

# Options and indications for implantable hearing devices

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# Contents of presentation

- Overview of the Cochlear Implant Clinic
- The current implant systems
- Recipient outcomes
- Recommendation guidelines
- Unilateral/asymmetrical hearing loss
- Question time



# Overview of our clinic

- Assist people who have a significant hearing loss in finding suitable options for improving their hearing
- Suitable options may include cochlear implants, bone conduction implants, middle ear surgery etc.
- Sole cochlear implant programme in Victoria since 1982; also provide support for Tasmania
- Multidisciplinary team
- Services provided through public and private funding options

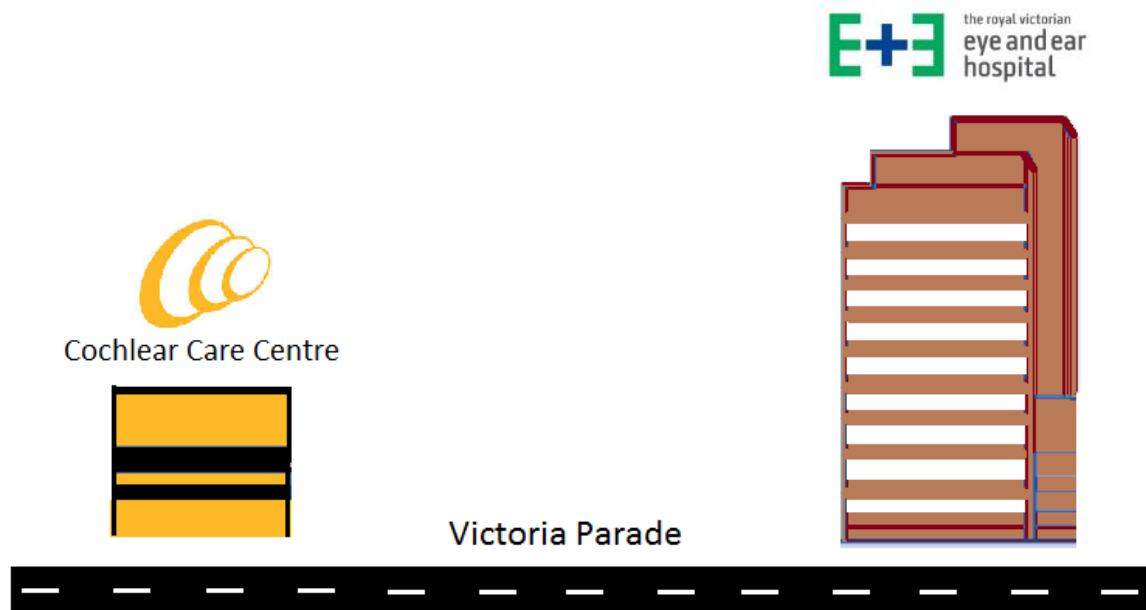
# Overview of our clinic

## Cochlear Care Centre

- All device troubleshooting
- Routine device programming
- Facilitate device replacement & upgrades

## RVEEH Cochlear Implant Clinic

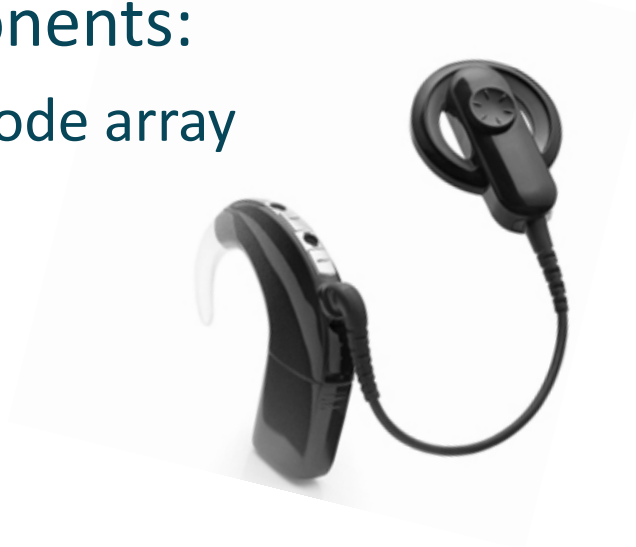
- Pre-operative assessment & counselling
- Post-op. care & device programming in initial phase
- All ENT services



# Current implant systems

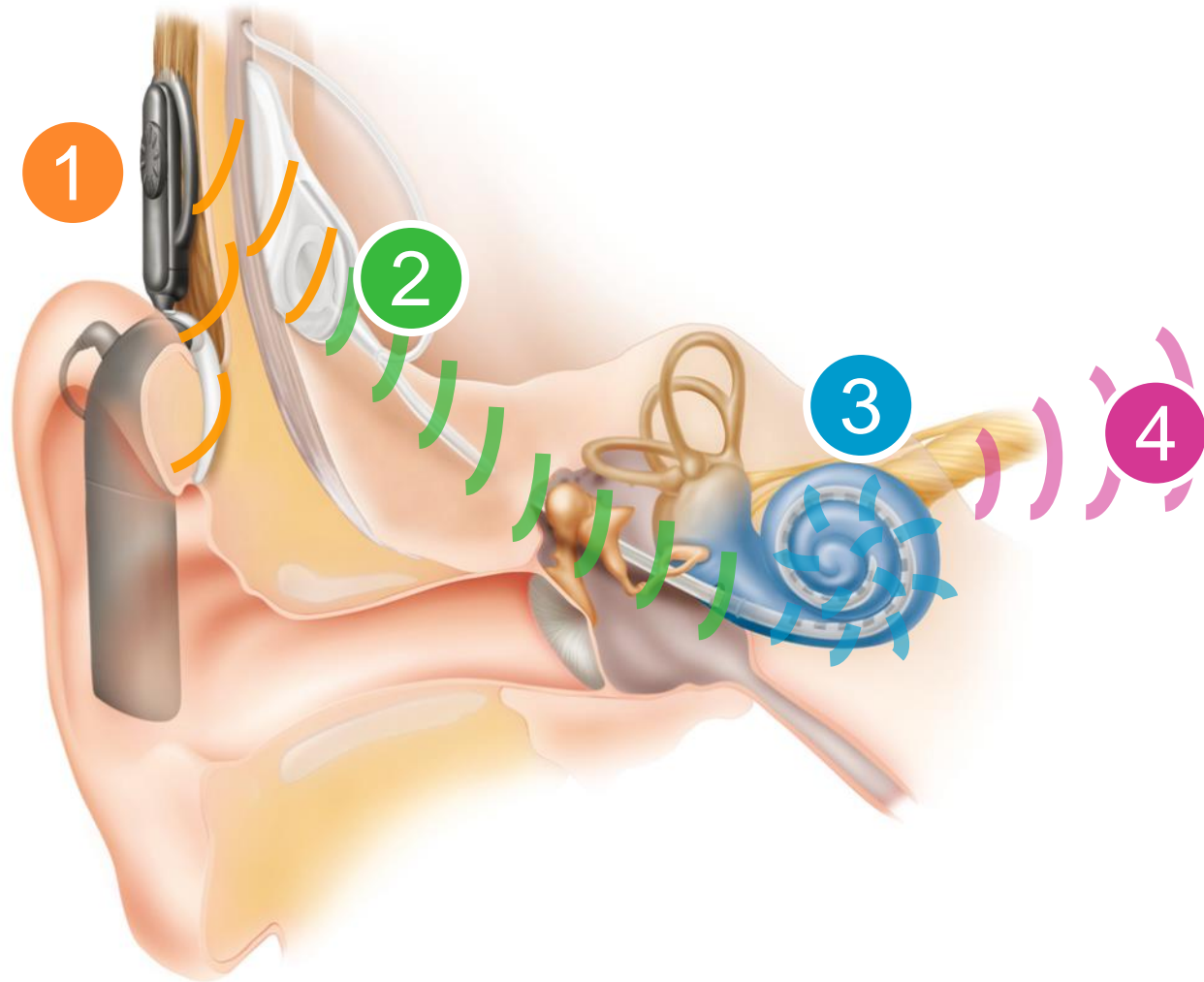
# What is a cochlear implant?

- A cochlear implant is a device surgically implanted into the inner ear.
- It can improve the hearing ability of children and adults by electrically stimulating hearing nerve fibres.
- Two main components:
  - implant & electrode array
  - sound processor

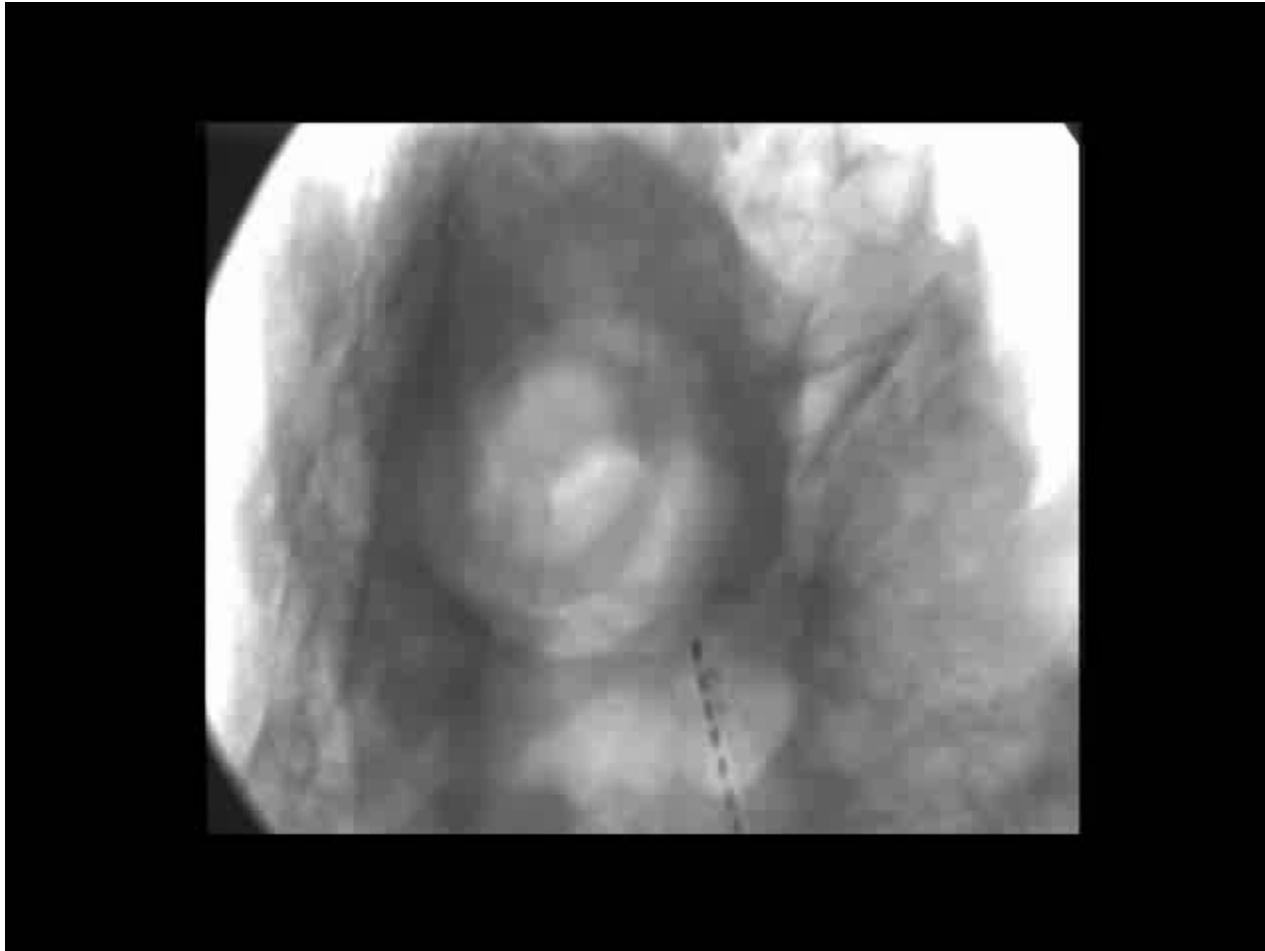


# How a cochlear implant works

1. The **sound processor** captures sound and converts it into digital code
2. The coded sound is transmitted via the **coil** to the implant
3. The **implant** converts the coded sound to electrical signals and sends them to the electrode array
4. The **electrodes** stimulate the hearing nerve, which relays sound to the brain



# Insertion of Cochlear Implant





# Choice of implants



## Profile Series

Thinnest

## CI24RE Series

Most reliable



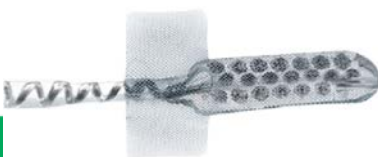
### Contour Advance®

Modiolar placement for optimum performance<sup>1</sup>



### Slim Straight

Thin full length electrode for hearing preservation<sup>2</sup>



### Straight

Suitable for abnormal cochleae



### Auditory Brainstem Implant\*

For auditory brainstem stimulation

<sup>1</sup> Holden et al, Ear and Hearing, 2013

<sup>2</sup> Skarzynski et al, Ear and Hearing, 2014

\* Product not available in all markets

# CP900 (Nucleus 6) system



# Nucleus CP900 Sound Processors

- Remote assisted fitting/Hearing Profile Adjustments
- Smart Sound iQ/”SCAN”
- Manual and auto-telecoil functions
- Auto FM
- CP910 Direct input for use with assistive listening devices
  - compatible with dynamic FM devices and Roger
  - compatible with wireless technologies

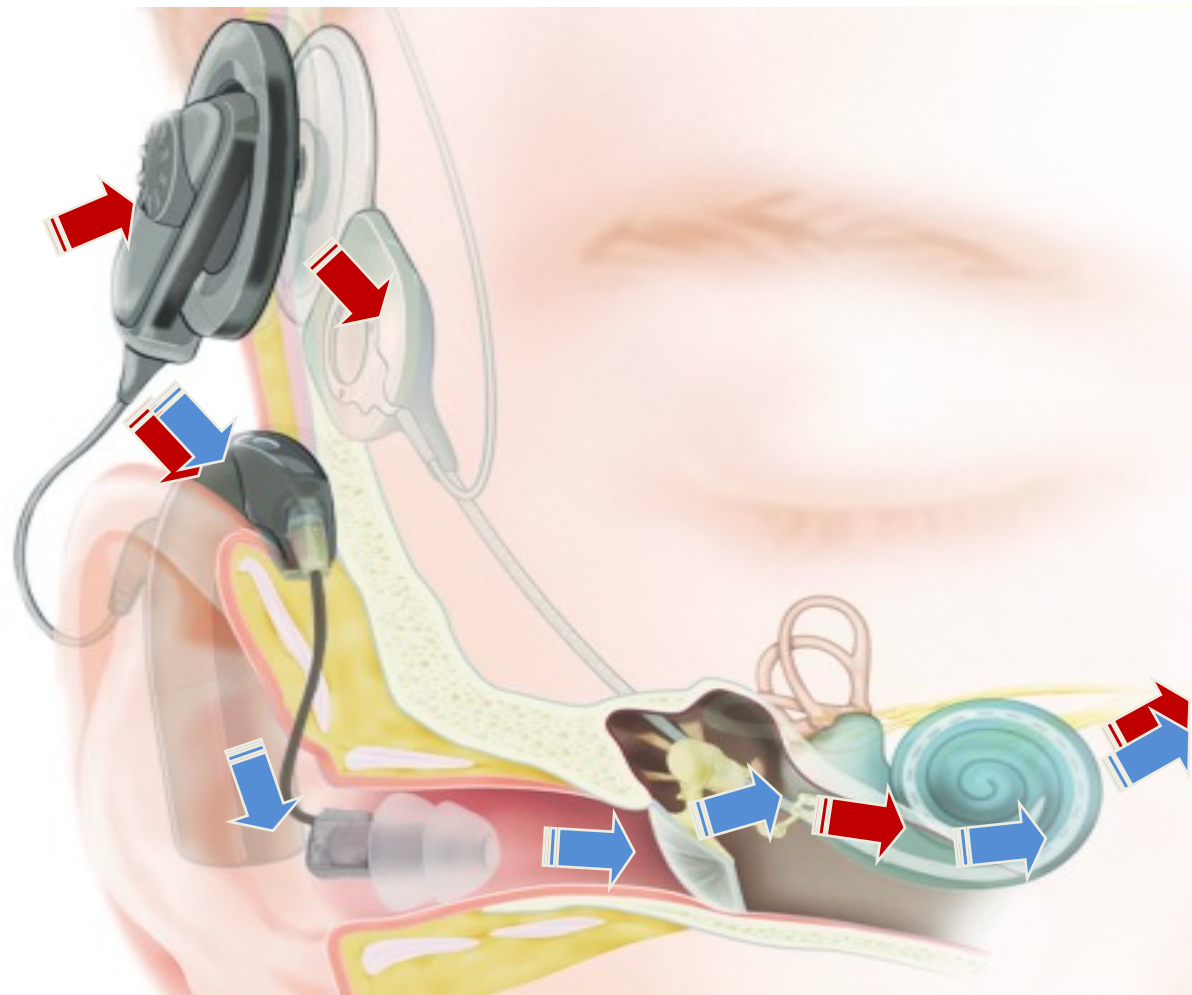
# Nucleus Aqua Accessories



# Hybrid system

- Provide the opportunity to offer acoustic and electrical inputs







# What is a bone conduction implant?

- A bone conduction implant is a device surgically implanted onto the mastoid bone.
- It can improve the hearing ability of people with conductive loss, mixed loss or SSD by vibrating the bone which contains the cochlea
- Two main components:
  - implant and sound processor

# The current bone conduction implant system





# The current bone conduction implant processor options



Baha 5



Baha 5 Power

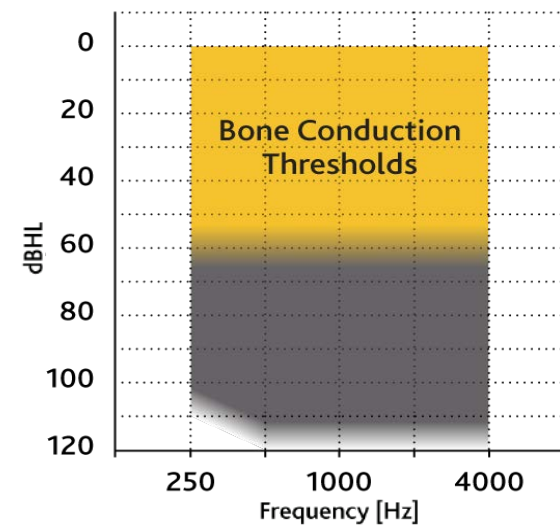
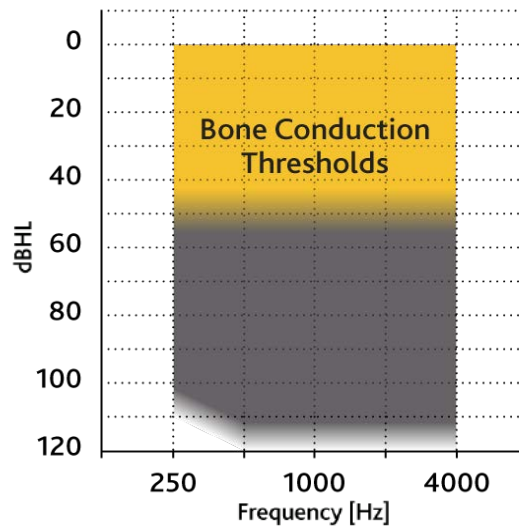
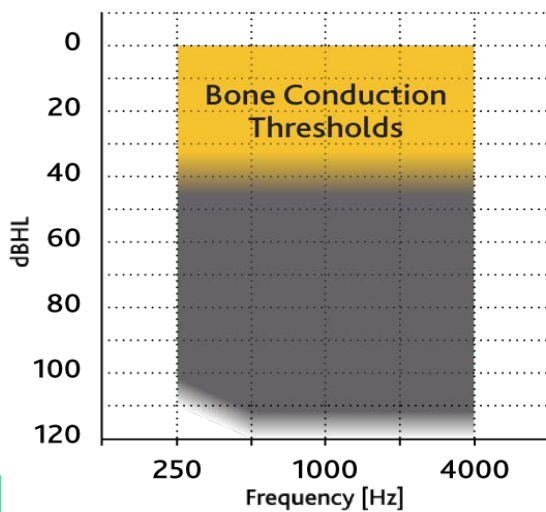


Baha 5 SuperPower

$\leq 45$  dB HL  
BC PTA<sup>2</sup>

$\leq 55$  dB HL  
BC PTA<sup>2</sup>

$\leq 65$  dB HL  
BC PTA<sup>2</sup>



1. Must have symmetrical bone conduction thresholds.
2. 4-frequency average across .5, 1, 2, and 3 kHz.

# Bone conduction implant for conductive/mixed losses

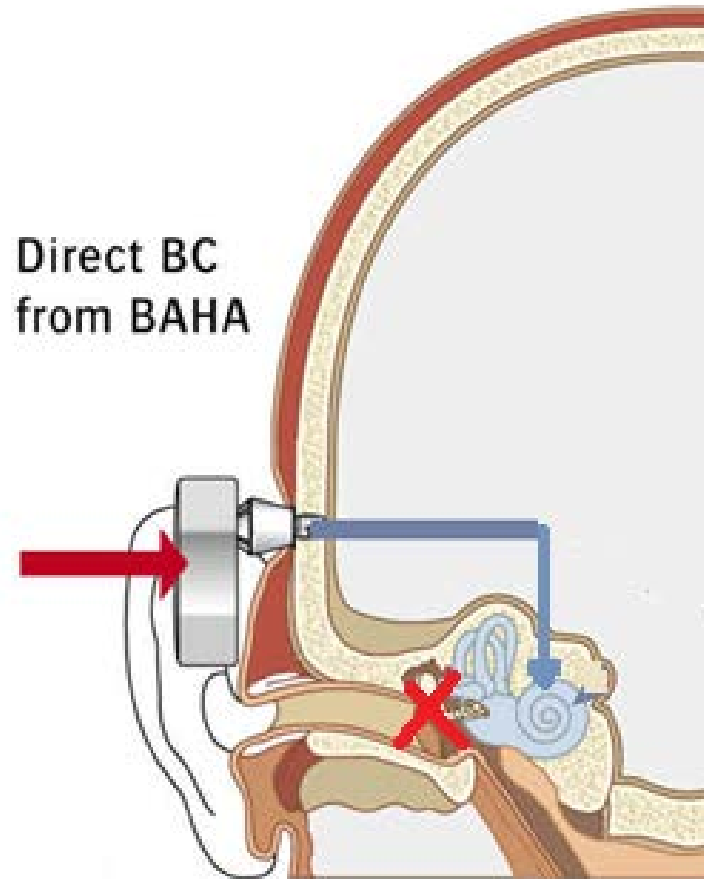


Image adapted from: <http://www.ent.uci.edu/clinical-specialties/ear-surgery/bone-anchored-hearing-aid>

# Bone conduction implant for SSD

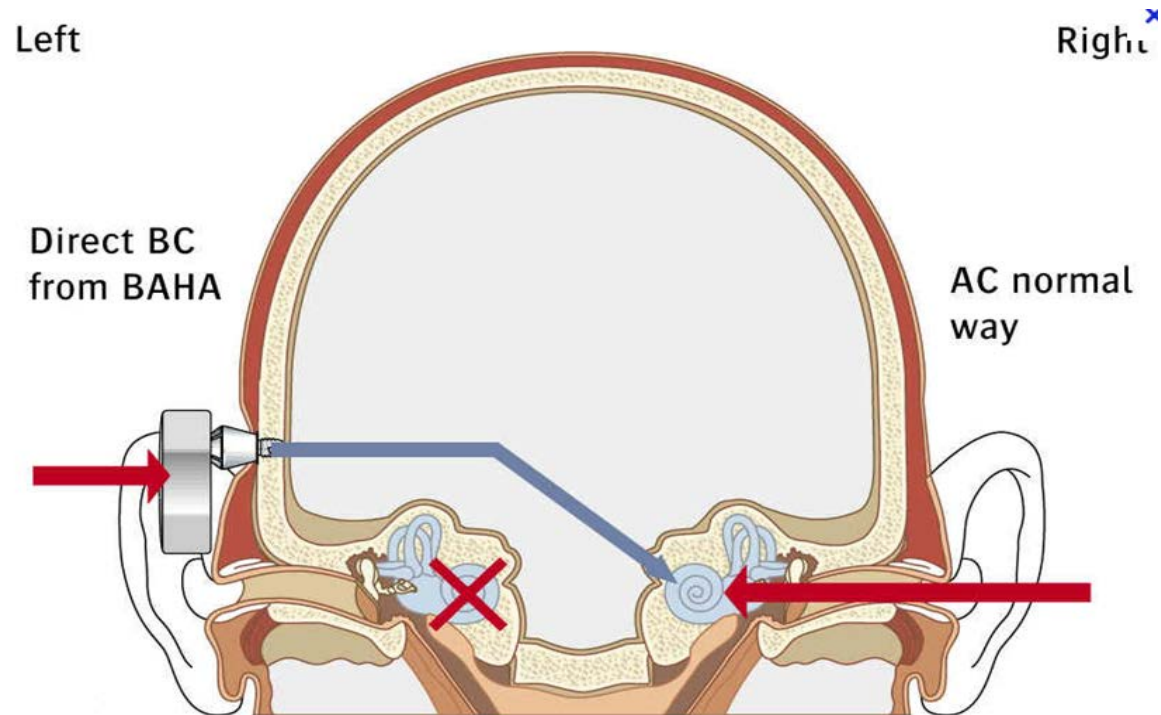
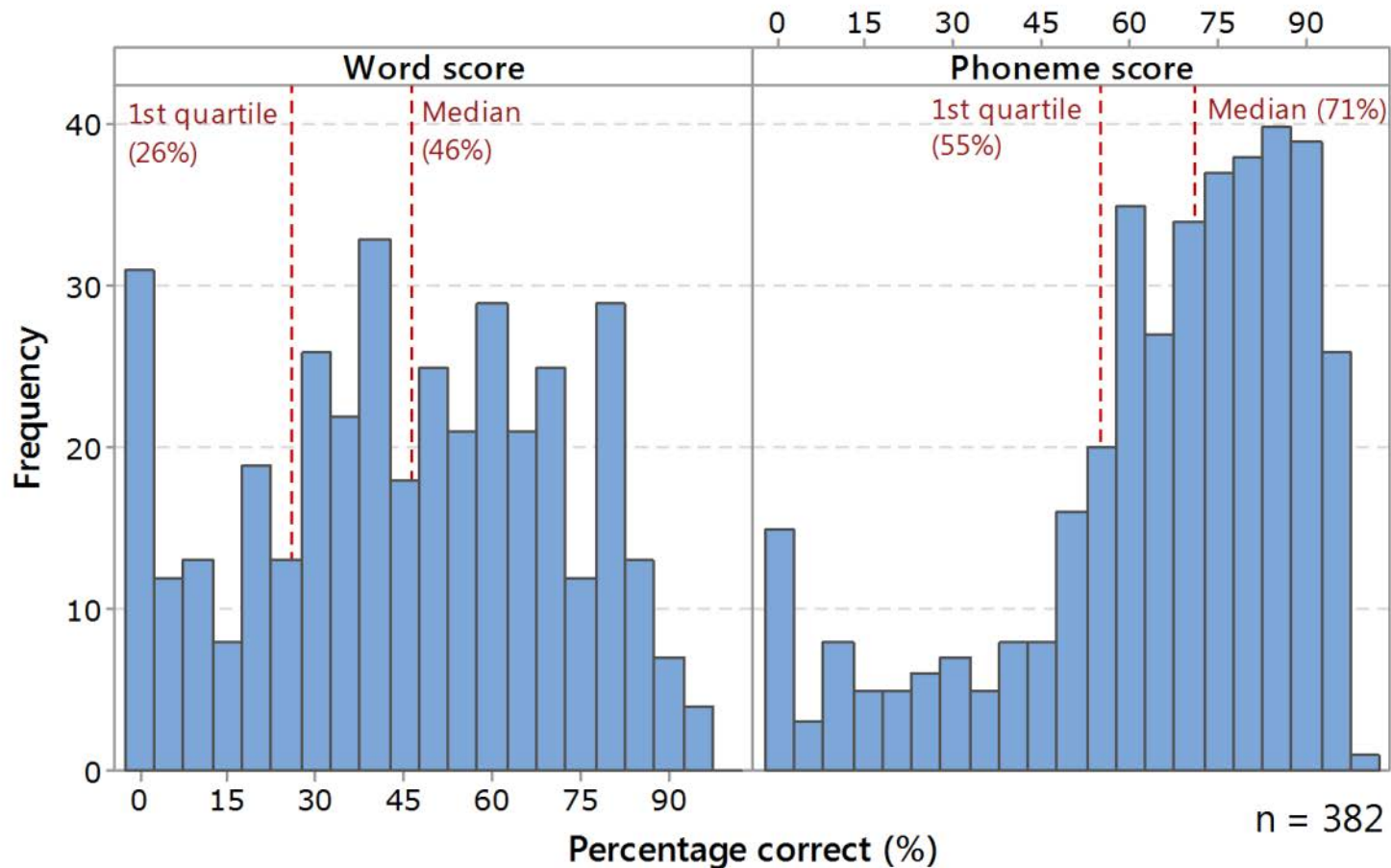


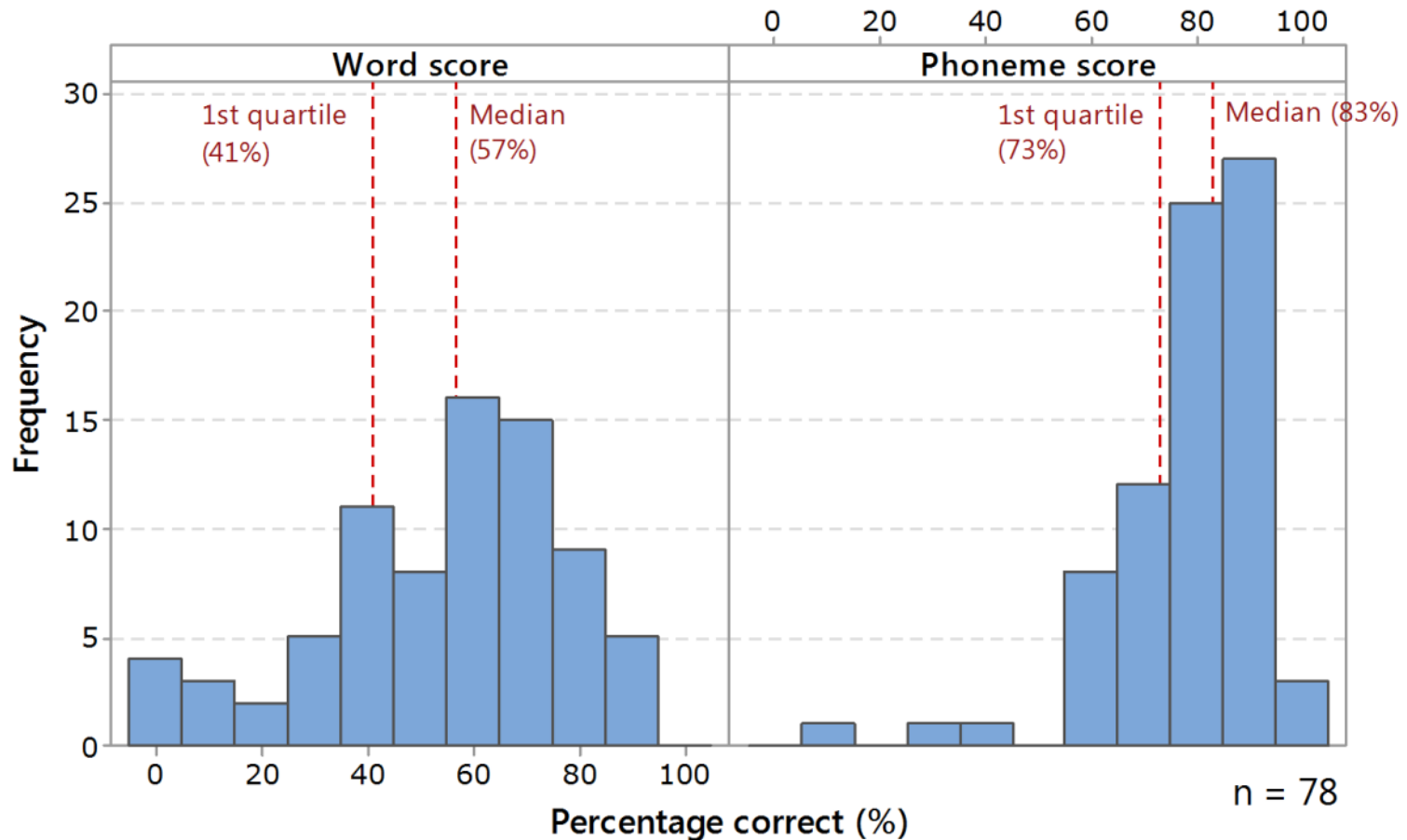
Image adapted from: <http://www.ent.uci.edu/clinical-specialties/ear-surgery/bone-anchored-hearing-aid>

# Recipient outcomes

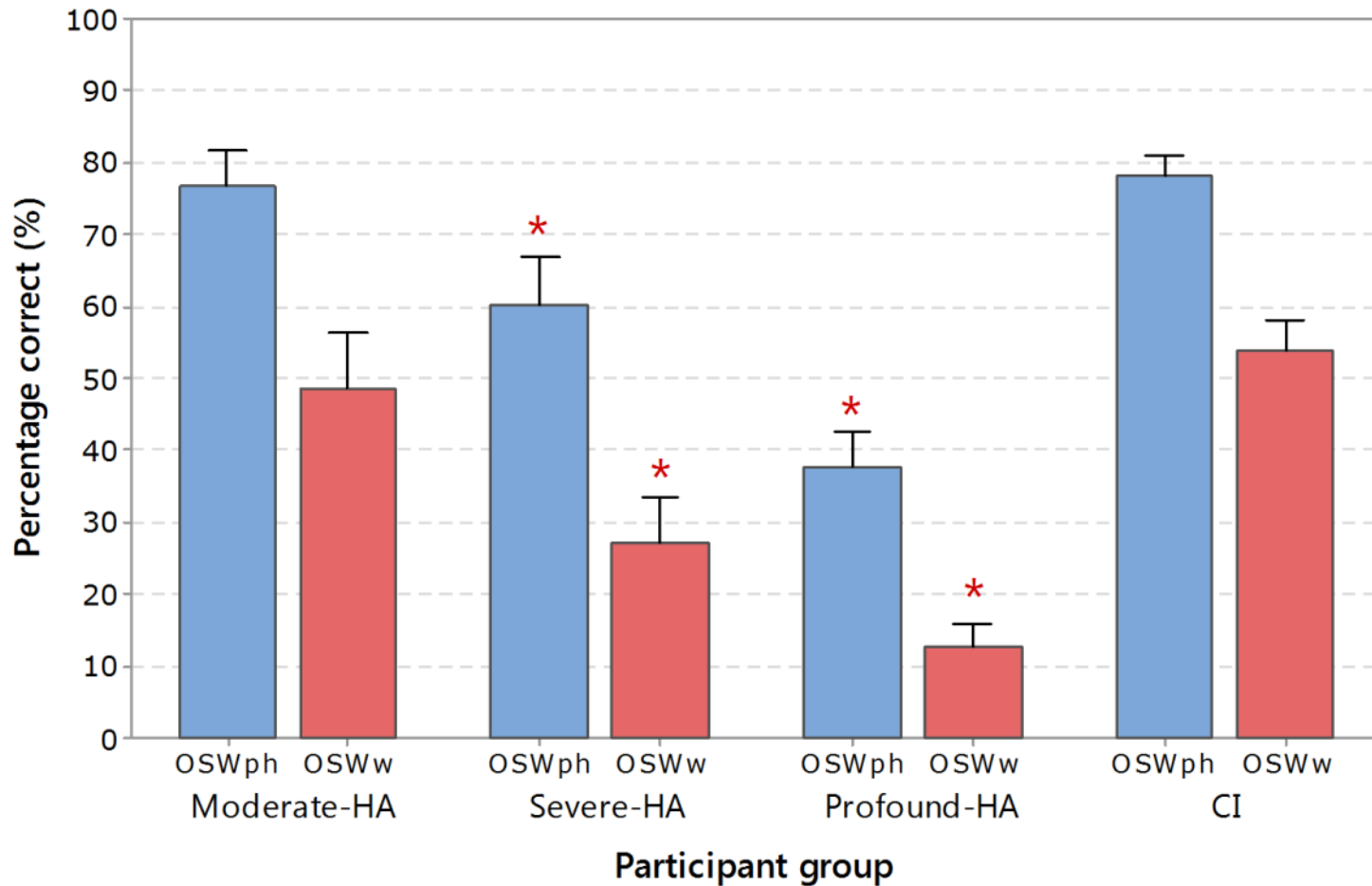
# Post-lingual adults: monosyllabic words



# Distribution of speech perception scores for children using CI



# Comparison between children using CI and HAs

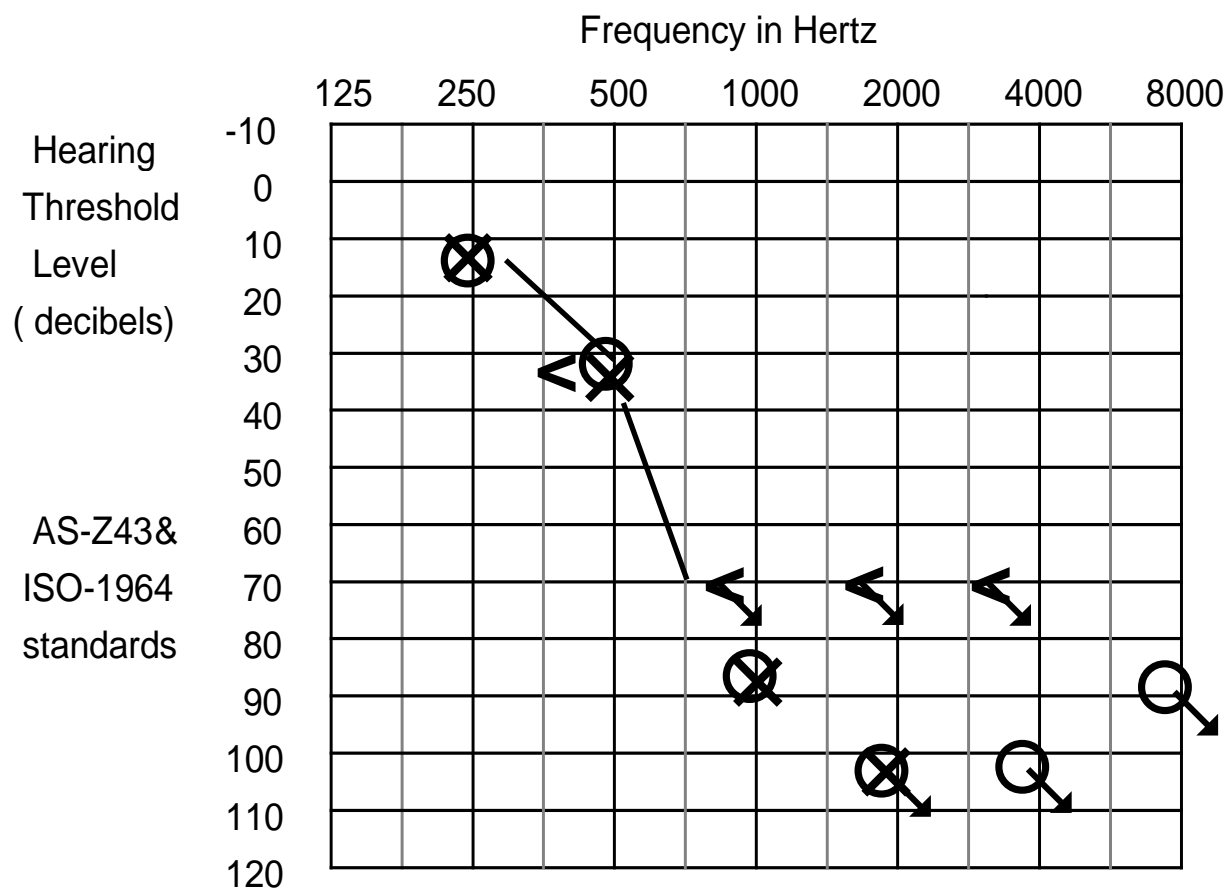


# Hearing preservation implants

- CI422/CI522 implants designed to minimize insertion trauma
  - Slim, full-length electrode array with 22 electrodes
  - 40% of recipients retain audible hearing in implanted ear
  - electro-acoustic stimulation possible with preserved low frequency hearing
  - electrical-alone speech perception equivalent to standard electrode arrays



# Case example: post-op. audiogram following insertion of CI422 implant into right ear



# Binaural considerations

- Bimodal device use
  - require contralateral hearing aid to be managed and optimized for best outcome
  - matching sound processing advantageous eg. ADRO
- Bilateral cochlear implantation
  - trend for simultaneous vs sequential implants for children (38% bilateral; 45% simultaneous)
  - growing number of adults receiving sequential bilateral implants (22%)
- Options routinely discussed at review appointments

# Recommendation guidelines

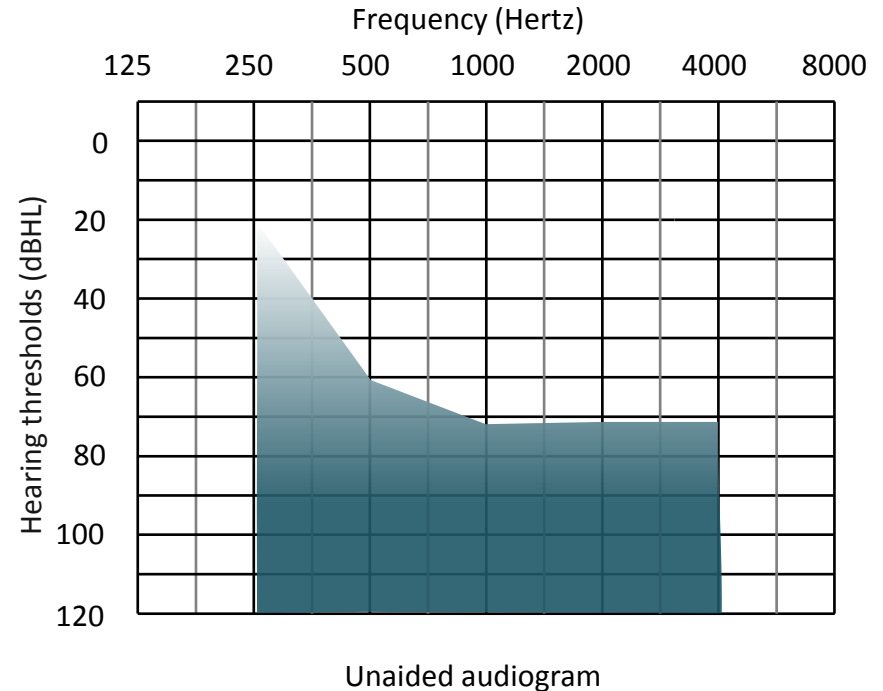
# How is a decision made?

- Implantable devices will not help everyone so a number of assessments are performed:
  - hearing and communication
  - anatomy and health of ears
  - general health and development
- Results considered by multi-disciplinary team
- Recommendation given to patient/family

# Referral guidelines for cochlear implants

Hearing impaired people may benefit from a cochlear implant if they have limited speech recognition ability with hearing aids, e.g.:

- complain that people mumble or aren't speaking clearly
- rely on lipreading or other visual cues like subtitles on TV
- have difficulty understanding people over the telephone
- avoid social gatherings because of the impact of noise



[Poorer ear hearing thresholds]

# Audiological guidelines

Consider option of cochlear implantation for adults if:

## POST-LINGUAL hearing loss

- Moderate-to-severe hearing loss or worse
- 55% or worse phoneme score in worse hearing ear

## PRE-LINGUAL hearing loss

- Moderate-to-severe hearing loss or worse
- Evidence that auditory cues assist communication

# Audiological guidelines

Consider option of cochlear implantation for children if:

- Unaided PTA is 65dBHL or worse in both ears
- $\leq 55\%$  phoneme score in worse hearing ear
- Not meeting expectations for oral language development

# Medical & developmental guidelines

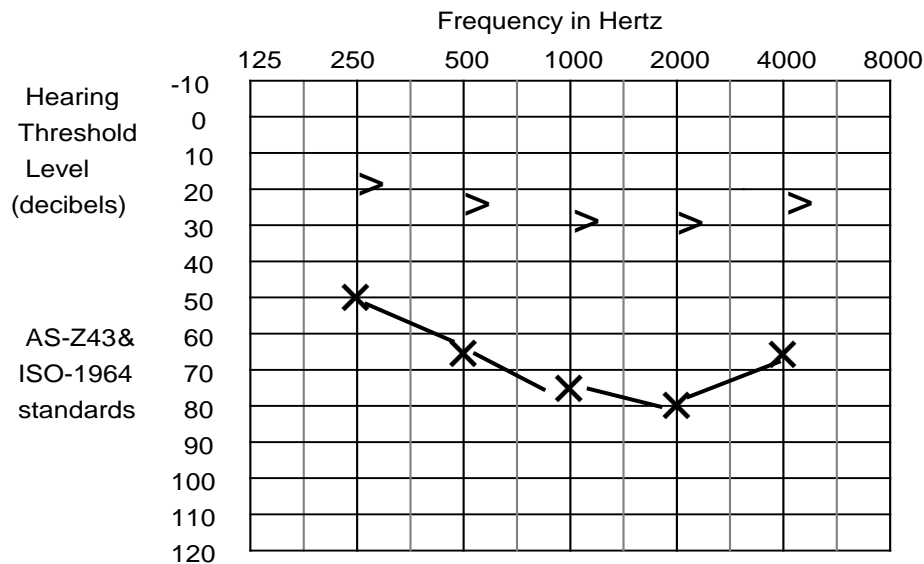
Consider option of cochlear implantation for people if:

- Evidence that an auditory nerve is accessible by an implant
- The surgical procedure can be performed with minimal risk to the patient
- Evidence that the patient has sufficient cognitive ability that they can respond to external stimuli

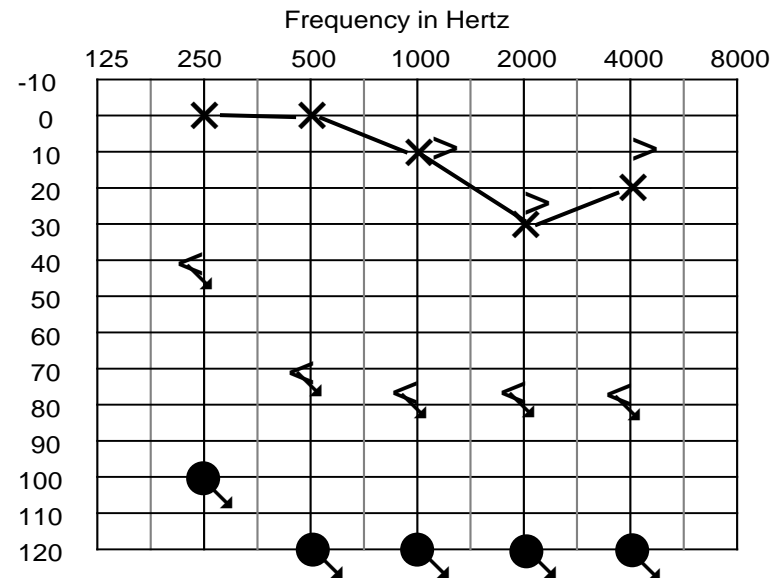


# Referral guidelines for bone conduction implants

Hearing impaired people may benefit from a bone conduction implant if they have:



Conductive (or mixed) hearing loss



Unilateral hearing loss

# Audiological guidelines

Consider option of bone conduction implantation if:

- Bone conduction thresholds better than 65dB
  - Conductive or mixed hearing loss
  - Unilateral hearing loss
- Benefit demonstrated with soft-band trial

# Medical & developmental guidelines

Consider option of bone conduction implantation for people if:

- Evidence that osseointegration is possible
- The surgical procedure can be performed with minimal risk to the patient
- The patient can manage to maintain a clean abutment site (for *Baha Connect*)

# Referral process

- Please include the following information in your referral:
  - patient demographic information, contact details and preferred contact person, Medicare number
  - interpreter requirements and language
  - history and aetiology of hearing loss
  - a current audiogram and/or previous audiograms
  - information about hearing aids
  - relevant medical issues
  - summary of relevant test results; eg. balance tests

# Unilateral/asymmetrical hearing loss



# Unilateral/asymmetrical hearing loss

- Bone conduction implant/CROS can help, however are limited in ability to provide true binaural cues
- Trials world-wide with cochlear implants
  - some improvements in understanding speech in noise
  - sound localisation is possible
  - positive reports on the effect on tinnitus
- Protocol in Melbourne involves bone conduction soft-band trial, recommended trial of CROS aid and careful counselling prior to recommending CI

# Clinical recommendations

## Bone conduction implants

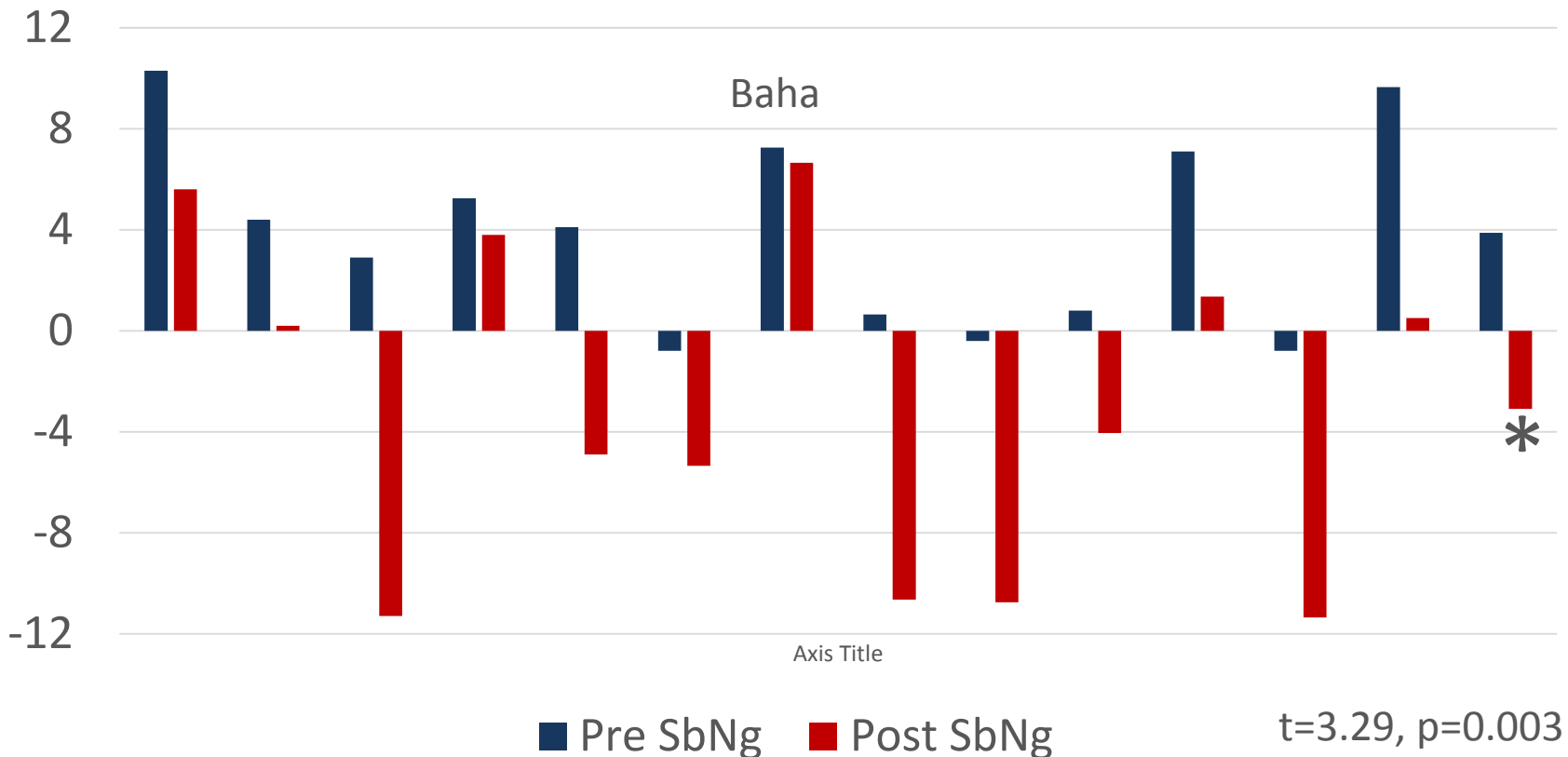
- For patients who:
  - are satisfied following a softband trial
  - gain benefit from sound awareness on the deaf side and do not anticipate true binaural hearing
  - do not have a intact auditory nerve or patent cochlea
  - have an intact auditory nerve and patent cochlea but do not want to undergo significant surgery
  - long term hearing loss

## Cochlear implants

- For patients who:
  - are not satisfied following a Baha and/or CROS trial
  - have a viable auditory nerve & patent cochlea
  - may consider the potential for partially restored binaural hearing
  - marked perceived problems with speech understanding in noise over an extended time
  - motivation to consider surgical intervention

# Preliminary outcomes for adults

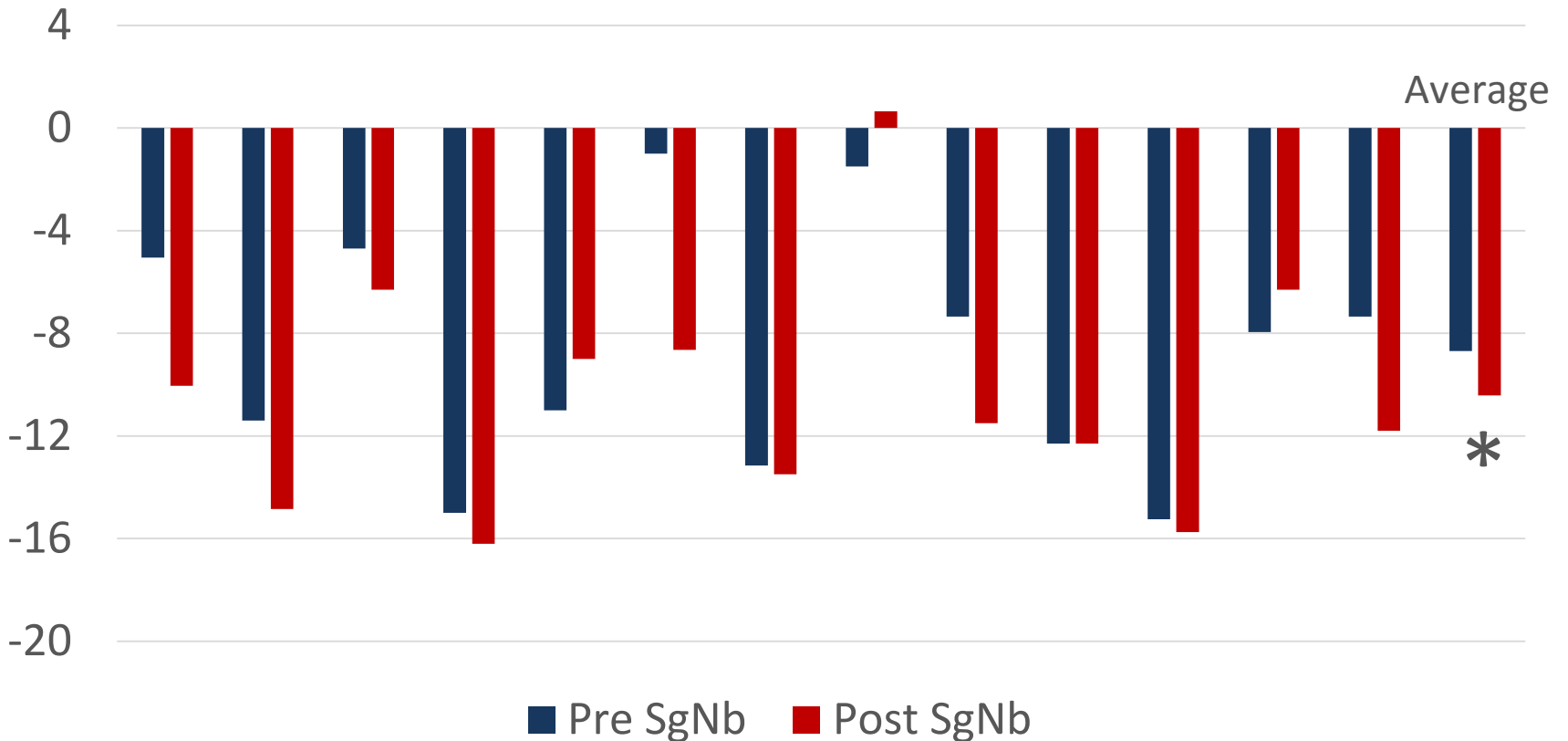
SRT: speech to 'bad' ear & noise to 'good' ear  
Pre- vs Post-Op (dB)





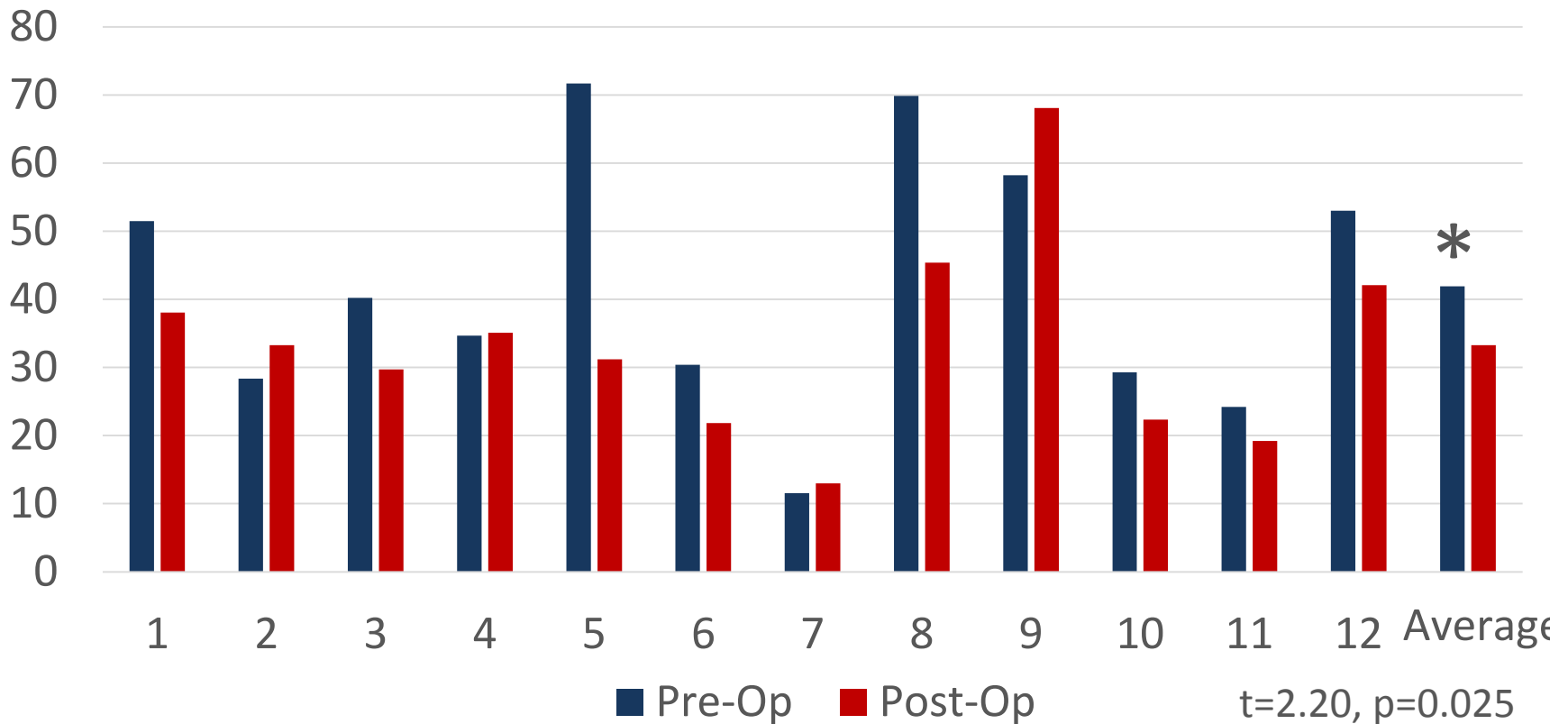
# Preliminary outcomes for adults

SRT: speech to 'good' ear & noise to 'bad' ear  
Pre- vs Post-Op



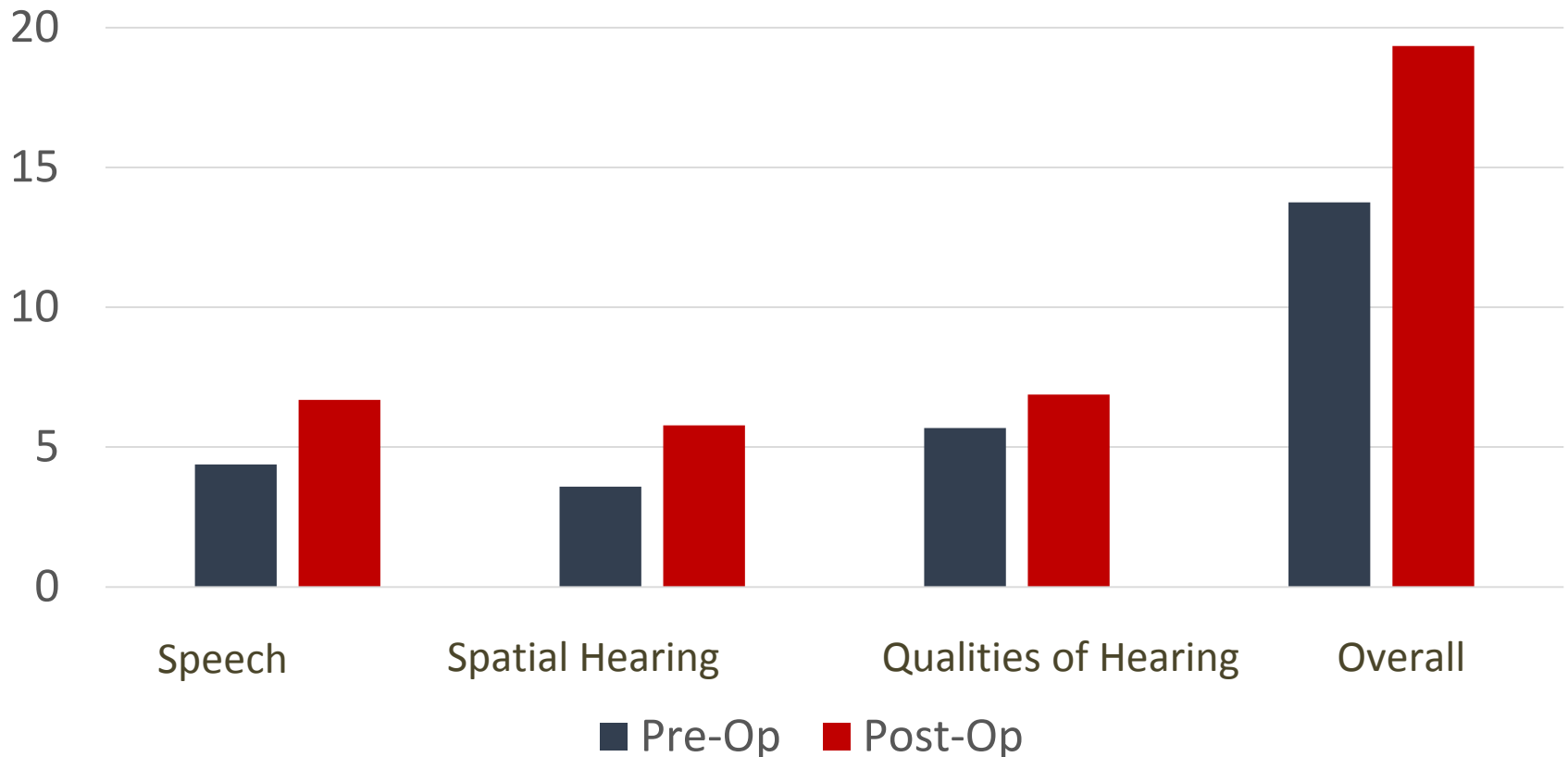
# Preliminary outcomes for adults

Comparison between localisation (degrees RMS)  
Pre- & Post-OP



# Preliminary outcomes for adults

Speech Spatial Qualities (SSQ) questionnaire  
Pre- & Post-Op (n=10)



# Issues for children with UHL/AHL

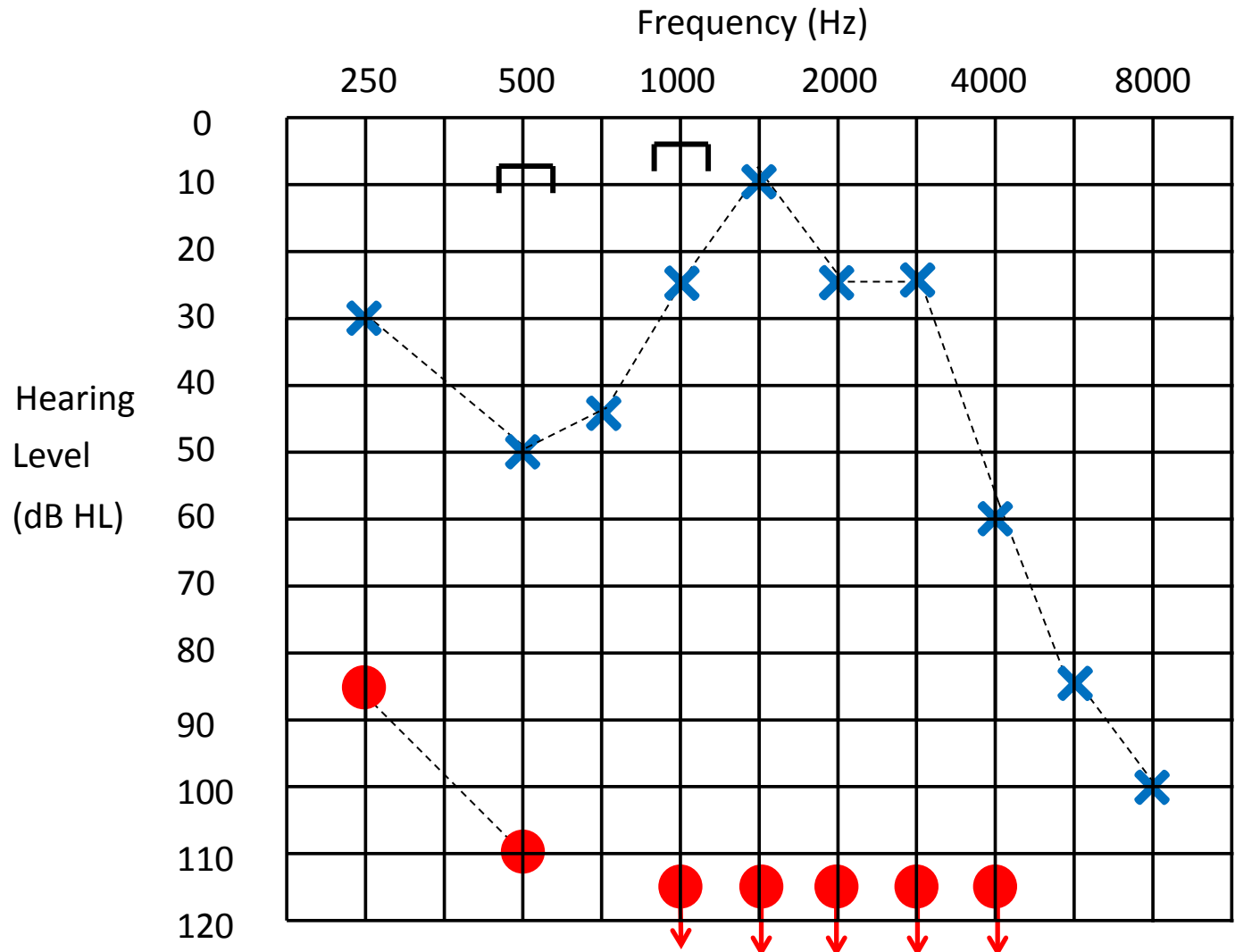
- Benefits of bilateral hearing
- What is the motivation of the family/child?
- Alternative management options, including no intervention
- Challenge of introducing a hearing device
- Integration of an electrical signal with normal (or near normal) contralateral hearing
- Presence of an acoustic nerve
  - high incidence of auditory nerve deficiency in children with congenital UHL (~50%)

# Melbourne results: CI for children with UHL/AHL

- 5 children with SSD/AHL have received a CI in Melbourne
- Age at CI range 4 months to 10 years age
- 4 out of 5 wearing most waking hours and reporting benefit
- Case examples

# Paed case study 1: Demographics

Age at onset	2 yrs 9 mths (detection)
Aetiology/risk factors	large vestibular aqueduct syndrome
Degree of hearing loss (at diagnosis)	right: moderate-severe left: mild
Other notes	progressive
Age at CI	10 years 4 months



**AGE AT CI:  
10y4m**





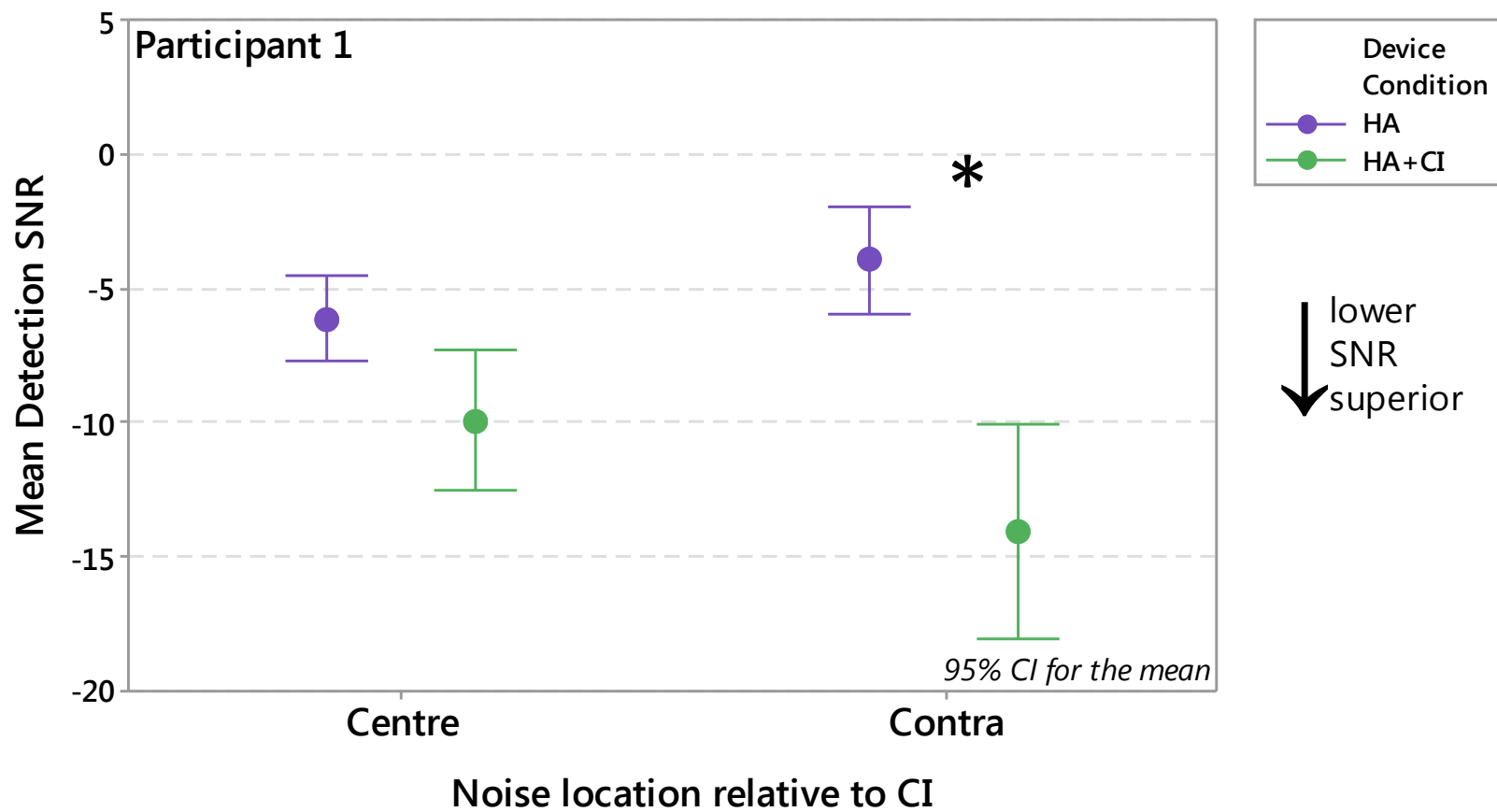
# Paed case study 1 : Functional outcomes

- from switch-on
  - adapted easily to CI
  - full-time use of HA+CI
- by 12 months post-op
  - follows group conversation more easily
  - does not feel “left out” within friendship group
  - correctly identifies mother’s location as upstairs or downstairs
  - still reliant on lip reading during CI alone habilitation (direct input)



# Paed case study 1 results: 4AFC

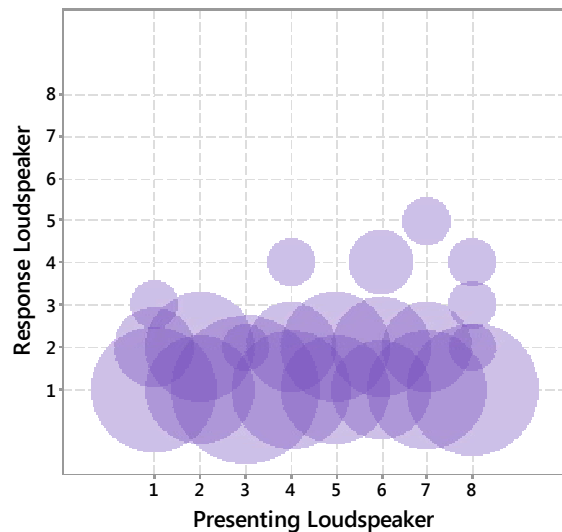
12 months post op.



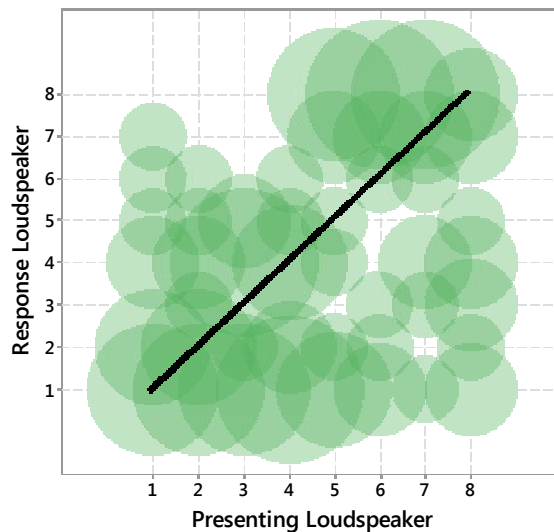
\* HA+CI superior to HA ( $p < 0.01$ )

# Paed case study 1 Results: Localisation

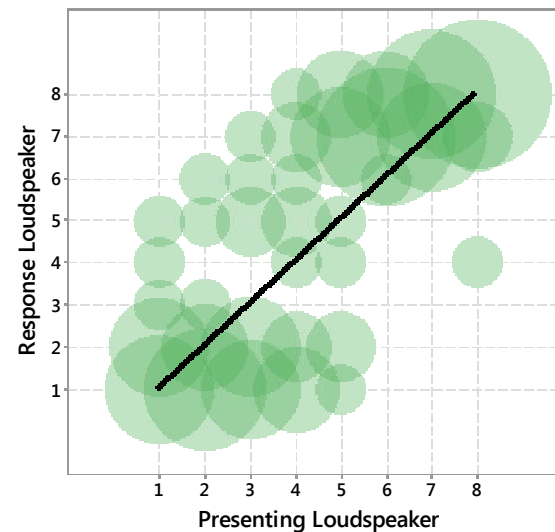
HA alone 6 months post op.



HA+CI 6 months post op.

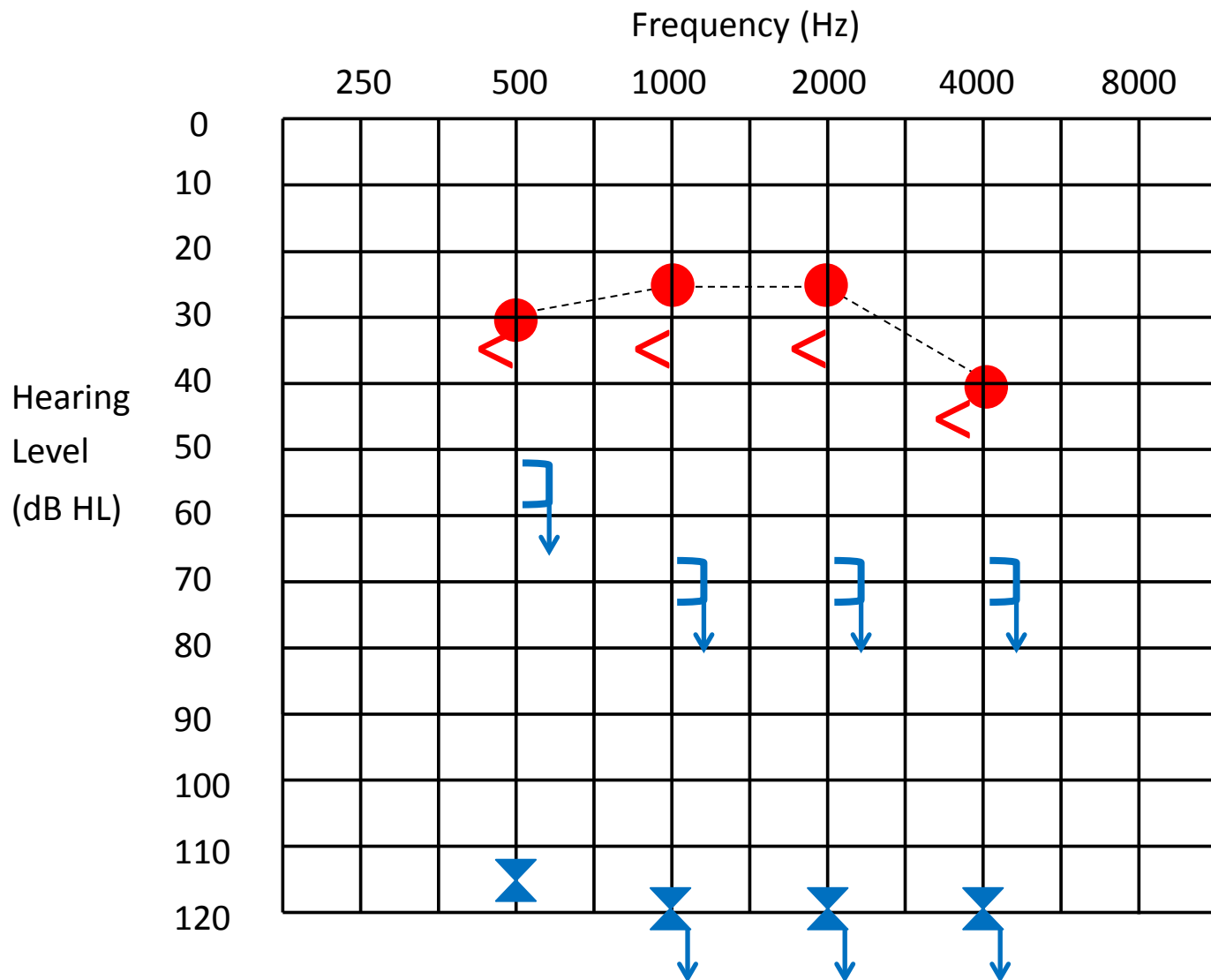


HA+CI 12 months post op.



# Paed case study 2: Demographics

Age at onset	2 yrs 9 mths (detection)
Aetiology/risk factors	history of CMV infection premature (33 wks gestation)
Degree of hearing loss (at diagnosis)	right: mild left: profound
Other notes	general delay in motor skills
Age at CI	6 years 11 months



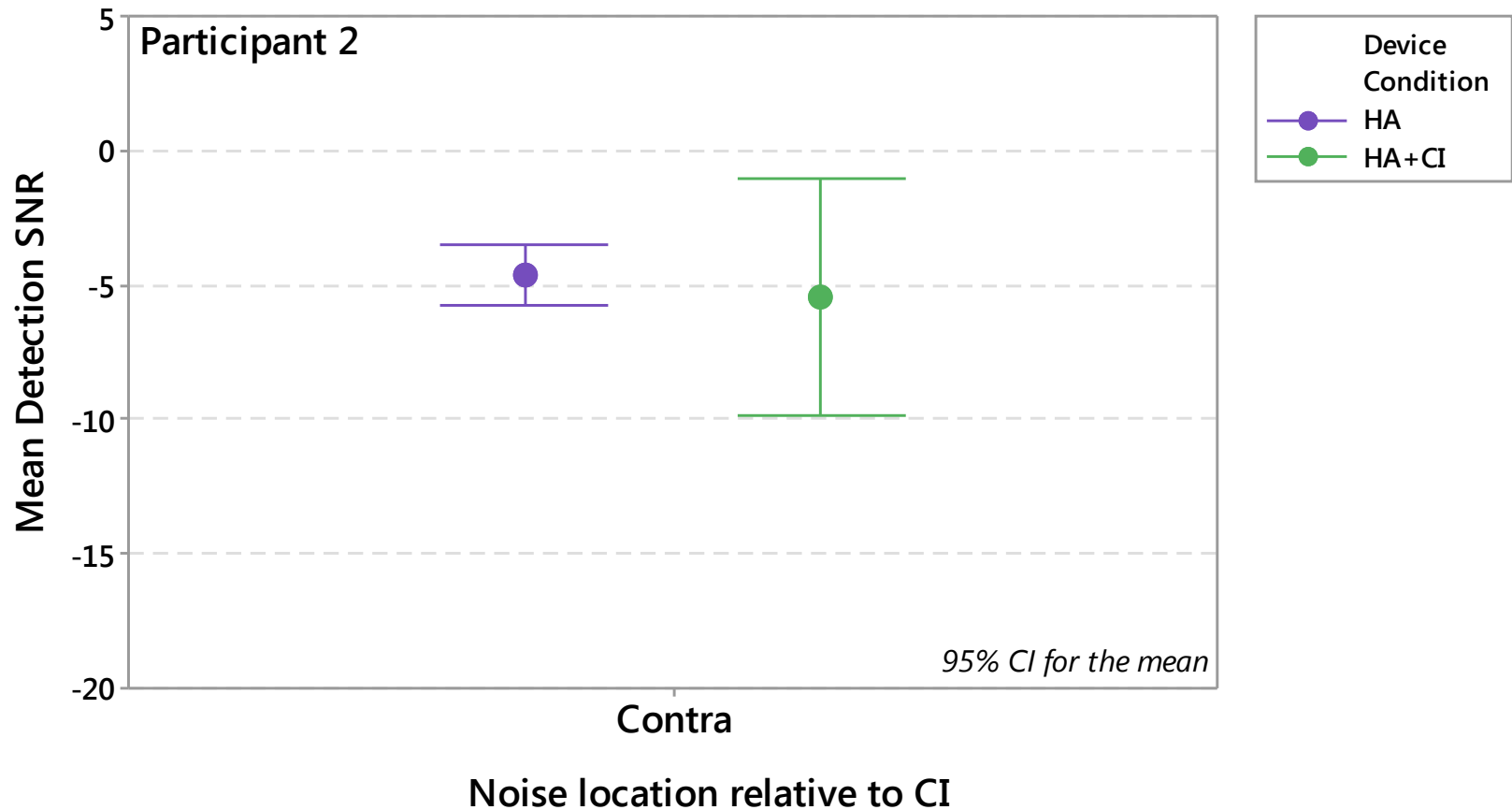
**AGE AT CI:**  
6y11m

# Paed case study 2 : Functional outcomes

- from switch-on:
  - daily usage rate of 70%
  - data logging suggested less device use than reported
  - child reporting annoying beeping only via CI
- by 12 months post-op:
  - part-time devices use, but less need to remind child to wear CI
  - no notable difference in performance with/without CI

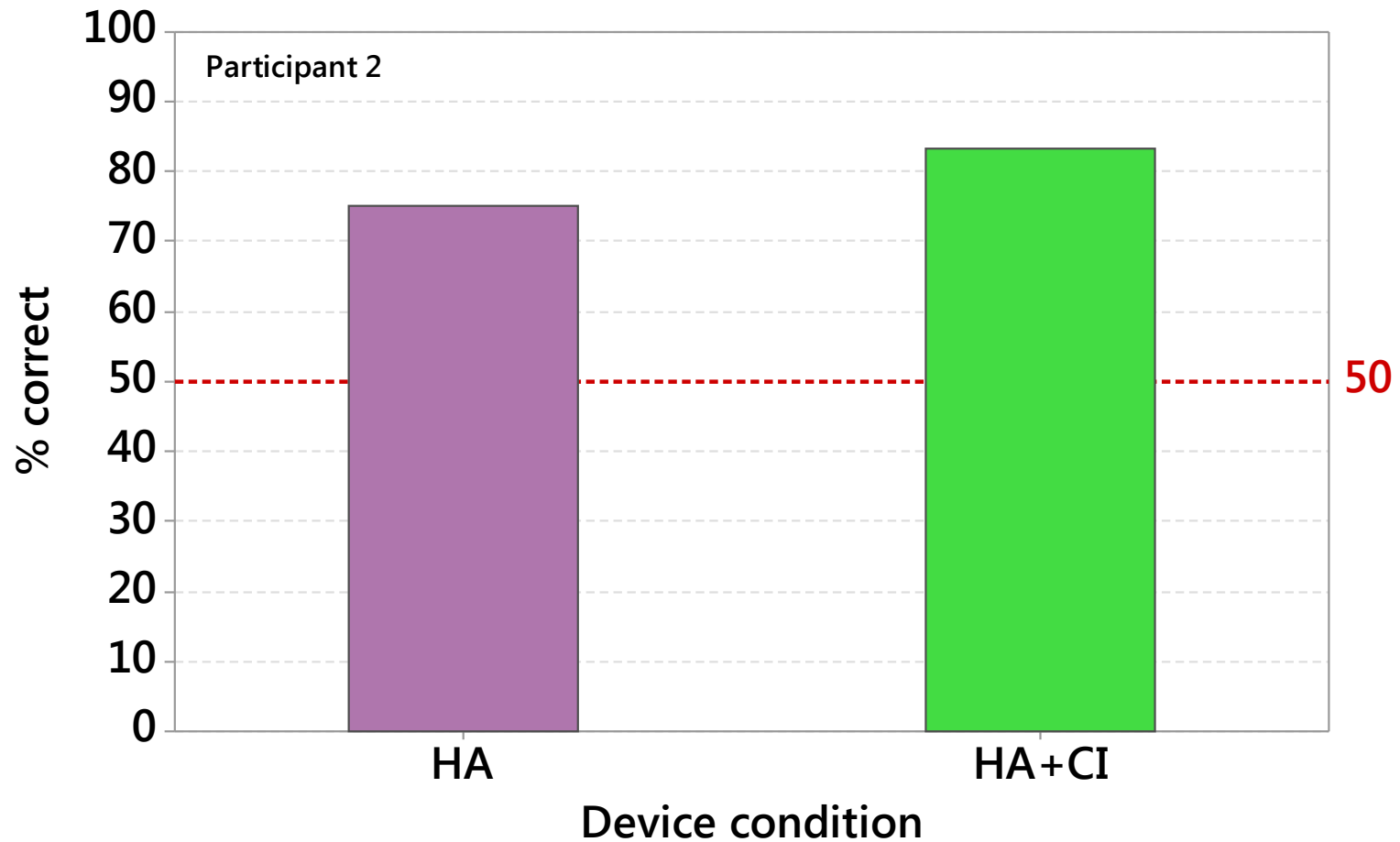
# Paed case study 2 results: 4AFC

12 months post op.



# Paed case study 2 results: Lateralisation

12 months post op.



# Conclusions for UHL/AHL

- Many similarities between working with adults/children having sequential bilateral implants and those with unilateral/asymmetric hearing loss
- Unique issues for this population
- Informed choice is challenging due to limited knowledge of outcomes with CI



# Summary

- The criteria for recommending implantation is evolving as increasing benefits are demonstrated
- Anyone who is not coping with hearing aids and who is interested in an implant, is welcome to be referred for a discussion
- Various device and surgical options for improving hearing will be investigated

# Questions?