“Evidence based selection of hearing aids and features”

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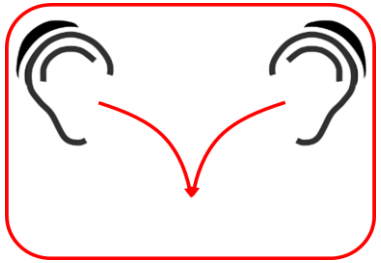
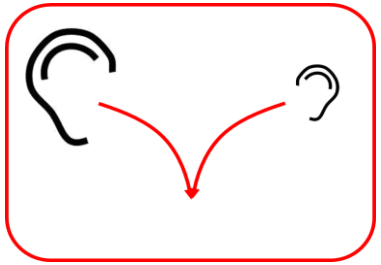
CRS - Amplifon Centre for Research & Studies – Milan – Italy
European Association of Hearing Aid Professionals – Brussels - Belgium

IFOS WORLD COURSE ON HEARING REHABILITATION

What is the basis for selection?



- **Symmetric Hearing Loss**
  - Good Localisation (Central Auditory Processing)
  - Poor Localisation (Central Auditory Processing)



- **Asymmetric Hearing Loss**
  - One Normal Ear – One Aidable Ear (Mono-Stereophony)
  - Asymmetric – Aidable Hearing Loss in both ears
  - Single Sided Deafness - One Un-Aidable Ear

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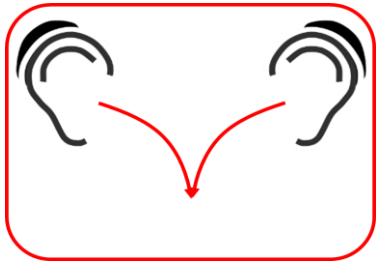

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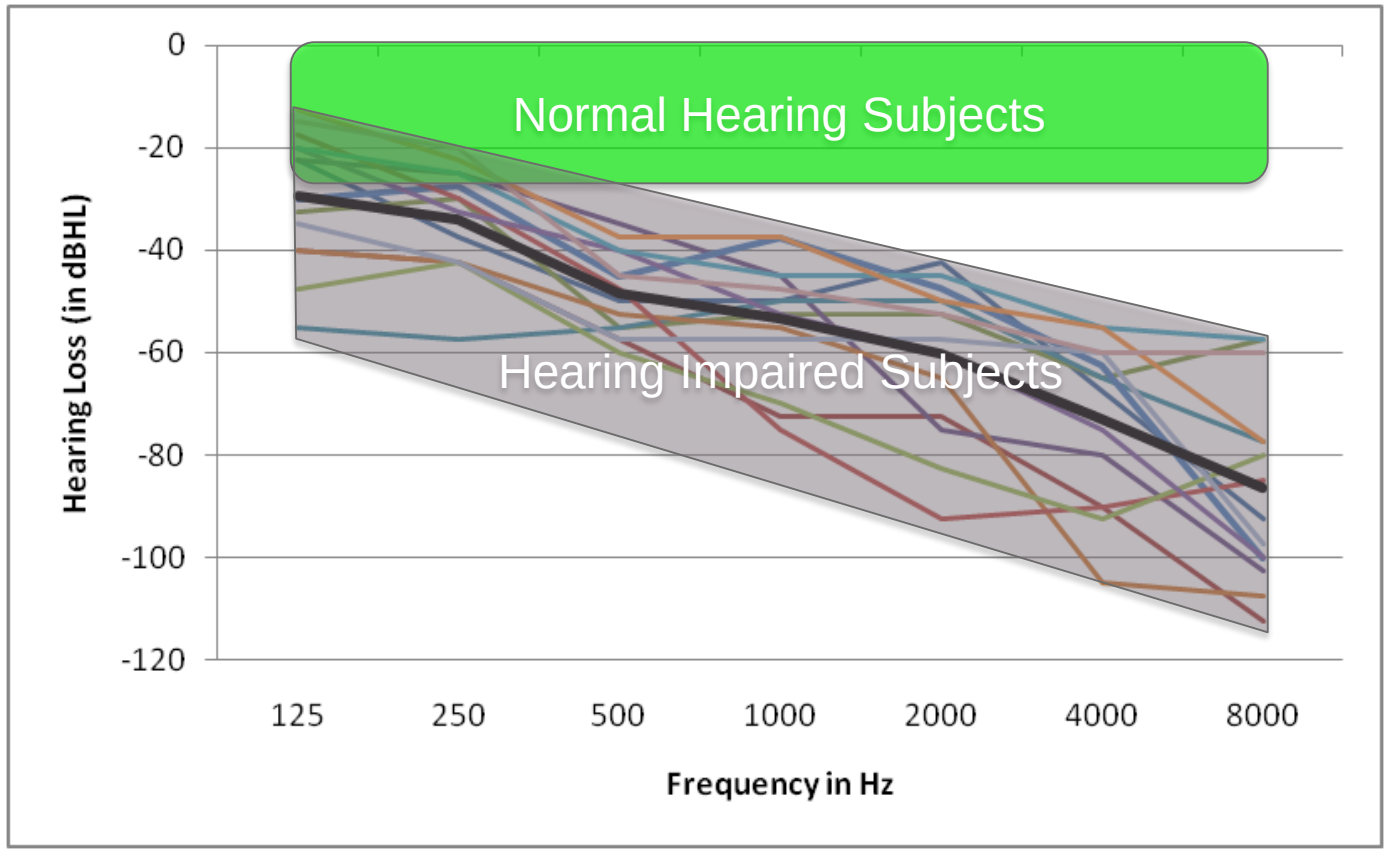
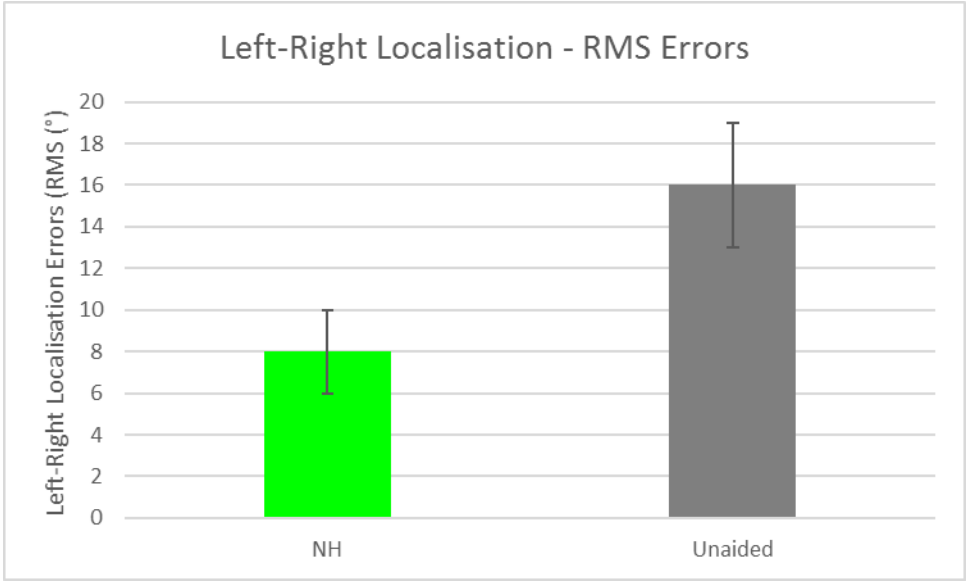
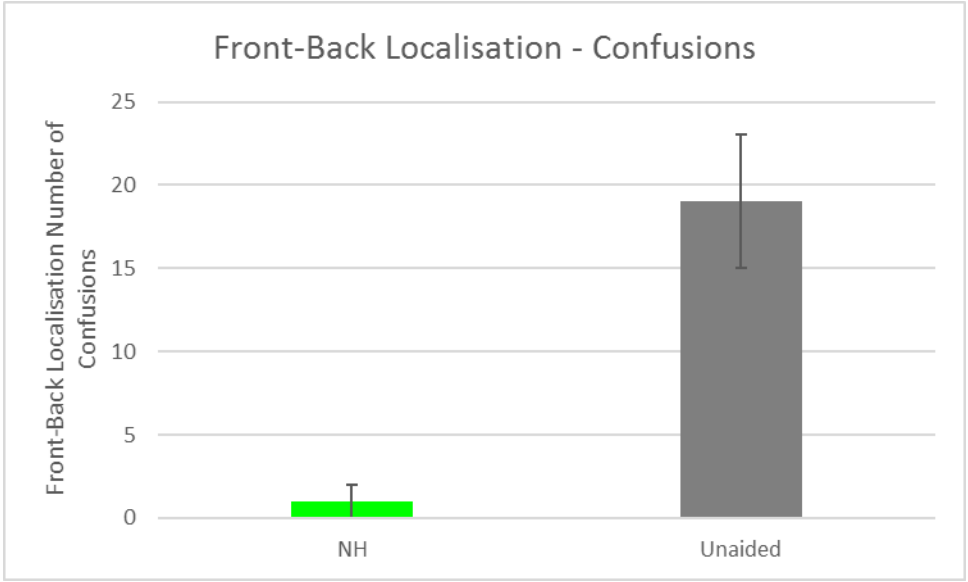
Left-Right and Front-Back Spatial Hearing with Multiple Directional Microphone Configurations in Modern Hearing Aids – Carette et al. 2014

Can symmetric hearing loss lead to localisation problems?



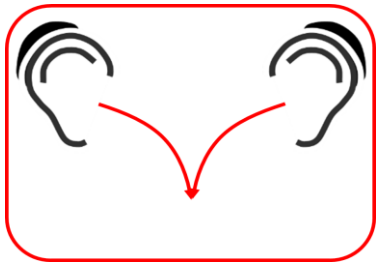


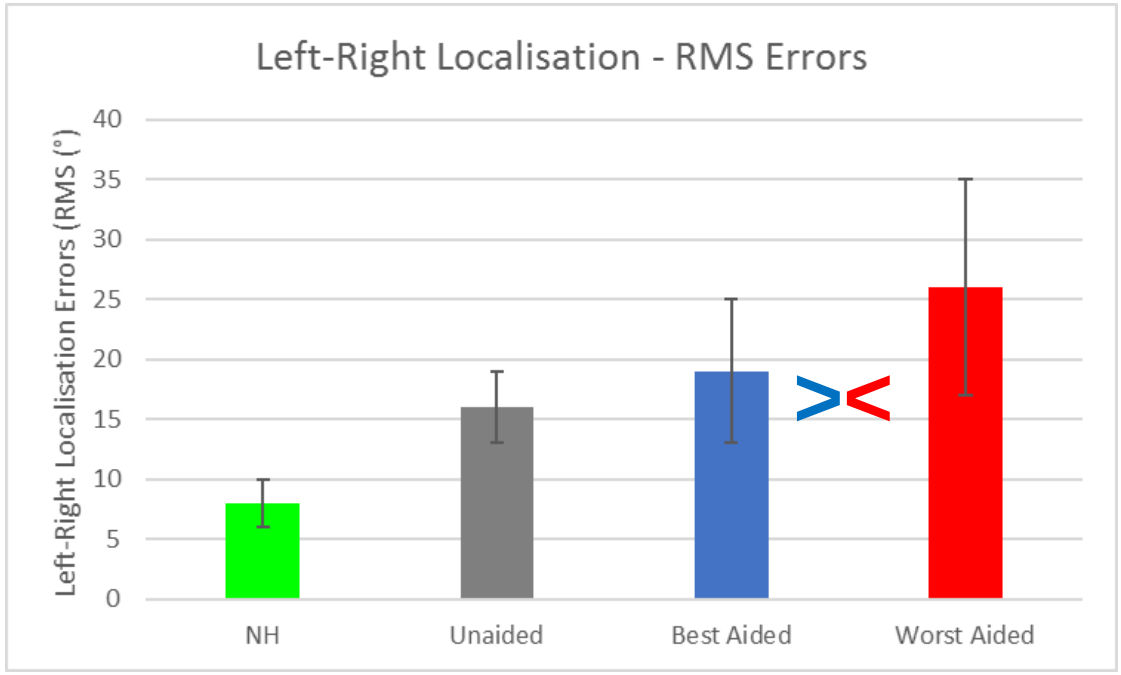


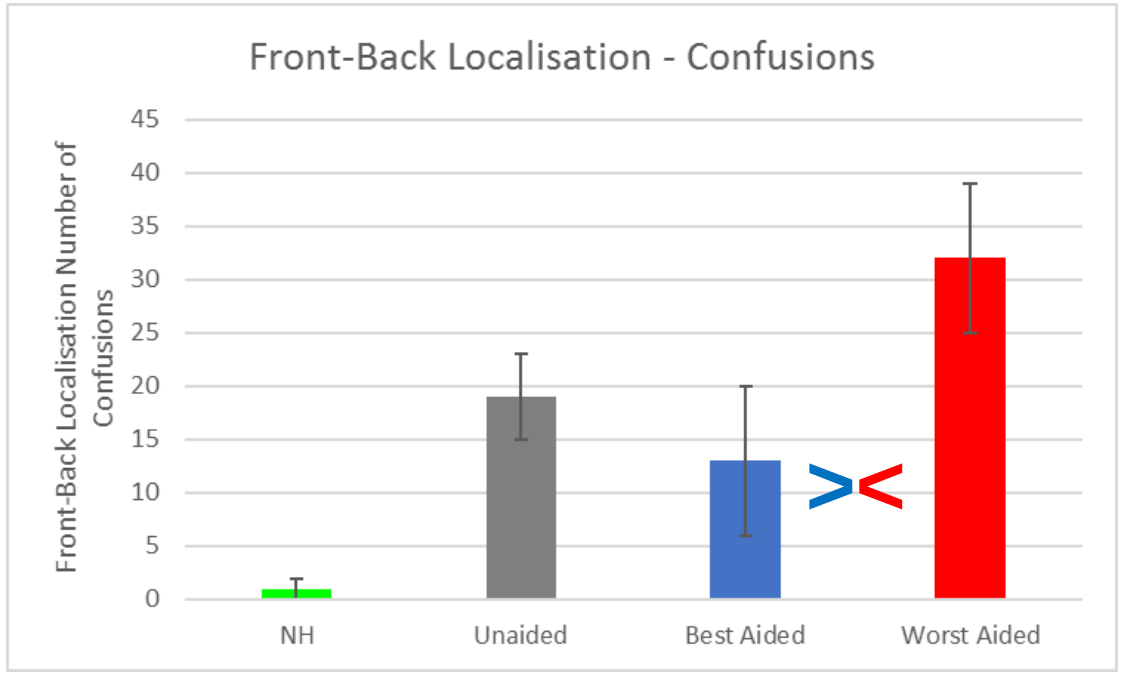
Symmetric Hearing Loss can result in Poorer Localisation

Left-Right and Front-Back Spatial Hearing with Multiple Directional Microphone Configurations in Modern Hearing Aids – Carette et al. 2014

Do Hearing Aids impact localisation in symmetric hearing loss?





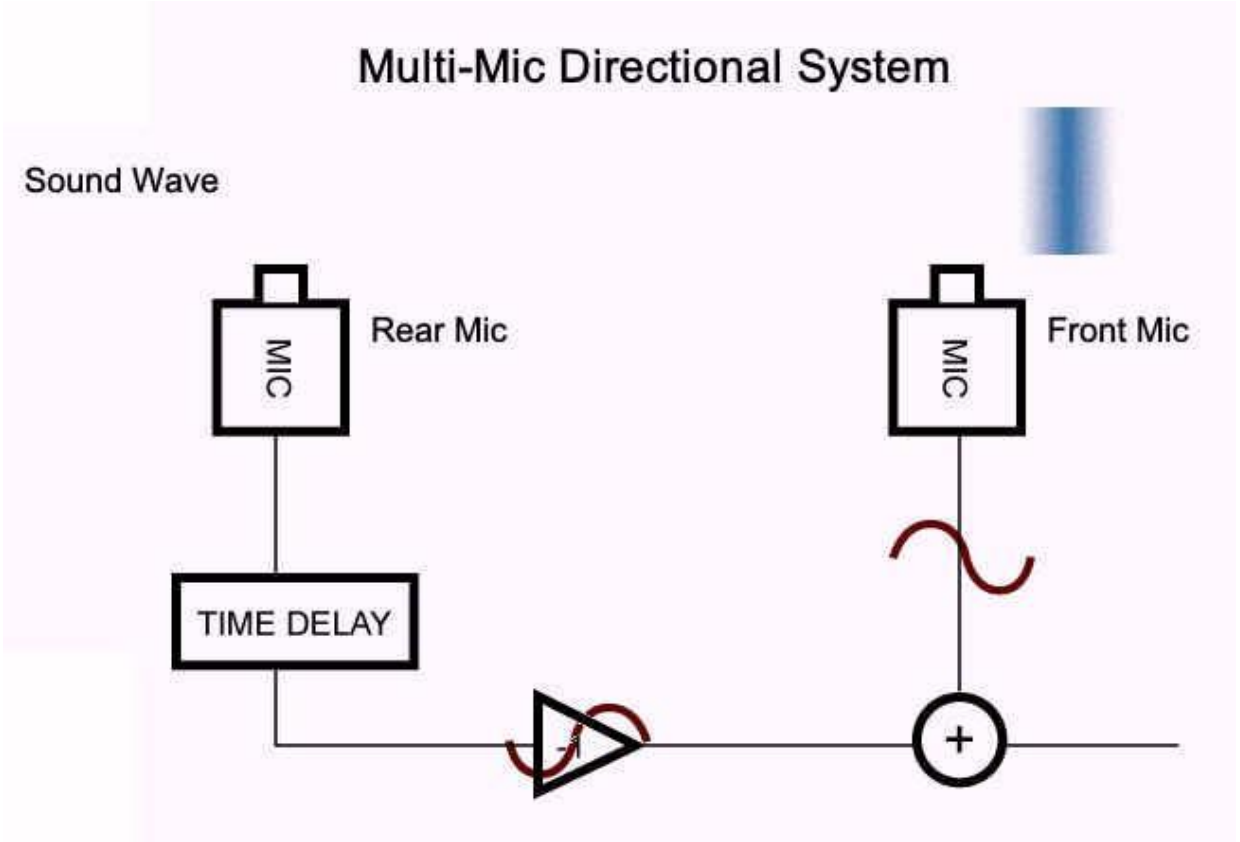


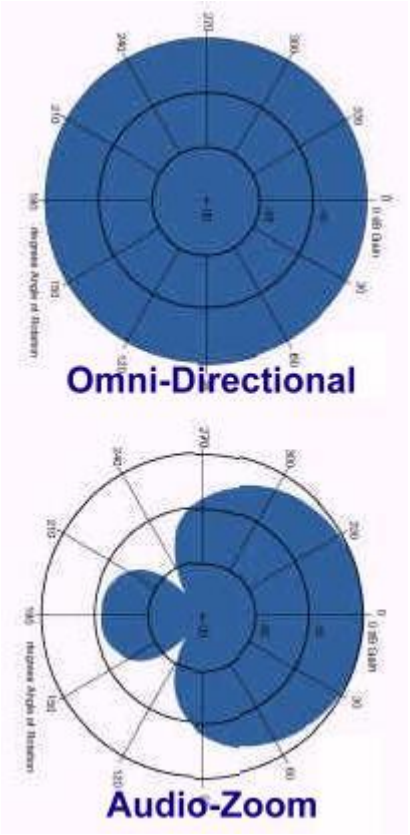
Directional Systems can result in Good or Poor Localisation

Traditional Fixed Directionality

+
Improves SNR by 3 dB

-
Low Frequency Roll Off
Wind Noise Problems
Noise (when using bass boost)





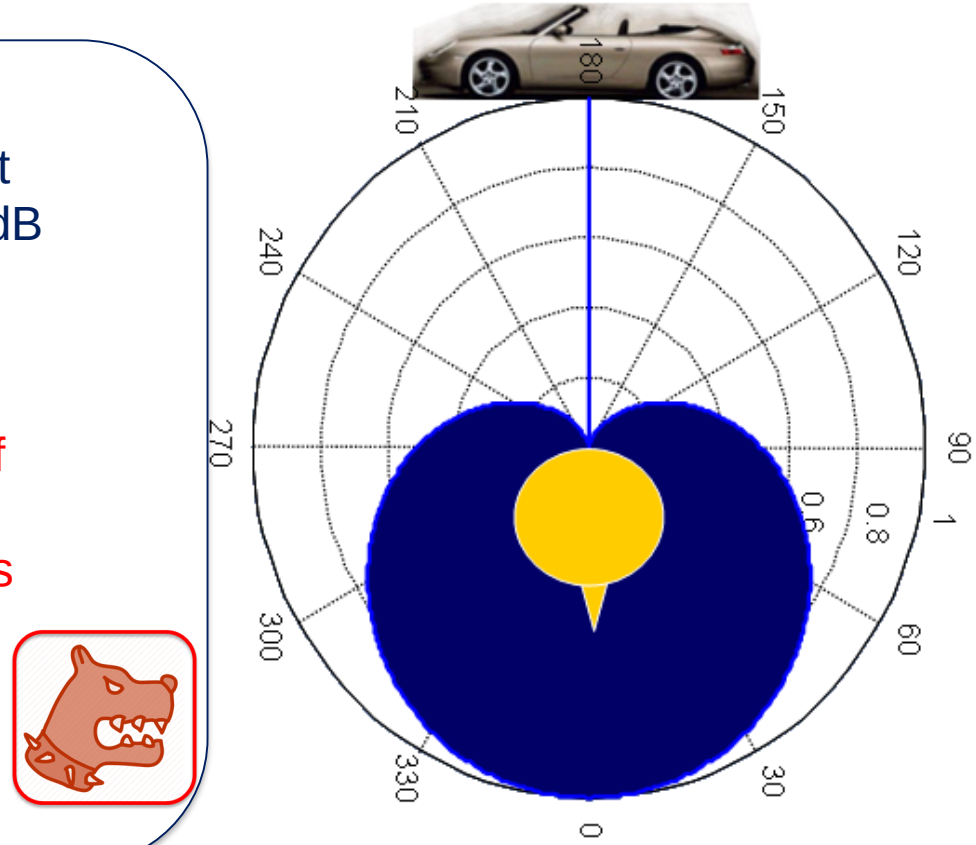
Adaptive Directionality

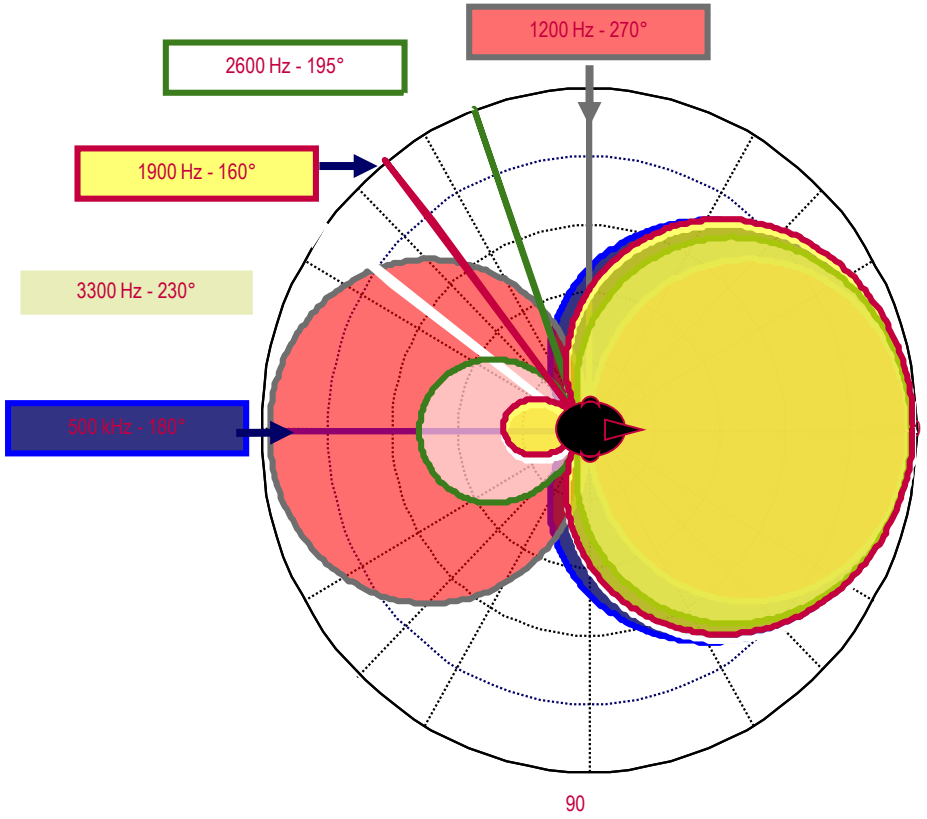
+

Impressive effect at first experience (realistic 3 dB SNR Improvement)

-

Low Frequency Roll Off
Wind Noise Problems
Noise (when using bass boost)
Left-Right Localisation Problems
Aggressive Processing





Horizontal localization with bilateral hearing aids

THE JOURNAL OF THE ACOUSTICAL SOCIETY OF AMERICA

JASA

Horizontal localization with bilateral hearing aids: Without is better than with

J. Acoust. Soc. Am. **119** (1), January 2006

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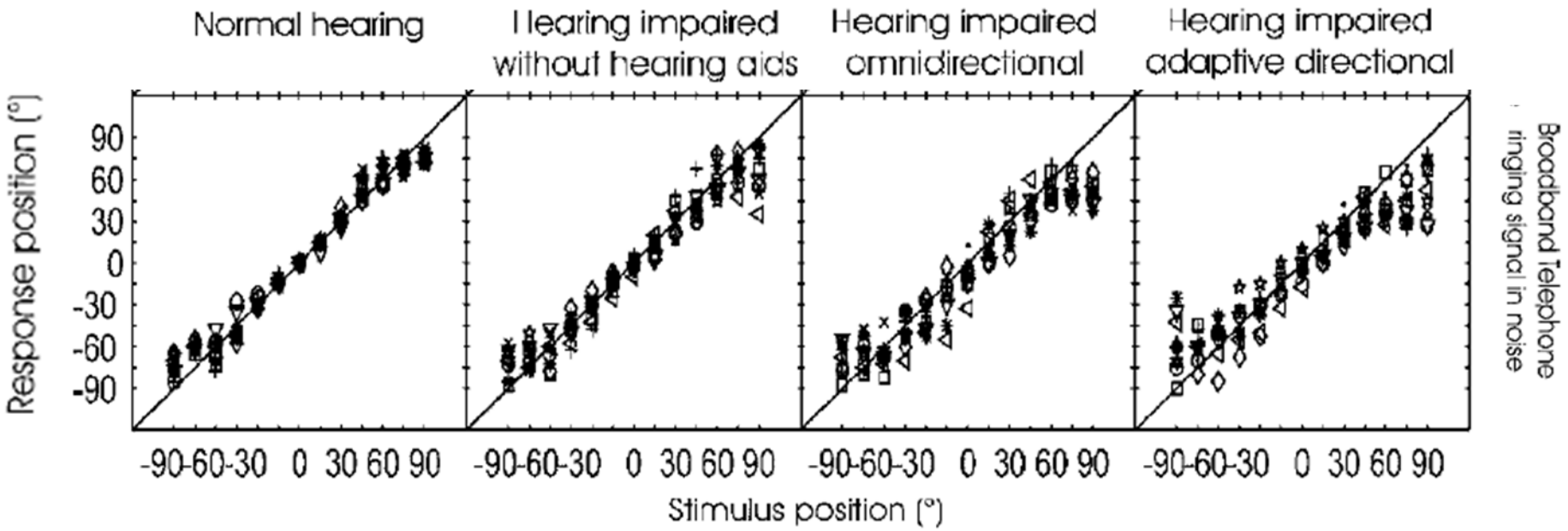
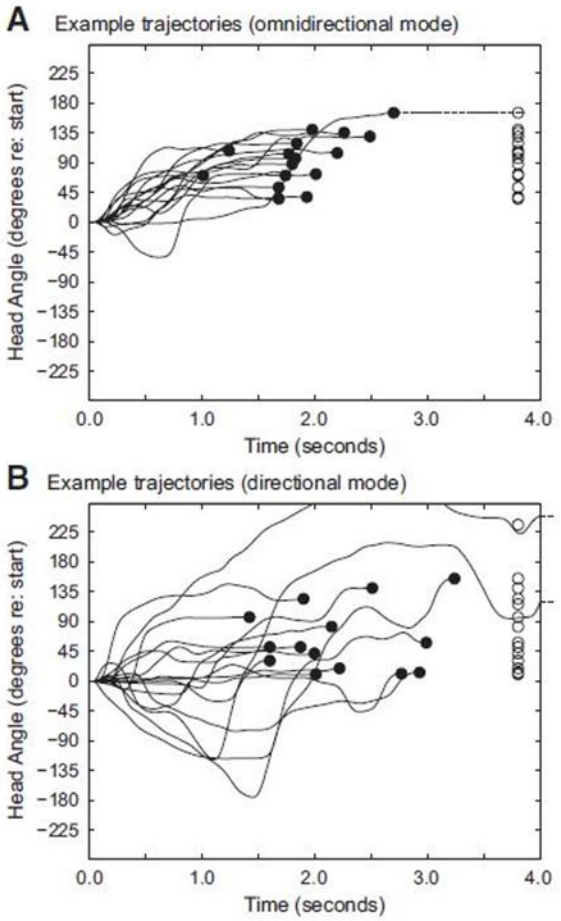
Adaptive Directionality in Hearing Aids Leads to Localisation Problems

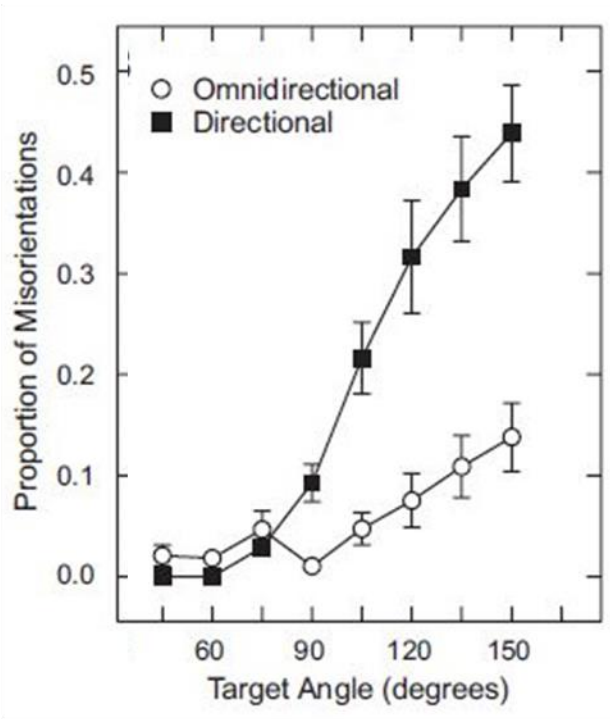
Omni is better
Unaided is better



Adaptive Directionality results in Localisation Problems

Directional Microphone Configurations and Orientation

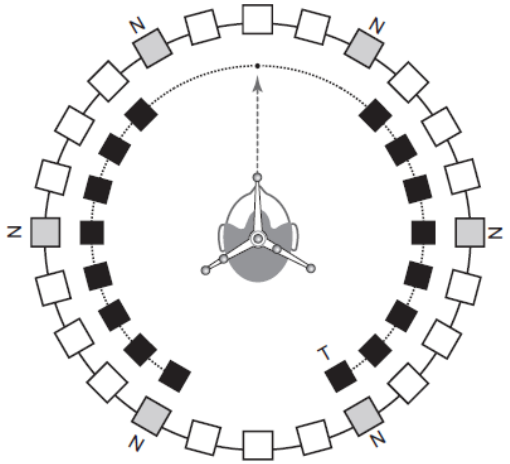




The Effect of Hearing Aid Microphone Mode on Performance in an Auditory Orienting Task

W. Owen Brimijoin, William M. Whitmer, David McShefferty, and Michael A. Akeroyd

EAR & HEARING, VOL. 35, NO. 5, e204–e212



Adaptive Directionality in Hearing Aids Leads to Orientation Problems

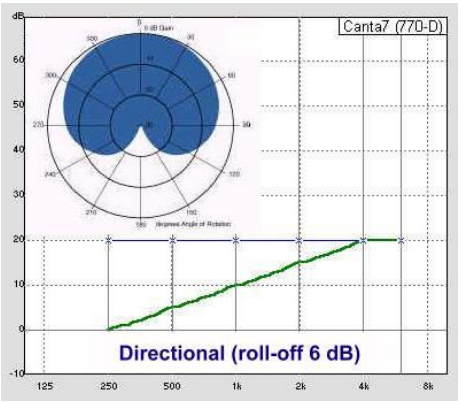
Omni is better

Adaptive Directionality results in Orientation Problems

In a double blind study, forced-choice design, 23 participants (hearing aid users) were asked to choose the program they judged as having the best sound quality (for Music-Speech-Environmental sounds). Groth, Laureyns, 2010

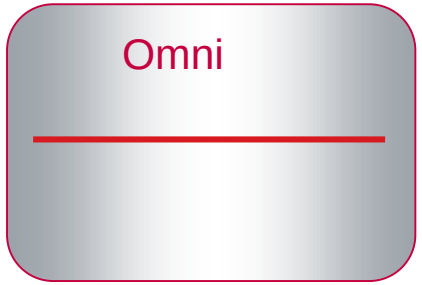
Traditional Fixed and Adaptive Directionality

The Roll-Off consequences



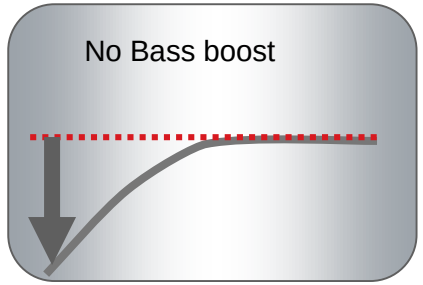
P1: Omni

+ Good Audibility
+ Low Noise



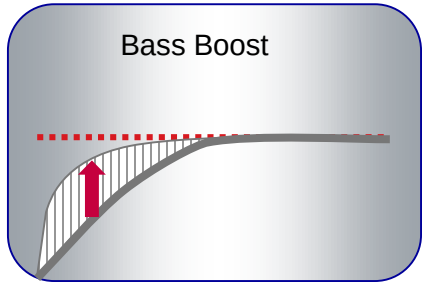
P2: No BassBoost

+ Low Noise
- Reduced Audibility
  lost low frequencies

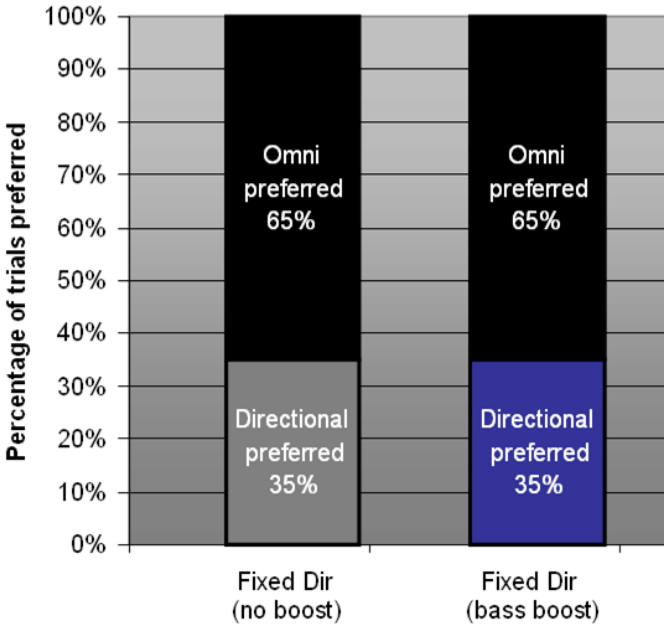


P3: BassBoost

+ Good Audibility
- High Noise
  bass noise-floor

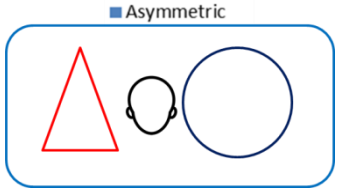


Sound quality preference for directional processing scheme compared to omnidirectional



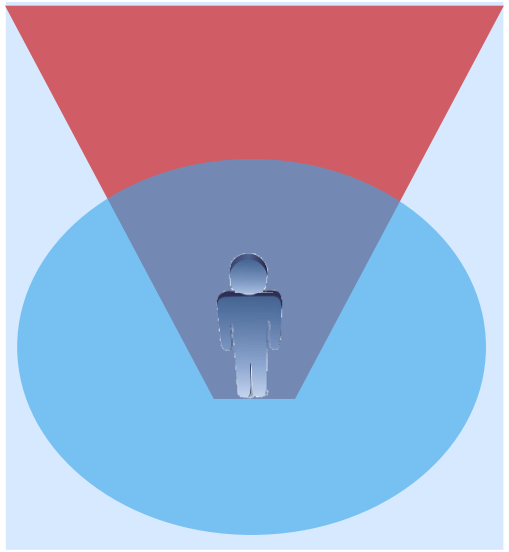
Traditional Directionality results in Poor Sound Quality

Asymmetric Directionality



\+
Better Sound Quality
Keep low frequencies at omni side
No need to switch
3dB SNR Improvement

\-
Left-Right Localisation Problems



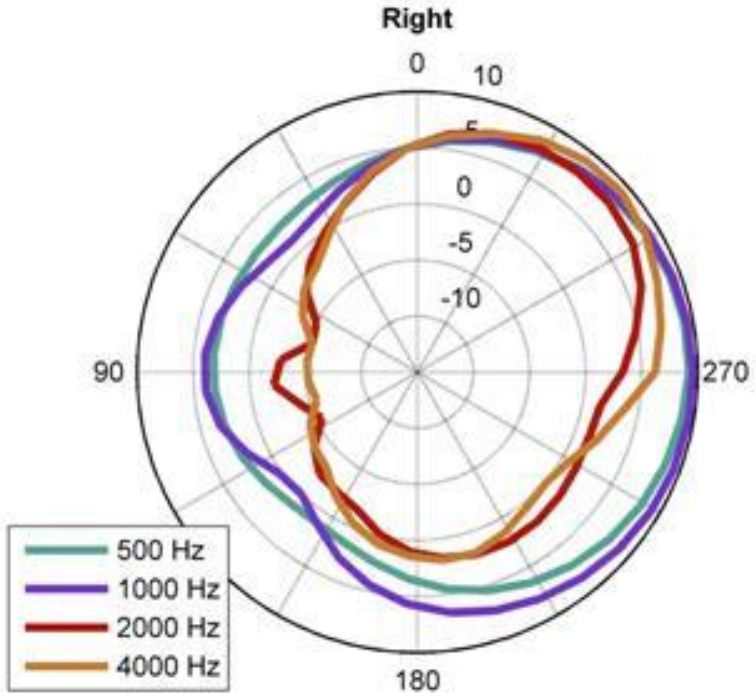
Pinna Directionality

+

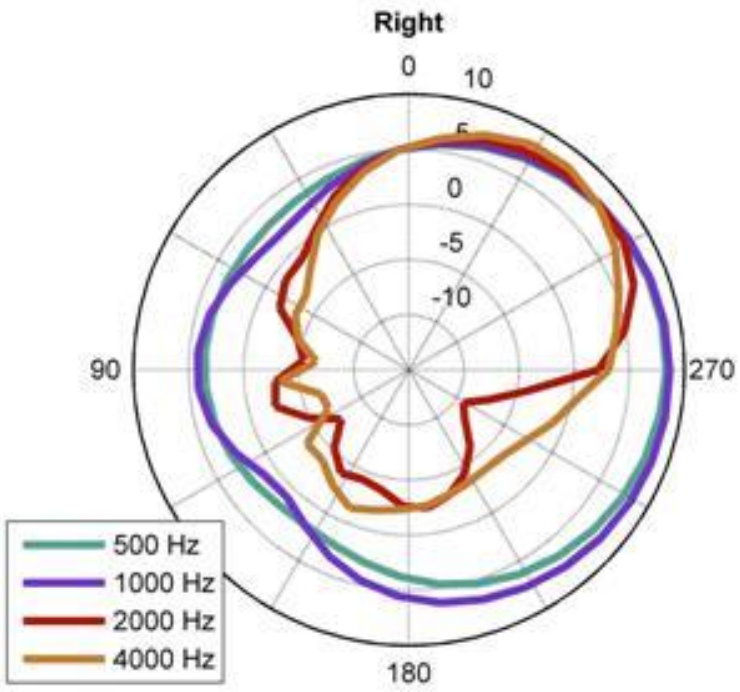
Better Sound Quality
Very natural experience
Keep low frequencies
No need to switch
Good localisation both Left-Right and Front-Back
3 dB SNR Improvement

-

Less impressive at first demo



Open human ear



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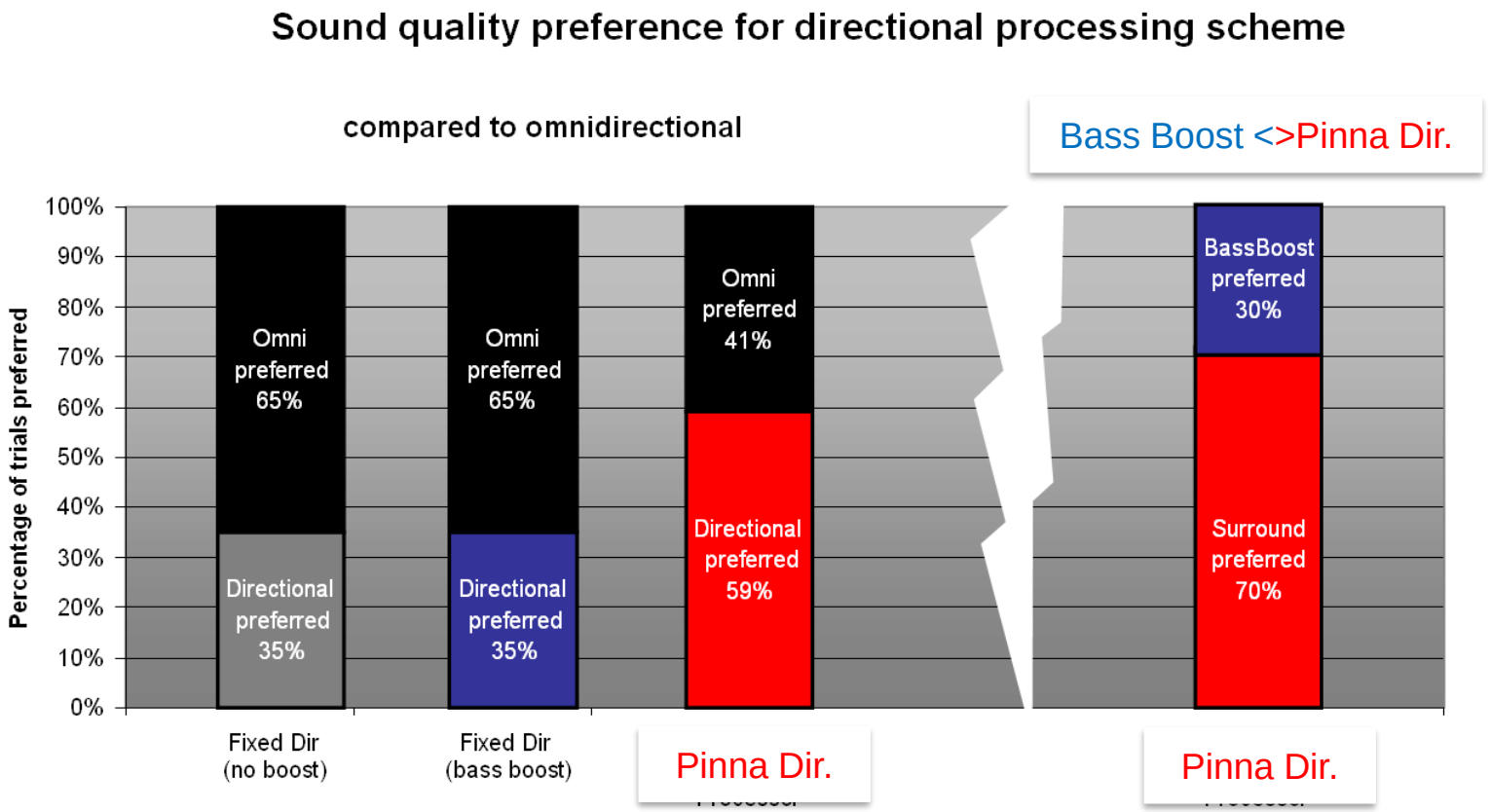
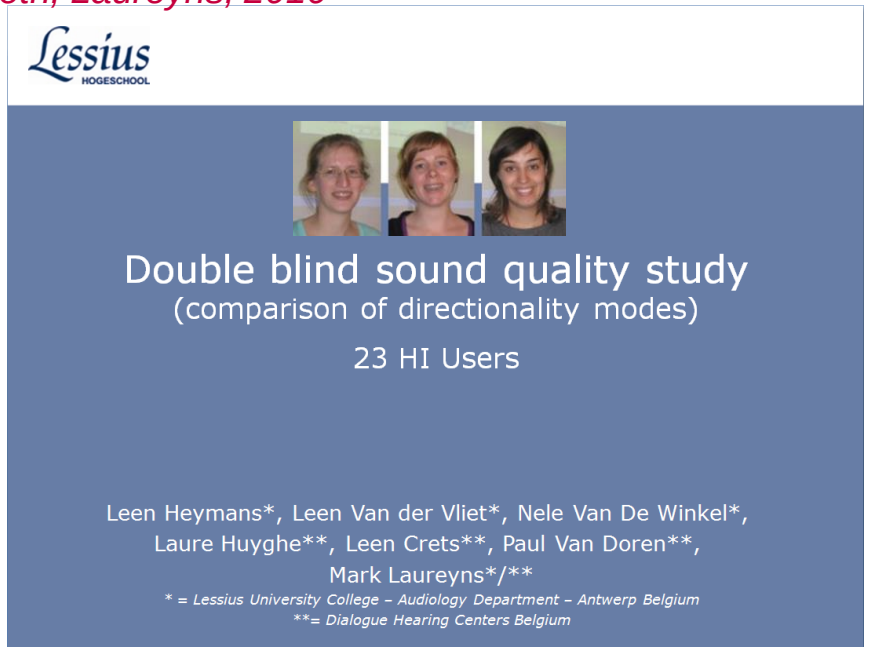
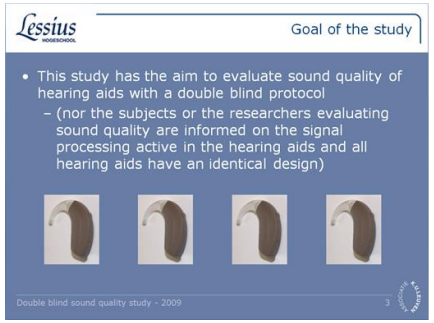
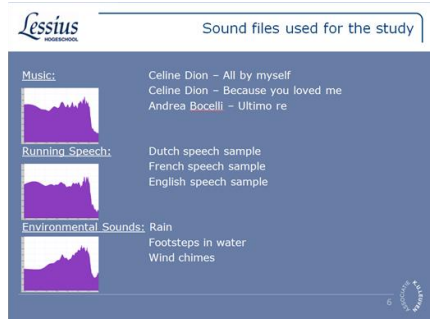
Sound Quality – Double Blind Study









Pinna Directionality results in the best sound quality

Directional Microphone Configurations & Localisation

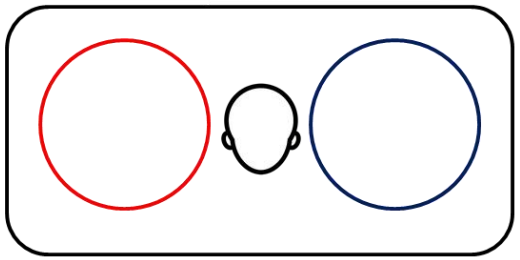
Left-Right and Front-Back Spatial Hearing with Multiple Directional Microphone Configurations in Modern Hearing Aids

J Am Acad Audiol 25:791–803 (2014)

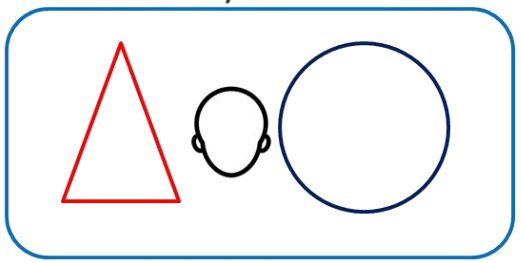
Evelyne Carette*†
Tim Van den Bogaert*
Mark Laureyns‡
Jan Wouters*

- Unaided
- Asymmetric
- Omni
- Pinna Dir.
- Ear2EarFF

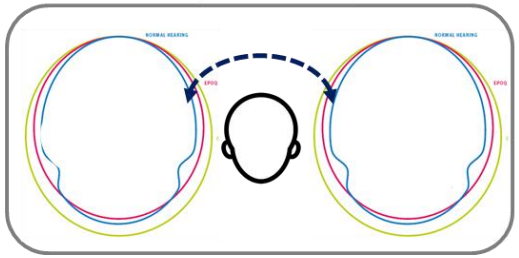
Omni



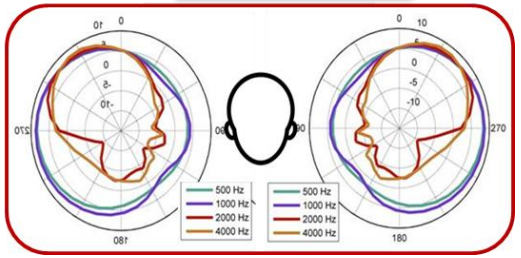
Asymmetric



Ear2EarFF



Pinna Dir.



IFOS WORLD COURSE ON HEARING REHABILITATION

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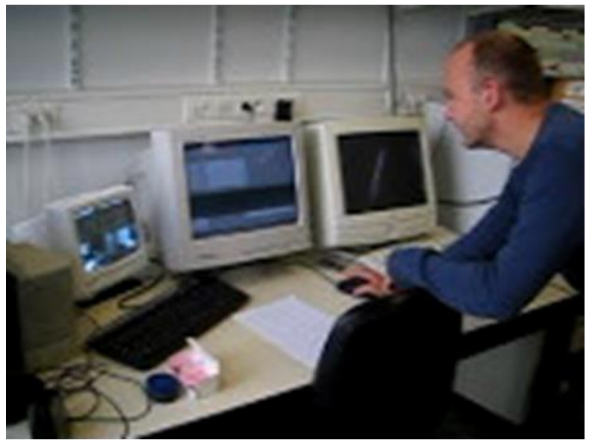
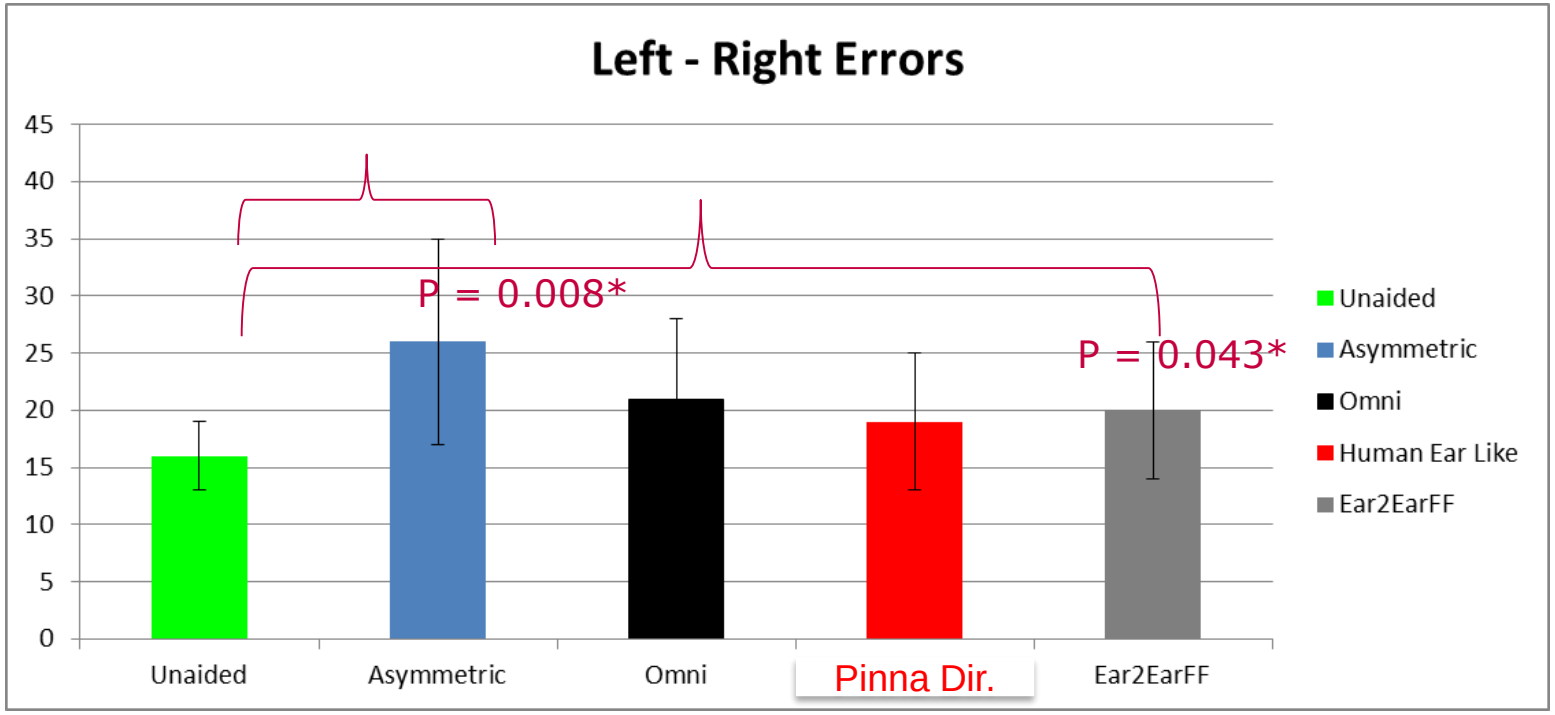
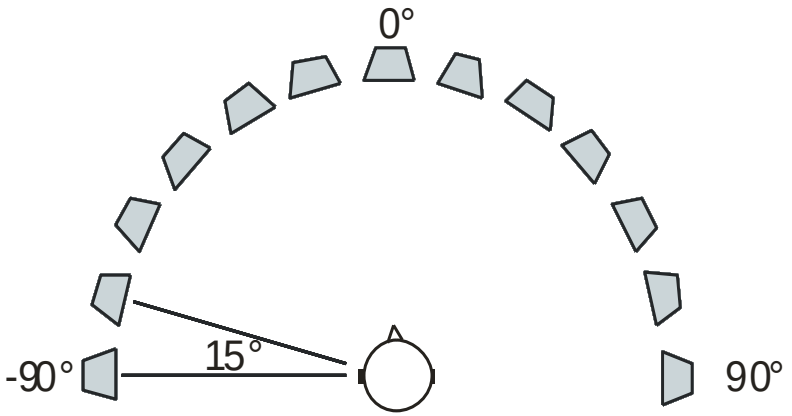
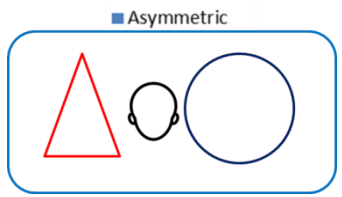


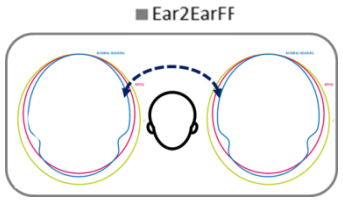
Directional Microphone Configurations & Left-Right Localisation

Left-Right and Front-Back Spatial Hearing with Multiple Directional Microphone Configurations in Modern Hearing Aids





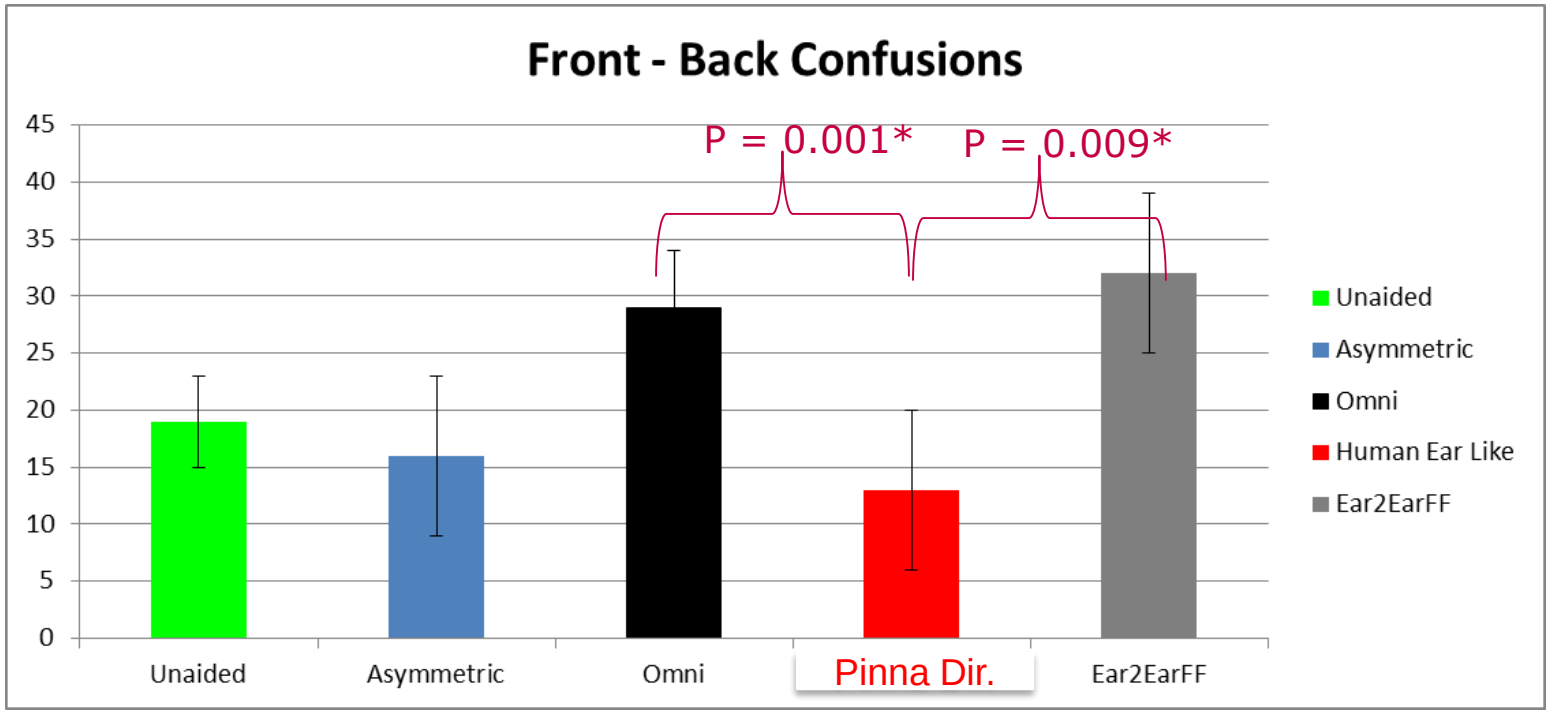


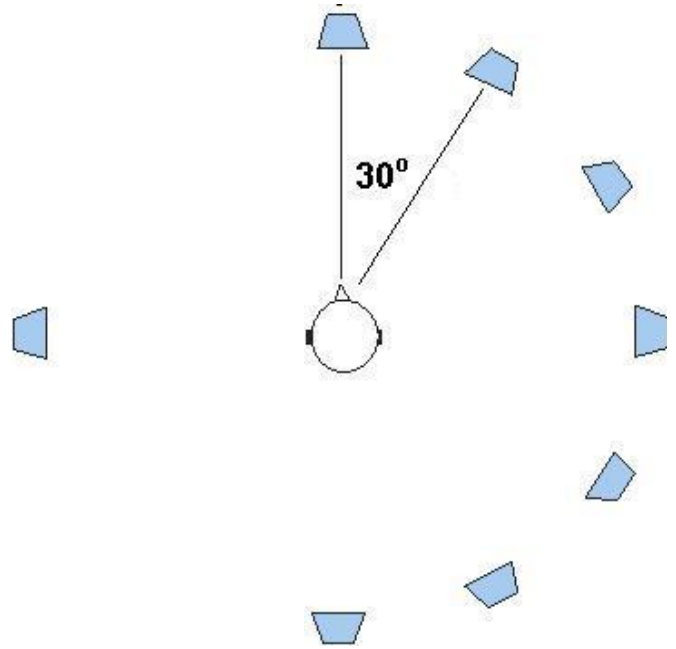


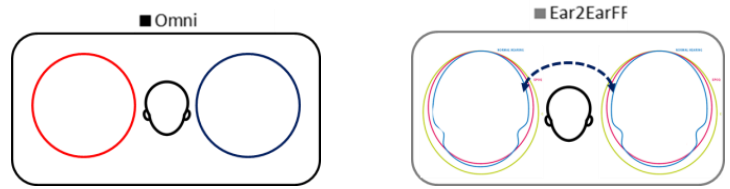
Pinna Directionality and Omni result in the best left/right localisation

Directional Microphone Configurations & Front-Back Localisation

Left-Right and Front-Back Spatial Hearing with Multiple Directional Microphone Configurations in Modern Hearing Aids

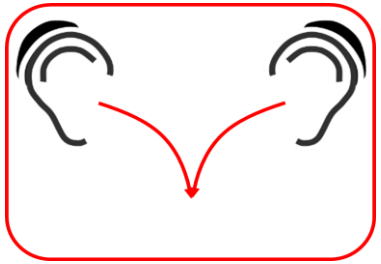






Pinna Directionality results in the best front/back localisation

What is the basis for selection?

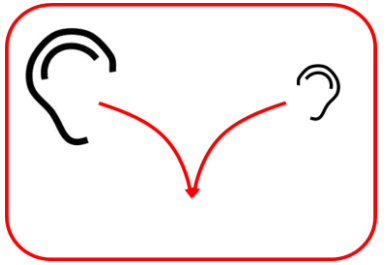


- **Symmetric Hearing Loss**
- Evaluate Localisation Performance – Test or Questionnaire (SSQ)

  - Good Localisation (Central Auditory Processing)
    - Select directionality that preserves localisation ques (Pinna Directionality is now available in all major hearing aid brands – but is rarely default)
    - Ensure good balance between both ears
    - Evaluated aided localisation performance (and compare to unaided)

  - Poor Localisation (Central Auditory Processing)
    - Evaluate if poor localisation could be caused by earlier hearing aid selection or fitting.
    - Here you can use more aggressive directionality
    - Consider accessories – remote microphone – FM systems (up to 20 dB SNR Improvement)

What is the basis for selection?



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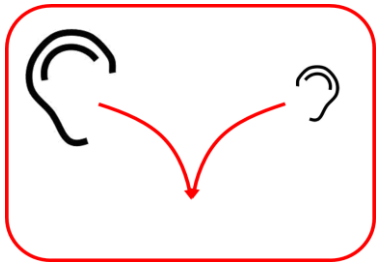
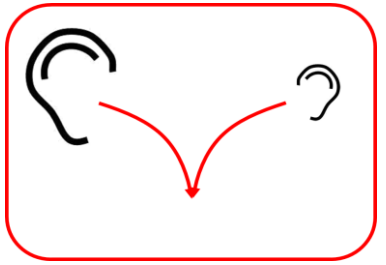


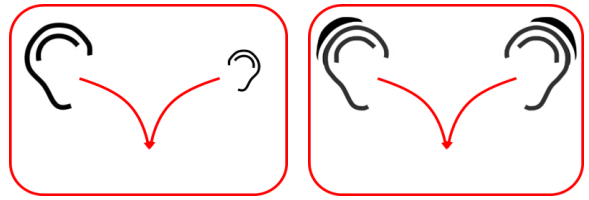
- **Asymmetric Hearing Loss**
  - One Normal Ear – One Aidable Ear (Mono-Stereophony)
  - Asymmetric – Aidable Hearing Loss in both ears
  - Single Sided Deafness - One Un-Aidable Ear



What is the basis for selection?

- **Asymmetric Hearing Loss**

  - One Normal Ear – One Aidable Ear (Mono-Stereophony)
    - The goal is to restore natural binaural hearing & localisation
    - Ensure good aided balance between both ears – don't use the fitting formula but use localisation or balance test
    - Select directionality that is comparable to the real ear performance (Pinna Directionality is now available in all major hearing aid brands – but is rarely default)
    - Use little or no noise reduction … this leads to unbalance between the ears
    - Evaluated aided localisation performance (and compare to unaided)



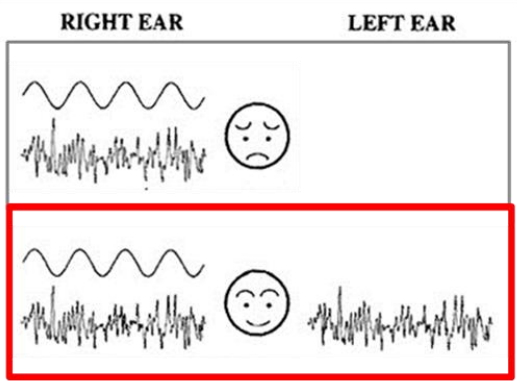
What is the basis for selection?

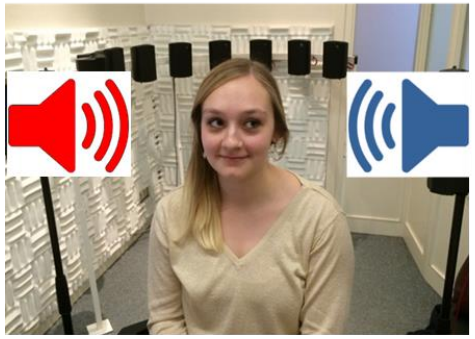
- **Asymmetric Hearing Loss – restore binaural masking release**

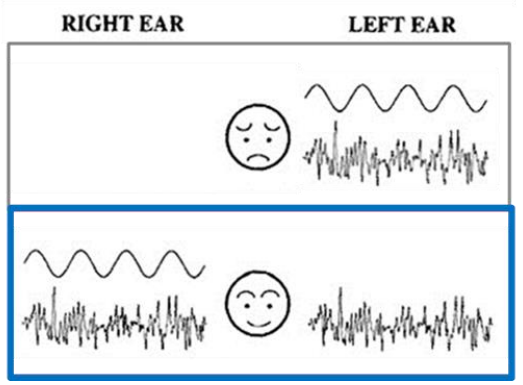
HP	FF	
3,0	2,5	NH
2,3	2,0	Control
1,3	1,0	HI users

Laureyns et al, 2017

30 Young Normal Hearing Subjects
– Avg Age 22y – 70% female
20 Control Subjects (Gender/Age)
– Avg Age 73y – 67% female
20 Hearing Instrument Users
– Avg Age 73y – 67% female







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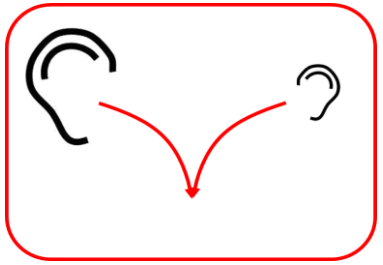


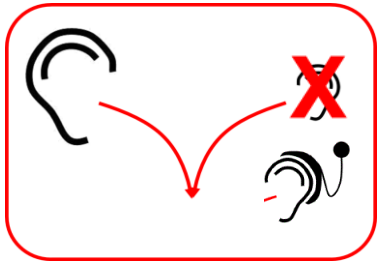
What is the basis for selection?

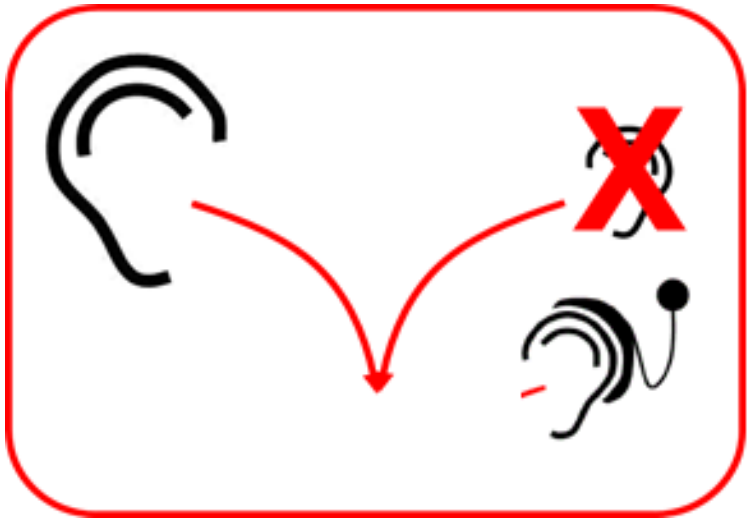
- **Asymmetric Hearing Loss**

  - Asymmetric – Aidable Hearing Loss in both ears
    - The goal is to restore natural binaural hearing & localisation
    - Ensure good aided balance between both ears – only use the fitting formula at the start for the worst ear - use localisation or balance test to fine-tune.
    - When the worst ear was not aided for a long time, allow time for habituation and repeat balance test systematically.
    - If speech intelligibility on the worst ear is poor, you may fit this ear as a noise reference ear (to support binaural masking release)

What is the basis for selection?

- **Asymmetric Hearing Loss**
  - Single Sided Deafness - One Un-Aidable Ear
    - CROS – Transcranial Cros – Hearing Aids – Bone Anchored
    - CI – Cochlear Implant on the unaidable ear





Single Sided Deafness and CROS

EAR & HEARING, VOL. 37, NO. 5, 495–507 (2016)

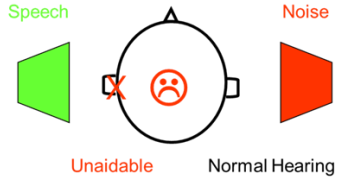
Conclusions:

Devices that reroute sounds from an ear with a severe to profound hearing loss to an ear with minimal hearing loss **may improve speech perception in noise when signals of interest are located toward the impaired ear**.

However, the same device may also **degrade speech perception as all signals are rerouted indiscriminately, including noise**.

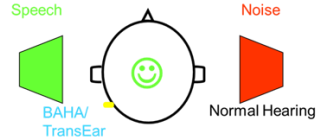
CROS works
if the noise is on the hearing side

Less than ideal listening situation speech is on the "bad" side and noise is on the "good" side



Unaided

Good listening situation because the device is on the side of the speech and will send speech to the "good" side



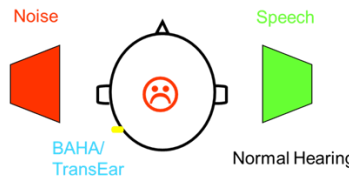
Aided

CROS does not work
if the noise is on the "deaf" side

Good listening situation because the speech is on the "good" side and the noise is on the "bad" side

Unaided

Less than ideal listening situation noise is on the "bad" side and is send to the "good" side where the noise will compete with the speech



Aided

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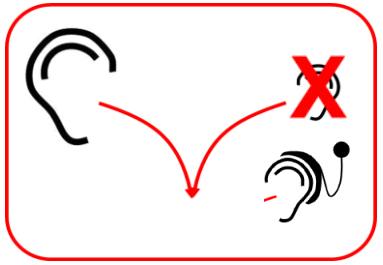
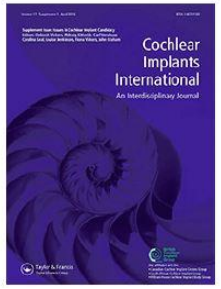
Single Sided Deafness and Cochlear Implants





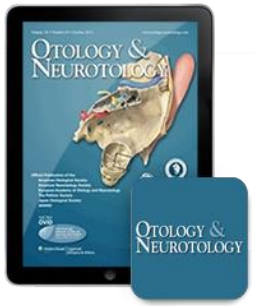
Cochlear Implants International
An Interdisciplinary Journal

ISSN: 1467-0100 (Print) 1754-7628 (Online) Journal homepage: http://www.tandfonline.com/loi/ycii20

Predicting speech perception outcomes following cochlear implantation in adults with unilateral deafness or highly asymmetric hearing loss

Pádraig T. Kitterick & Laura Lucas

Patients with a shorter duration of deafness were more likely to improve in listening conditions that created a less favourable SNR at the implanted ear than the non-implanted ear.
Those with more residual hearing in the better ear were more likely to improve in the listening condition that created a less favourable SNR at that ear.



Otology & Neurotology
37:e154–e160 © 2016, Otology & Neurotology, Inc.

Single-sided Deafness Cochlear Implantation: Candidacy, Evaluation, and Outcomes in Children and Adults

David R. Friedmann, Omar H. Ahmed, Sean O. McMenomey, William H. Shapiro, Susan B. Waltzman, and J. Thomas Roland Jr.

Conclusions: The data reveal significant improvement in speech perception performance in quiet and in noise in patients with single-sided deafness after implantation.

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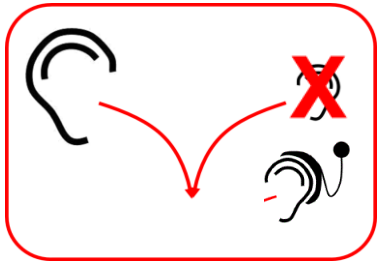
Single Sided Deafness and Cochlear Implants



Although cochlear implant is not a Food and Drug Administration-approved treatment for SSD, several recent studies show improvements in speech understanding, sound localization, and tinnitus.

REVIEW

Current Opinion in Otolaryngology & Head and Neck Surgery

Cochlear implantation and single-sided deafness

Joshua Tokita[a], *Camille Dunn*[a], *and Marlan R. Hansen*[a,b]

Tokita et al. Curr Opin Otolaryngol Head Neck Surg 2014, 22:353–358

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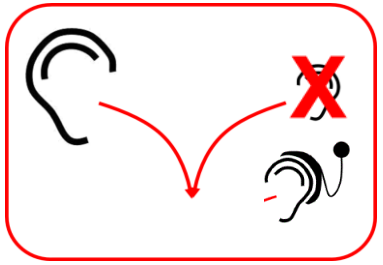
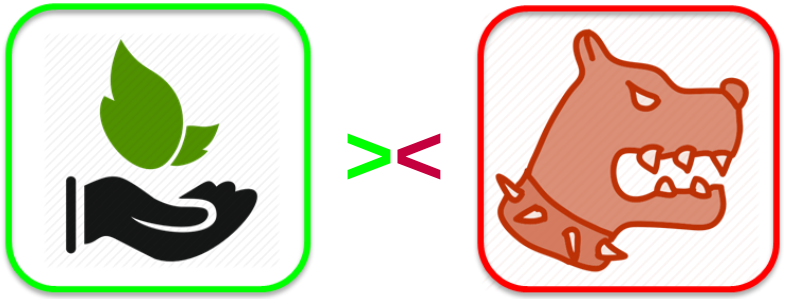


What is the basis for selection?

- **Asymmetric Hearing Loss**

  - Single Sided Deafness - One Un-Aidable Ear
  - CROS – Transcranial Cros – Hearing Aids – Bone Anchored
    - The goal is to reduce the head shadow effect
    - CROS improves the situation if speech is on the “deaf” side and noise on the “good” side.
    - CROS makes things worse, if speech is on the “good” side and noise on the “deaf” side.
    - Classification or Noise Reduction may reduce the negative effects
    - YOU CAN NOT IMPROVE LOCALISATION!
  - CI – Cochlear Implant on the unaidable ear
    - This can improve localisation (next to communication and tinnitus)
    - But mostly not seen as a cost-effective intervention (for now …)

Conclusion



Natural >< Aggressive

- **In binaural fitting – localisation is essential**
  - **Evaluate Localisation** both unaided and aided
  - When localisation is possible, **select natural features that preserve localisation cues**.
    - Watch out for aggressive signal processing
    - Pinna Directionality preserves localisation cues and sound quality.

- **For mono-stereophony**
  - Avoid Noise Reduction
  - Only Human Ear Like Directionality
  - Fitting needs to be based on balance not on the default gain formula

- **Don’t go for quick fit … or default … go for personalised quality hearing care.**

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“Evidence based selection of hearing aids and features”

Mark Laureyns
Thomas More University College – Department of Audiology
Antwerp - Belgium

CRS - Amplifon Centre for Research & Studies
Milan – Italy

European Association of Hearing Aid Professionals
Brussels - Belgium

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