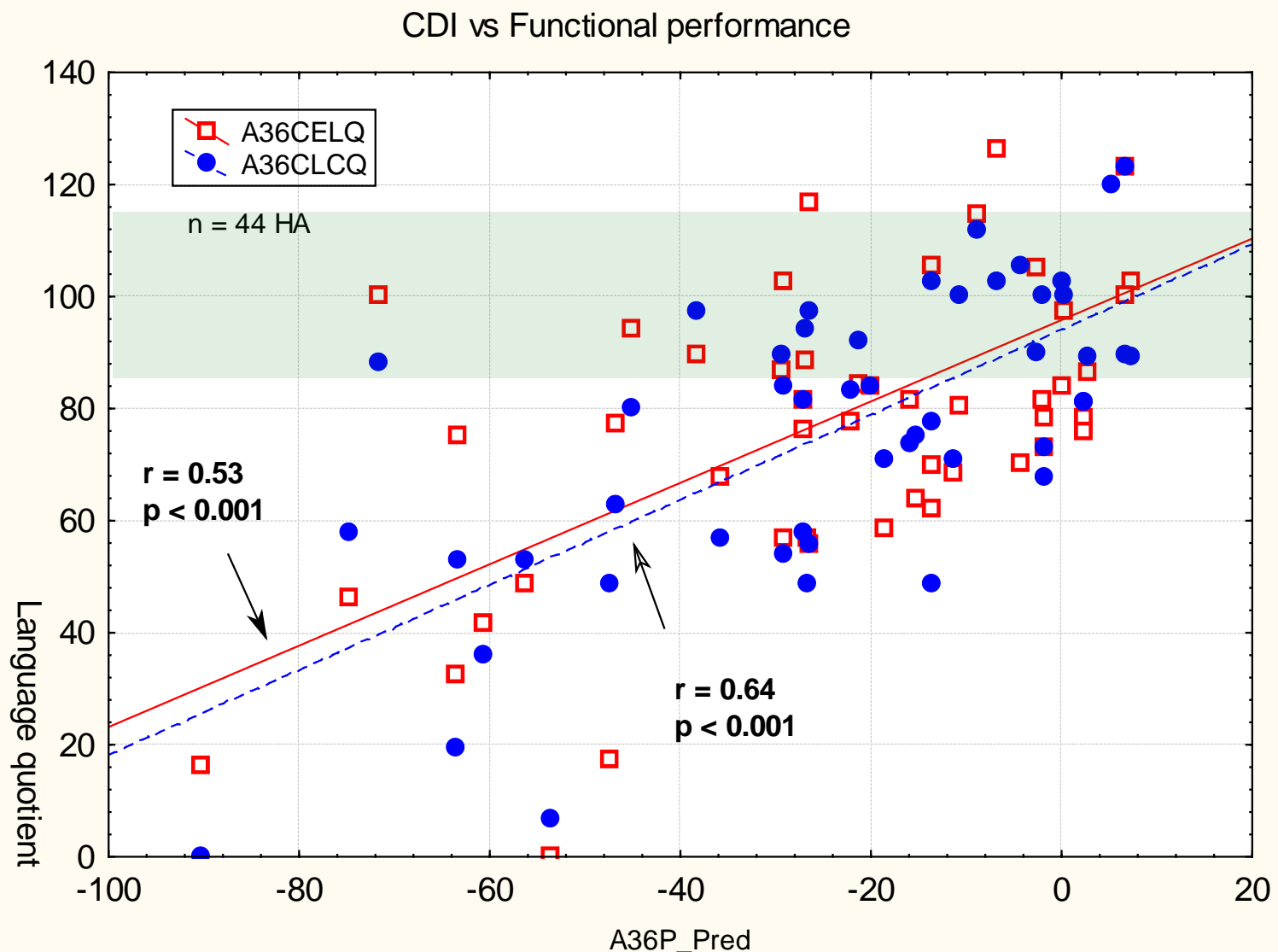
Functional performance (PEACH) at 3 yrs

Effect of age of fitting: $p = 0.1$



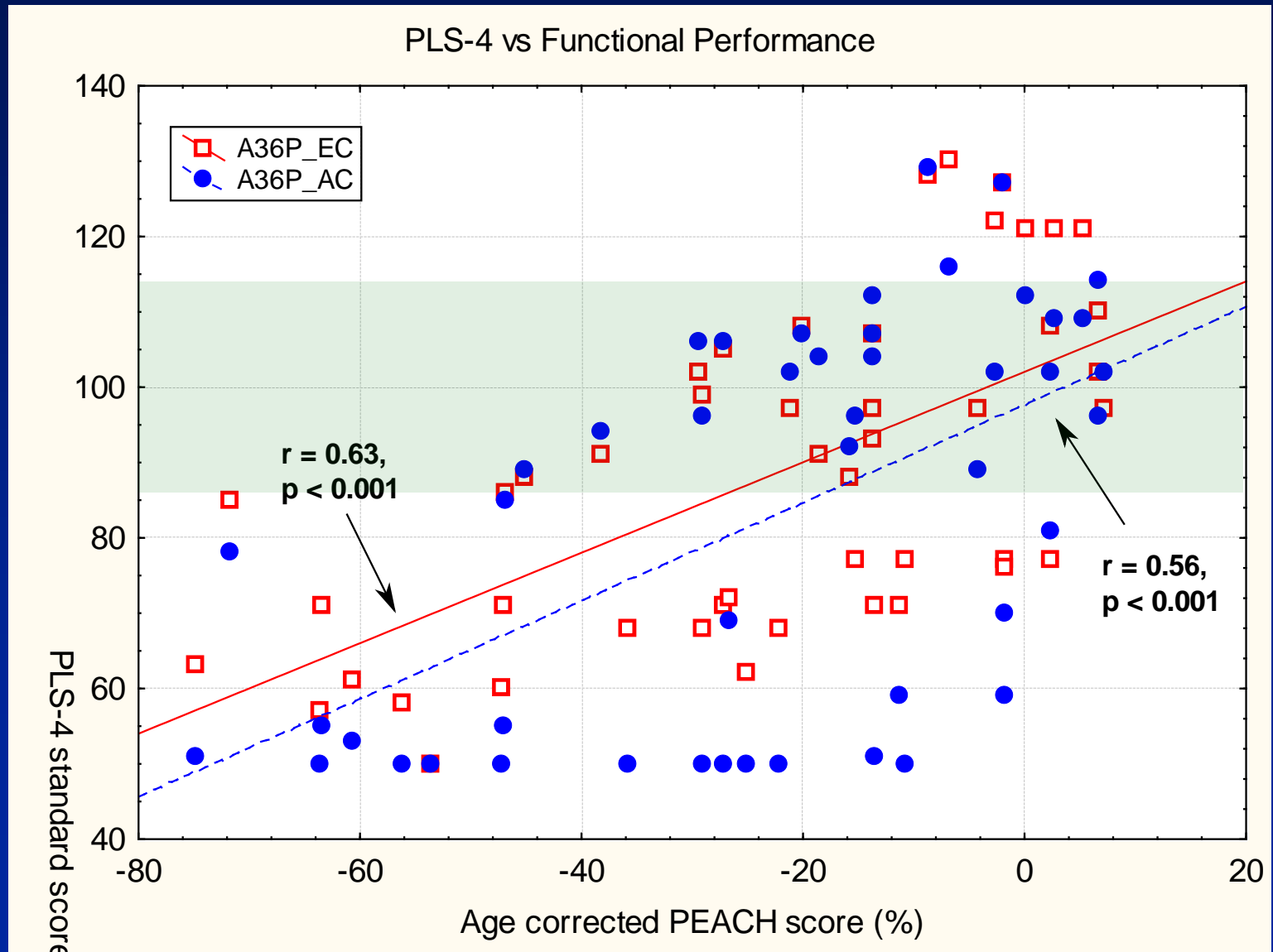
PEACH correlated with language skills

CDI

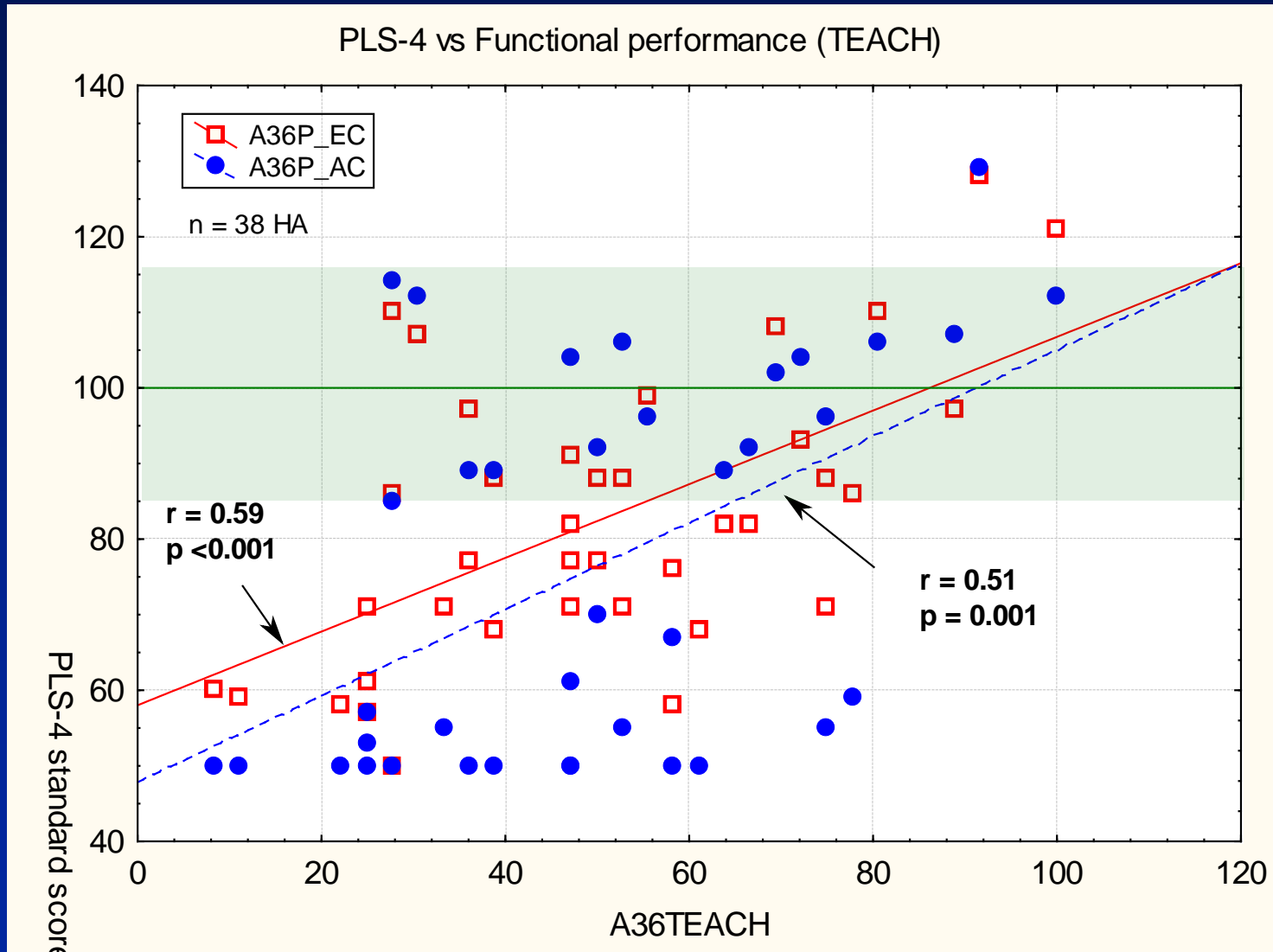


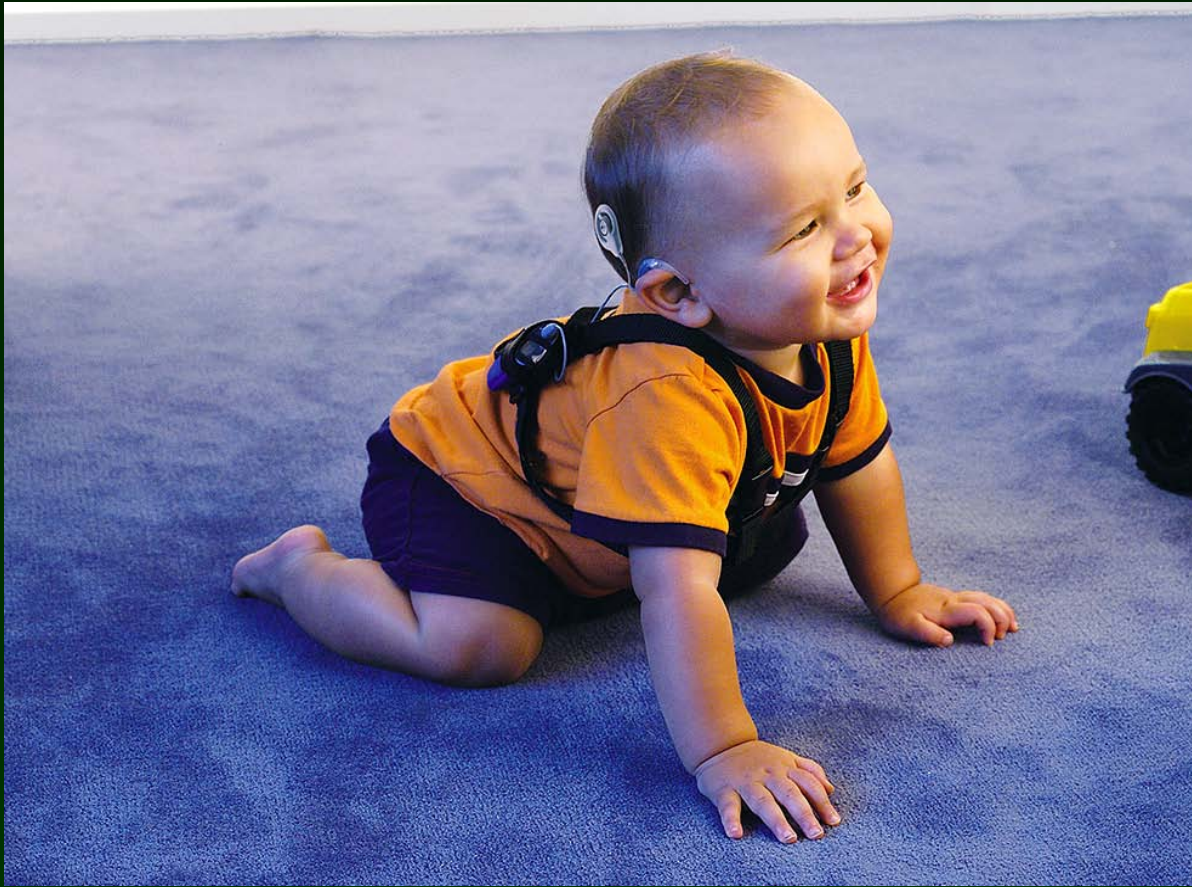
PEACH correlated with language skills

PLS-4



TEACH correlated with language skills



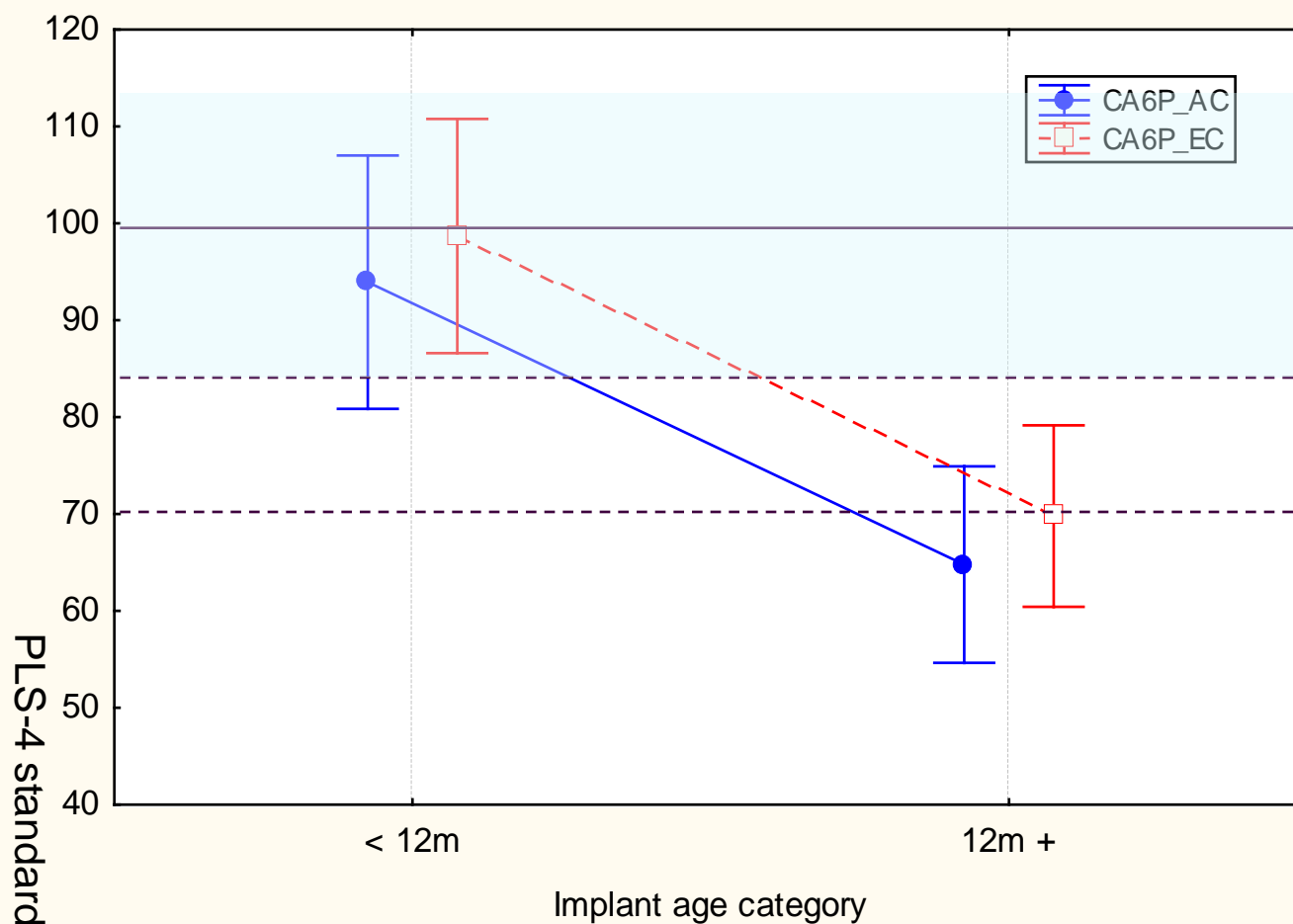




Six months after implantation

Covariate means:
MonFit: 10.97917

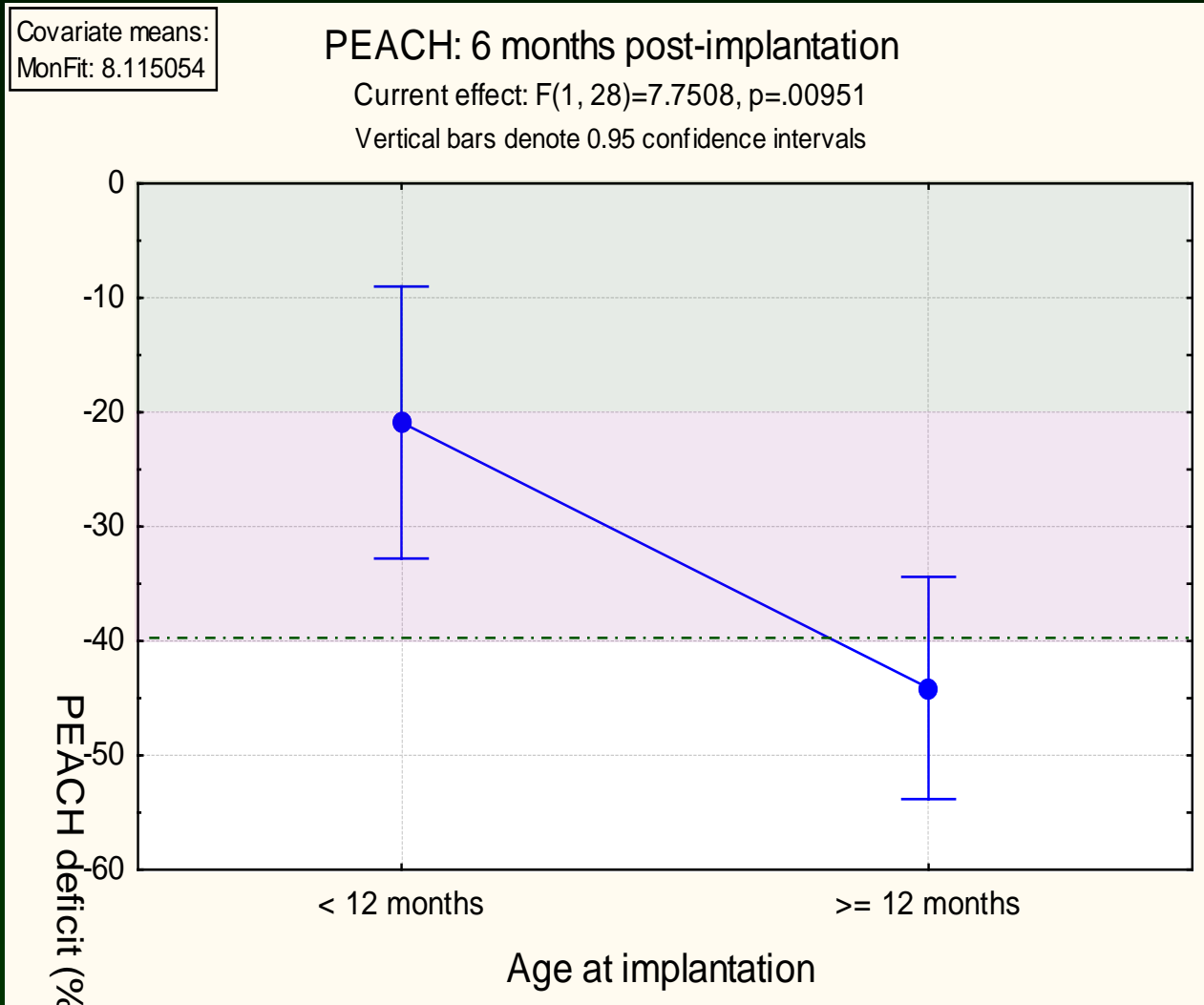
Language at 6 months after implantation
Wilks lambda=.71507, $F(2, 28)=5.5785$, $p=.00914$





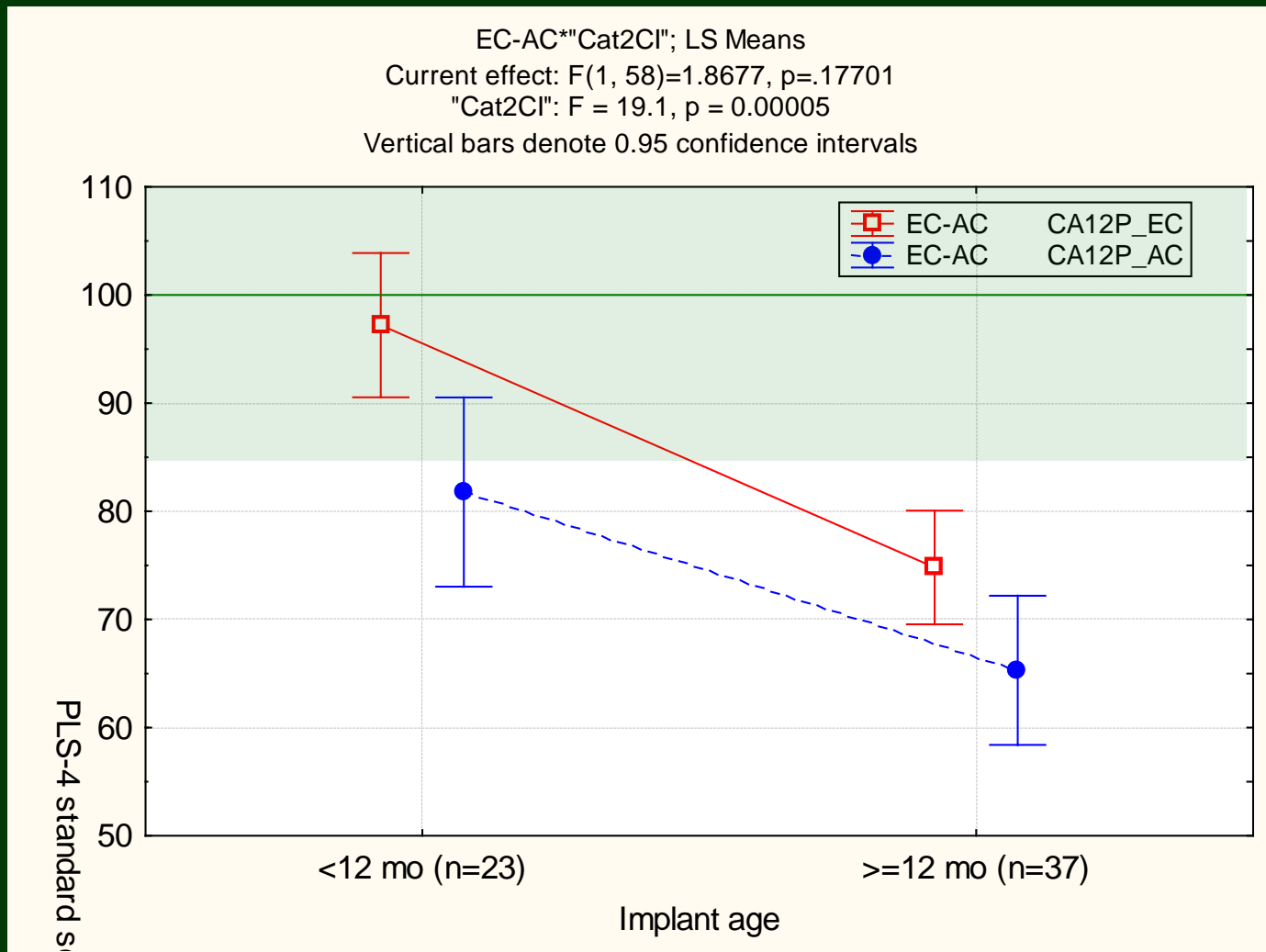
Functional performance

Effect of age of implantation: $p = 0.009^*$



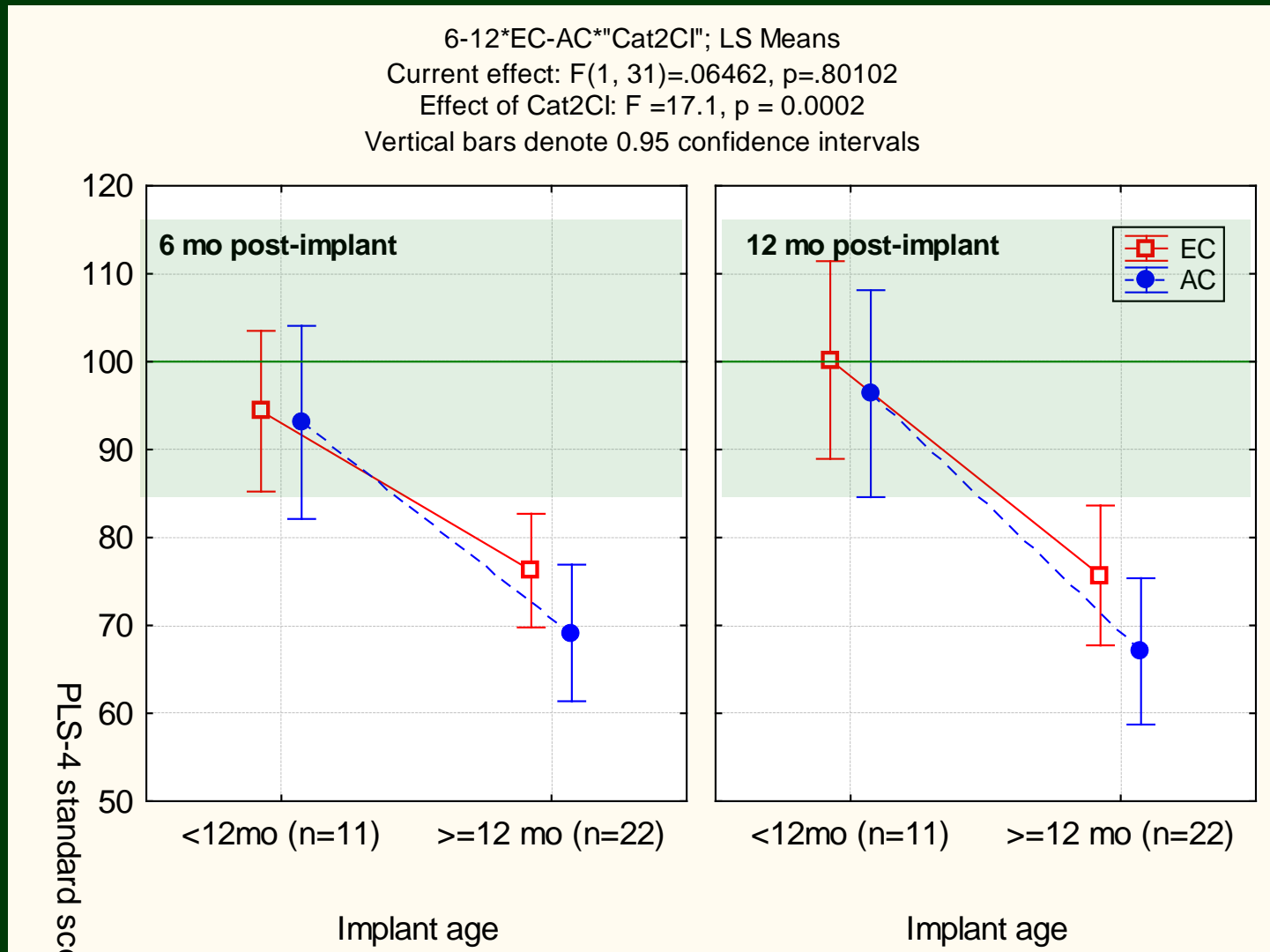
Language at 12 months post CI

Effect of age at implant: $p < 0.0001^$*

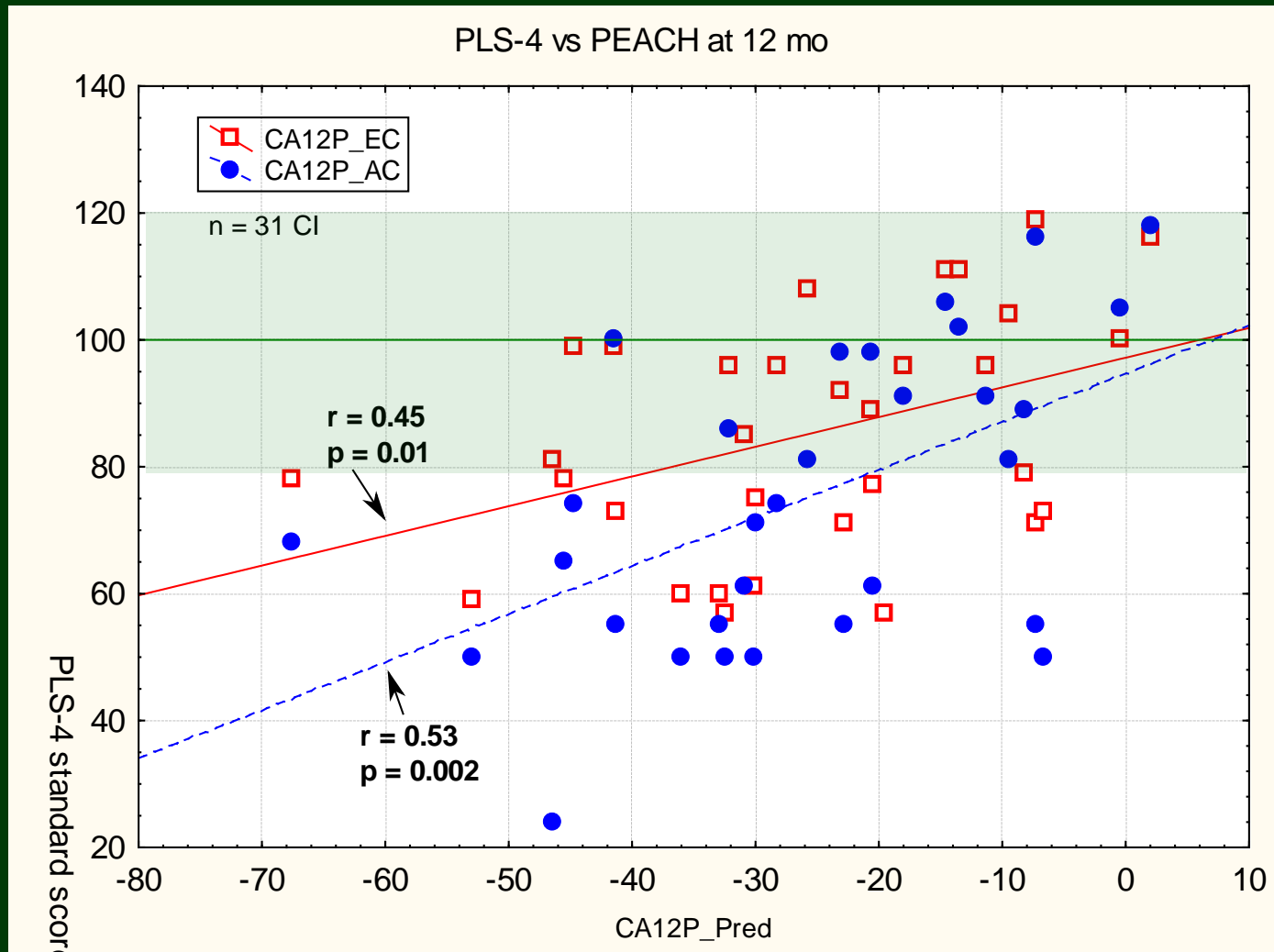


Language at 6 and 12 months after implant

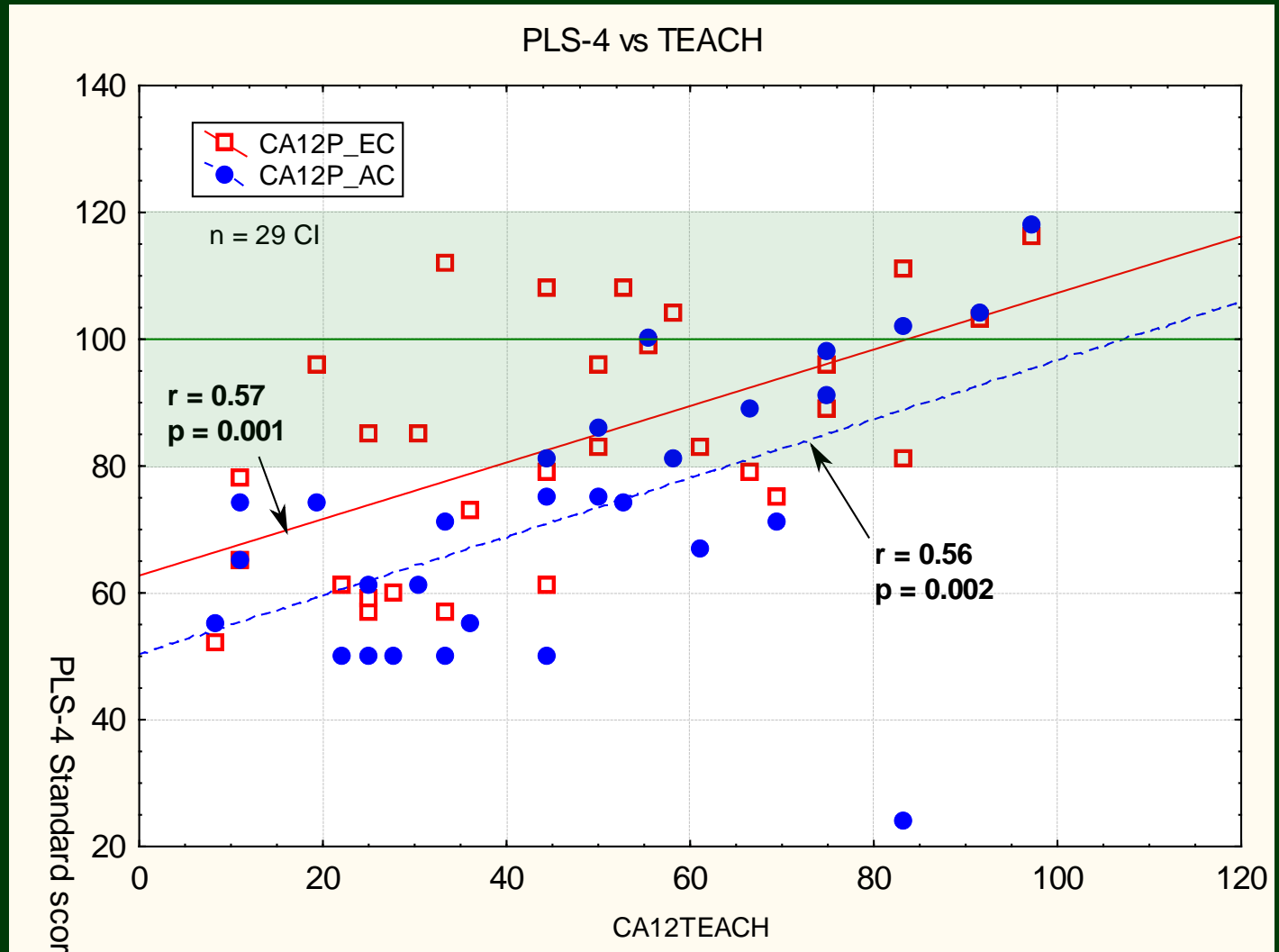
Effect of implant age: $p < 0.001$



PEACH correlated with language skills

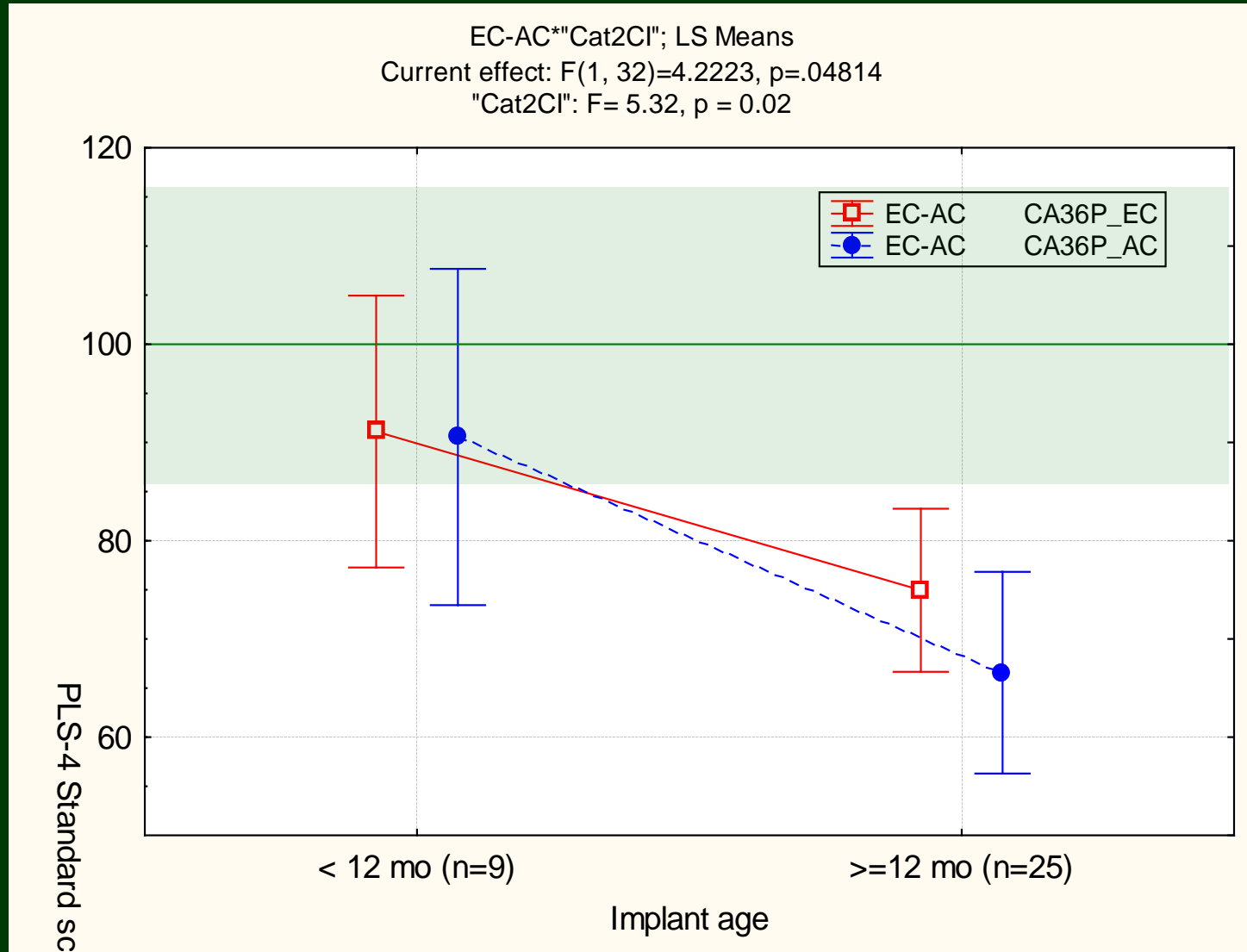


TEACH correlated with language skills



Language skills at 3 yrs

Effect of age of implant: $p = 0.02$



Summary of interim findings

- ◆ At 6 and 12 months after hearing aid fitting, children who received early intervention developed language within the range of normal-hearing peers.
- ◆ At 3 years of age, severity of hearing loss has a greater effect than age of fitting on language development of children with hearing aids.
- ◆ Children who received an implant before 12 months of age developed expressive and receptive language within the range of normal hearing peers, when measured at 12 months after implantation and at 3 years of age.

On-going work

- ◆ Individual development of different outcomes over time
- ◆ Effect of multiple factors on outcomes of children with hearing loss
- ◆ Develop a clinical tool so that children's outcomes could be predicted shortly after intervention. This will be used to guide best practice intervention for hearing loss.



Screening and Early detection

- ◆ *“My husband, he ...grew up in a Deaf family and he wanted to know because he missed out on hearing aids and speech and any of those opportunities and he felt that if our children were deaf they should have access to those services”*
- ◆ *“Part of me wishes we had found out later.”*
- ◆ *“... it wasn't until they (the children) slept through the night at about 3 months that I actually felt human and ready to cope with it.”*

Diagnosis

- ◆ *(Parent who is hearing) “ It was a complete shock and I wanted to know how, why ... wanted an answer.”*
- ◆ *(One parent is hearing, one is deaf) “...it wasn't hard for me, it didn't worry me the slightest (deaf parent). It was hard for her (hearing parent)”.*
- ◆ *(Parent who is deaf) “I suppose the only slight disappointment I have had that she might cop a little bit of teasing at school ... or she might have to work a little bit harder. But no real, no real dramas from my, from my end.”*

Amplification

- ◆ *“.. telling me to put double sided tape on his ear and things like that. You know, I was just horrified.”*
- ◆ *“It felt like a horrible thing to do to your child. Like when you think of sticking something to the side of their head that’s going to hurt when it pulls off.”*
- ◆ *“... it did take me quite a while to come to terms with it (hearing aids). It took me months to be able to touch the hearing aids and work them with her.”*
- ◆ *“... that was a defining moment in a sense because he was really proud of them.”*

Audiological service

- ◆ *“I had a brilliant audiologist ... and she bent over backwards to fit us in if something was going wrong because that is the only time we would be there.*
- ◆ *here... they just don't get, they just don't appear to get it.”*

Intervention services

- ◆ *“... it was really discriminatory!”*
- ◆ *“... the therapist makes it”.*
- ◆ *“ (I changed services) because it didn’t feel right”.*
- ◆ *“I never clicked with the therapist ... (and when I went to another centre) she (habilitationist) walked in the door and I felt comfortable from day one”.*

Service personnel

- ◆ *“... But unless you are going to see them at least once a week you just haven't got that relationship with them and so you just don't know each other well enough to trust them and talk honestly.”*

Parenting

- ◆ *“I think that I was dashing from appointment to appointment. I just didn’t have time to go and sit in the park with the child like I did with our first who wasn’t deaf.”*
- ◆ *“Not just walking past a flower and going ,’Oh, smell the flower,’ but saying it ten times. So it was more aware.”*
- ◆ *“Looking back I felt like I missed out on, you know, that babyhood of being able to enjoy him as a baby, because I was .. travelling down here all the time.”*

Cochlear implant

- ◆ “*cochlear implants take you into a different world*”.
- ◆ grow up in an ‘*oral world*’ or in a ‘*signing world as part of a Deaf community*’?

Our team at NAL & participating programs

- ◆ Patricia van Buynder,, Lauren Burns, Carina Law, Allison Baker, Geraldine Krynder, Angela Wong, Sanna Hou, Jane Oliver, Karen McGhie, Chris Flynn, Vicky Zhang, Allison Brower
- ◆ Julia Day, Kathryn Crowe, Nicole Mahler-Thompson, Vivienne Martin, Sonya Cornick, Laura Street
- ◆ Samantha Youn
- ◆ Emma Rushbrooke, Lynda Close (*Hear & Say Centre*)
- ◆ Greg Leigh, Robyn Smith (*Royal Institute for Deaf and Blind Children*)
- ◆ Lynne Paul (*St Gabriel's School for Hearing impaired children,*
- ◆ Strathfield Catholic Centre for hearing impaired children)
- ◆ Tracy Hopkins, Maree Doble (*The Shepherd Centre*)
- ◆ Kylie Rankine, Colleen Psarros, Sharan Westcott, Leanne Skinner (*Sydney Cochlear Implant Centre*)
- ◆ Jamie Leigh, *Cochlear Implant Clinic, Royal Victorian Eye and Ear Hospital*
- ◆ Matilda Rose Early Intervention Centre

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And Very special thanks to

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To review information on outcomes study:

www.outcomes.nal.gov.au

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Outcomes of Children with Hearing Impairment



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Hi, I'm LOCHI the lion from the Longitudinal Outcomes of Children with Hearing Impairment study. This study is conducted by the

National Acoustic Laboratories (NAL)

to examine the long-term speech, language, psychosocial and educational outcomes of children with hearing impairment. Children who wear hearing aids and/or cochlear implants are included.



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