

# A truly self-fitting hearing aid: need, concept, and feasibility

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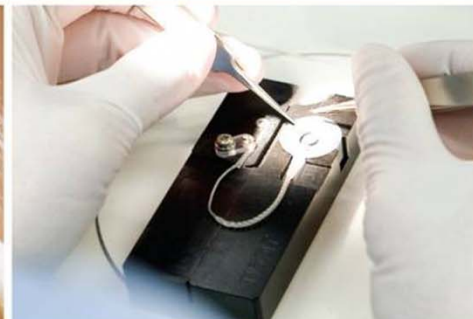
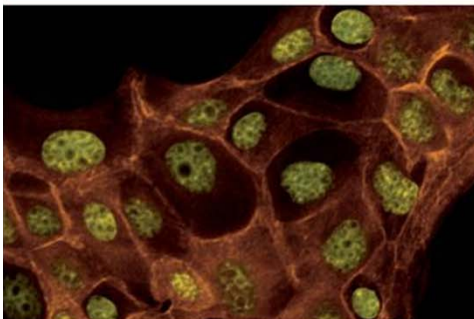
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Advances in Audiology, December 2012, Las Vegas

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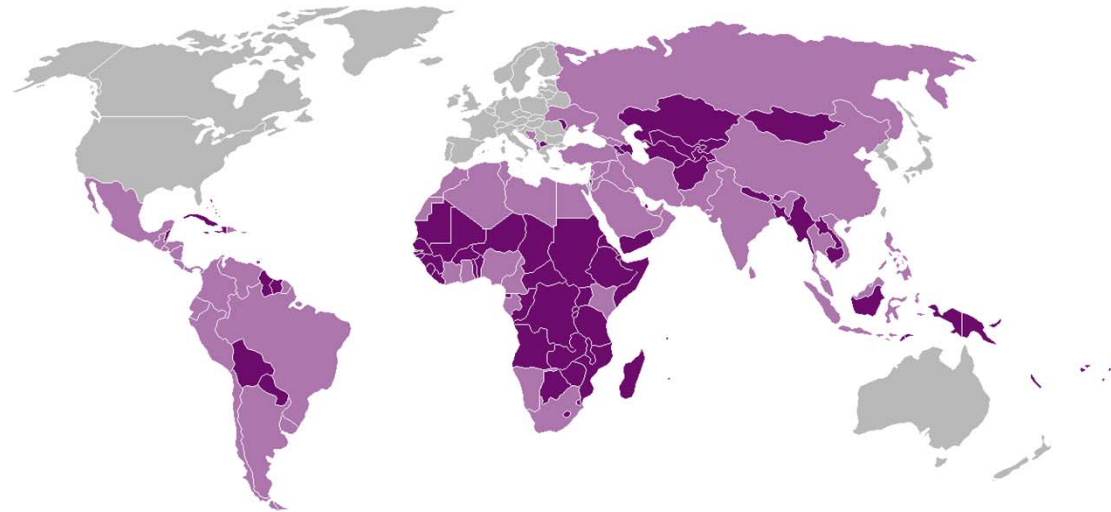


# Background

- Truly self-fitting devices
  - No professional input
  - No computer support
  - No telephone access
  - No ear impressions

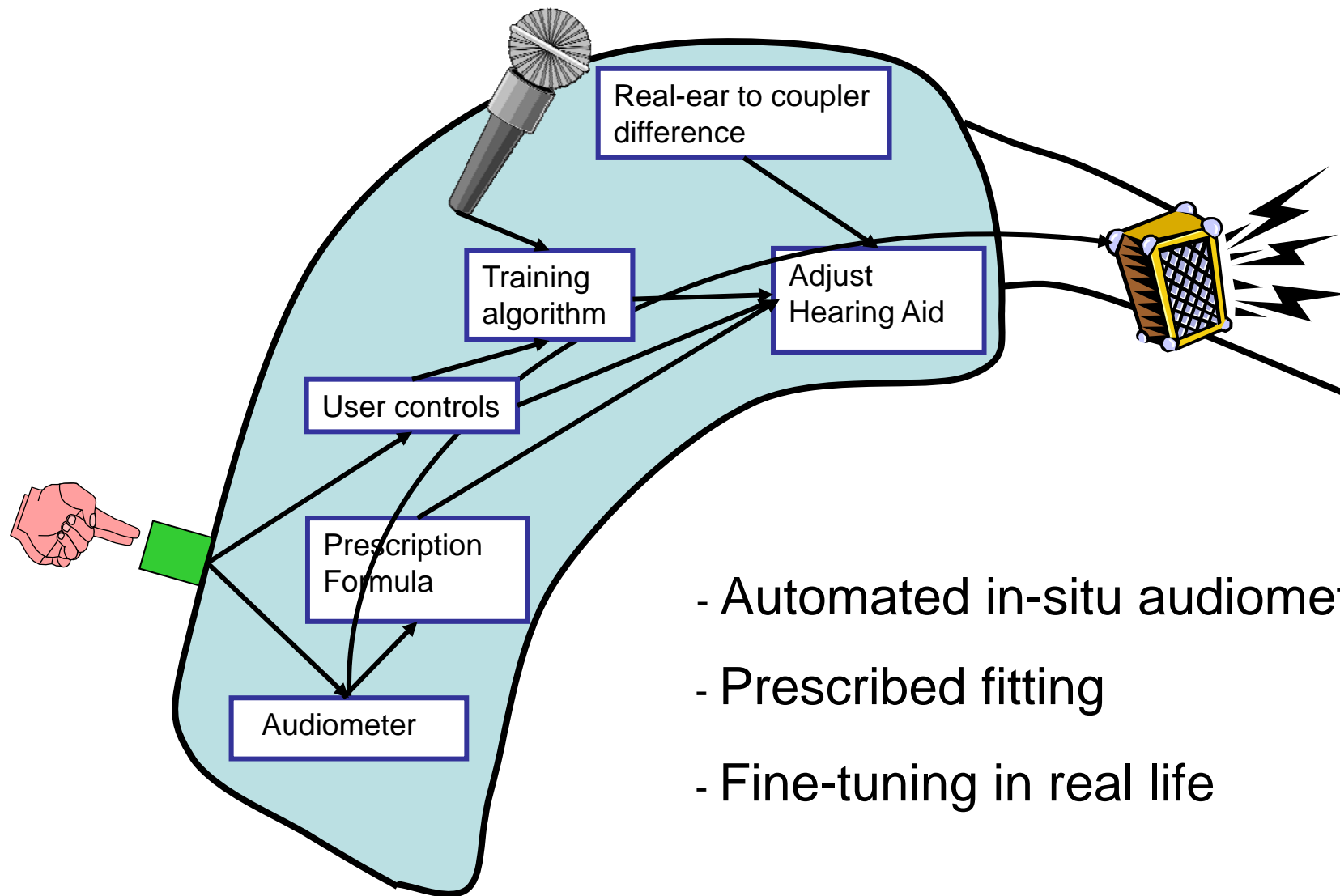


- Self-fitting hearing aid concept patented in 1984 (Köpke et al.)



- Developing countries
  - Deficit in both the provision of hearing aids and the number of hearing health care providers who are skilled to fit them
- Developed countries
  - Unreliable services to remotely located populations (indigenous people in particular)

# Self-fitting hearing aid (concept)



- Automated in-situ audiometry
- Prescribed fitting
- Fine-tuning in real life

Re Convery et al., 2011

- Understand the concept
  - Management
    - Preparations
      - Assembly
    - Automated in-situ audiometry
    - Contraindications to fitting
      - Asymmetry
      - Conductive component
    - Fine tuning (training)



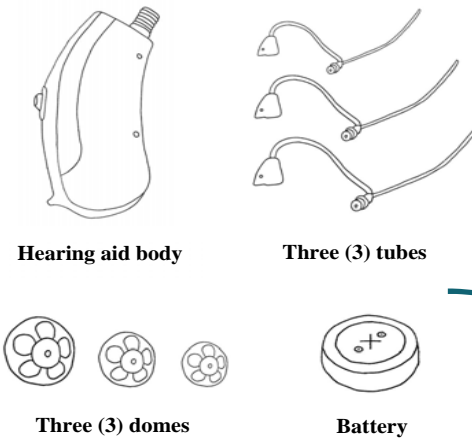
# Assembly Instructions

- Designed in accordance with best practice health literacy principles (*“ability to read, use and understand health information”*)

third grade reading level

**Parts of the hearing aid**

- The parts for the right hearing aid are in the red bag. The parts for the left hearing aid are in the blue bag.
- Open the blue bag and take out the parts.
- Check you have all the parts:

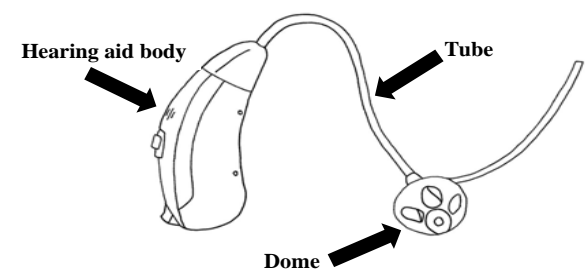


**Hearing aid body**      **Three (3) tubes**

**Three (3) domes**      **Battery**

2

4. Now you will put the parts together. Please follow the steps shown on the next few pages. This is how the hearing aid will look when you are finished.



**Hearing aid body**      **Tube**

**Dome**

3

line drawings paired with text to reinforce the message

Re Caposecco et al., 2011

# Assembly instructions

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- An instruction booklet for each ear
- Left/right color coded
- Defined steps:
  - Tube selection
  - Dome selection
  - Attach dome to tube
  - Attach tube to HA body
  - Insert battery
  - Insert device into ear
  - Troubleshooting (tube and dome sizes)
  - Button press

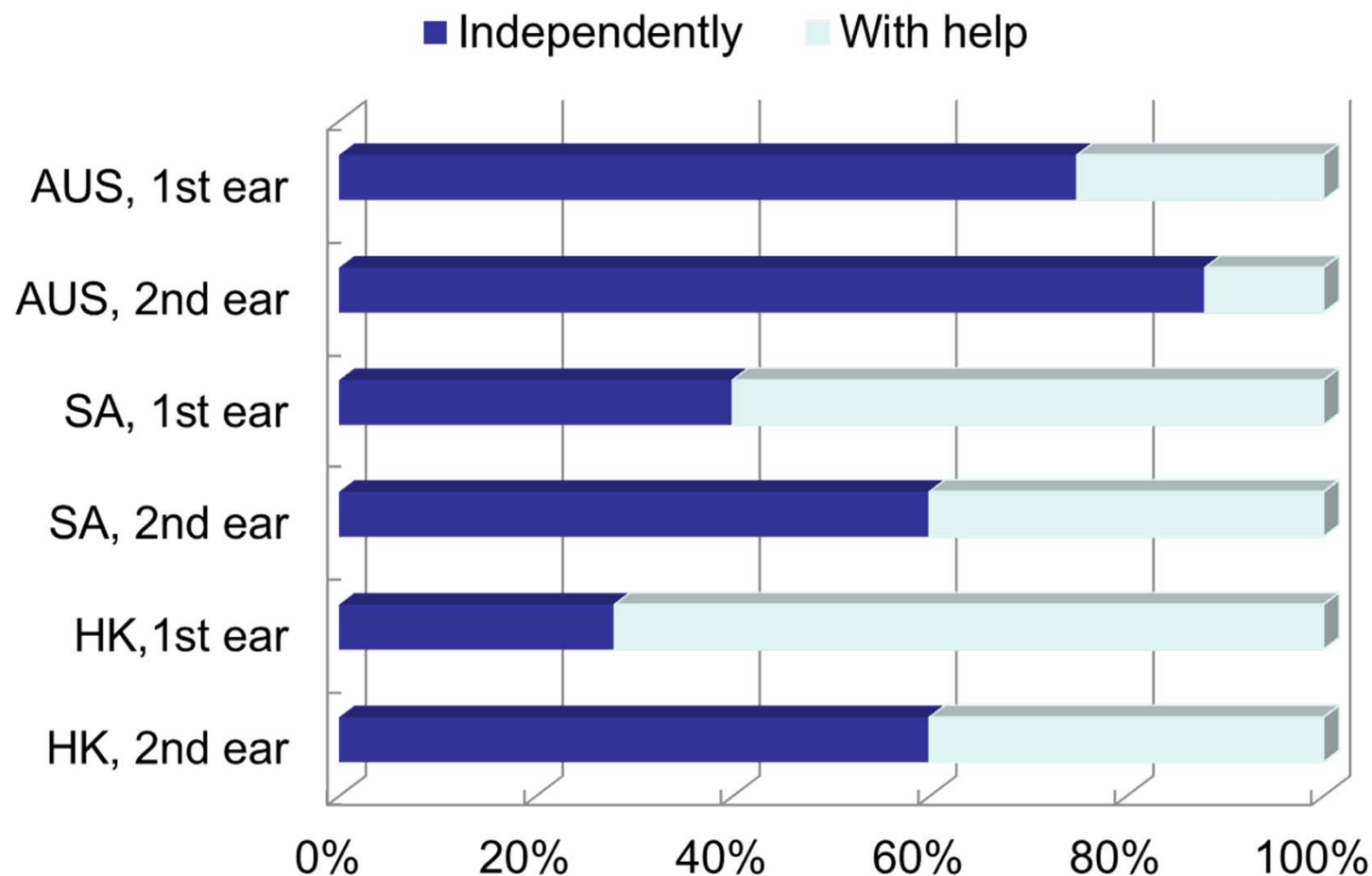
- Hearing-impaired participants with partner

| Parameter               | Australia<br>(N = 80)  | South Africa<br>(N = 40) | Hong Kong<br>(N = 40)   |
|-------------------------|------------------------|--------------------------|-------------------------|
| Instructions            | English<br>Version 1.0 | English<br>Version 2.0   | Mandarin<br>Version 2.0 |
| Age (years)             | 73                     | 67                       | 74                      |
| Occupation (rating)     | Manager                | Unemployed               | Labourer                |
| Vision (self-rating)    | Excellent/good         | Good                     | Good                    |
| Reading (self-rating)   | Excellent              | Good                     | Moderate                |
| Cognition (score)       | 26/30                  | 22/30                    | 22/30                   |
| Health literacy (score) | 34/36                  | 27/36                    | 26/36                   |
| Dexterity (sec)         | 101                    | 116                      | 108                     |

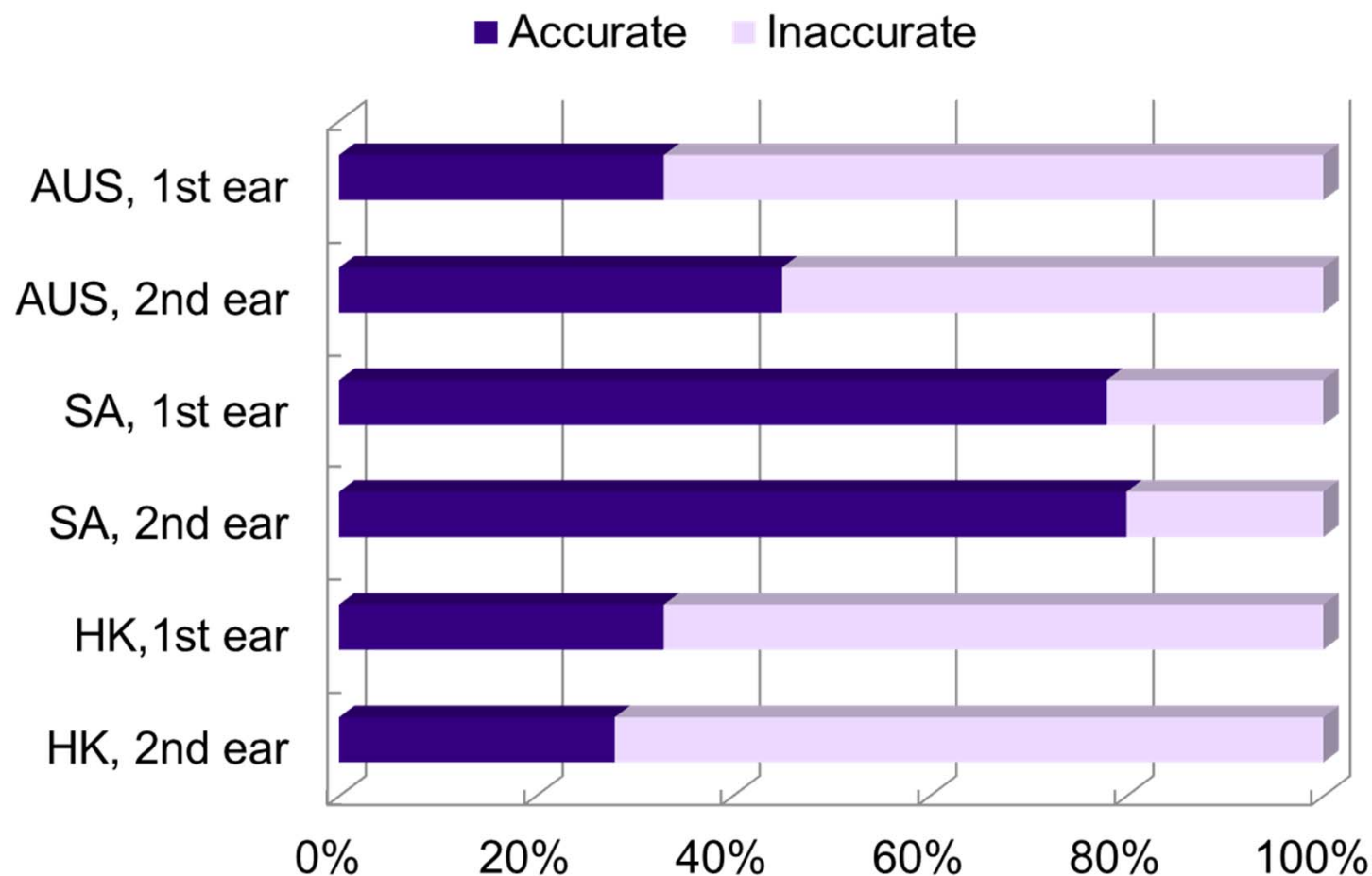
(Convery et al., in preparation)

Monitor independence and accuracy





- More people in the AUS population managed task on own
- Health literacy primary determining factor
- More managed task on own the second time (all populations)



- SA population most accurate – revised instructions
- Health literacy and cognition were contributing factors
- 58% of HK subjects did not read the instruction booklet fully, or at all

## *Conclusion:*

Task seems manageable by a wide cross section of the population provided instructions are carefully designed taking low health literacy into account

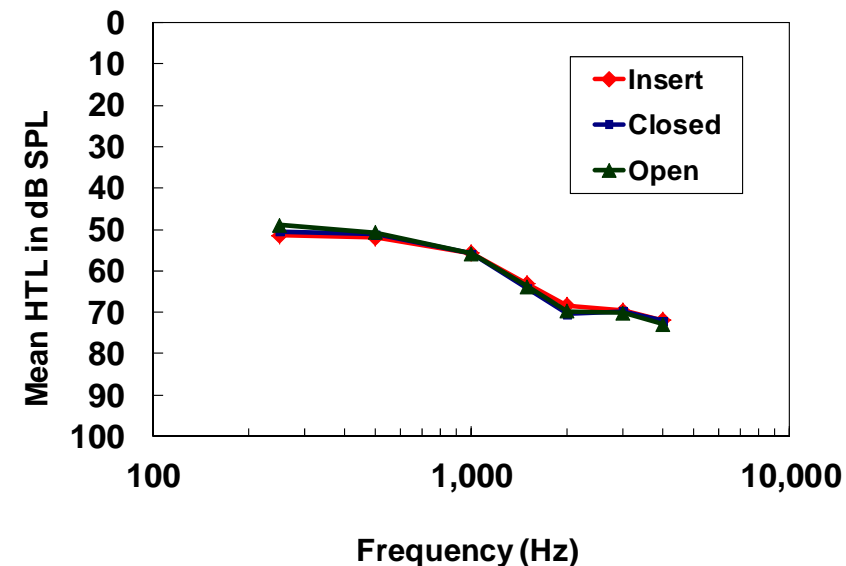
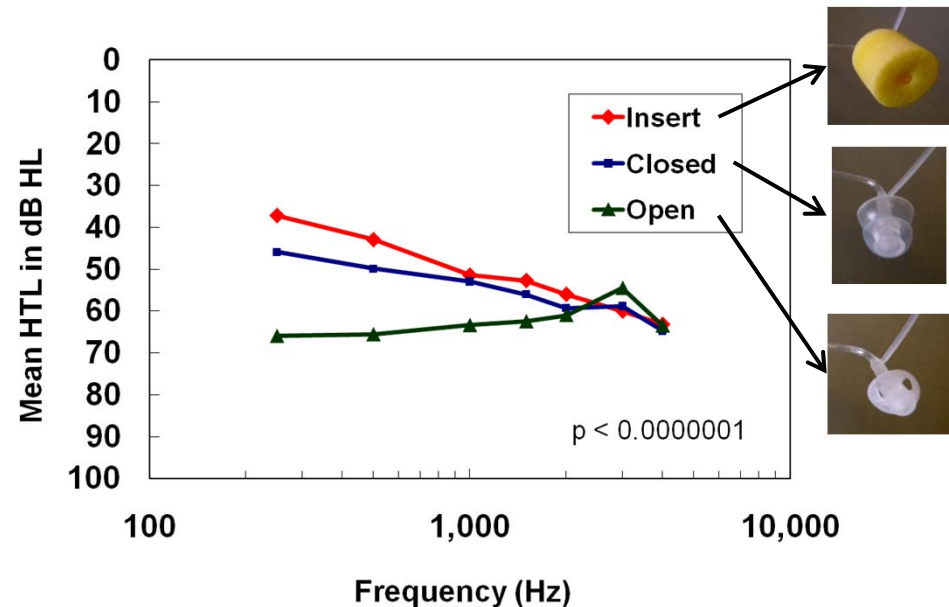
- Reliability and validity of automated in situ audiometry fundamental for the SFHA
- Automated audiometry verified (e.g. Ho et al., 2009; Margolis et al., 2010; Swanepoel et al., 2010)
  - Automated (Auto) and manual (Man) audiometry by a clinician on 117 ears (Convery et al., in preparation)

| Frequency | Test-retest | Auto-Man   |
|-----------|-------------|------------|
| 500 Hz    | $r = 0.98$  | $r = 0.98$ |
| 1000 Hz   | $r = 0.98$  | $r = 0.98$ |
| 2000 Hz   | $r = 0.98$  | $r = 0.99$ |
| 4000 Hz   | $r = 0.99$  | $r = 0.98$ |

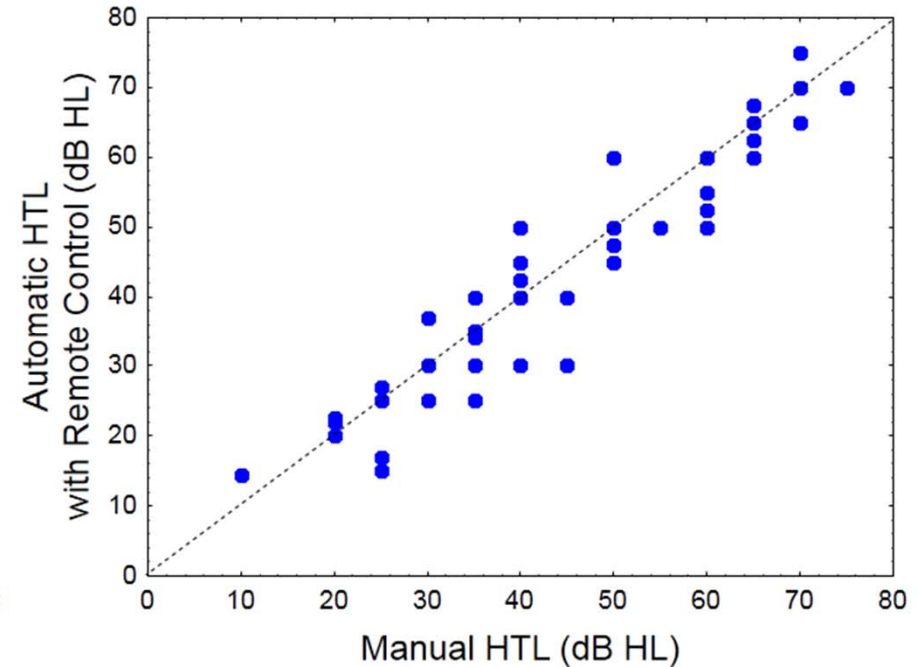
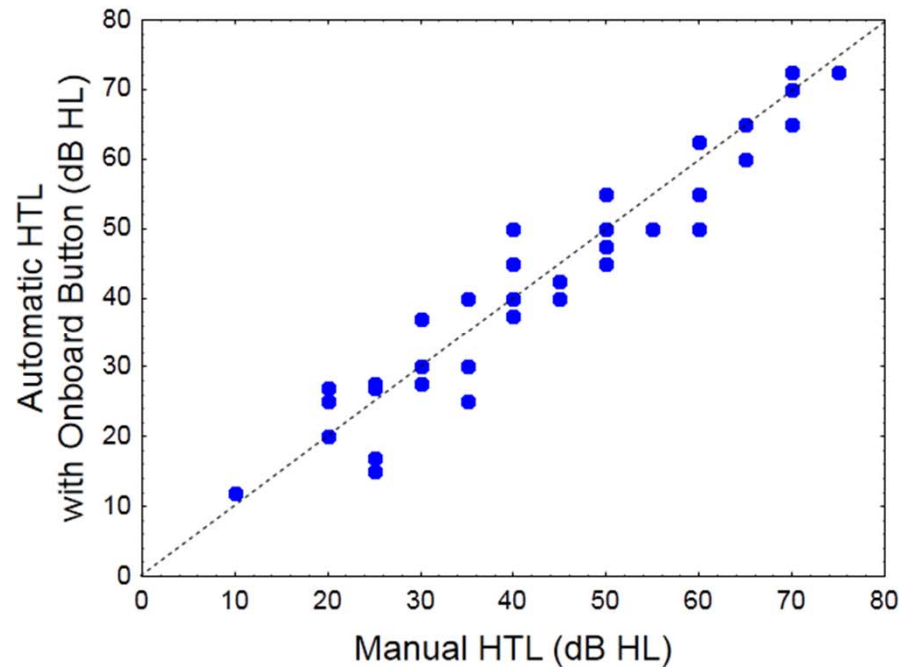


# Audiometry

- In situ audiometry through a hearing aid attached to different instant-fit tips is valid and reliable provided transducer and coupling specific REDD's are applied (O'Brien et al., 2010)



- Investigate validity and reliability of *self-managed, automated in situ audiometry*
  - Assisted automated in situ audiometry
  - Self-managed automated in situ audiometry



- Investigate validity and reliability of *self-managed*, automated in situ audiometry
- The challenges of self-administered automated in situ audiometry:
  - Placement of tip
  - Distortion free tones and dynamic range
  - Ambient noise
  - Transducer and coupling specific calibration
  - Response time and false positives

## *Conclusion:*

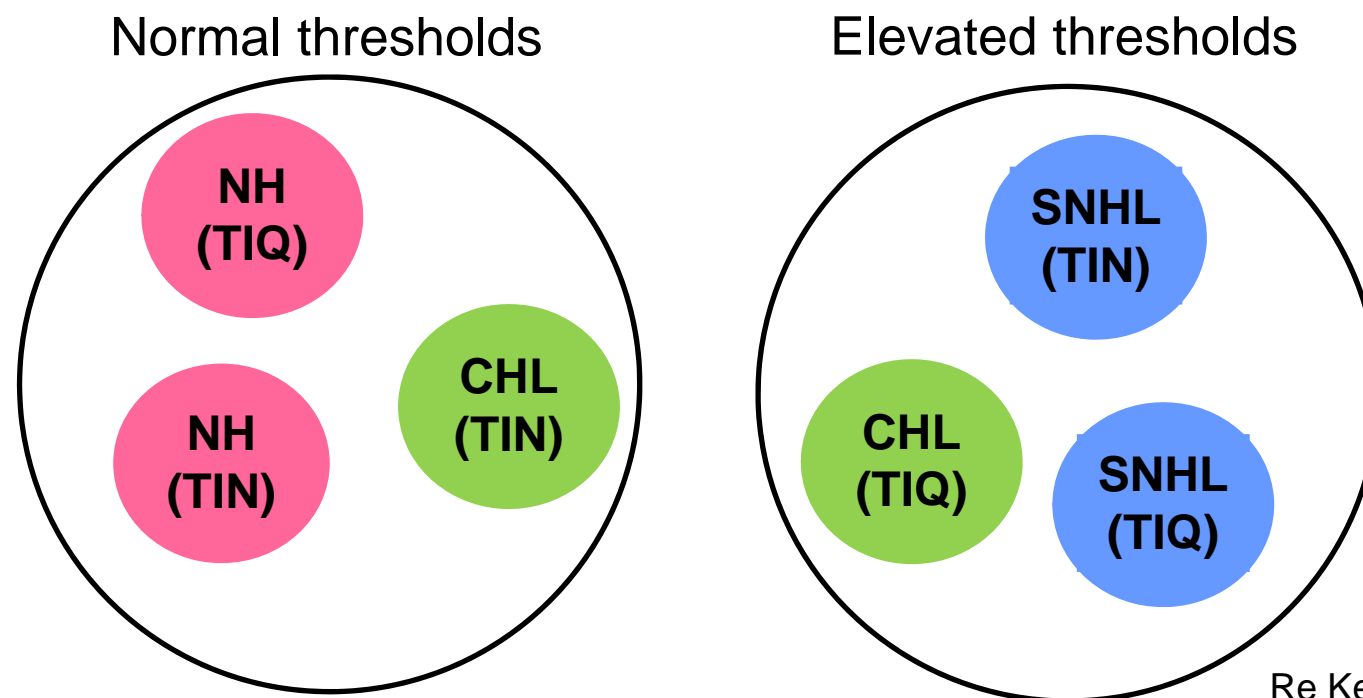
Implementation of automated in situ audiometry viable

- self-management of task to be fully investigated



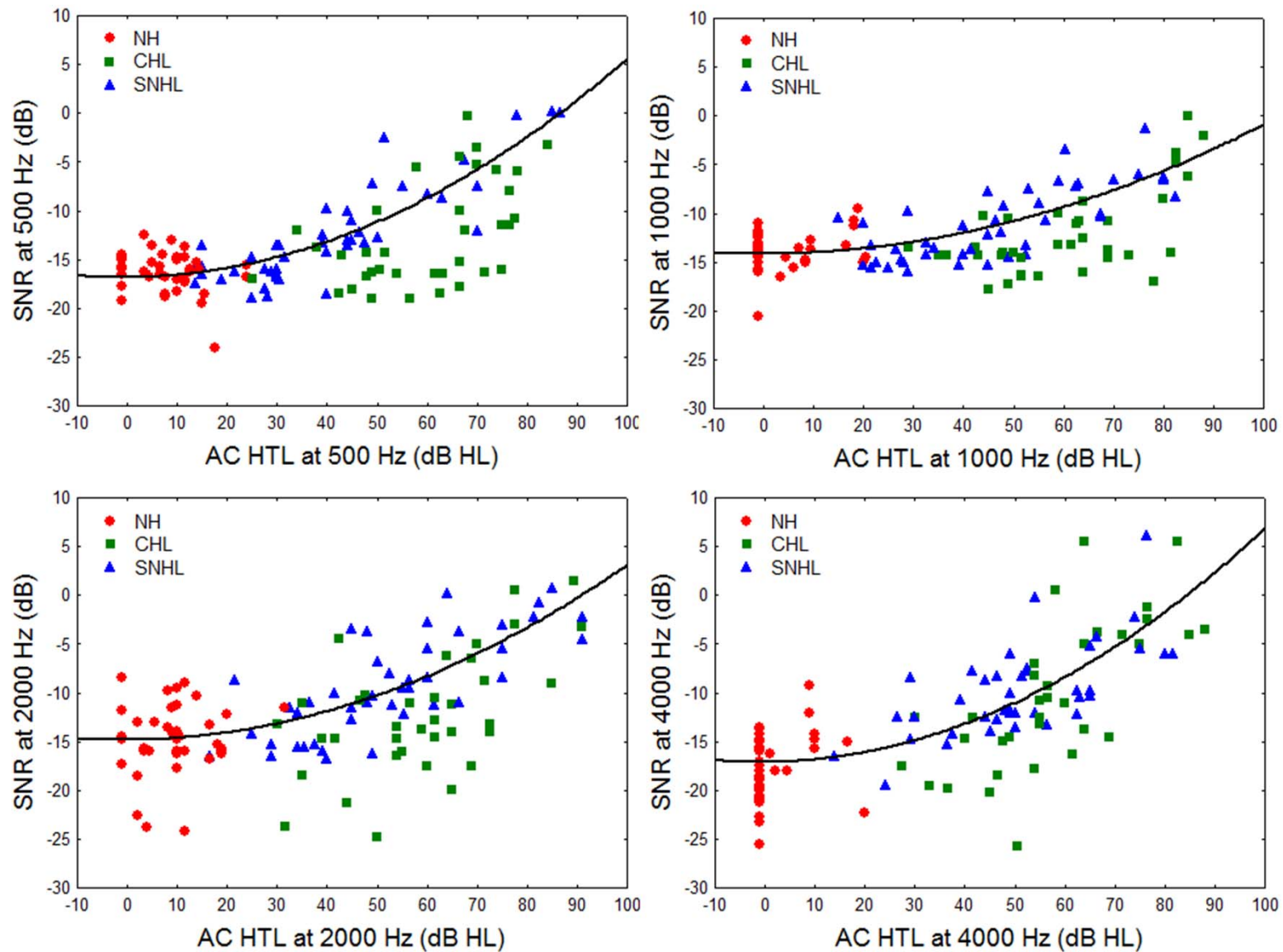
# Contraindications to fitting

- Contraindications to hearing aid fitting
  - Asymmetry – masking (wireless)
  - Conductive component?
    - Tone test in quiet (TIQ) and in modulated noise (TIN)

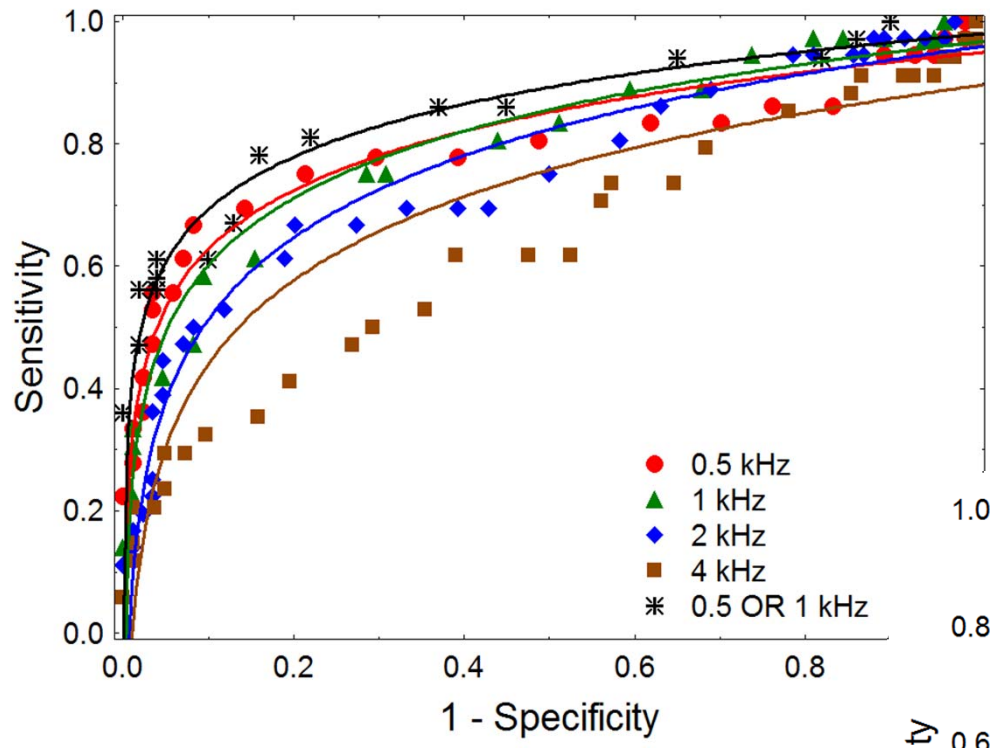


Re Keidser et al., 2011

# Prediction of CHL

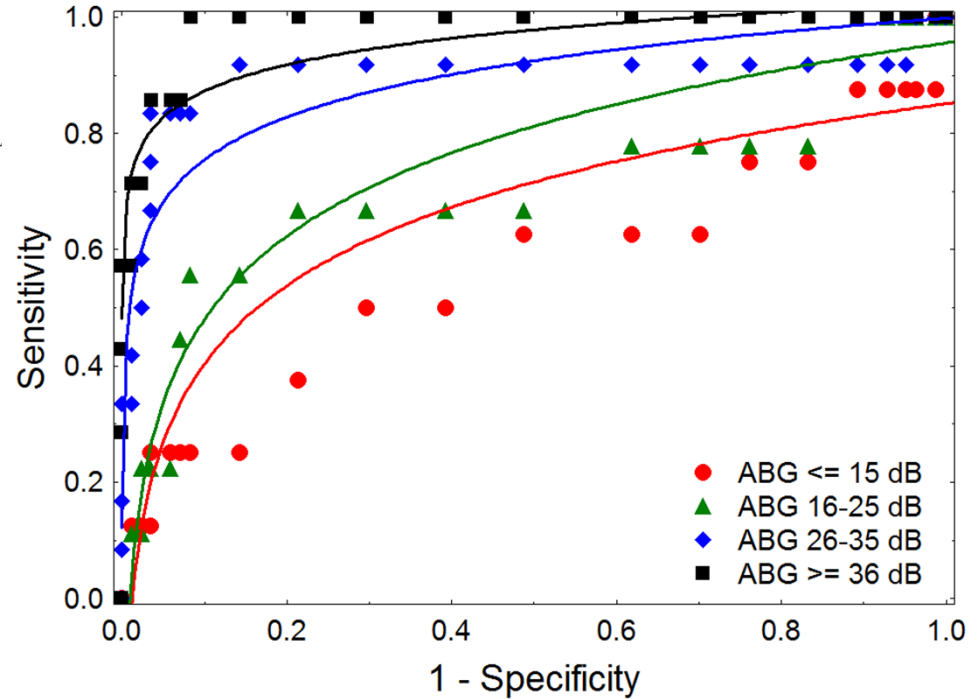


# Prediction of CHL



The accuracy of prediction is best

- at low frequencies
- for larger air-bone gap



Re Convery et al., in preparation

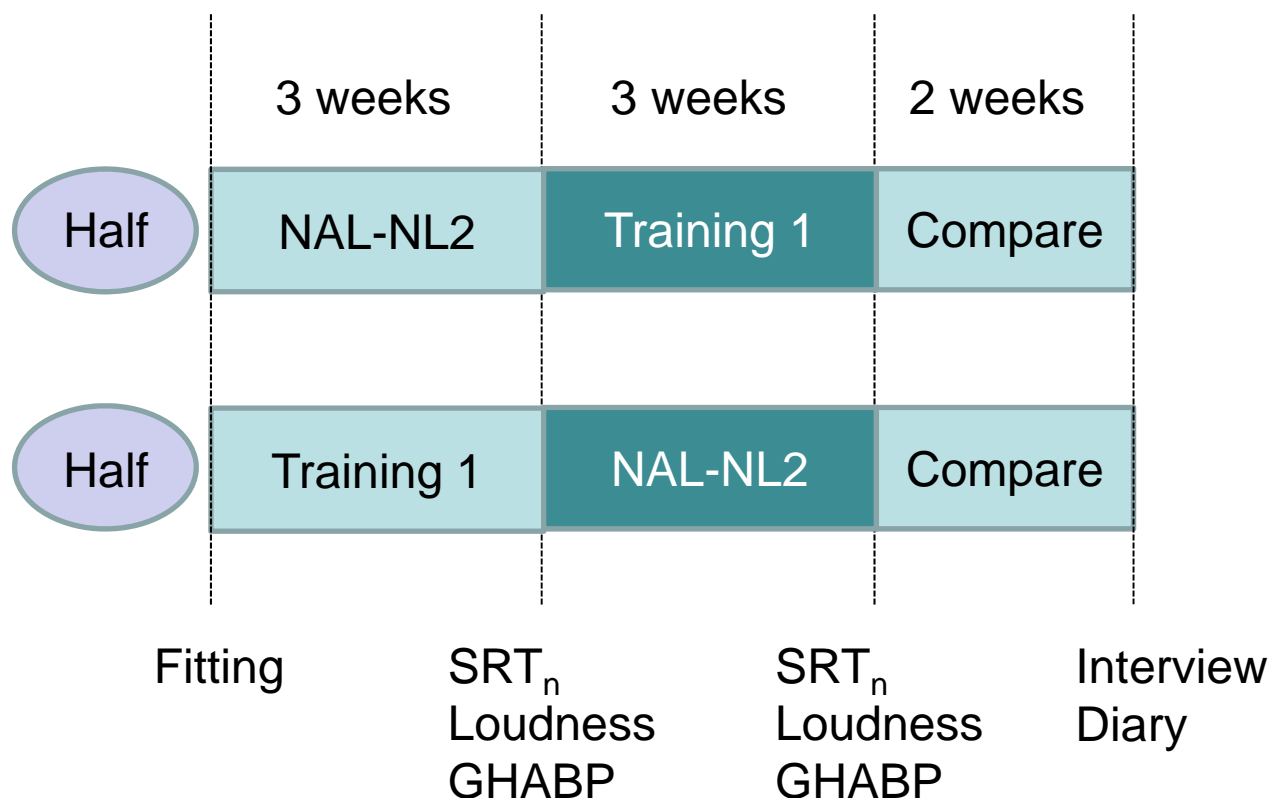
## *Conclusion:*

Accuracy of identification of air-bone gap in at least 80% of cases using air conduction tone tests presented in quiet and in noise

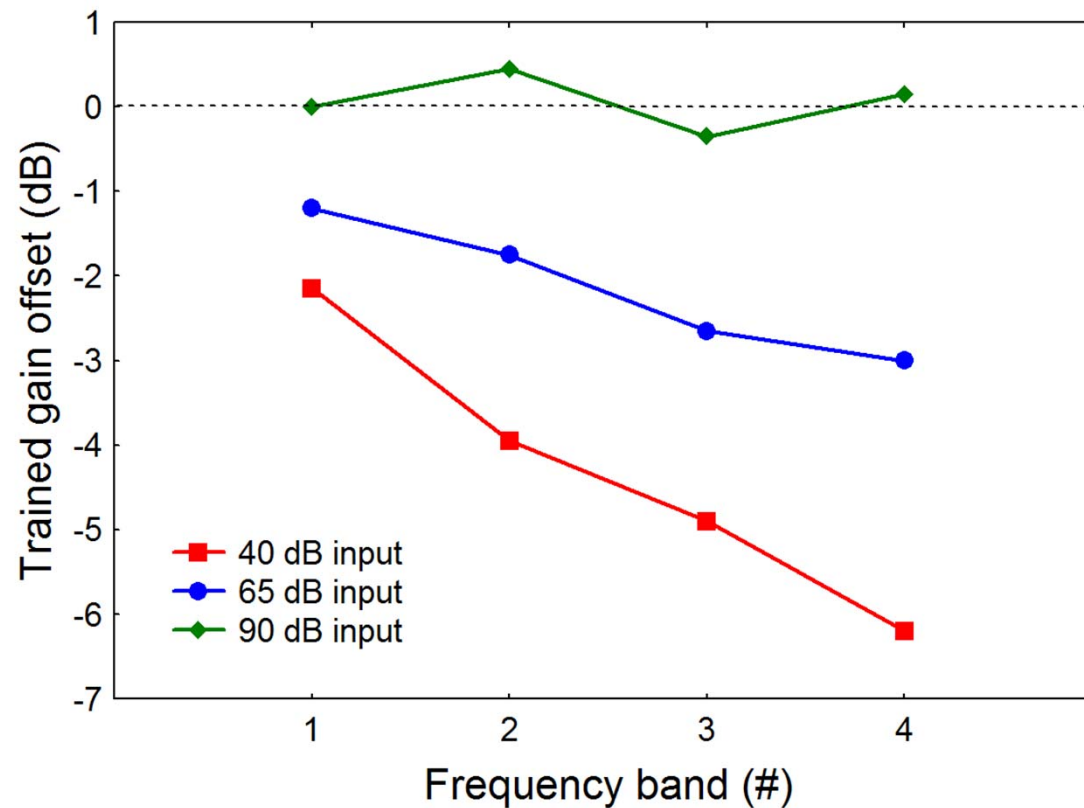
- feasibility of identifying asymmetry using wireless connection to be investigated

# Fine-tuning

- 18 participants (median age = 79 years; PTA = 53 dB HL)
- Siemens prototype BTE (training of the compression characteristic in four frequency bands and six environmental sound classes)



# Trained parameters



(LF gain, HF gain): gain variation at 65 dB input

(LF CR, HF CR): difference in gain variation at 40 and 90 dB input

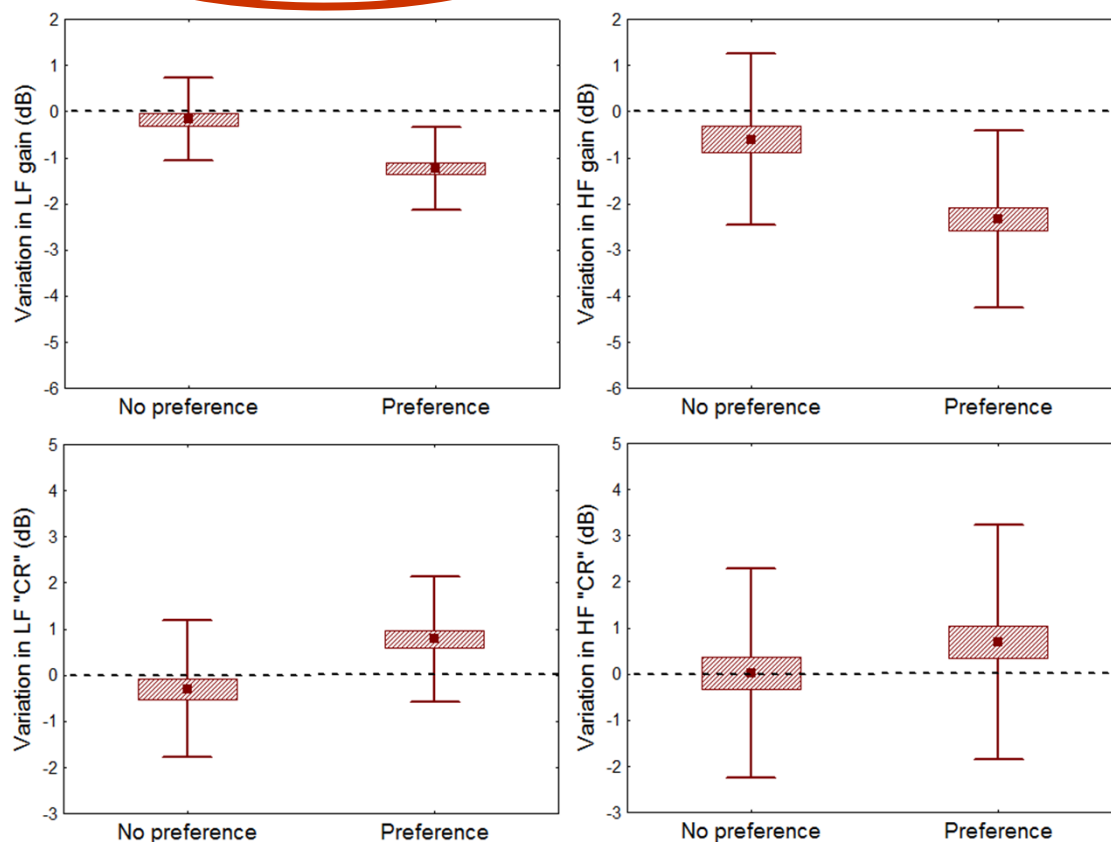
# Efficacy of training

- Preferences:

- 8 no preference
- 8 trained response
- 2 NAL-NL2

5.1 adj/day - trained in 2.4 sound classes

8.7 adj/day - trained in 3.5 sound classes



- No effect of training on outcome measures

- Those who preferred the trained response were more satisfied (8.1 vs 7.0 in rating)

Re Keidser & Alamudi, submitted

*Conclusion:*

Training is effective for those who want a change to prescription



- A truly self-fitting hearing aid:
  - Is feasible, but outcomes are unknown
  - Is a viable solution for those who do not have reliable access to audiological services
- Implications for clinicians:
  - Anticipated to be negligible
    - Many need and prefer the services of clinicians
    - Increasing demand due to population aging
    - Increasing market size due to hearing aids becoming more effective in noise for milder hearing loss

- Data on the feasibility of a truly self-fitting hearing aid are generally promising;
  - *Assembly*: manageable by a wide cross section of the population provided instructions are carefully designed taking low health literacy into account
  - *Automated in situ audiometry*: implementation viable
    - Technical issues to be addressed
    - self-management of task to be fully investigated
  - *Contraindications to fitting*: accuracy of identification of air-bone gap in at least 80% of cases using air conduction tone tests presented in quiet and in noise
    - feasibility of identifying asymmetry using wireless connection to be investigated
  - *Fine-tuning*: training effective for those who want a change to prescription
  - *Delivery model?*
    - Supply of instant-fit ear tips and batteries

# Acknowledgements

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For further information: Trends in Amplification (2011), or contact [Gitte.Keidser@nal.gov.au](mailto:Gitte.Keidser@nal.gov.au)



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