Cochlear Implantation for Single-Sided Deafness in Children and Adolescents

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DISCLOSURES

I have no proprietary interest in any product, instrument, device, service or material related to this presentation

I will be discussing off label use of a cochlear implant

Current Indications for Use

Adult cochlear implant candidacy

2005

bilateral moderate to profound sensorineural hearing loss ≤ 50% sentence recognition in the ear to be implanted and

≤ 60% in the best aided condition

*Medicare guidelines stipulate ≤ 40% sentence recognition

Pediatric cochlear implant candidacy

2009

children 12 – 23 months of age, ≥ 90 dB HL and lack of auditory progress

children ≥ 24 months of age, ≥ 70 dB HL and score ≤ 30%

on LNT or MLNT

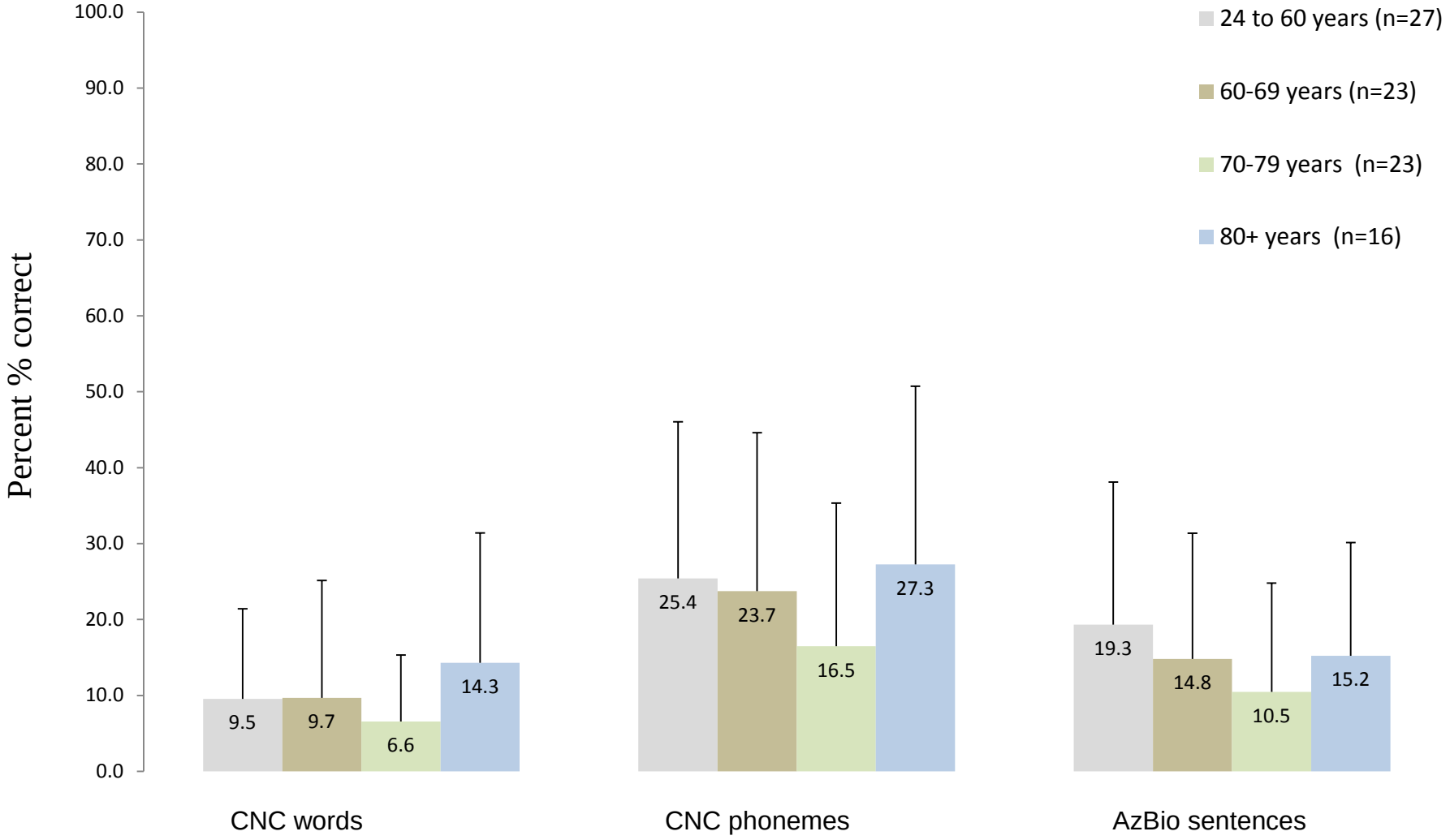
Background

- Mayo Clinic – Post-lingually deafened adult data
- 310 implanted patients between Jan 2010 and Jan 2012
- 89 cases were included in analysis after removing:
  - Children
  - Adults getting second sided implant
  - Pre-lingually deafened

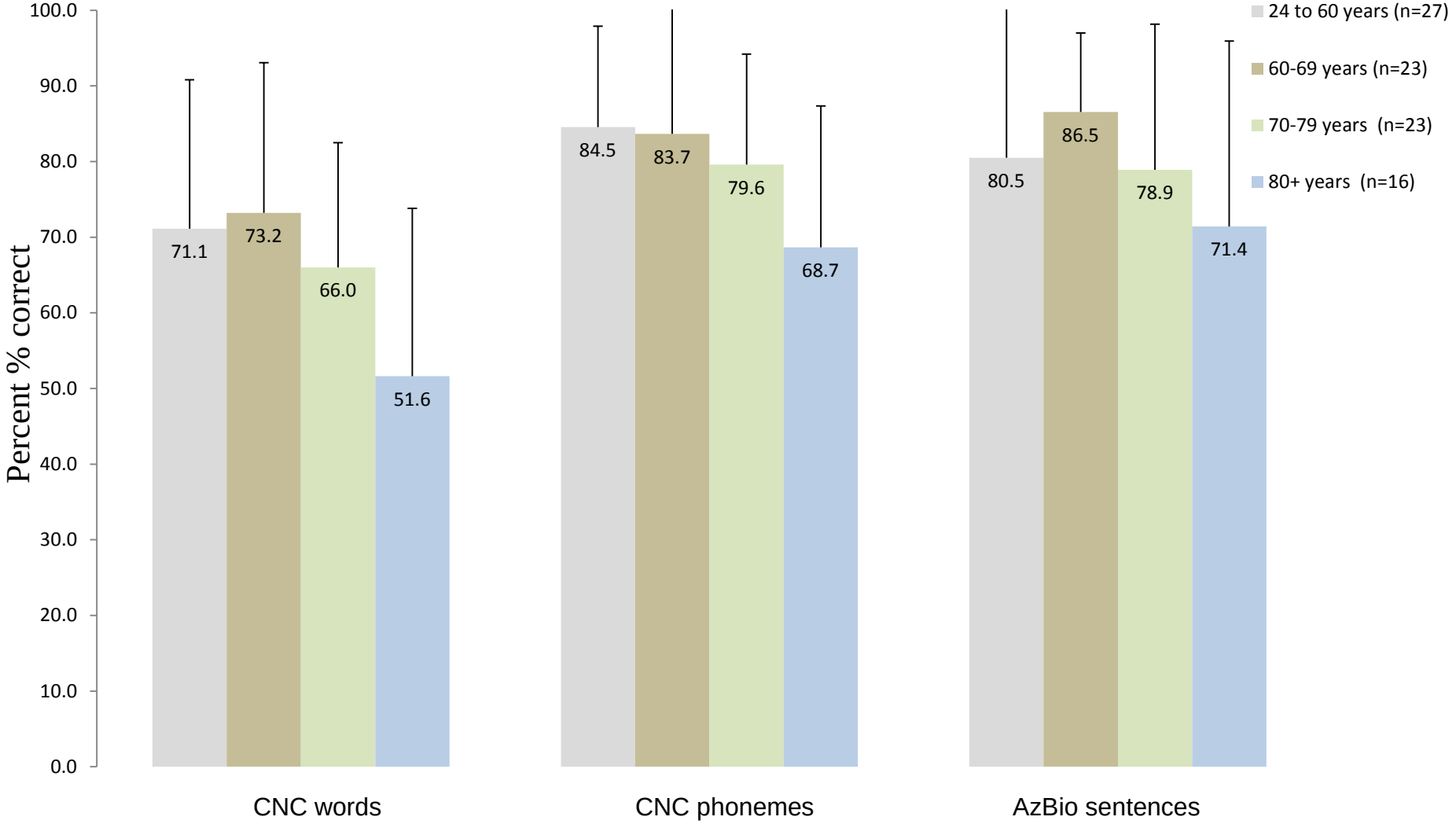
  Incomplete data points

  Patients in FDA clinical trials

- Speech presented at 60 dB SPL in a sound field
  - Preoperatively with hearing aid on the ear to be implanted
  - Postoperatively with sound processor and user settings



Phonak - Unilateral Hearing Loss in Children



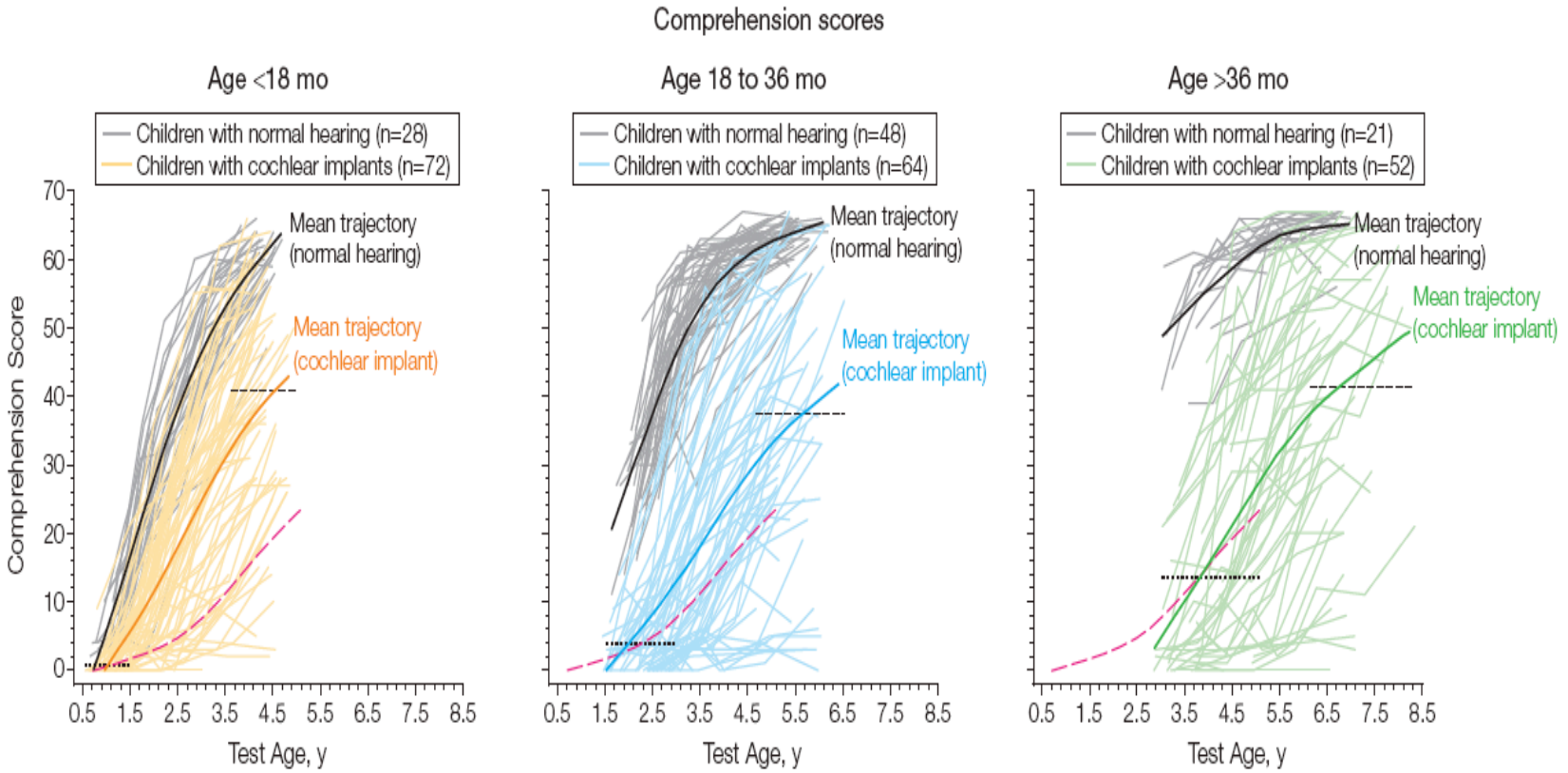
Phonak - Unilateral Hearing Loss in Children

Niparko et al. (2010). Spoken Language Development in Children Following Cochlear Implantation, *JAMA, 303 (15)*

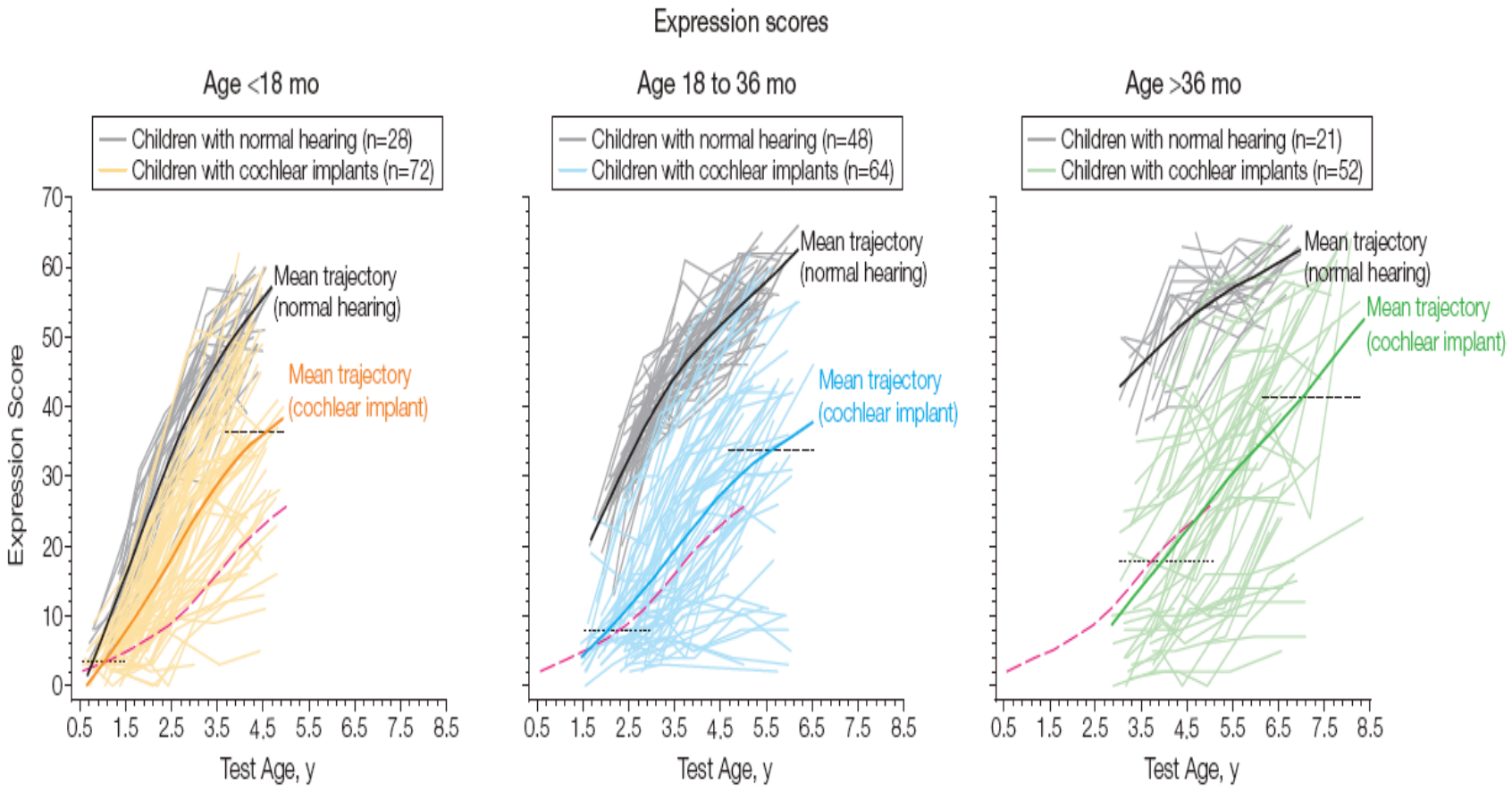
- 188 children from 6 centers who had CI prior to 5 years of age and 97 same-age children with normal hearing
- Performance of spoken language comprehension and expression using the Reynell Developmental Language Scales
- All children scored within two standard deviations of the norm on the Bayley Scale of Infant Development or Leiter Performance Scale-Revised

Niparko et al., 2010
Comprehension Scores

Figure 1. Developmental Trajectories of RDLS Raw Scores of Comprehension and Expression Grouped by Age at Baseline



Niparko et al., 2010
Expressive Scores



Background

- Cochlear implants improve localization and speech understanding in noise among adults and children with single-sided deafness (Firszt et al, 2012; Arndt et al., 2011; Friedman et al., 2016; Mertens et al, 2015; Beurnstein et al, 2017; Zeitler et al. 2015)

Specific aims

- *Aim 1*. Does cochlear implantation restore speech understanding abilities to the ear implanted among adults and children with unilateral hearing loss (UHL)
- *Aim 2.* Does cochlear implantation result in a binaural advantage among adults and children with UHL: improved speech understanding in diffuse noise, improved self perceived spatial hearing, decreased listening effort

- Binaural advantage
  - Overall speech understanding in noise is enhanced when using two ears compared to one (Bronkorst & Plomp, 1988; Licklider, 1948)
- Binaural disadvantage, interference
  - Overall speech understanding in noise is worse when listening with interaural asymmetries compared to listening with the better hearing ear (Shinn-Cunningham et al., 2001; Rothpletz et al., 2004)

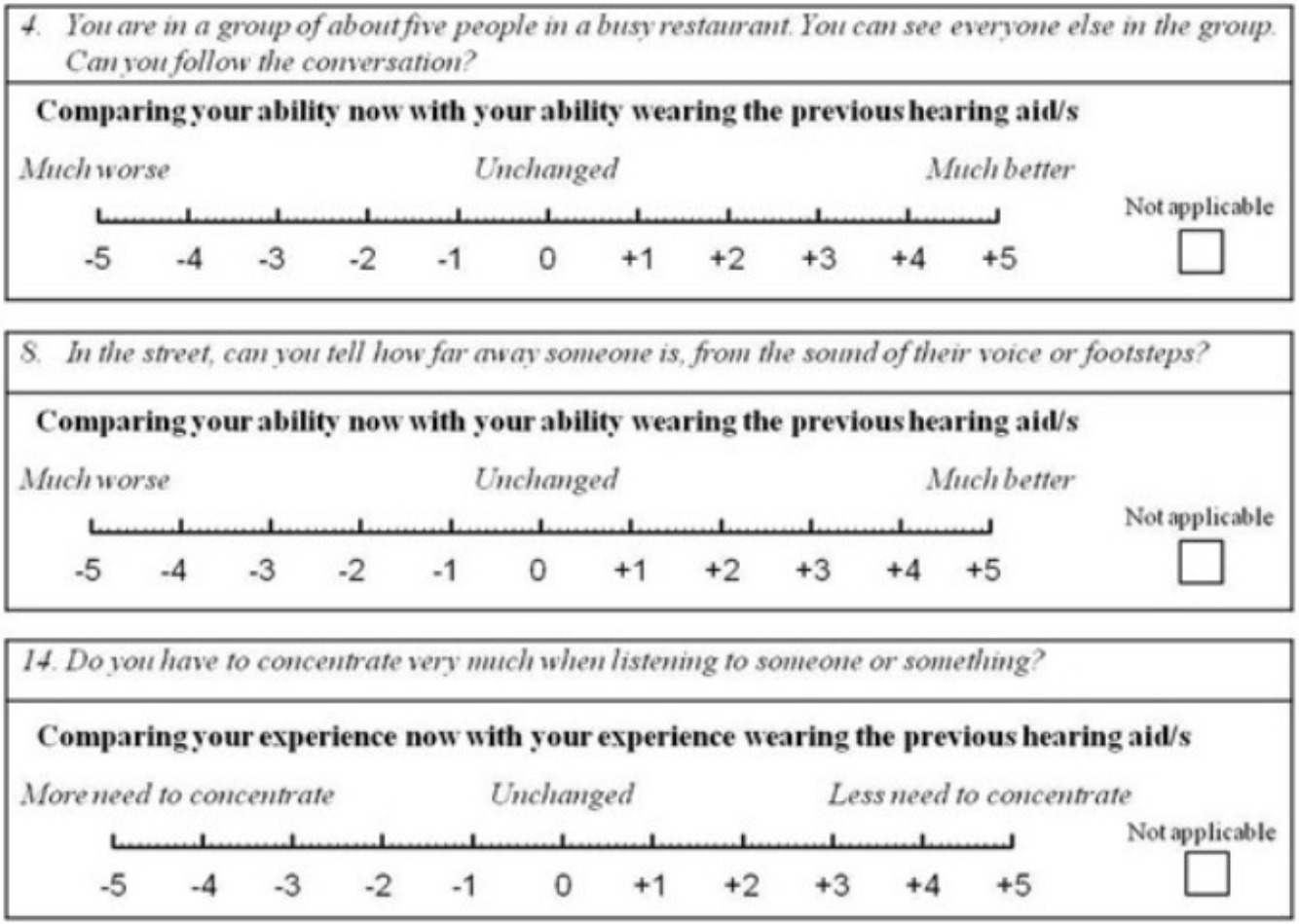
Participants

- Inclusion
  - Moderate to severe sensorineural hearing loss on the affected side, with contralateral hearing thresholds ≤ 30 dB HL through 2K Hz
  - Aided monosyllabic word score less ≤ 50%, ear to be implanted
  - Adults and children
    - Started with children 7 to 18 years of age and older, then removed the lower age limit
    - Started with hearing loss that was greater than 6 months and less than two years
- Exclusion
  - Known cognitive deficits
  - Retrocochlear hearing loss

Test Measures

- Speech understanding in quiet
  - Speech presented at 60 dB SPL in a sound field (contra ear masked)
    - CNC words (Peterson & Lehiste, 1962)
    - AzBio sentences (Spahr & Dorman, 2012)
- Speech understanding in noise
    - HINT sentences adaptively (Nilsson et al., 1998) in an R-SPACE 8-speaker array
- Questionnaires
    - Speech Spatial Hearing Questionnaire-Comparative (SSQ-C; Noble & Gatehouse, 1990)
    - SF-36 (Ware & Sherbourne, 1991)
    - Njimegen Cochlear Implant Questionnaire (Hinderink et al., 2009)
- Listening effort
    - Dual task paradigm

Speech, Spatial and Qualities of Hearing Questionnaire – Comparative (SSQ-C)



4. *You are in a group of about five people in a busy restaurant. You can see everyone else in the group. Can you follow the conversation?*

Comparing your ability now with your ability wearing the previous hearing aid/s

Much worse — *Unchanged* — *Much better*

-5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5

Not applicable ☐

5. *In the street, can you tell how far away someone is, from the sound of their voice or footsteps?*

Comparing your ability now with your ability wearing the previous hearing aid/s

Much worse — *Unchanged* — *Much better*

-5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5

Not applicable ☐

14. *Do you have to concentrate very much when listening to someone or something?*

Comparing your experience now with your experience wearing the previous hearing aid/s

More need to concentrate — *Unchanged* — *Less need to concentrate*

-5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5

Not applicable ☐

British Cochlear Implant Group

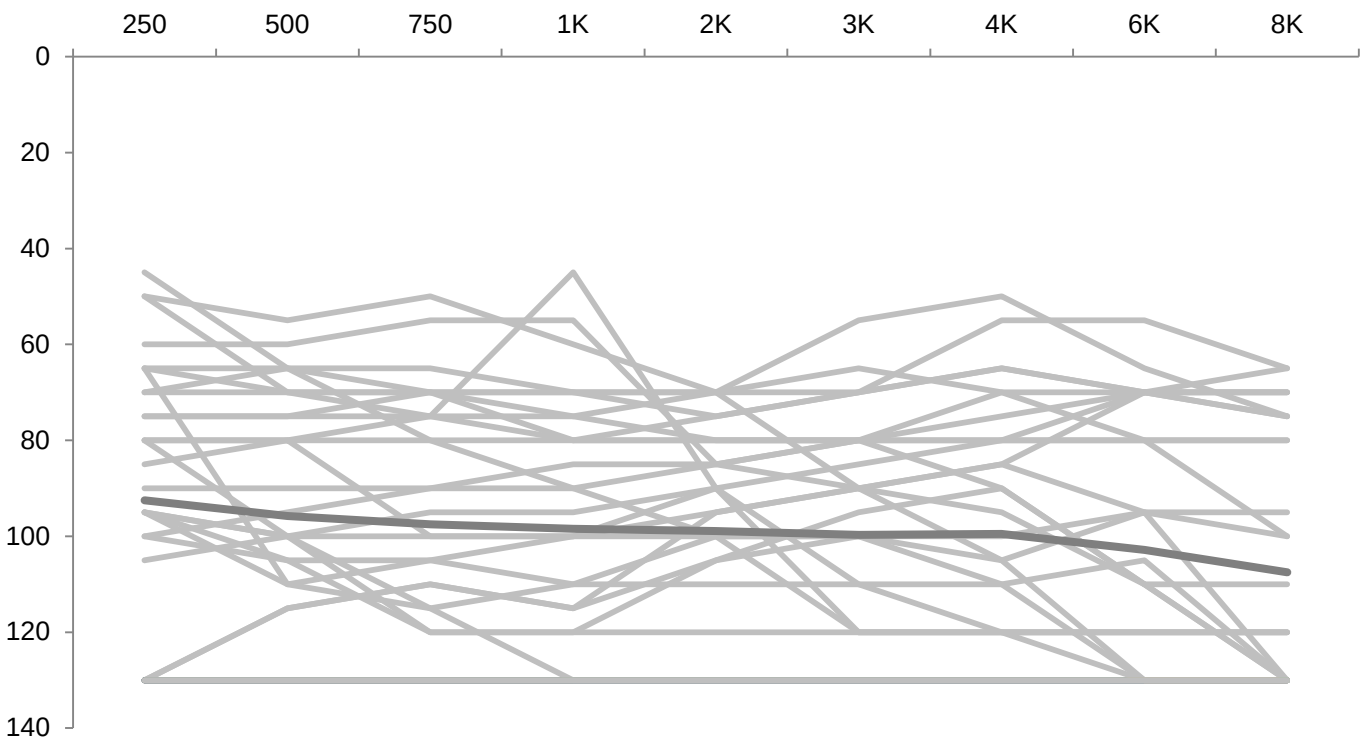
Test Intervals

	Pre-operative (37)	3-months post activation (32)	6-months post activation (28)	12-months post activation (20)
CNC words	X	X	X	X
AzBio Sentences	X	X	X	X
Speech in noise (R-SPACE)			X	X
Questionnaires			X	X
Listening effort				X

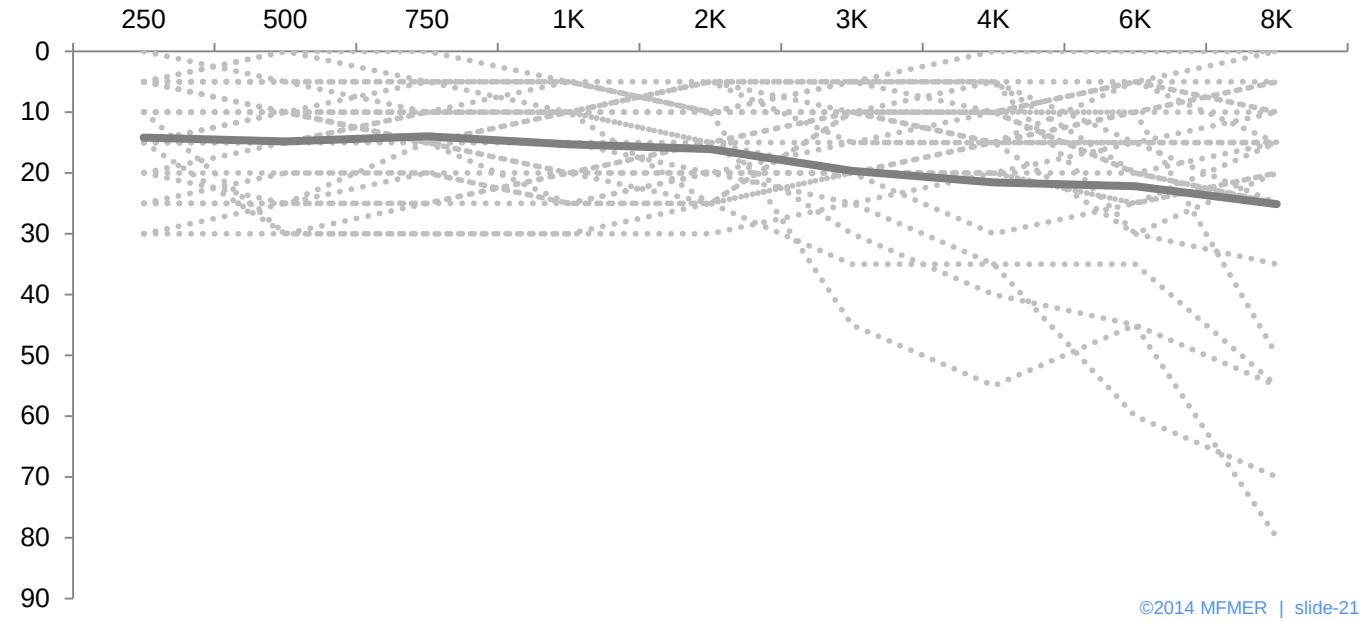
Participants

- 42 implanted (33 adults, 9 children)
  - 5 withdrew
    - 2 lost to follow up (moved)
    - 2 progressed to bilateral
    - 1 became a non-user
    - 1 failed device
- Comprised of 18 Cochlear, 14 MED EL, 1 AB

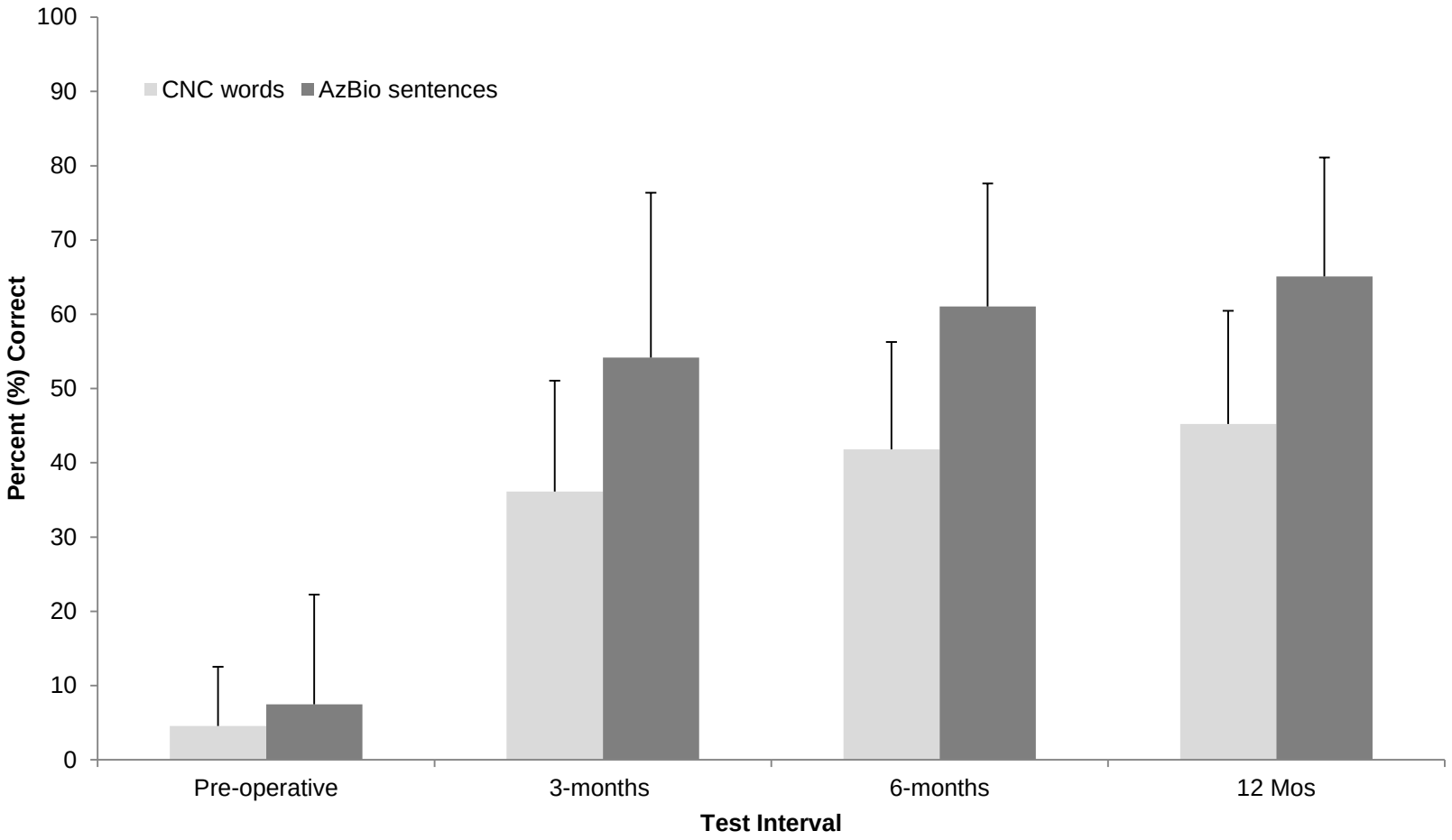
Ear implanted

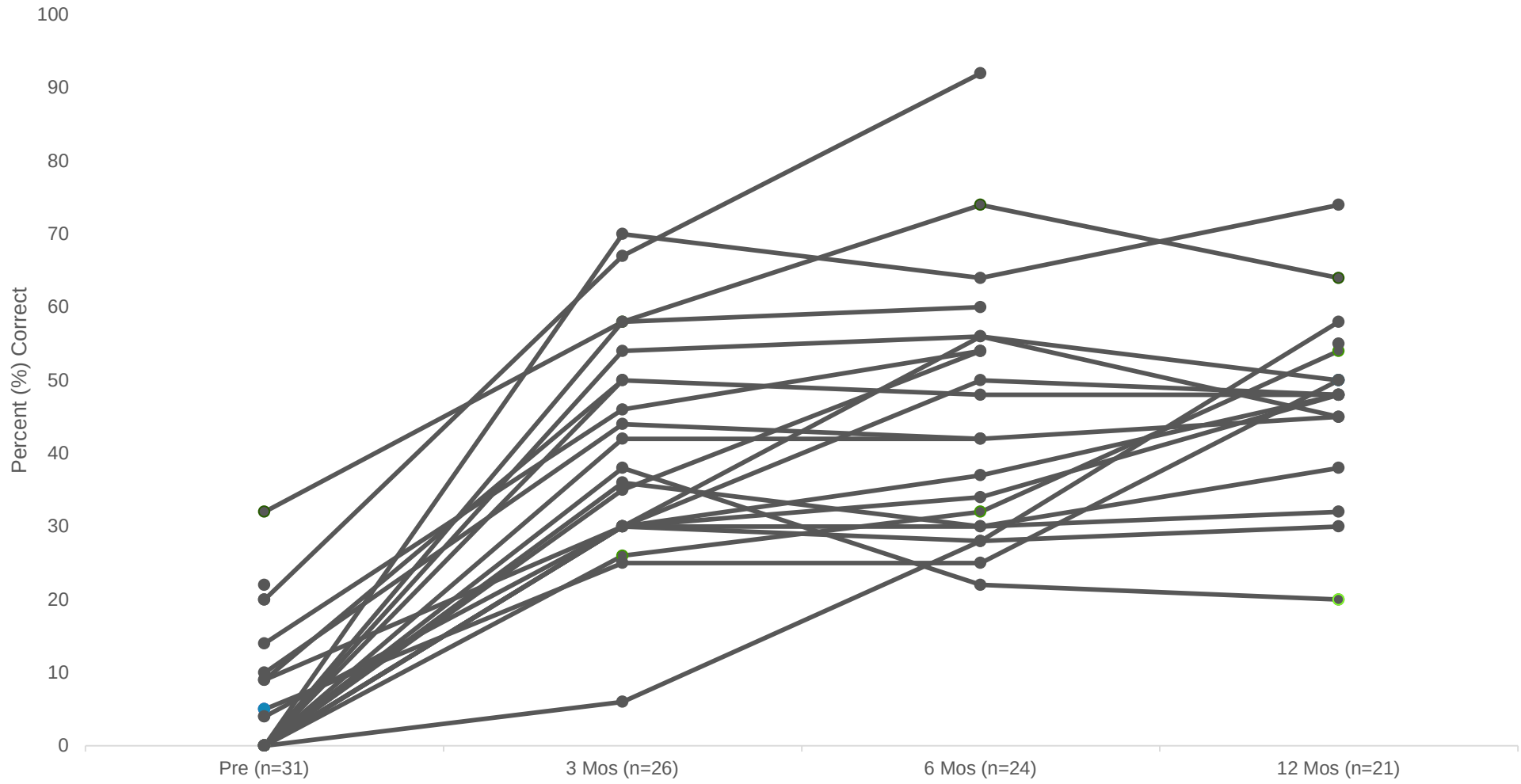


Ear not implanted

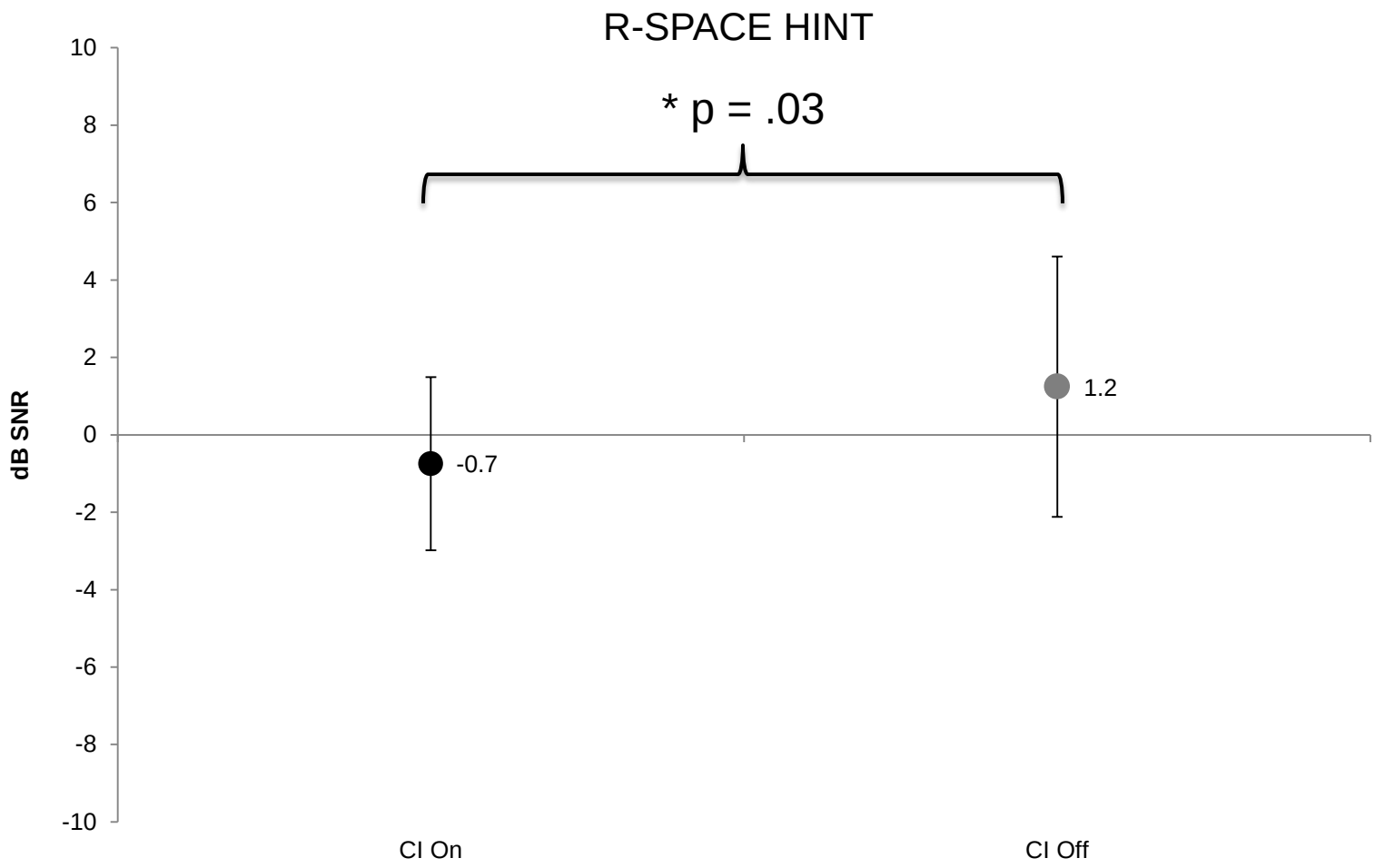


Results: Speech Understanding





Phonak - Unilateral Hearing Loss in Children



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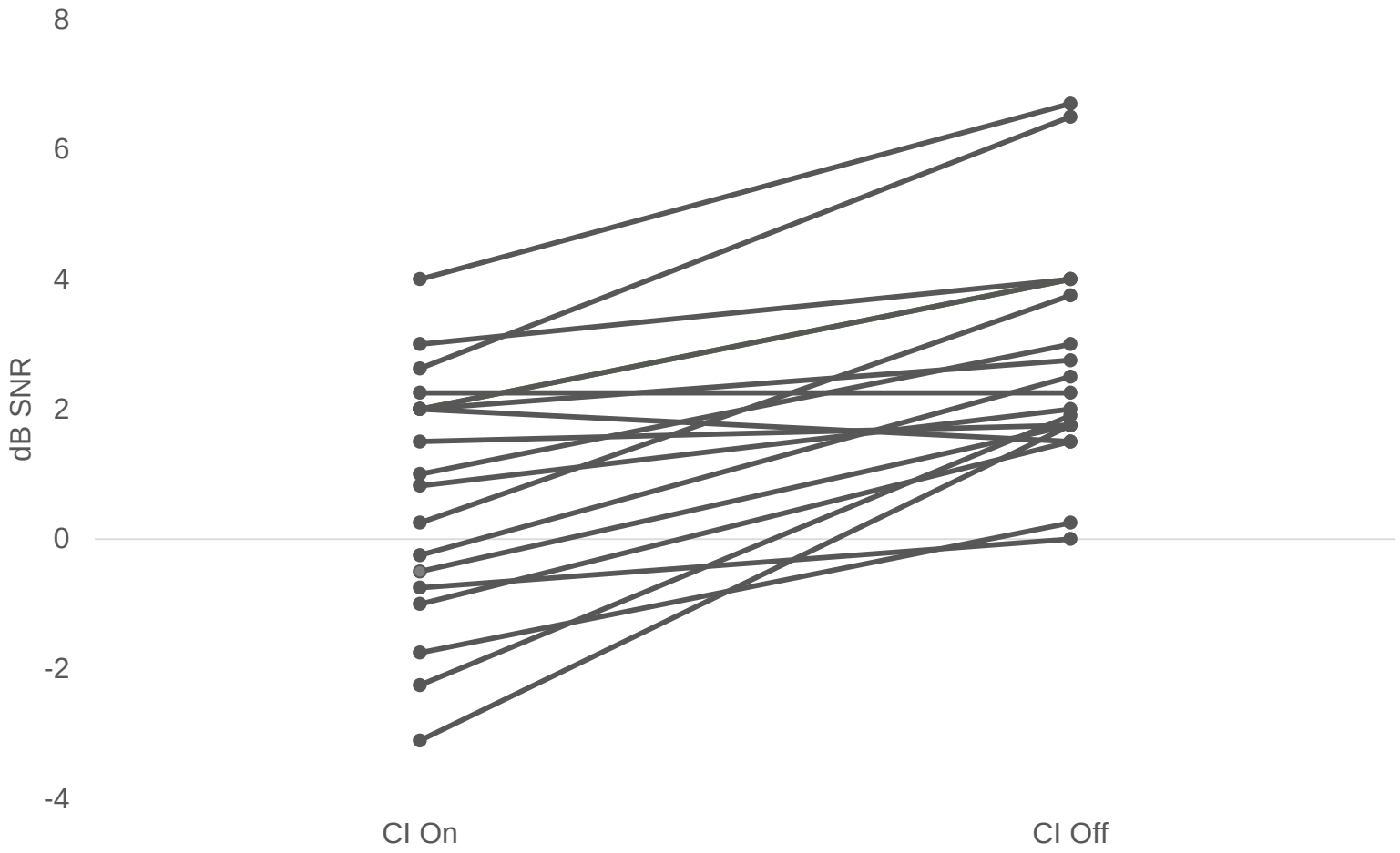
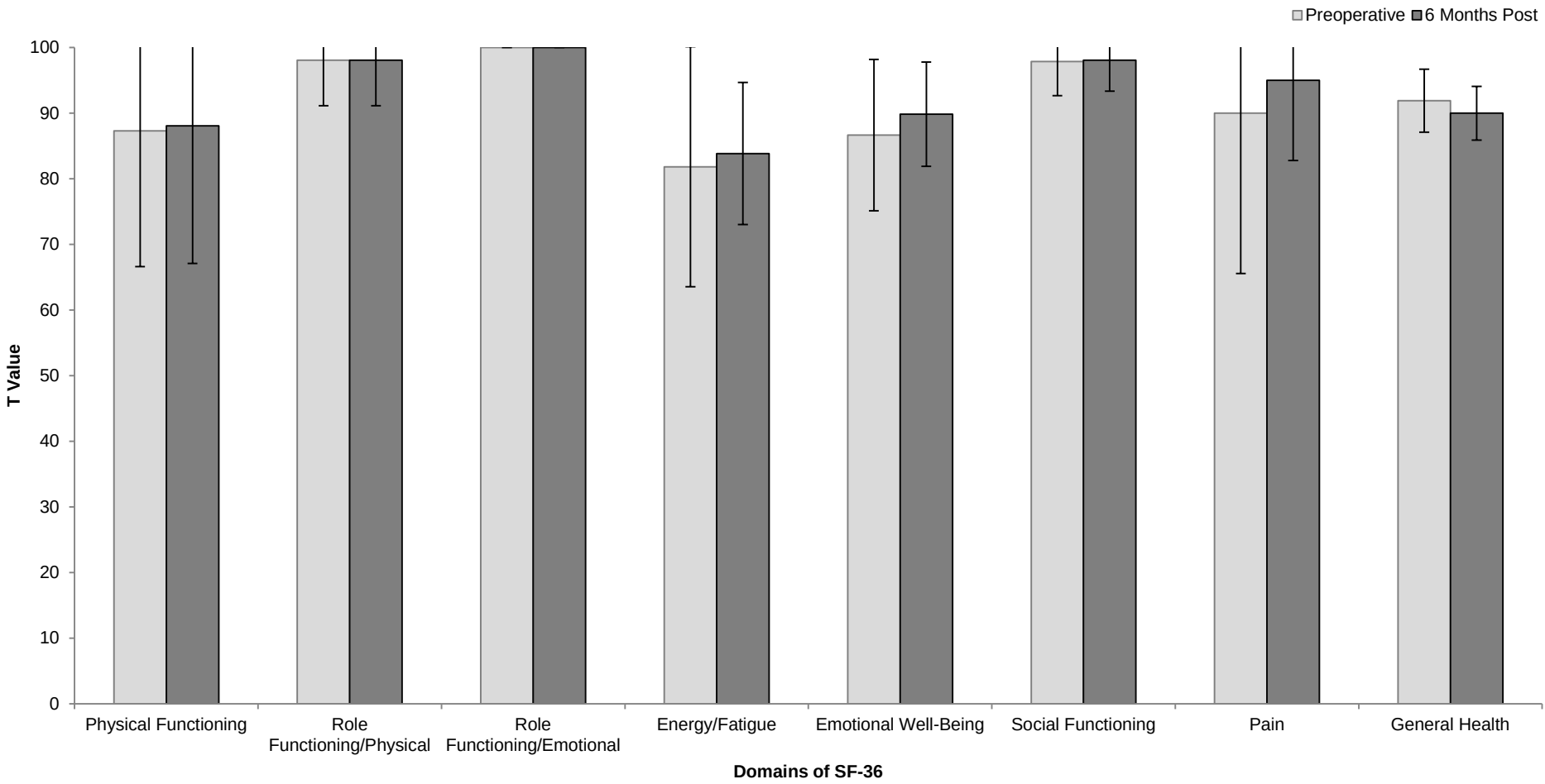


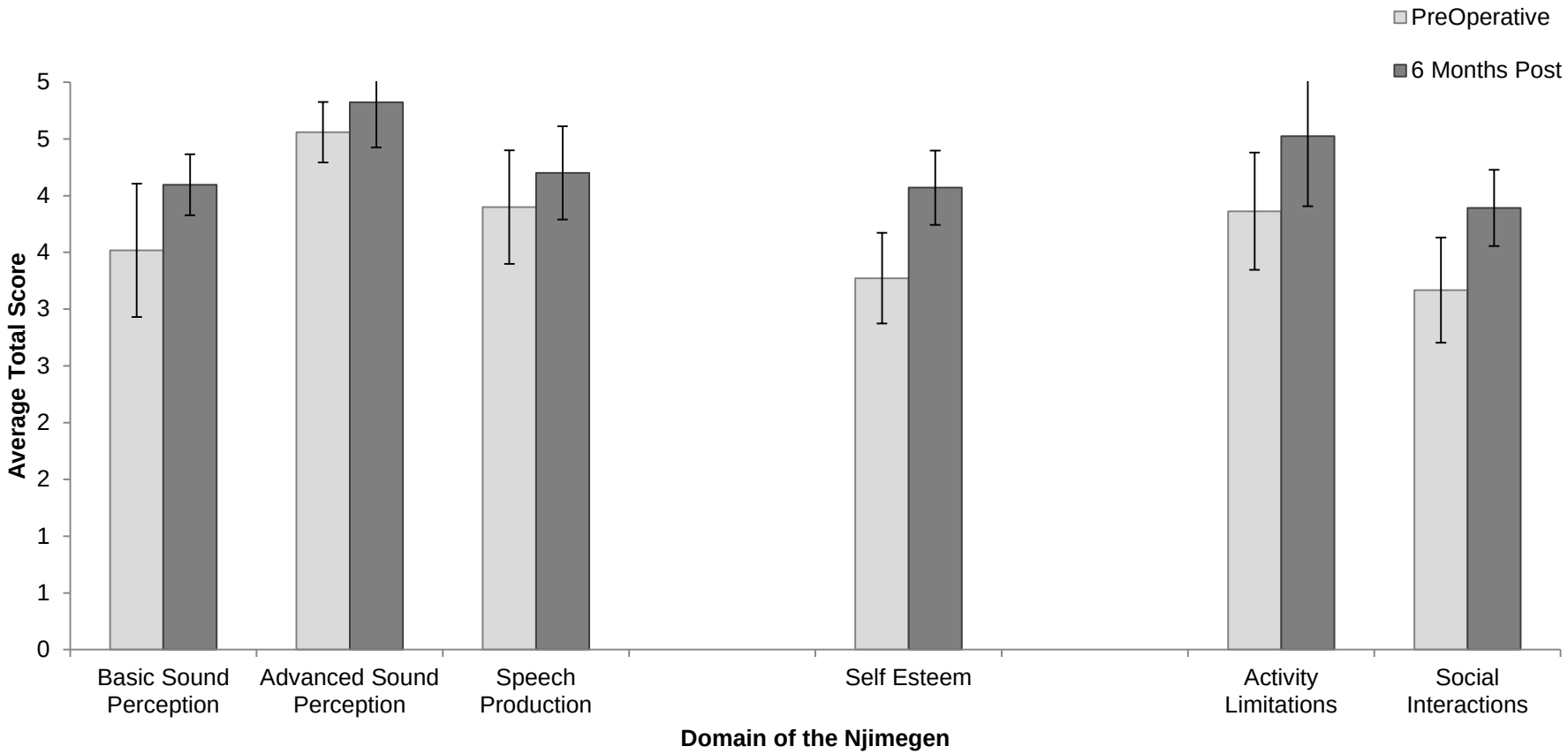
Phonak - Unilateral Hearing Loss in Children

Results – SF-36



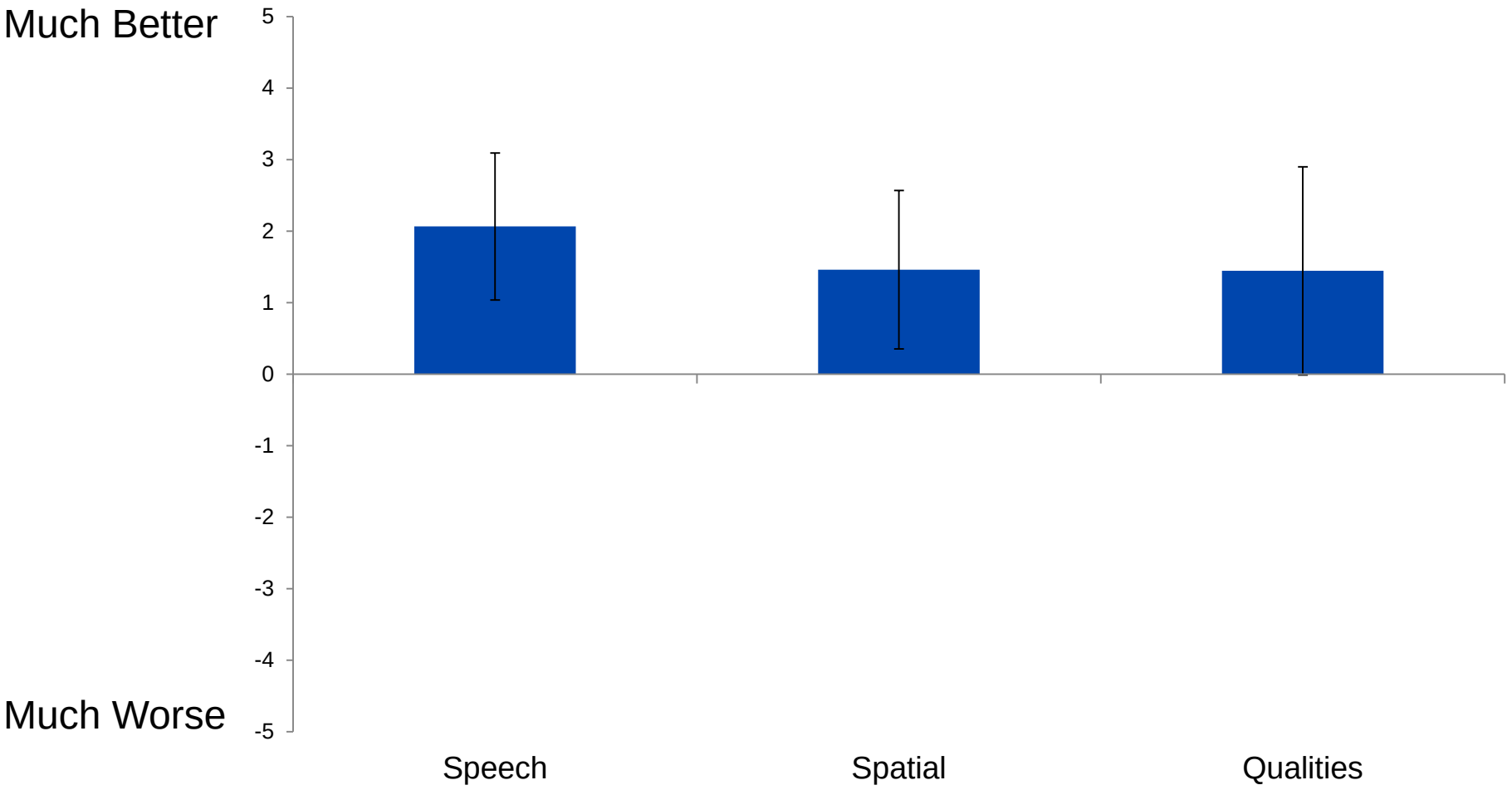
Phonak - Unilateral Hearing Loss in Children

Results - NCIQ



Phonak - Unilateral Hearing Loss in Children

Results: Self perceived benefit; SSQ-C



Phonak - Unilateral Hearing Loss in Children

Implanted Children

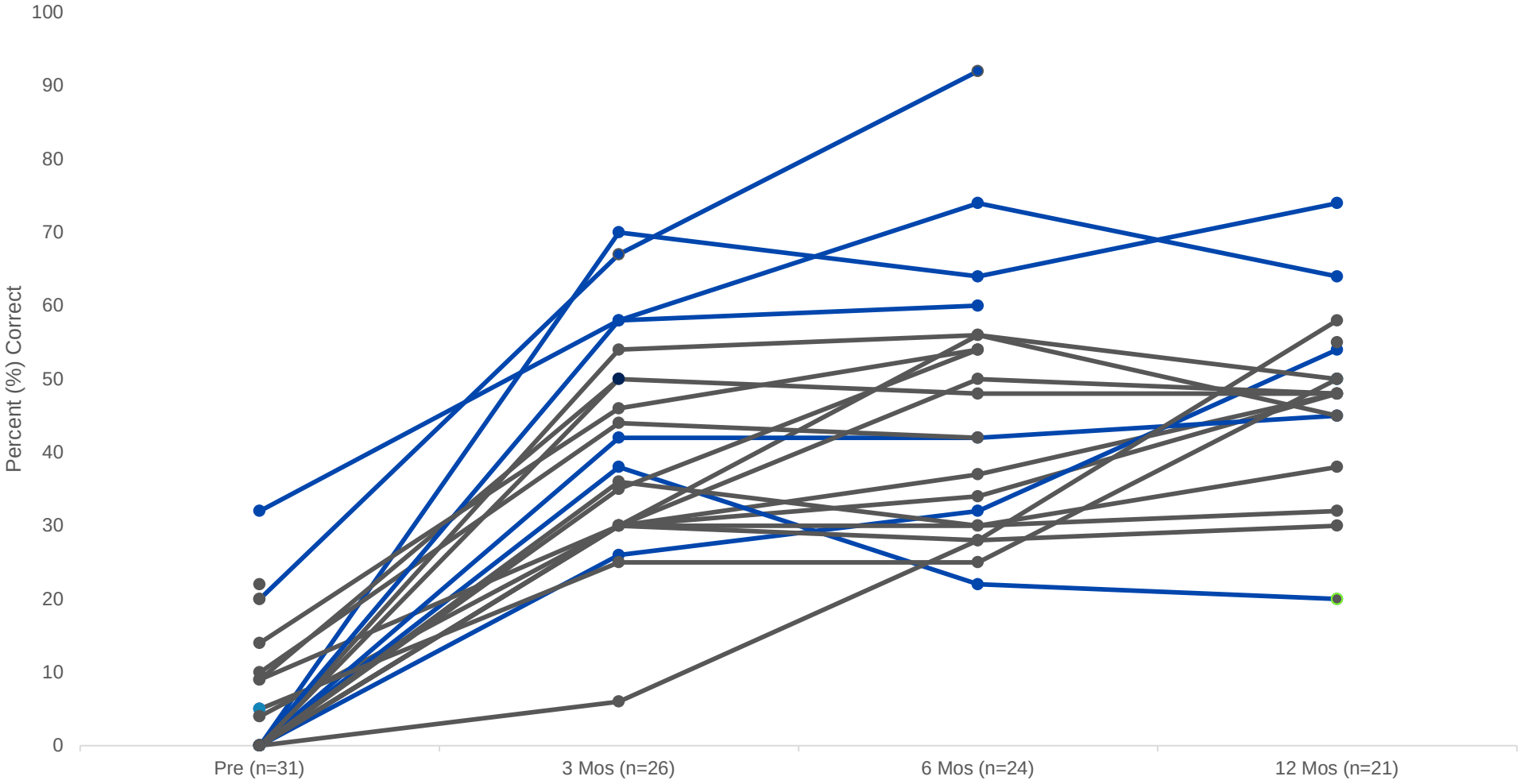
Subject	Age (yrs)	Sex	Side	Etiology	Notable	DOD (yrs)
1	7.0	M	L	Idiopathic Sudden		1.1
2	11.0	M	R	Cholesteatoma	BAHA removal	2.9
3	15.2	F	R	Idiopathic Sudden		1.5
4	7.4	F	R	Idiopathic Sudden		.8
5	1.5	F	L	Idiopathic Congenital		1.5
6	5.8	M	L	Idiopathic Congenital		5.8
7	8.9	M	L	Idiopathic Congenital		8.9
8	9.5	F	L	Idiopathic Congenital		9.5
9	10.0	F	R	Idiopathic Progressive		4.0

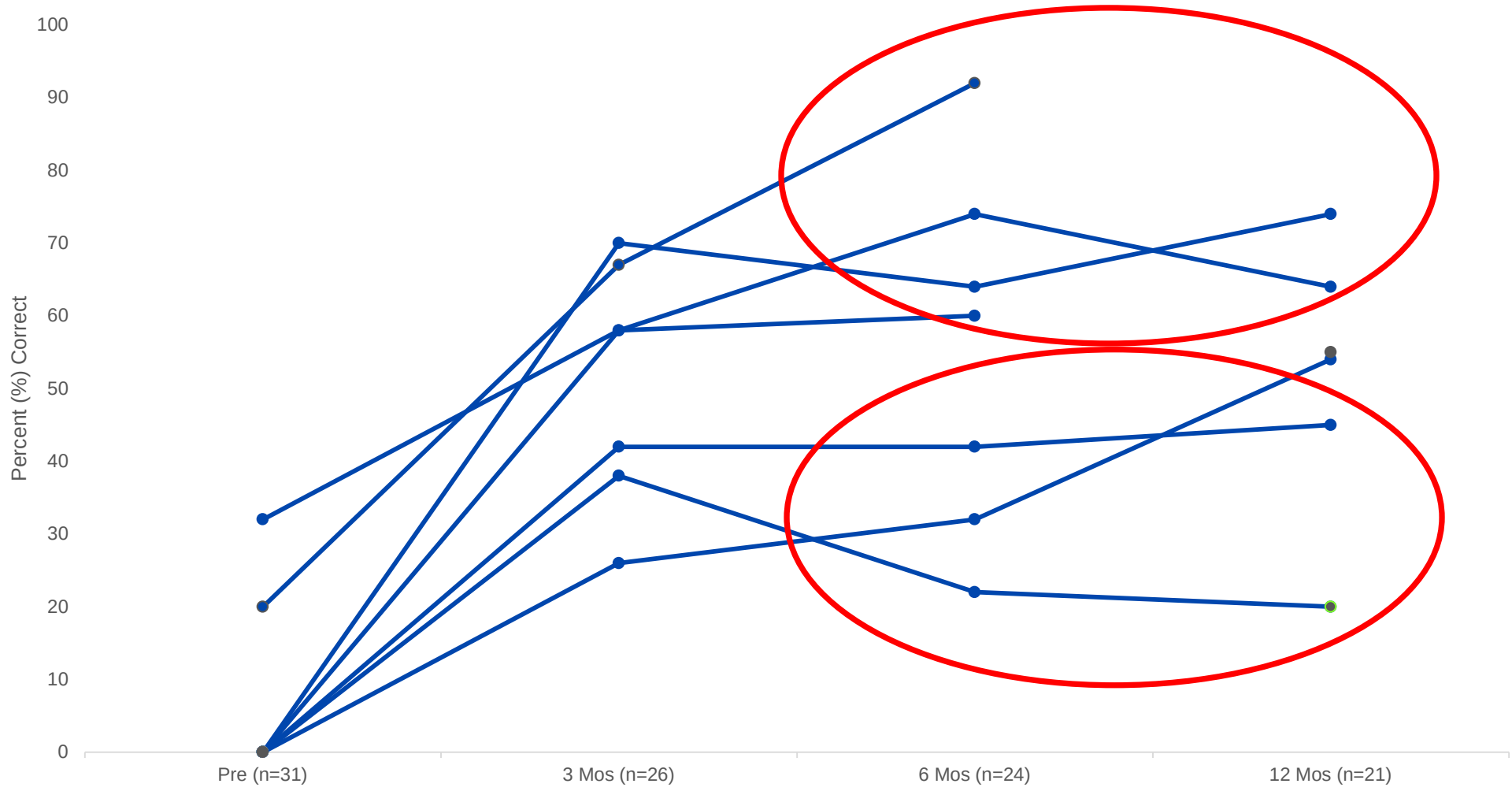
Implanted Children

Subject	Insertion	Device
1	RW	Med El Flex 28
2	Cochleostomy SV	Cochlear 24 RE
3	RW	Med El Flex 28
4	RW	Cochlear 522
5	RW	Cochlear 522
6	RW	Med El Flex 28
7	RW	Med El Flex 28
8	RW	Med El Flex 38
9	RW	Med El Standard

- Frequency of device use
  - 8 of 9 implanted children are full time CI users
- Tinnitus
  - Four had tinnitus preoperatively
  - All 4 experienced improvement with device ”on”
    - 2 complete resolution
    - 2 partial resolution

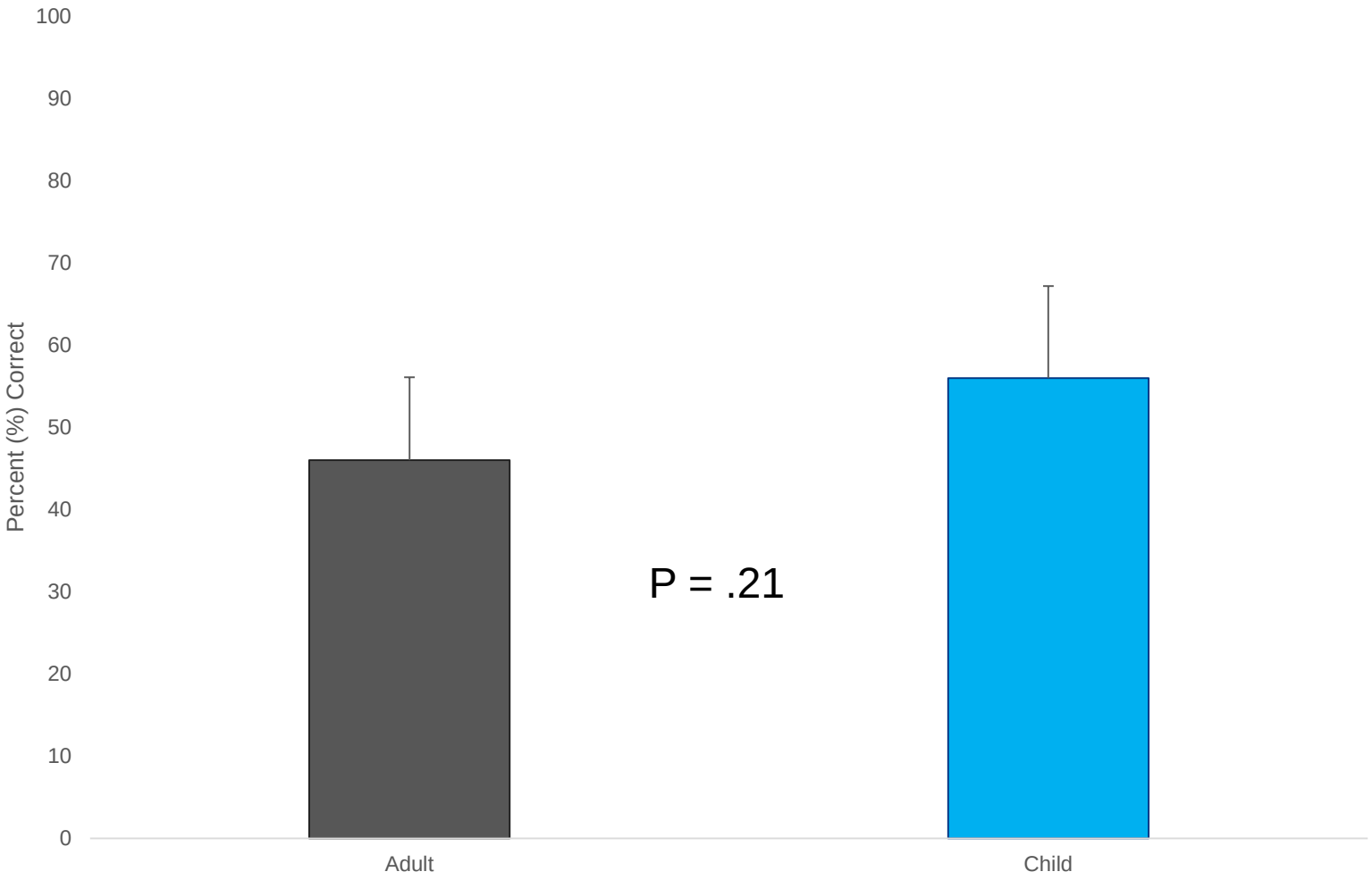
CNC word scores





Phonak - Unilateral Hearing Loss in Children

Monosyllabic Word Score – ear implanted, 6 mos



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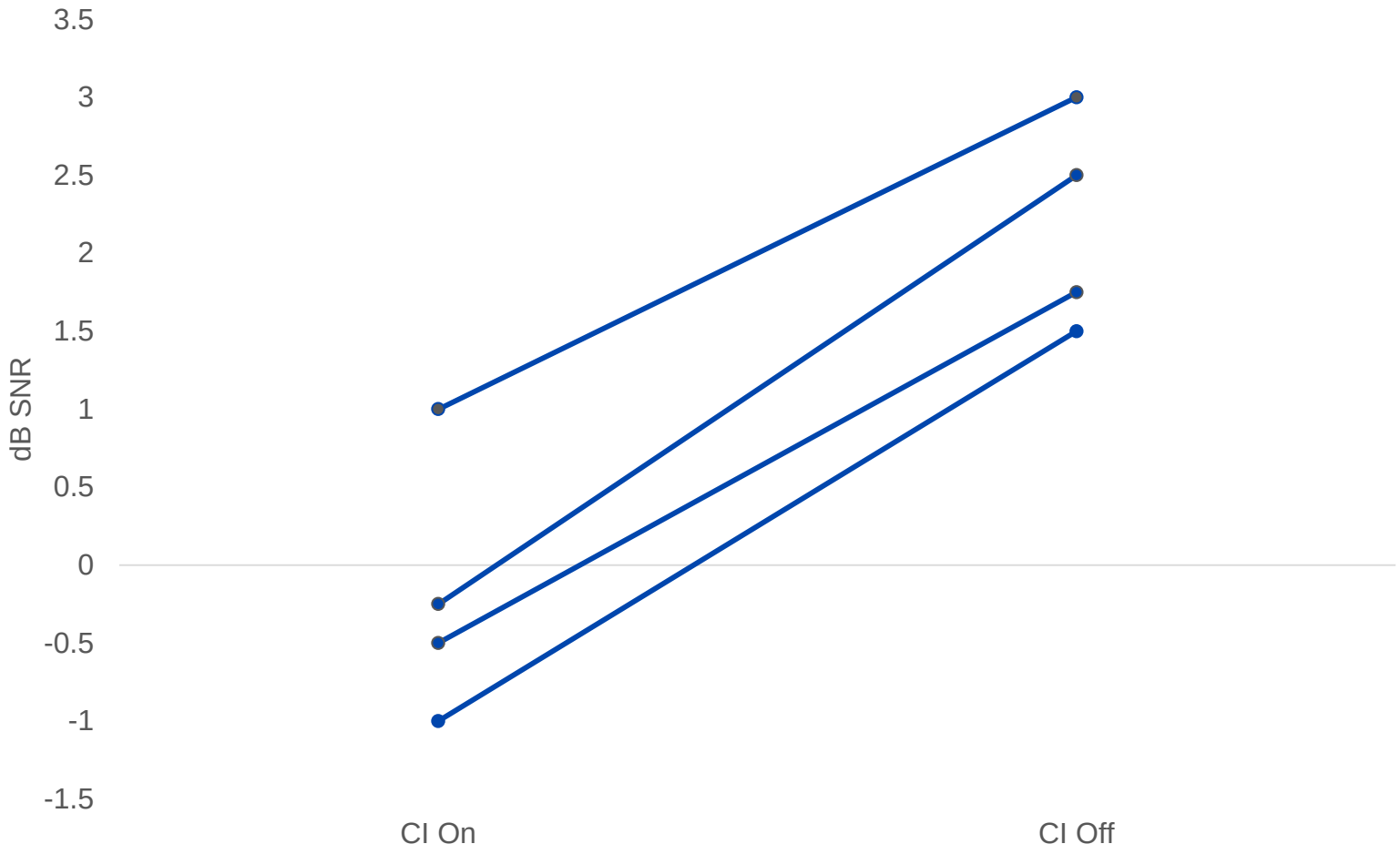

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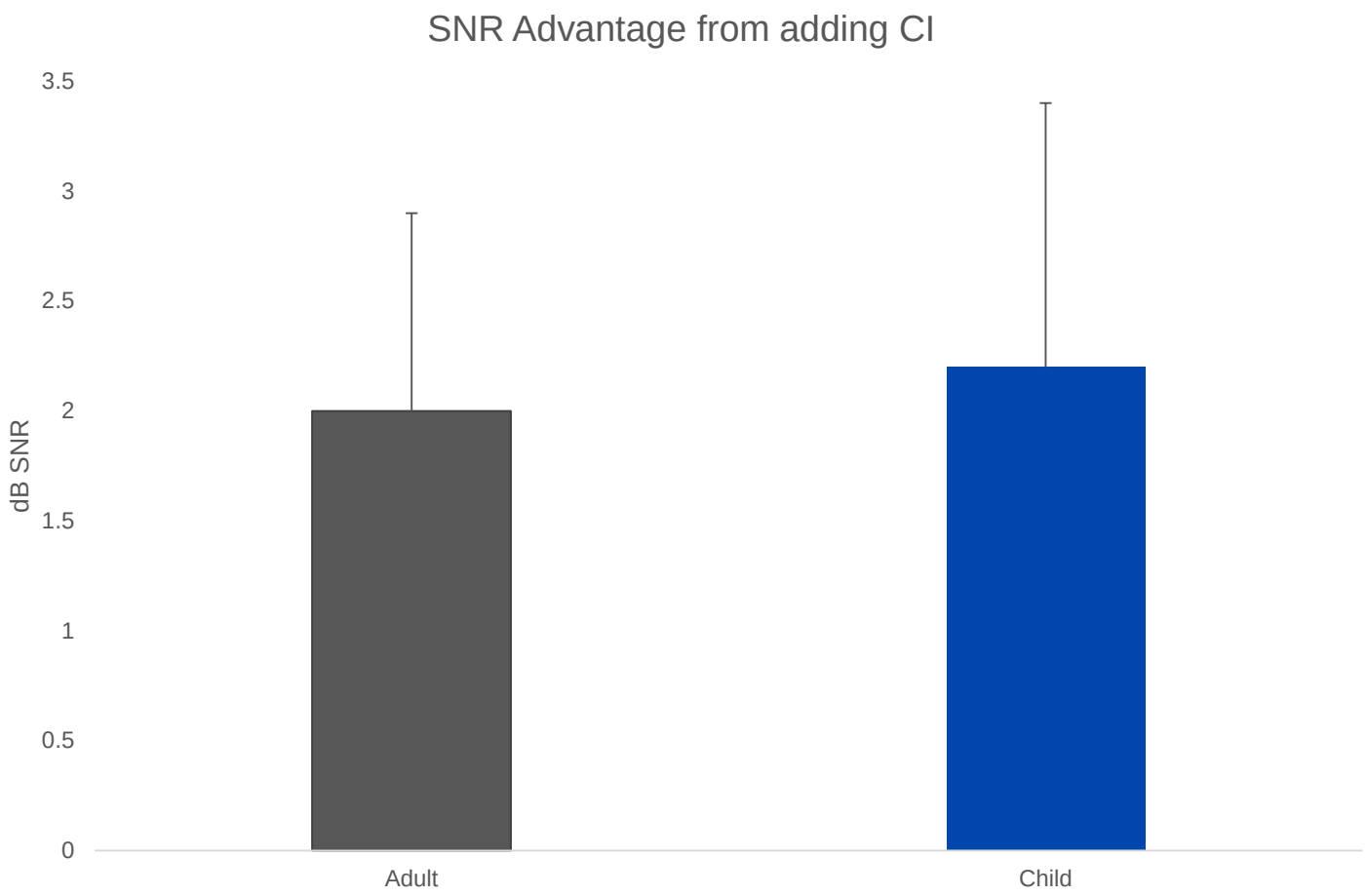


Phonak - Unilateral Hearing Loss in Children

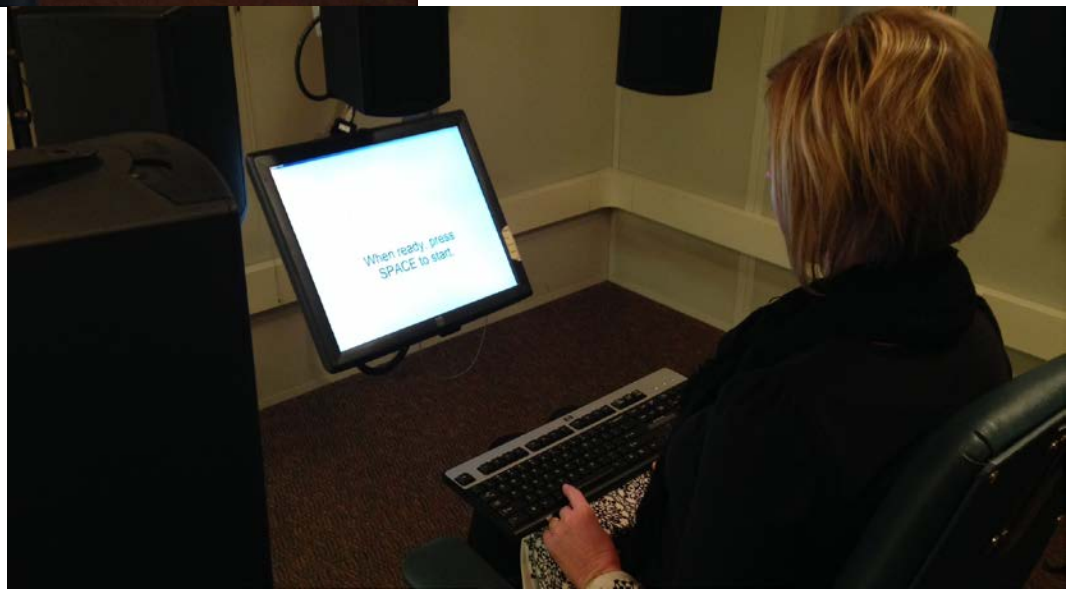
Listening effort

- Dual task
  - Primary task, speech recognition
  - CNC words at 65 dB SPL
  - Restaurant noise at 65 dB SPL
  - Baseline, quiet, noise (device on, device off)

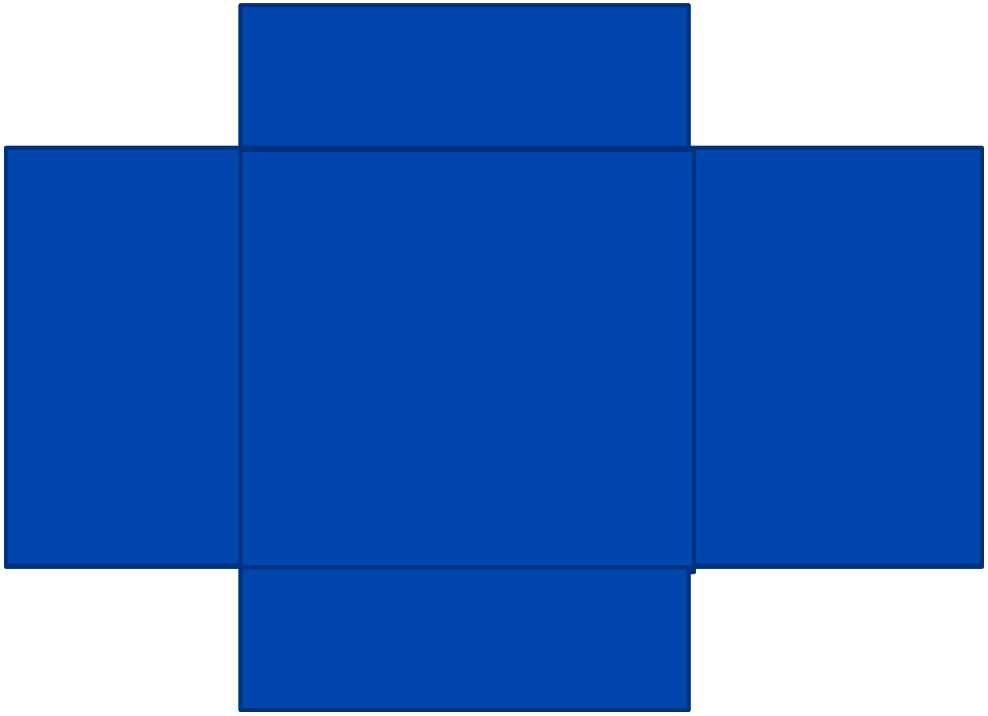
  - Secondary task, button push to perfect square among tall and long rectangles

  Latency of the button response is the dependent variable

Phonak - Unilateral Hearing Loss in Children

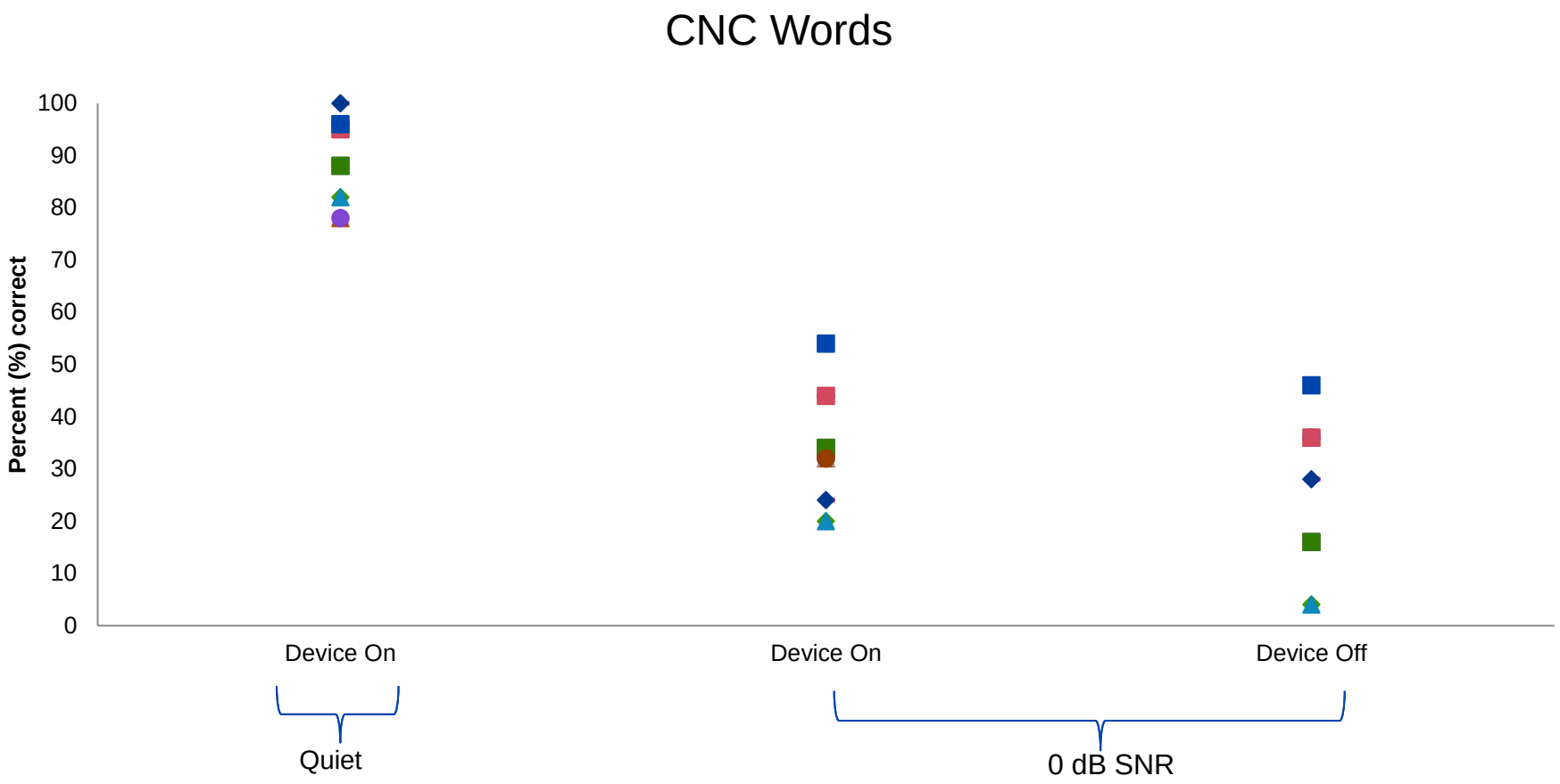

When ready, press
SPACE to start.

Listening Effort – dual task



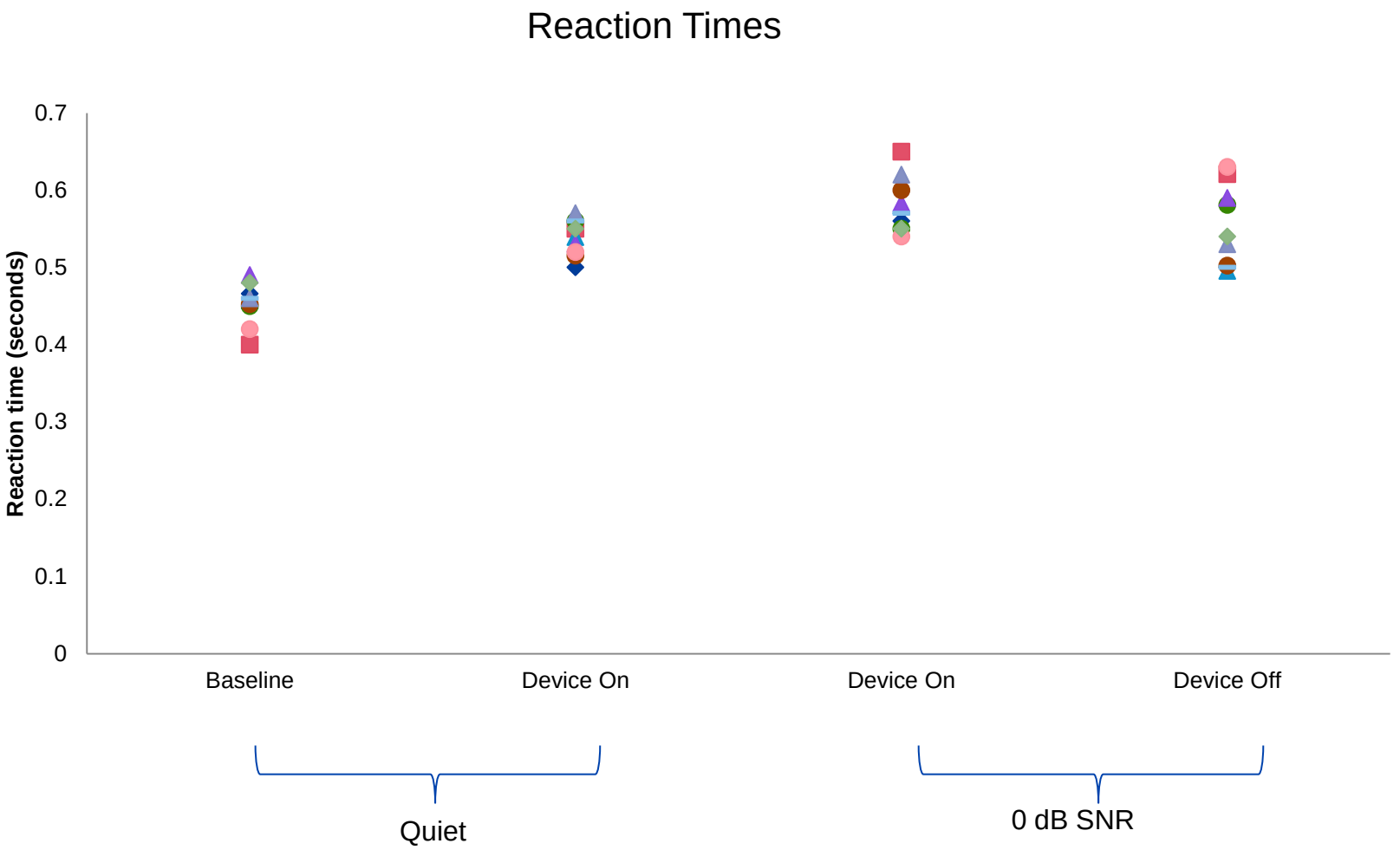
Phonak - Unilateral Hearing Loss in Children

Results: Listening effort (n=10)



Phonak - Unilateral Hearing Loss in Children

Results: Listening effort, 12 mos (n=10)



Phonak - Unilateral Hearing Loss in Children

Clinical implications

- CI can improve speech understanding for those with UHL
- CI can improve HRQoL using a measure that is disease specific
- CI may have a negligible impact on listening effort
- Insurance remains an obstacle
- Despite our best efforts, one became a non-user

Questions & Discussion

