CARDIFF UNIVERSITY
PRIFYSGOL CAERDYDD

School of Psychology

Jacques Grange & John Culling

SpiN 2014 Jan 9

How CI users can make the best of their implants in SpiN situations:

- POSITIONING IN A ROOM
- HEAD ORIENTATION STRATEGY
- TRANSLATIONAL AVENUES

Sponsored by:

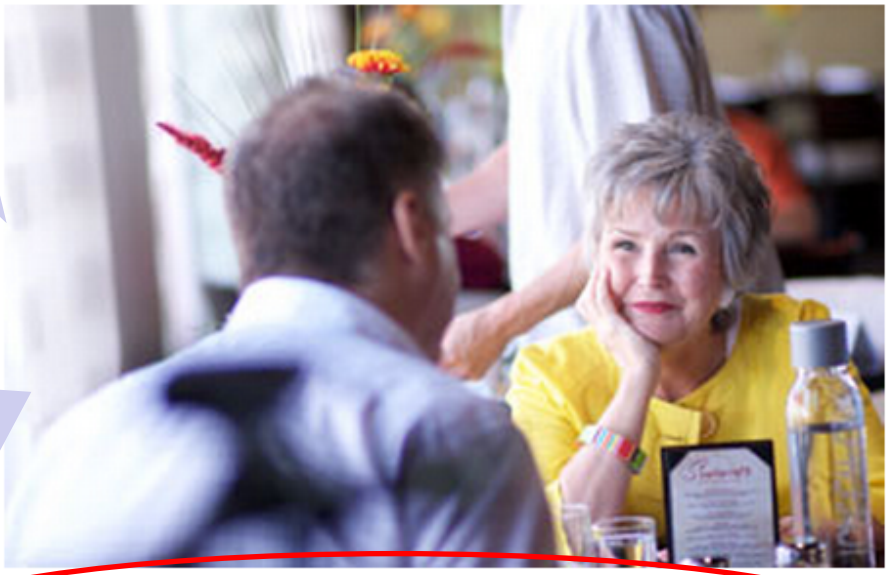
ACTION ON HEARING LOSS

In collaboration with

UCL

Hearing in noise with a cochlear implant

riday, August 19th, 2011 | Posted by Ellen Beer in Cochlear Implants



"Now I'm able to be in noisy situations and actually hear someone in front of me."

When I wore hearing aids my outgoing personality stayed a the party invitations arrived with my friends in small grou one, but parties? If you ha hearing loss I'm sure you ca

Step in the door and greet quickly retreat to the quiete st room. Nod and smile as frie hope you can read lips e of what they say to you.

Click here for Suzanne Video Gallery.

As the party pro esses the music gets l uder ng with t

Presentation roadmap

- Motivation
- Spatial Release from Masking (SRM)
  SRM Model , Fixed-head Benefits of Bilateral Implantation
- SRM Model Predictions with Head Orientation
- Experiment 1: NH Audio Paradigm - model verified
- Experiment 2: Free-head Paradigm - NH & CI Behaviour
  & impact of audio-visual cues
- Experiment 3: SRM Improved with Lip-reading
- Experiment 4: SRM Improved with Head Orientation
- Conclusions / take-home message

Motivation: current UK Policy on cochlear implantation

NICE 2009

NICE recommendations:

Bilateral cochlear implantation (**BCI**) for children

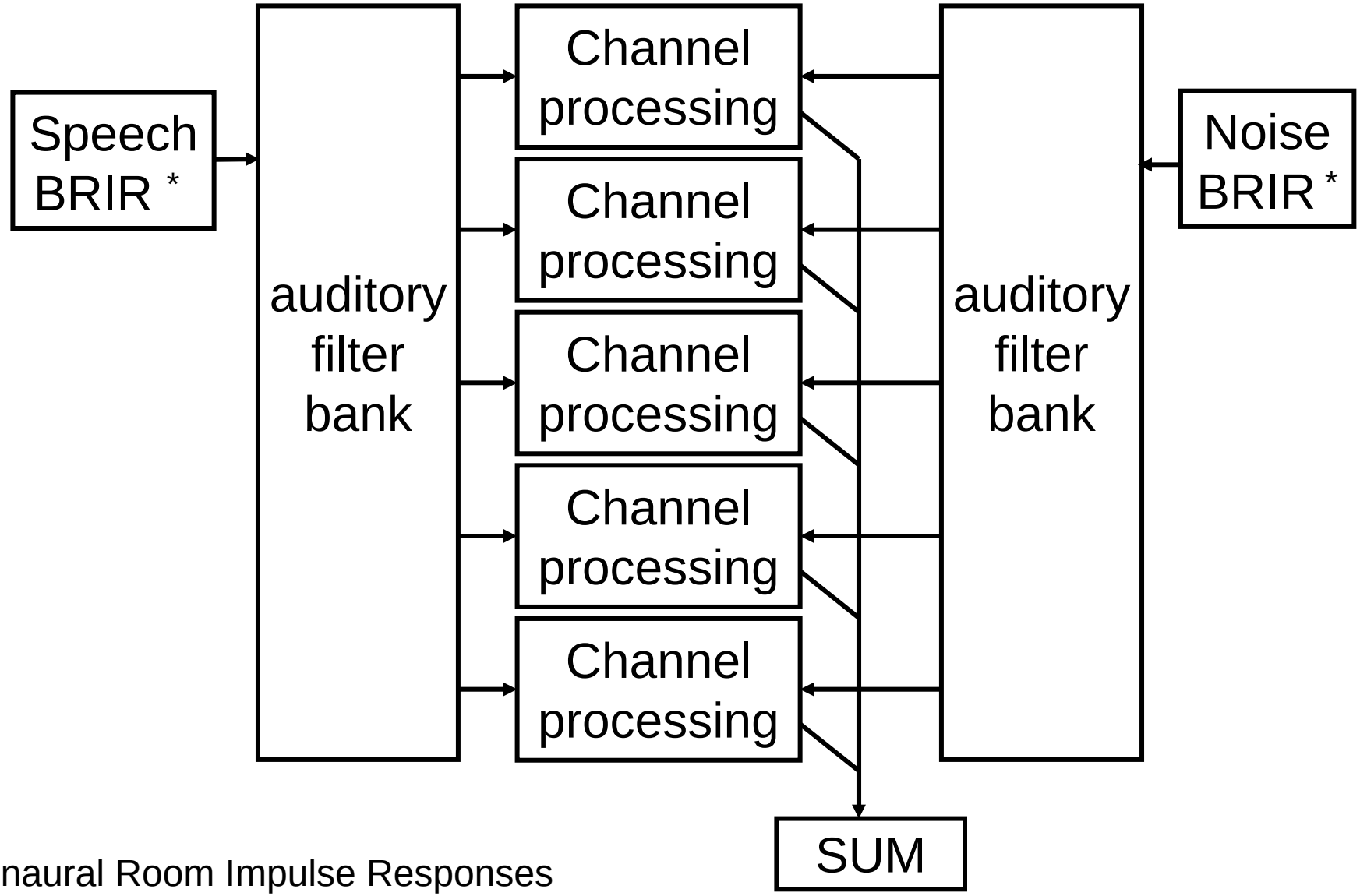
Unilateral (**UCI**) for adults

Lack of data on benefits of BCI for adults

- Inform policy with more evidence of adult BCI benefits
- Help CI users make the best of their CI(s) in terms of:
  - Listener's positioning in a noisy context
  - Head orientation w.r.t. speaker
- Translational application

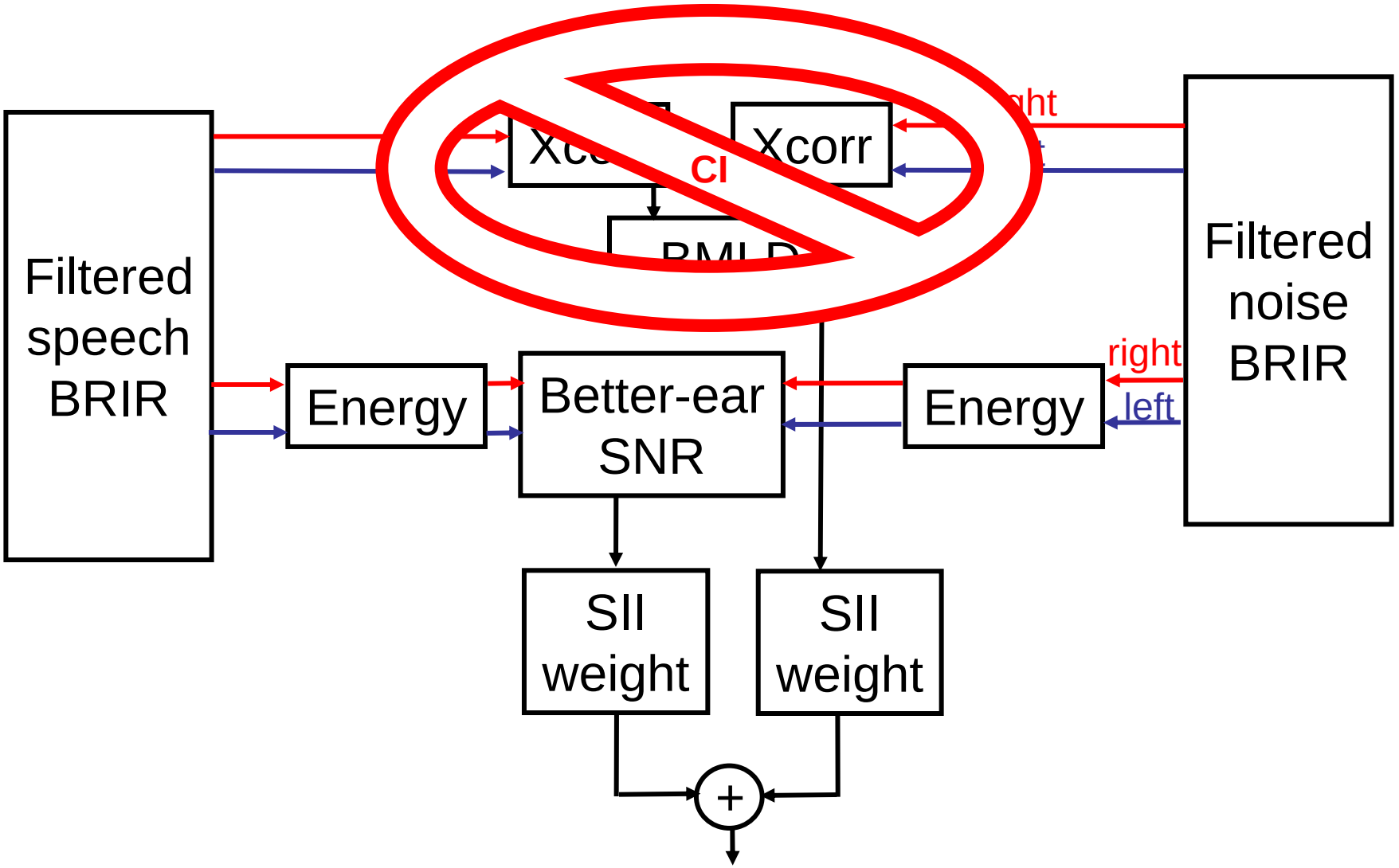
Model of SRM

Lavandier & Culling (2010), Jelfs et al.(2011)



* Binaural Room Impulse Responses

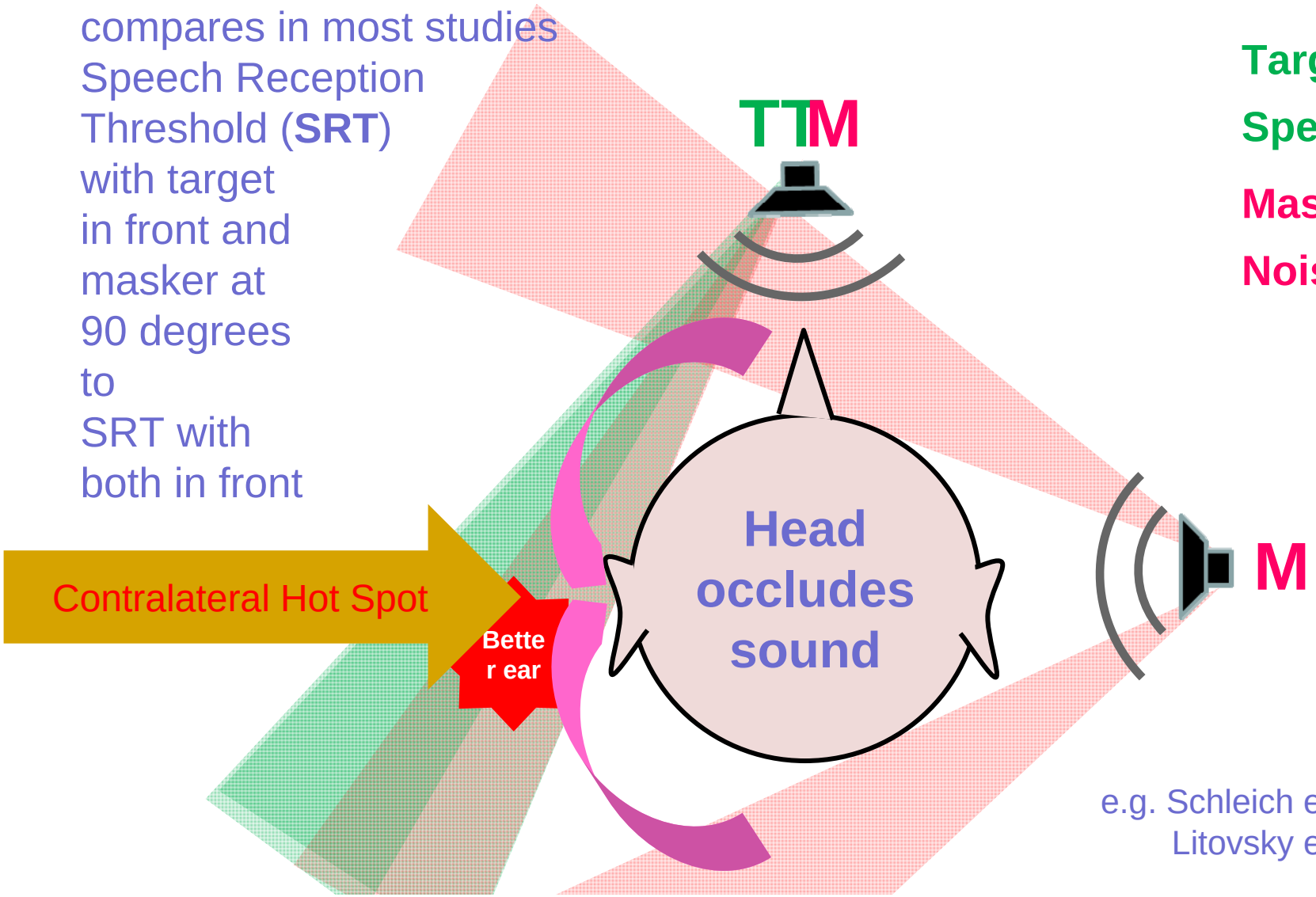
Model of SRM



- Binaural Masking Level Difference from Equalization-Cancellation theory
  Durlach (1963/72) and Culling (2004)

Spatial Release from Masking (**SRM**) – fixed head

Spatial Release from Masking (SRM) compares in most studies Speech Reception Threshold (**SRT**) with target in front and masker at 90 degrees to SRT with both in front



e.g. Schleich et al (2004)
Litovsky et al (2006)

Spatial Release from Masking (SRM) – fixed head

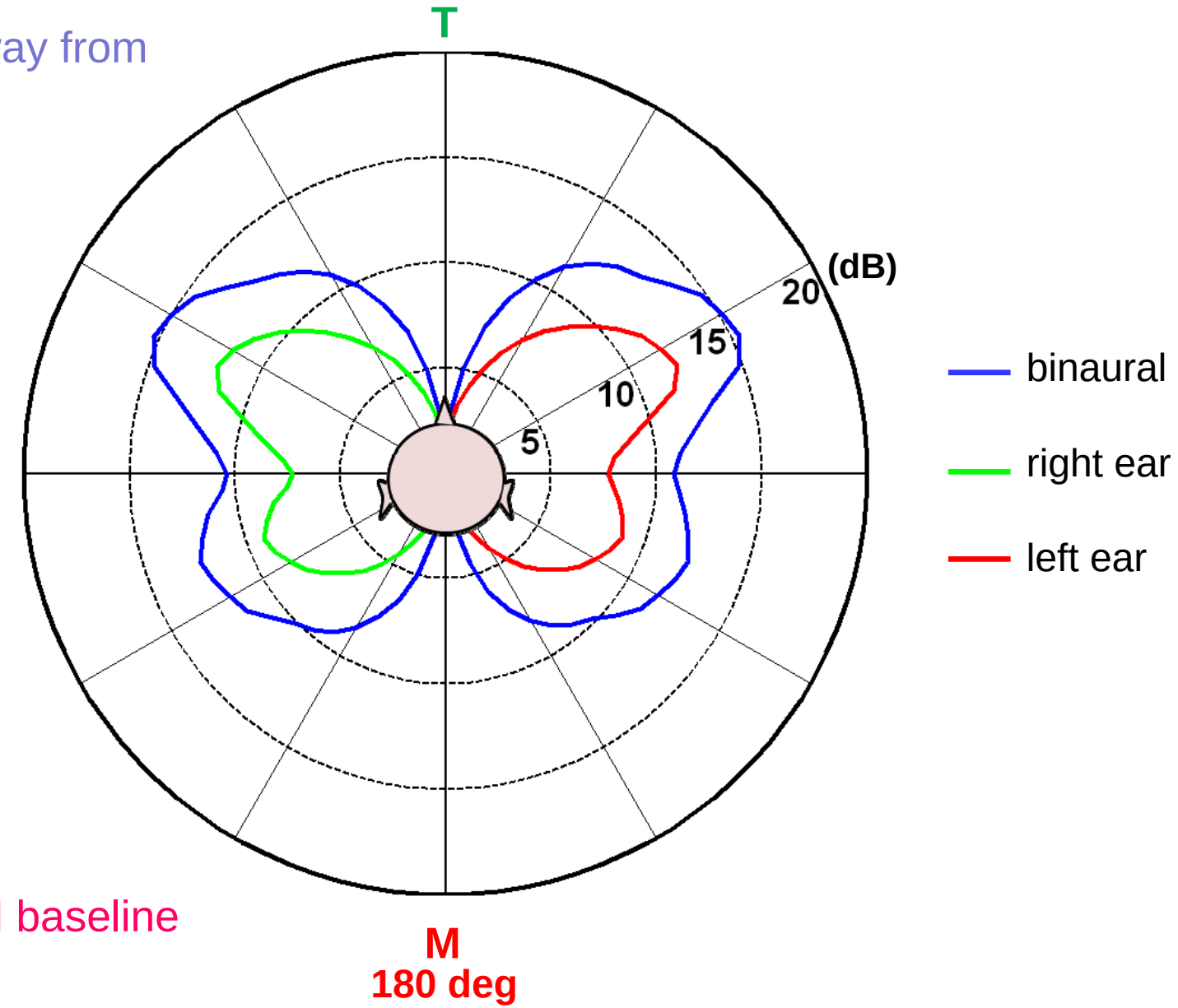
Culling, Jelfs, Talbert, Grange & Backhouse (2012), "The benefit of bilateral vs. unilateral cochlear implantation to speech intelligibility in noise", *Ear and Hear.* 33,673-682

Good, but head is fixed.

- How about more natural, free-head situations
- and head orientation strategies?

Expt. 1: head orientation benefit - predictions

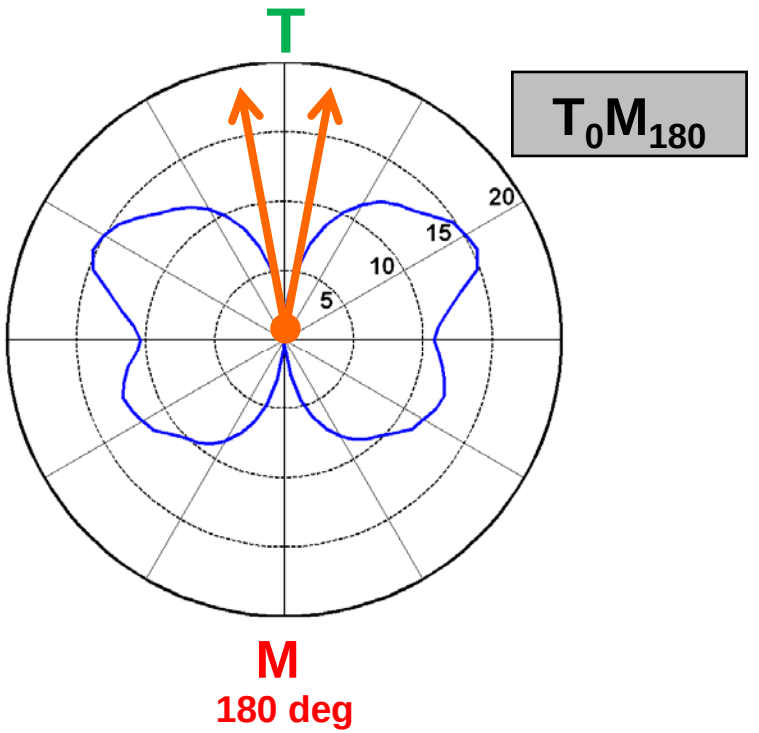
Head rotation away from the target can be very, VERY beneficial...

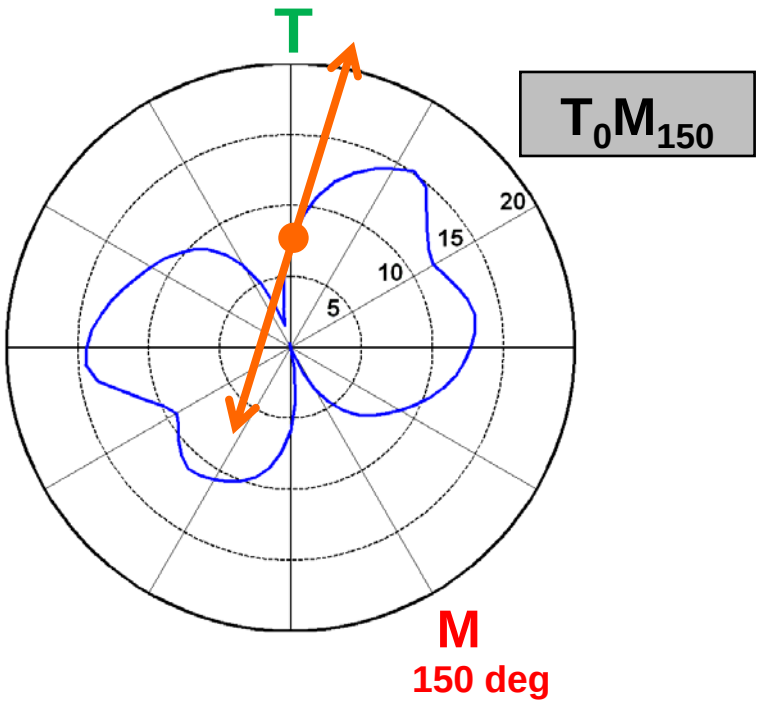


No data found for NH listener !!

>> Start with NH baseline

Hypotheses & research questions





- Do listeners rotate their head spontaneously?
- If so, is head orientation strategy driven by SRM gain or slope?
- Or by localisation of sound sources?
- Do listeners scan for- or jump to- the optimum orientation?

Experiment 1: paradigm of NH baseline

Simple paradigm

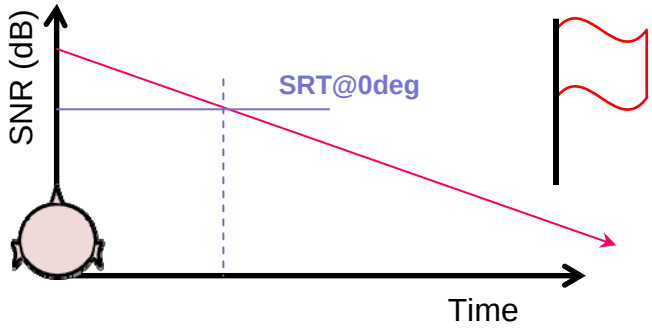
Separate SRT and head orientation measurements

12 young NH participants (mean 20 yrs)
Sound-deadened room (60ms RT60)

Head orientation paradigm:

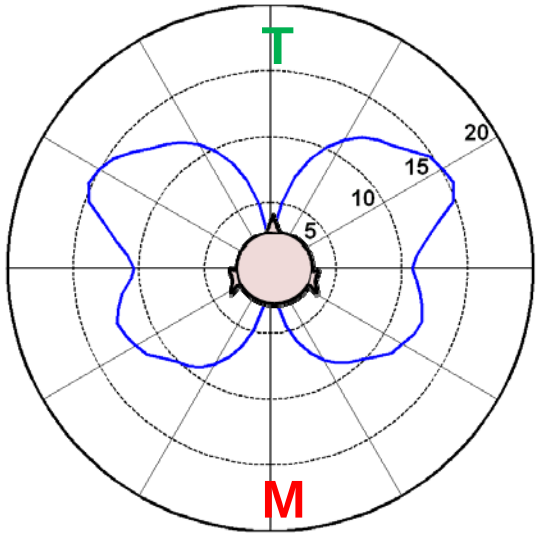
Measure free head orientation when playing a long track, gradually diminishing the SNR
>> Undirected task!
Covert overhead video recording

Participant simply to flag when they lost track



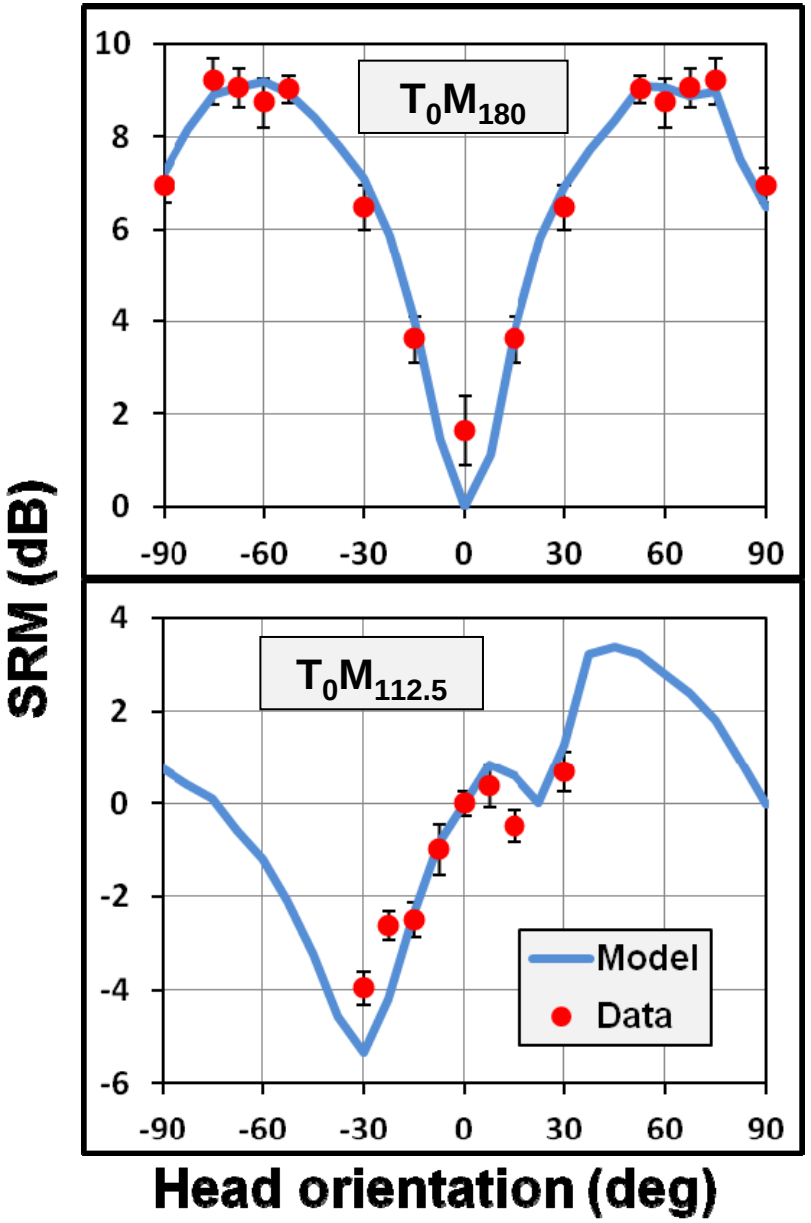
SRT paradigm:

Verify model with fixed head
- Adaptive SRT_{50} measurements
- IEEE sentences, 1 up 1 down
- Masker: steady speech-shaped noise

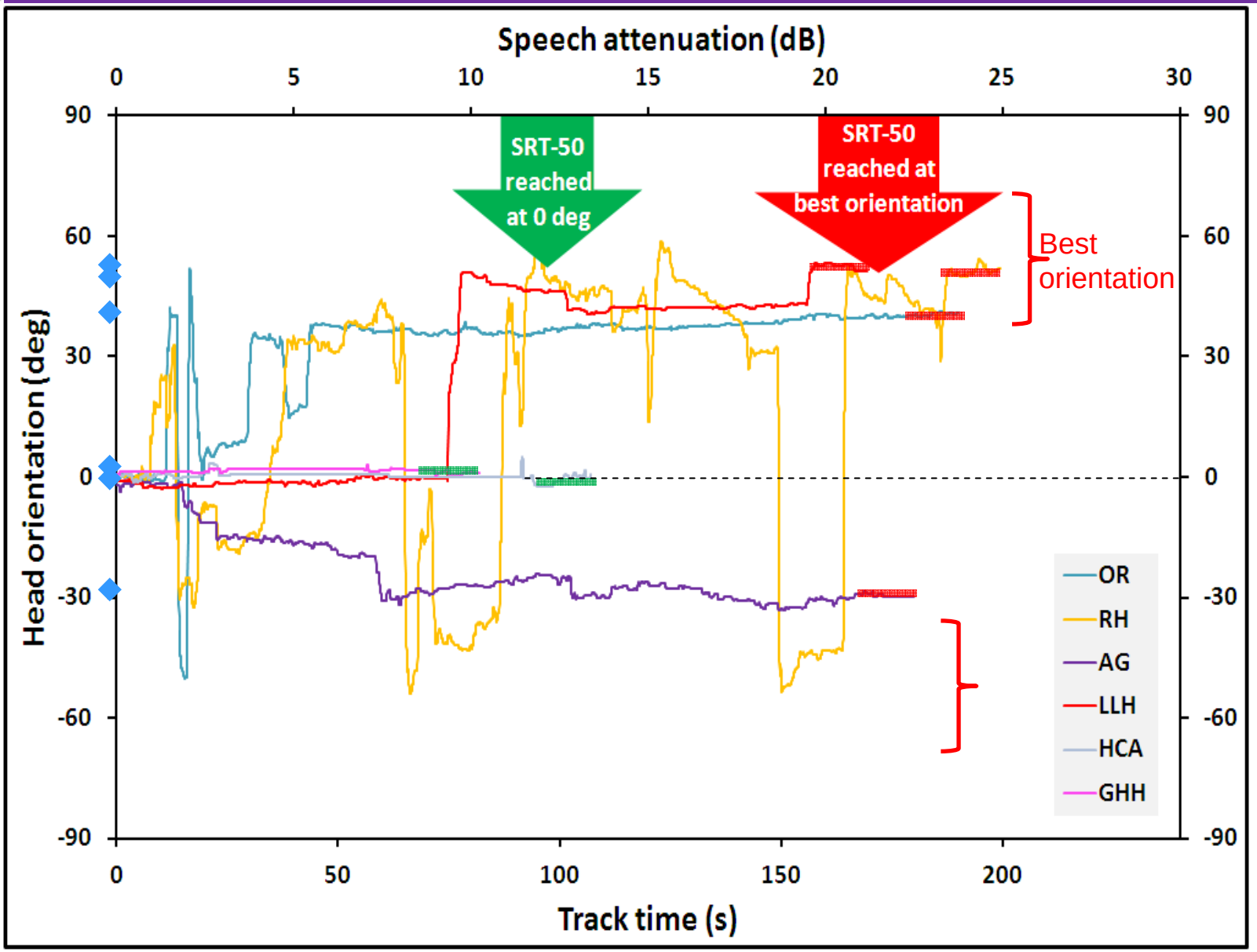


NH SRT's - data vs. predictions

- Excellent match between data and model, typically within < 1dB
- Head orientation benefit up to 8dB in NHs



Head orientation track examples T_0M_{180}

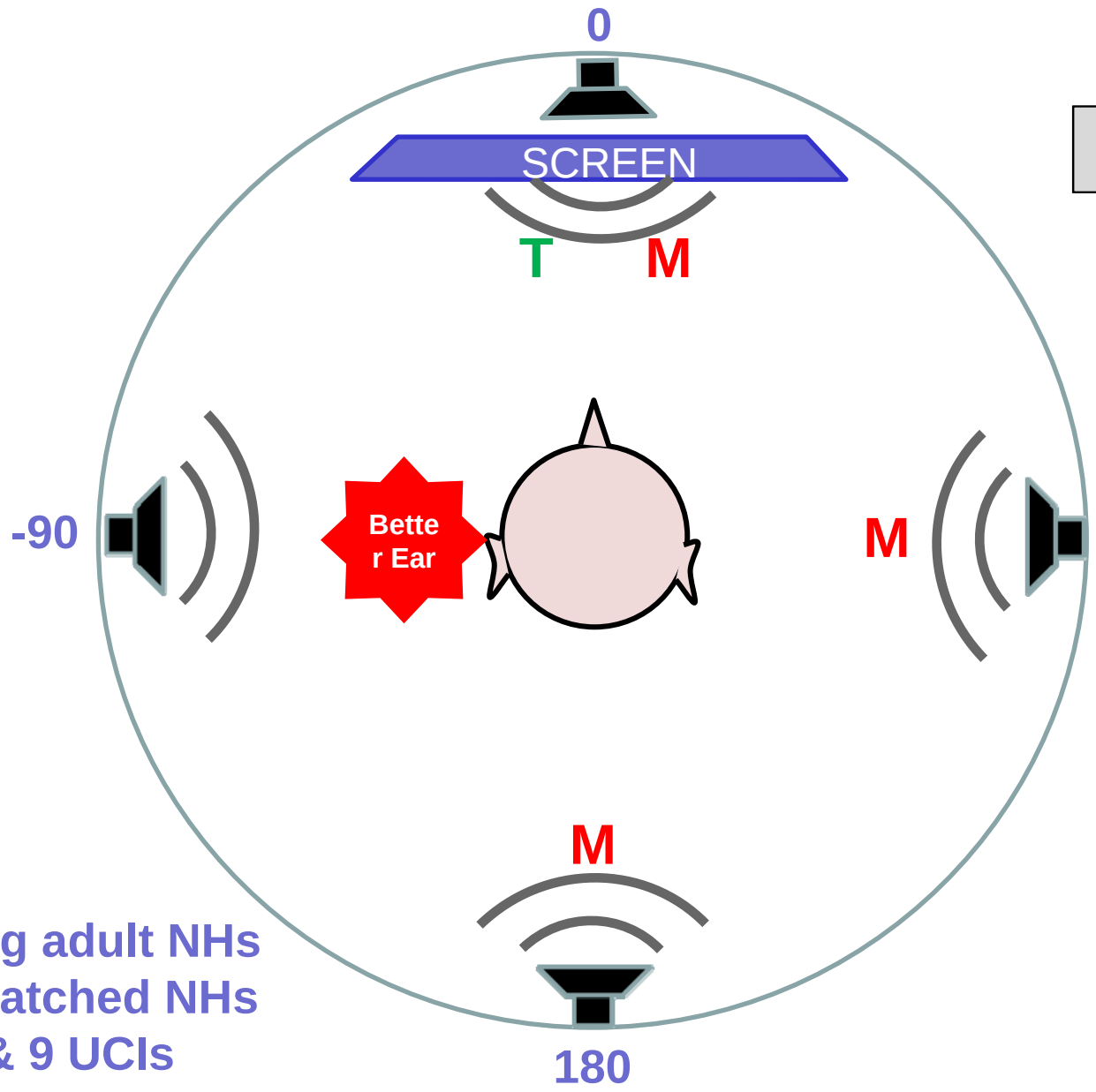


NH head orient

Great, but so far young NHs in audio alone.

- How about impact of visual cues?
- Does lip-reading affect free-head strategies?
- How do CI users and NHs compare for SRM and head orientation strategies with age-matching

Expt. 2: Free Head audio & audio-visual (AV), NH & CI



Configuration

T_0M_{180}

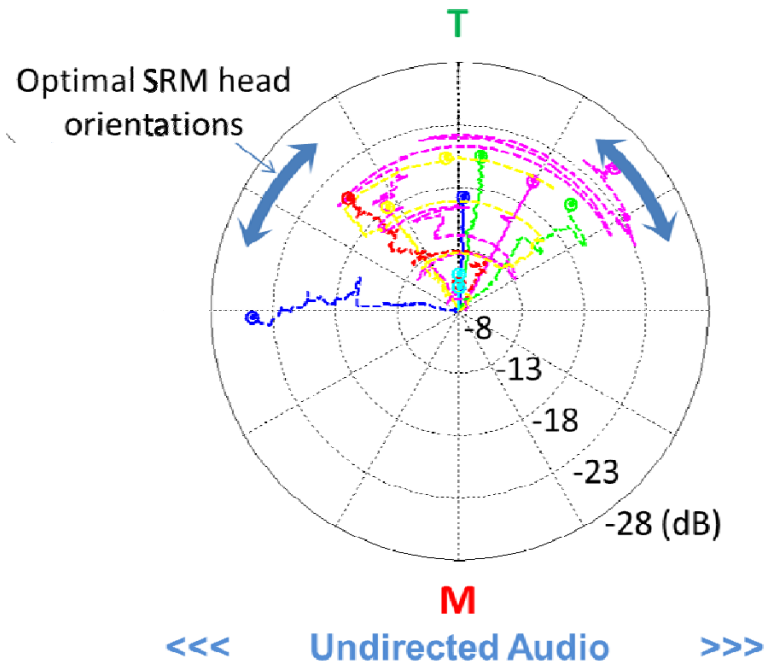
Favour the Better ear

Unchanged paradigm

12 young adult NHs
8 age-matched NHs
8 BCIs & 9 UCIs

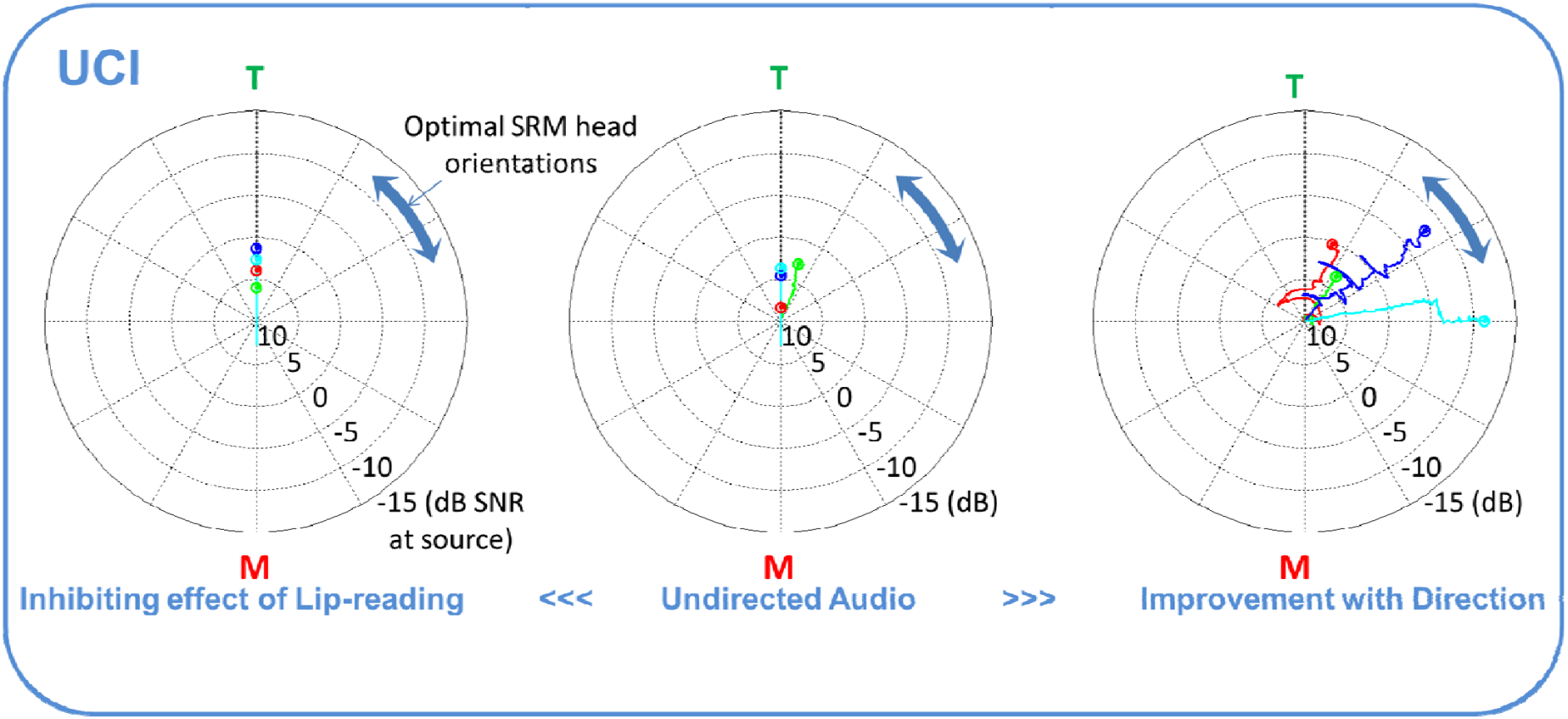
Expt. 2: NH head orientation tracks in T_0M_{180}

NH

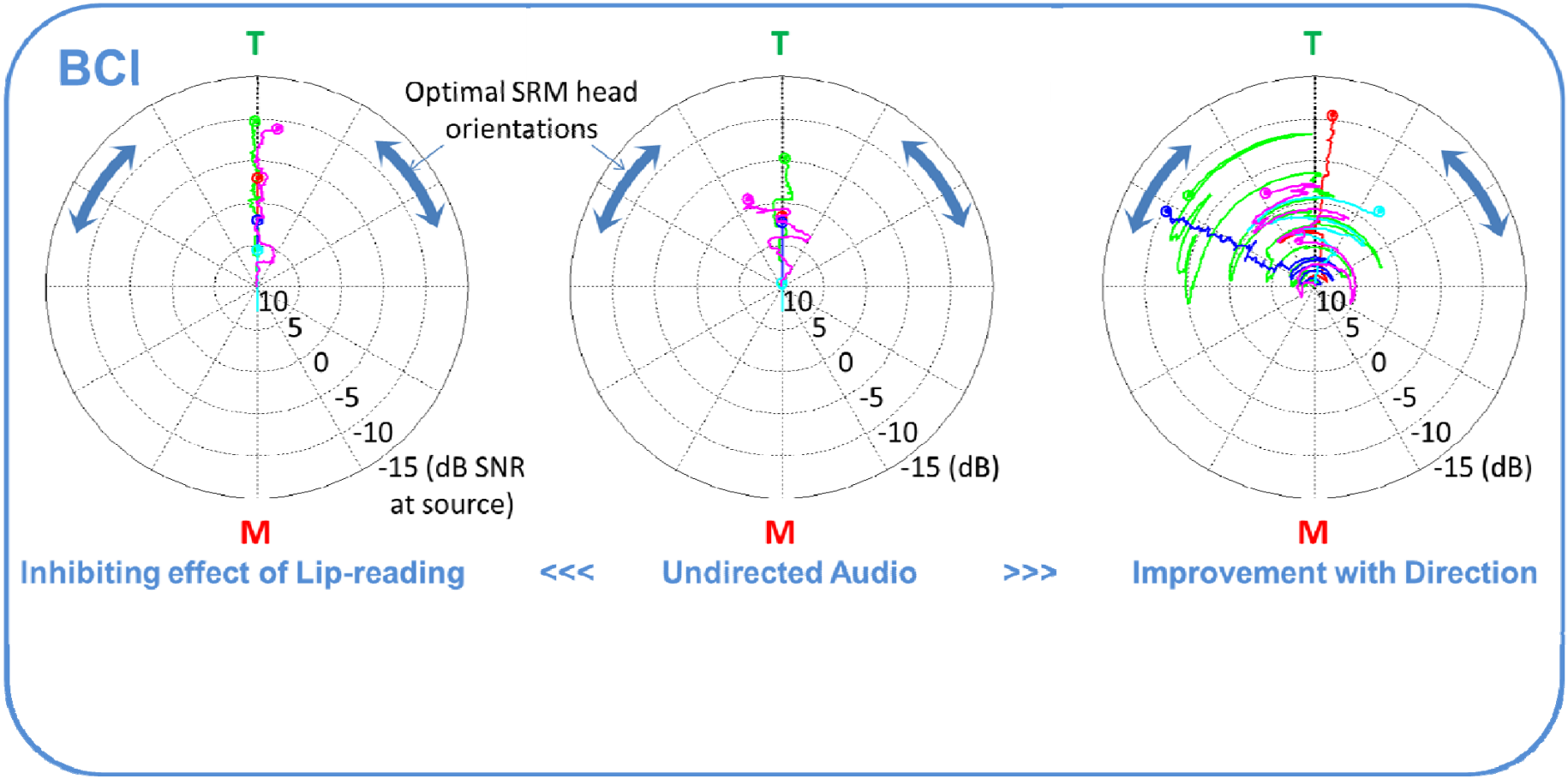


No change with age-matched NHs other than improved directed performance

Expt. 2: UCI head orientation tracks in T_0M_{180}



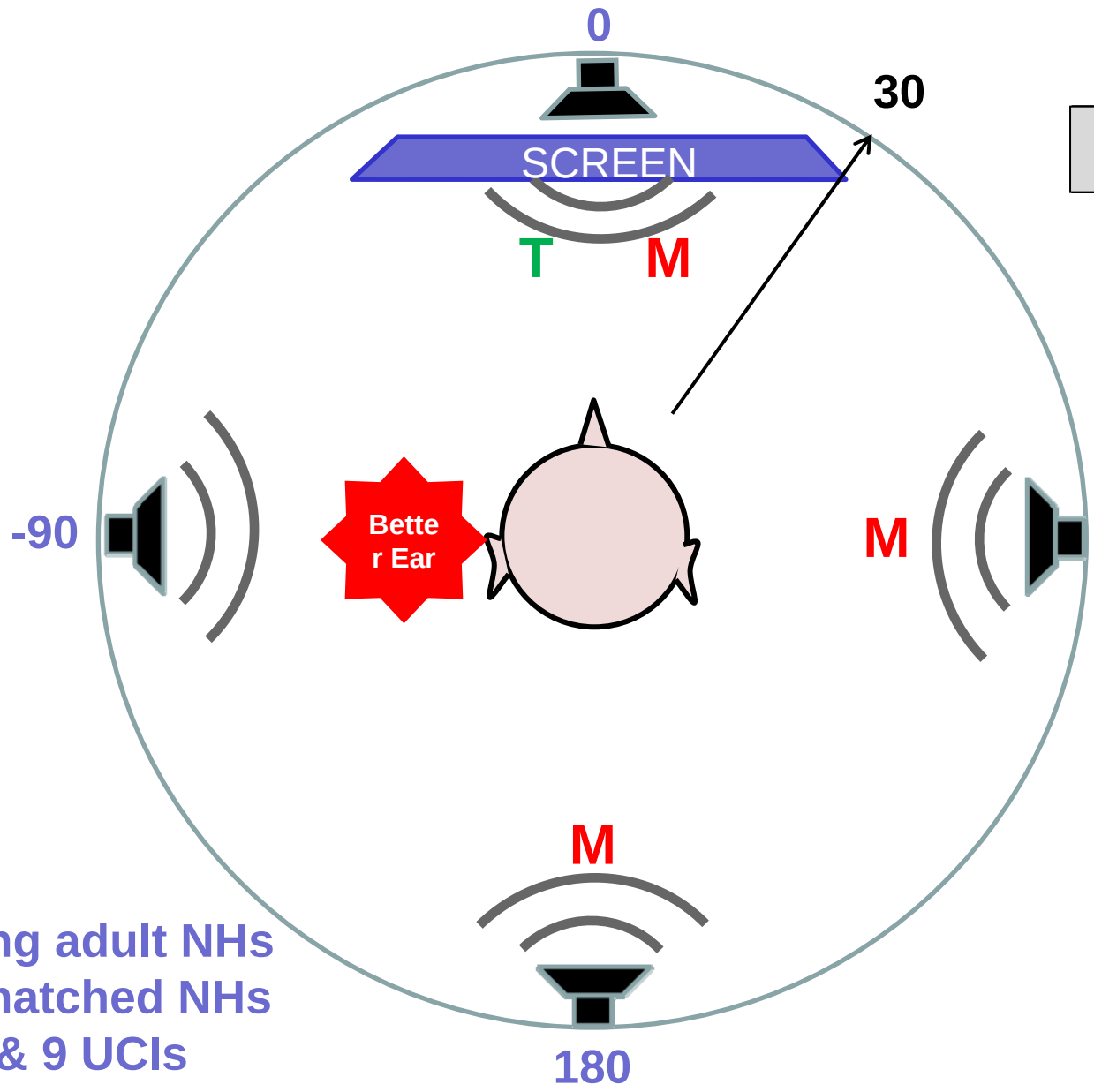
Expt. 2: head orientation track examples T_0M_{180}



Tested CIs make little spontaneous head orientations, due in part to:

- **Being an over-tested population, frequently tested with head fixed**
- **Audiologists aledgedly advising them to face the speaker**
- **Being more reliant on lip-reading (AV)**

Expt. 3: Lip-reading audio & AV paradigms, NH & CI



Configuration

$H_{30}M_{180}$

Favour the Better ear

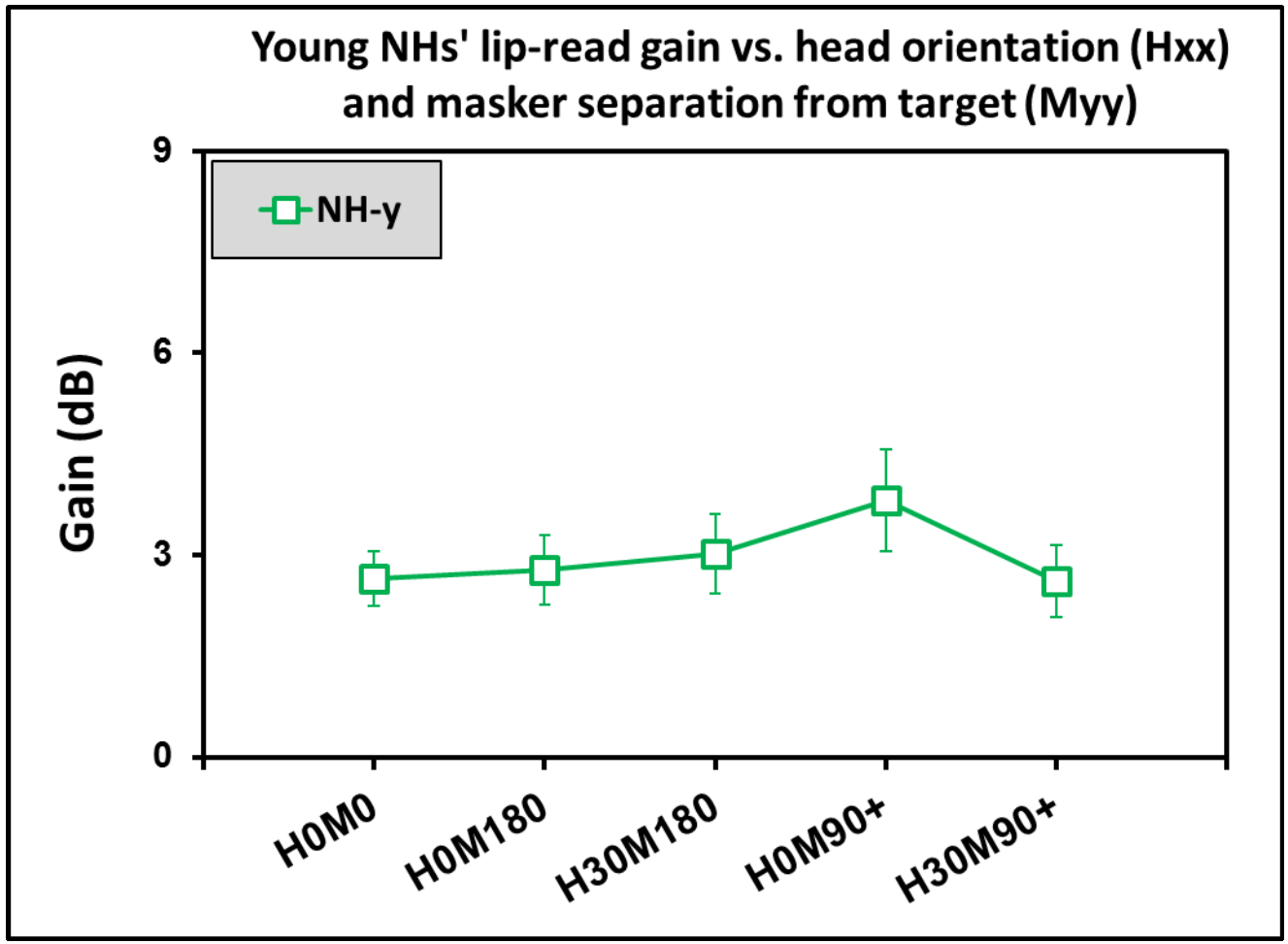
12 young adult NHs
8 age-matched NHs
8 BCIs & 9 UCIs

Expt. 3: Impact of Lip-reading

Bespoke SRT adaptive tracks optimised for CIs:

- Modified Plomp (1986) method
- High predictability SPIN sentences
- Repetition of presentations till >50% correct allowed
- Simply subtract AV SRT from the audio SRT

Expt. 3: Impact of Lip-reading



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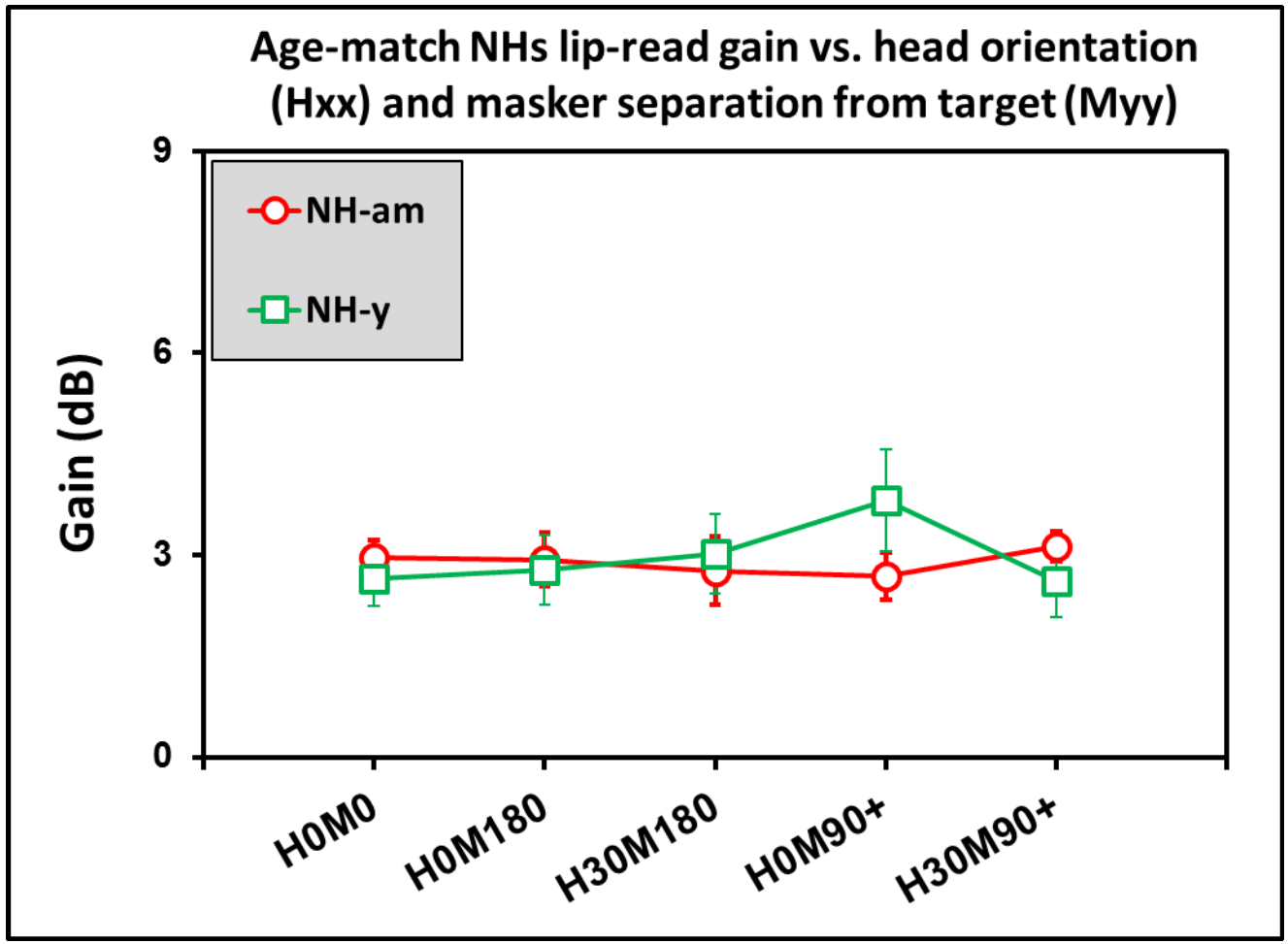

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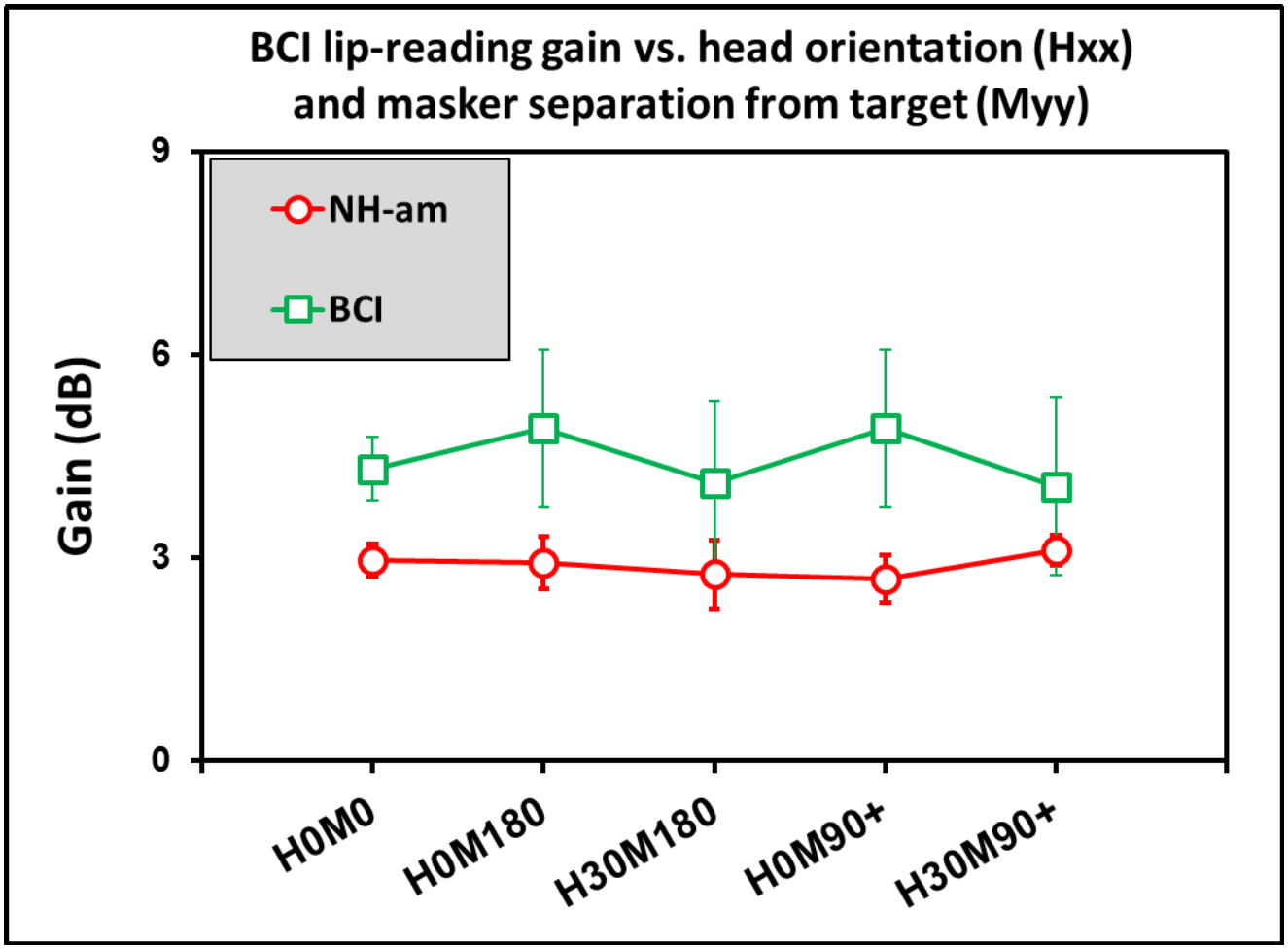

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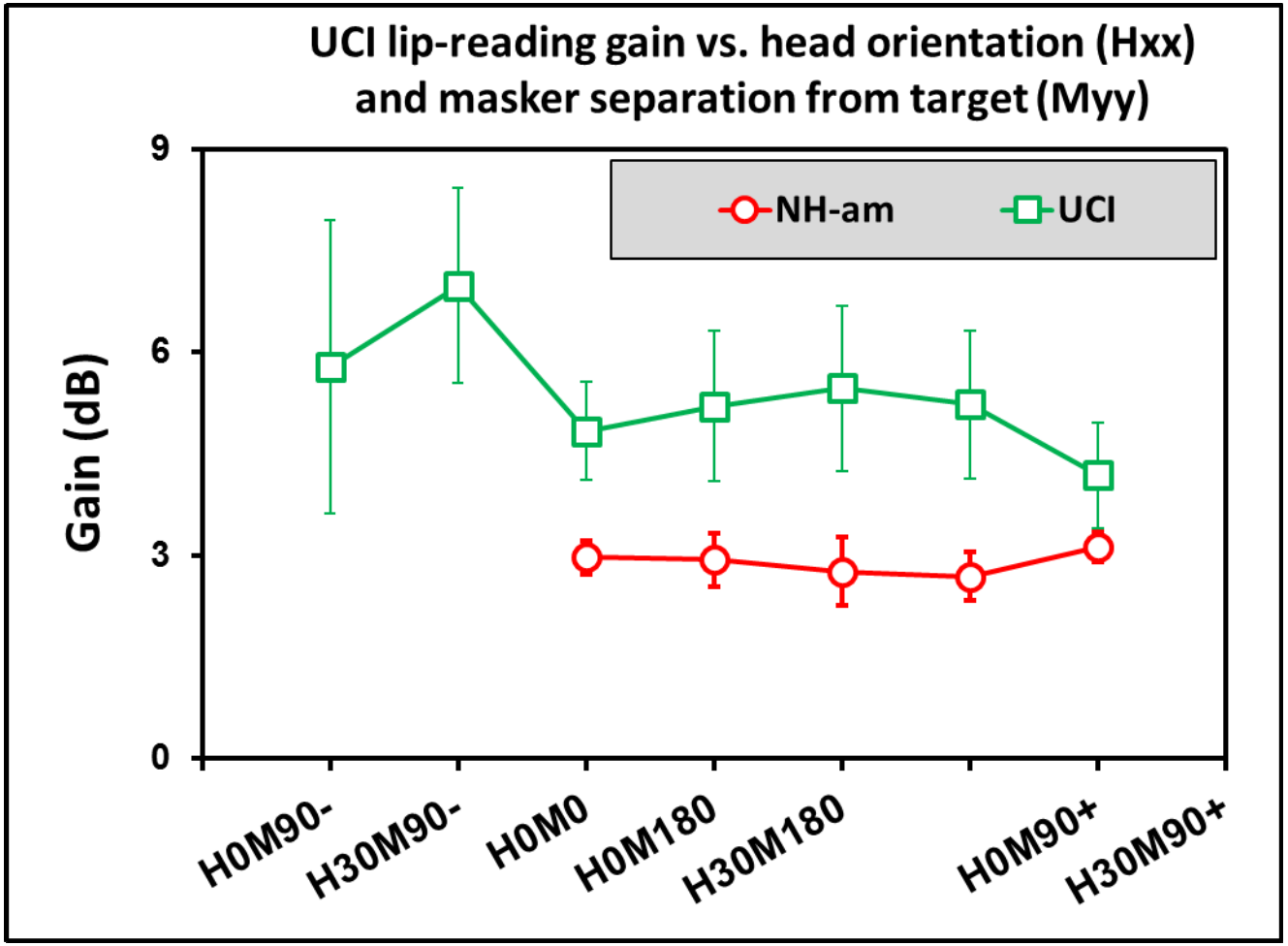

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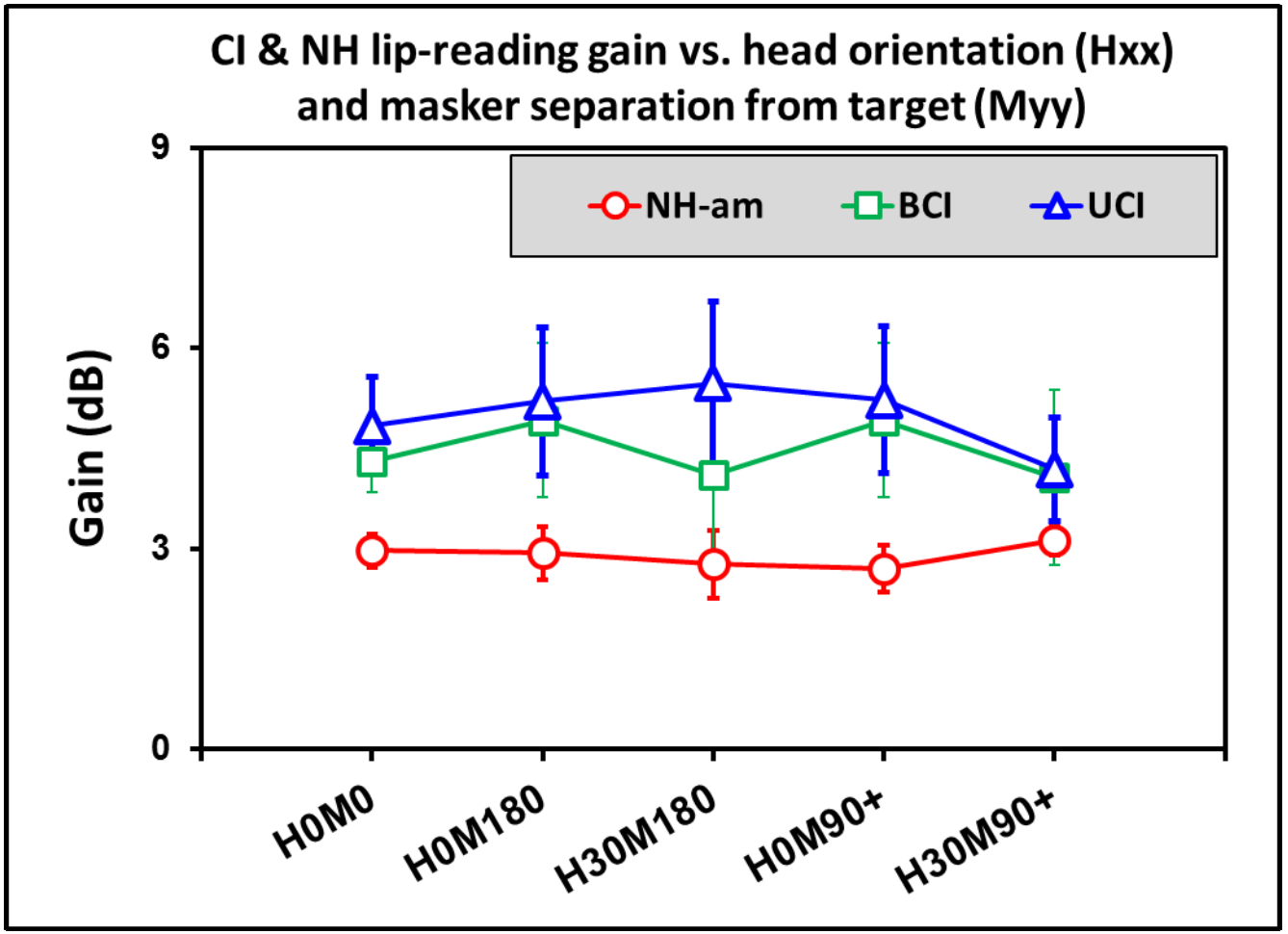
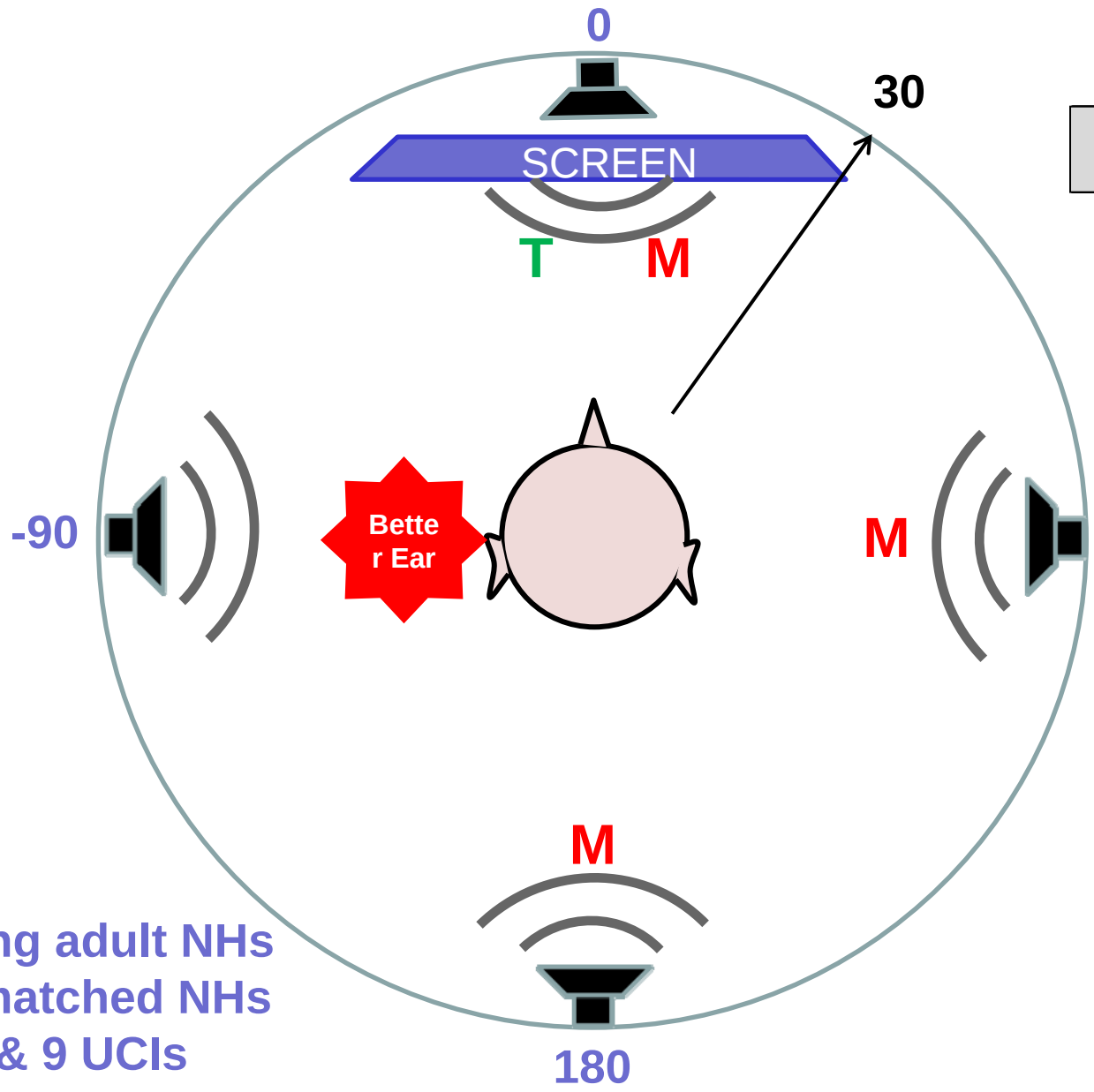


Lip-reading gain independent of head orientation!

Expt. 4: Audio SRMs, 30 deg head turn benefit



Configuration

$H_{30}M_{180}$

Favour the Better ear

12 young adult NHs
8 age-matched NHs
8 BCIs & 9 UCIs

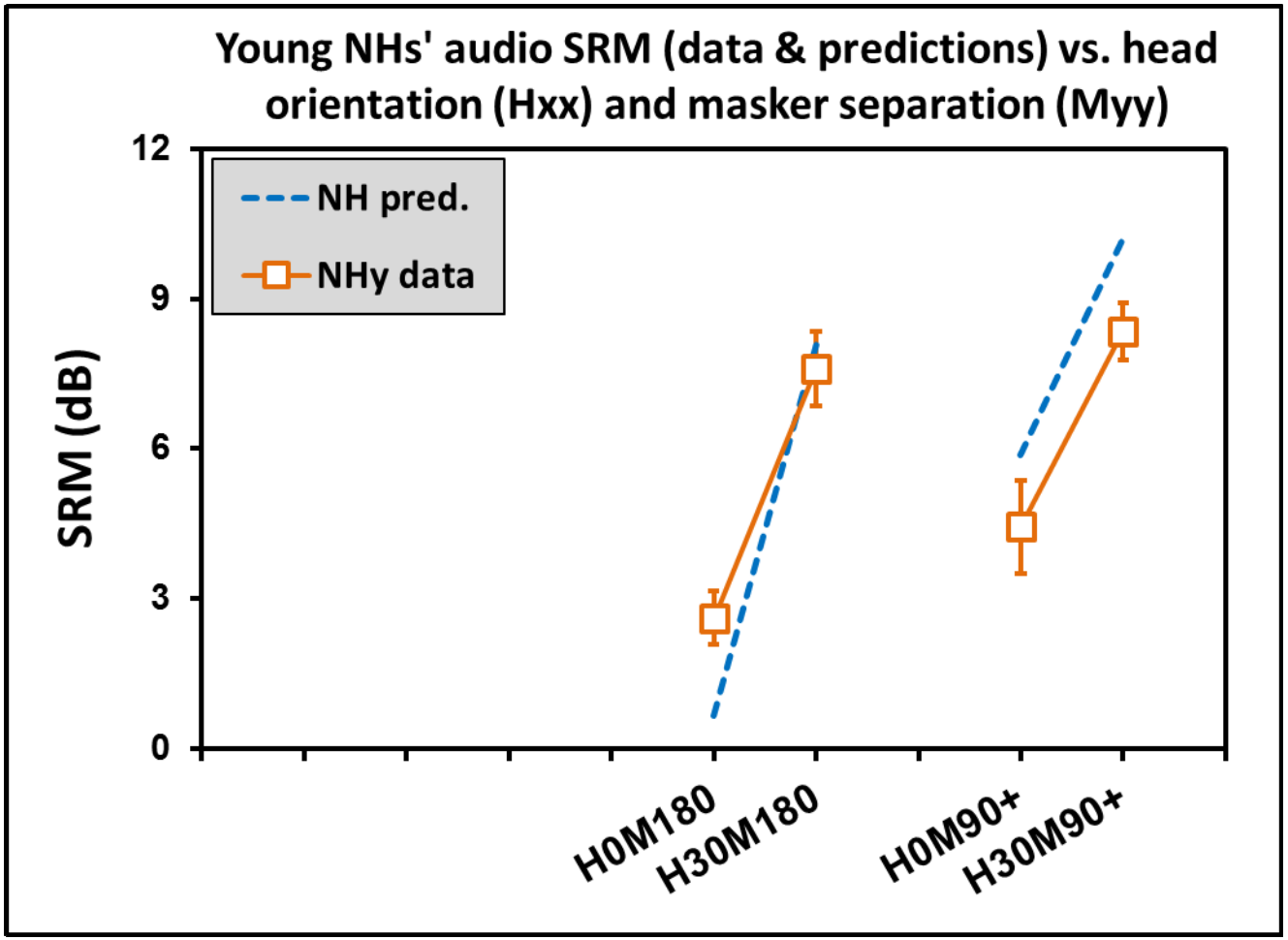
Expt. 4: Audio SRMs, 30 deg head turn benefit

More accurate SRT adaptive tracks optimised for CIs:

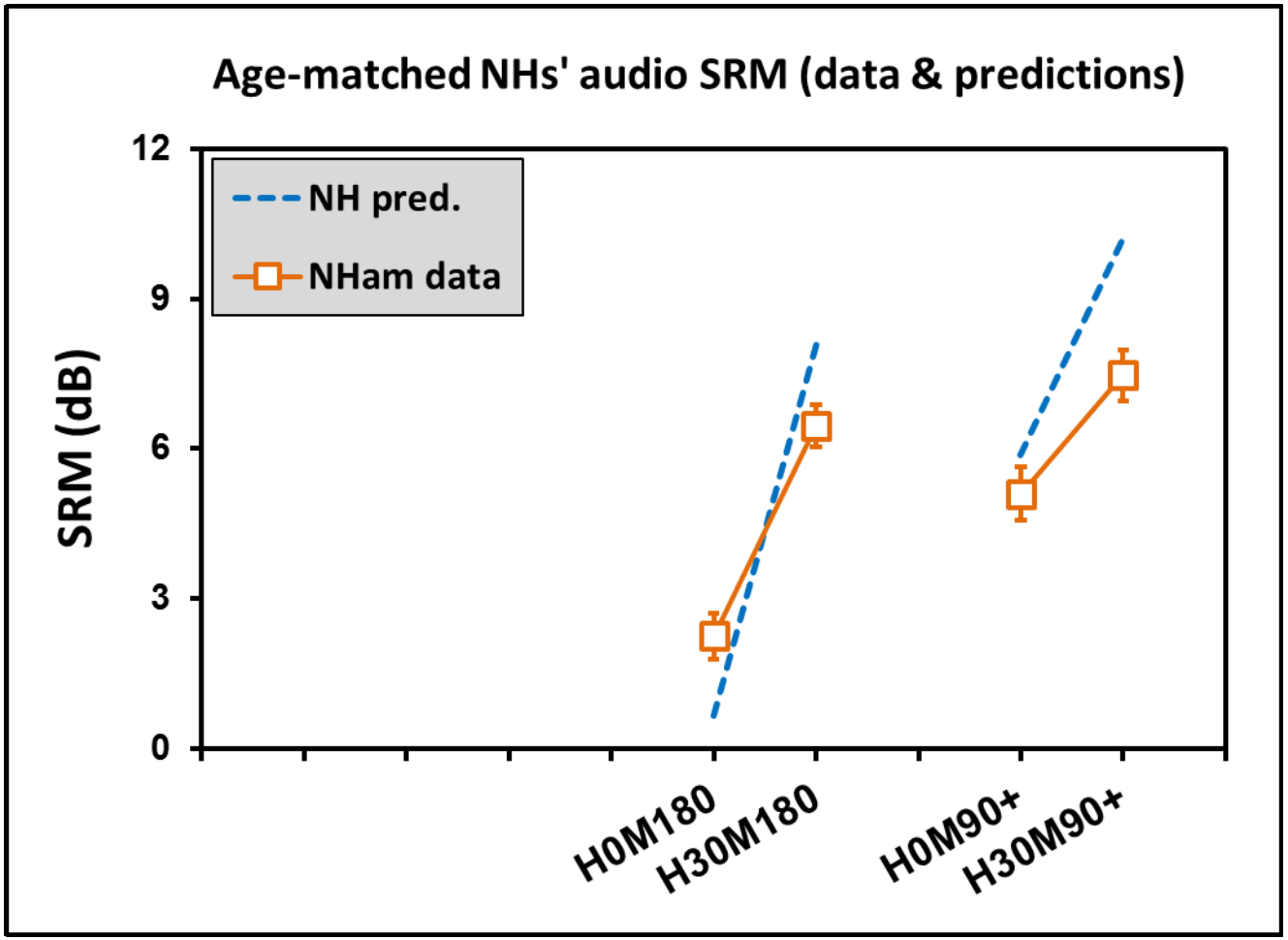
- IEEE sentences (5 key words)
- Modified Plomp (1986) method
- Sentences presented only once from staircase trigger
- 5 repeats per condition to reduce variance

Expt. 4: Audio SRMs, 30 deg head turn benefit

SPIN

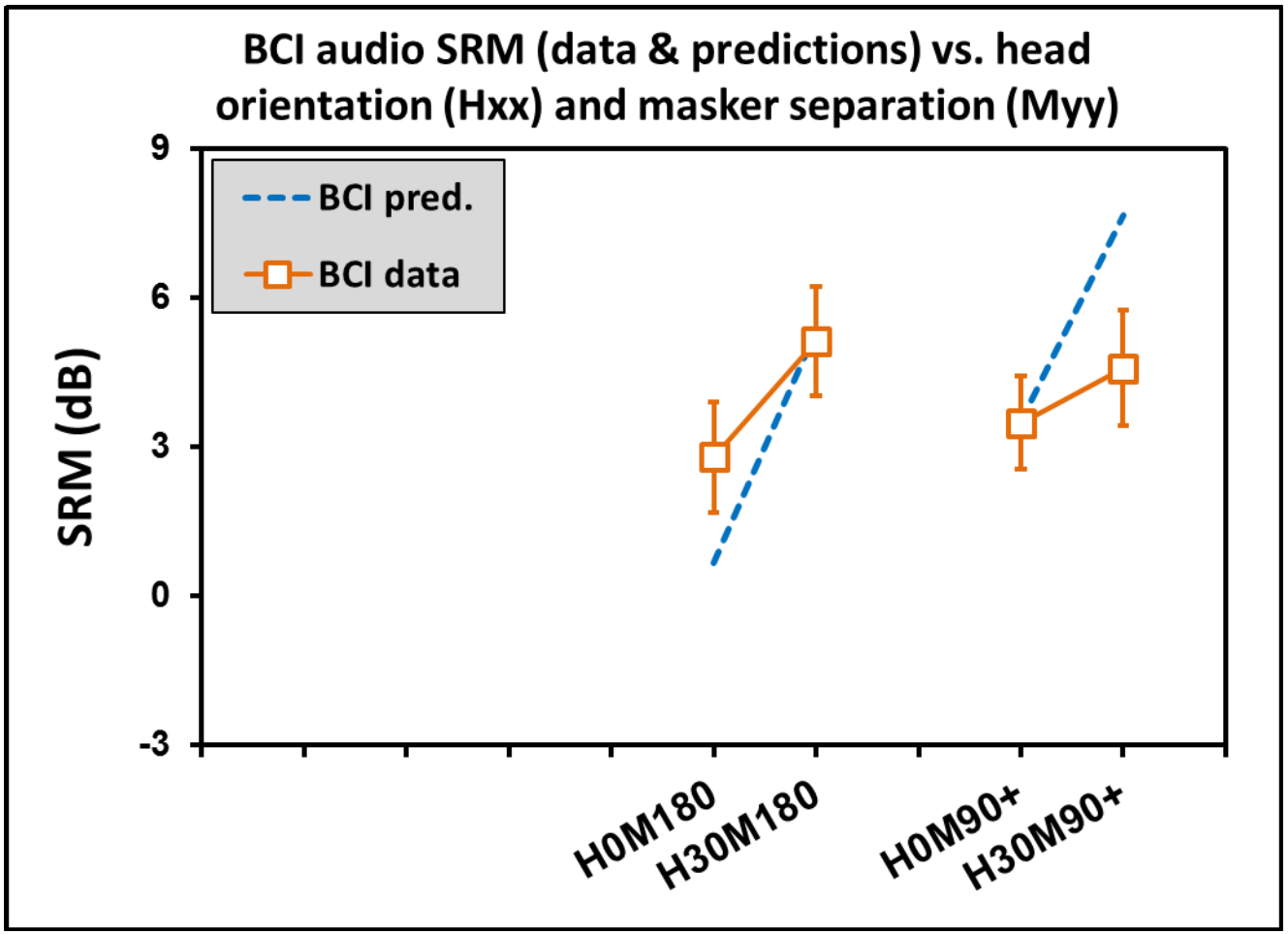


Expt. 4: Audio SRMs, 30 deg head turn benefit



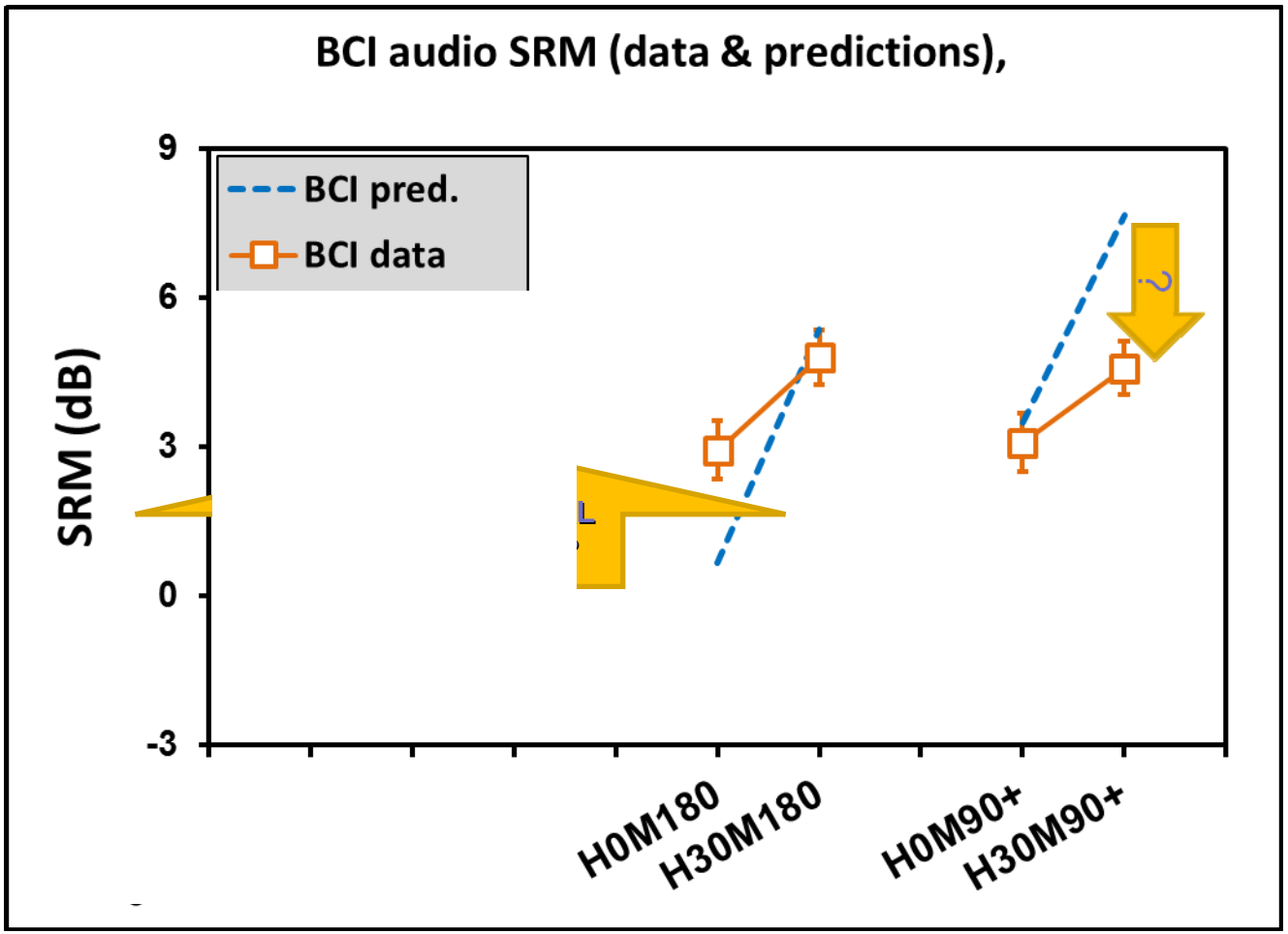
IEEE

Expt. 4: Audio SRMs, 30 deg head turn benefit



SPIN

Expt. 4: Audio SRMs, 30 deg head turn benefit

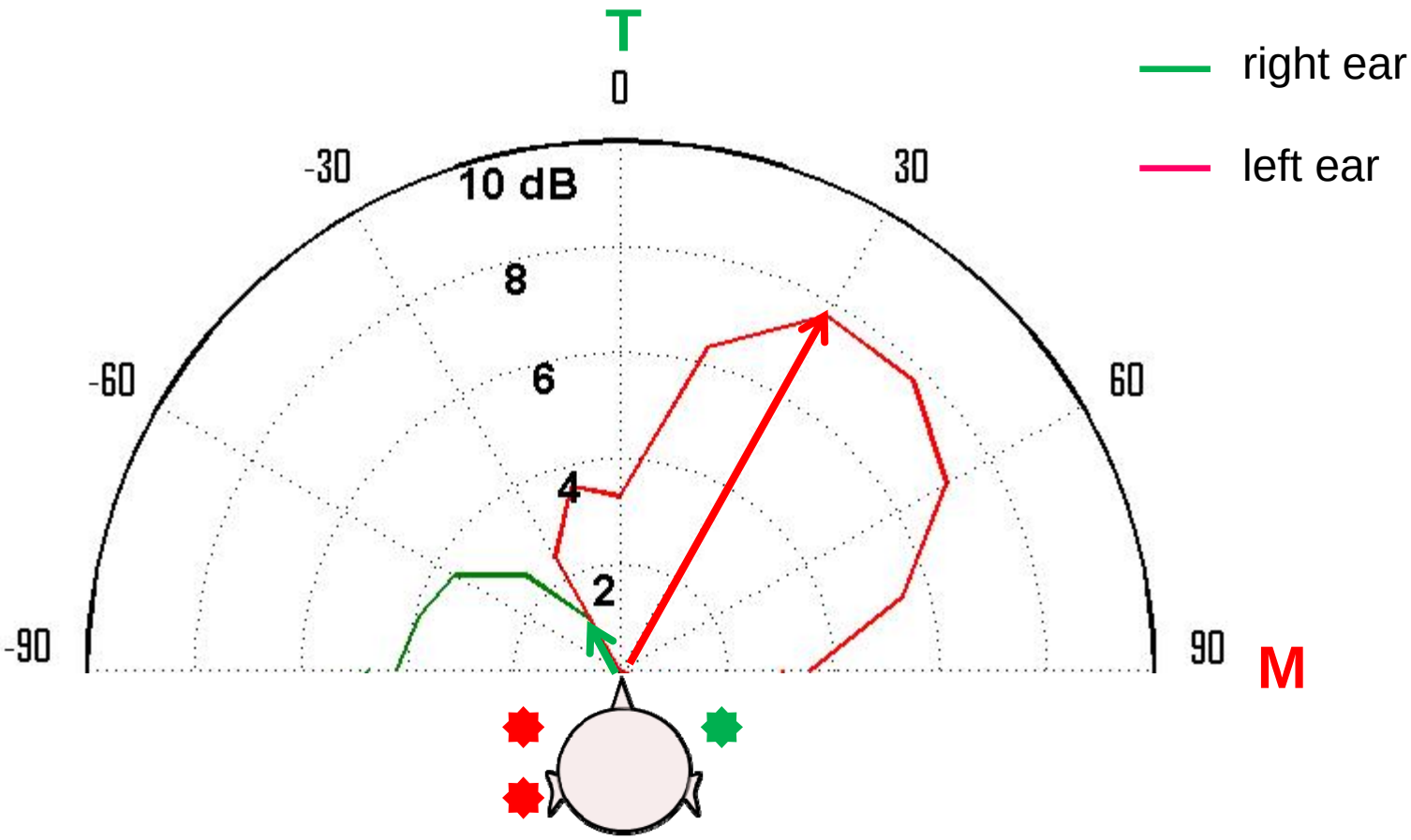


IEEE

Schleich et al., 2004

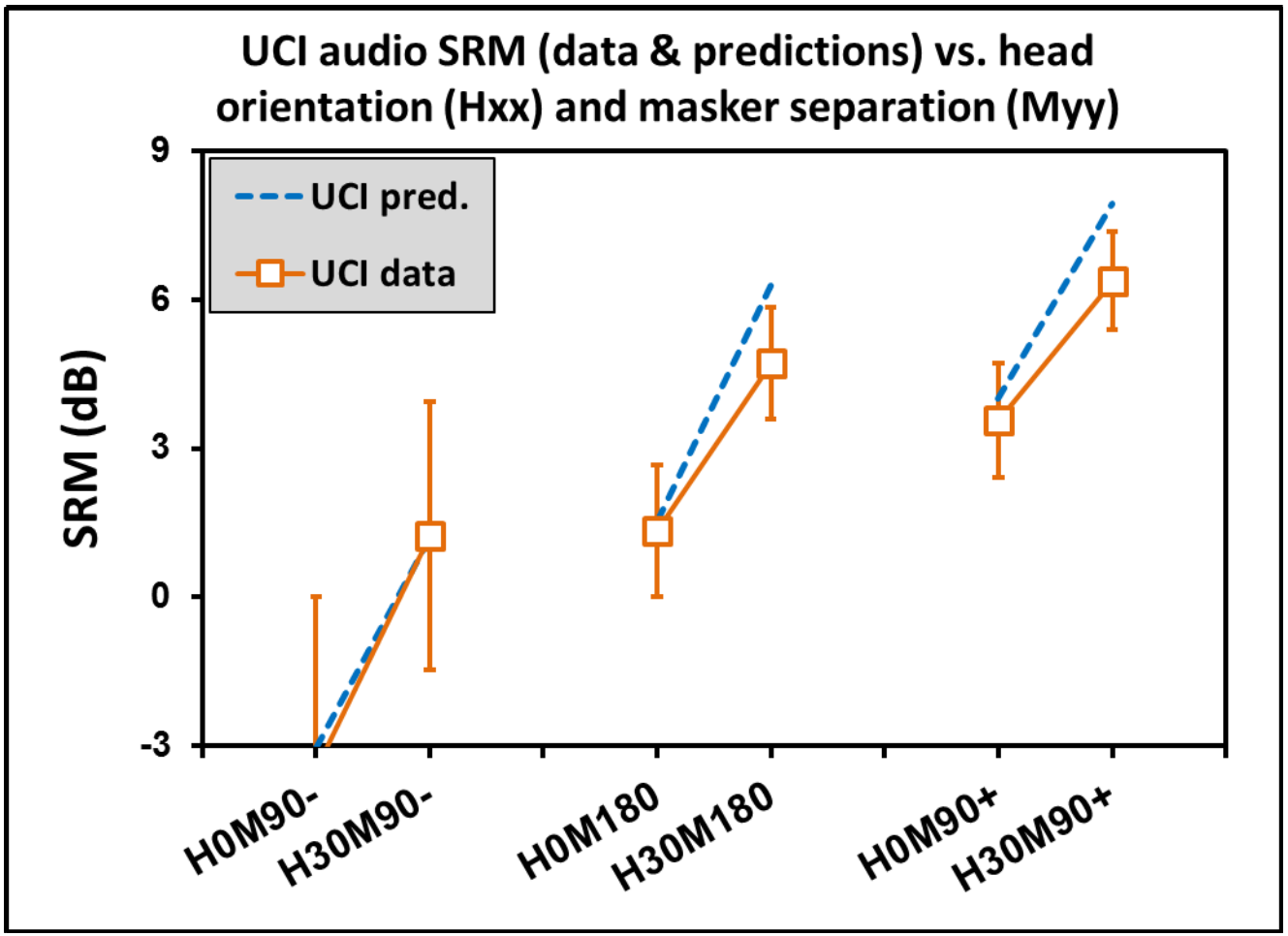
Benefit of BCI over UCI perspective

Predicted benefit (dB) in unfavourable UCI configuration vs BCI



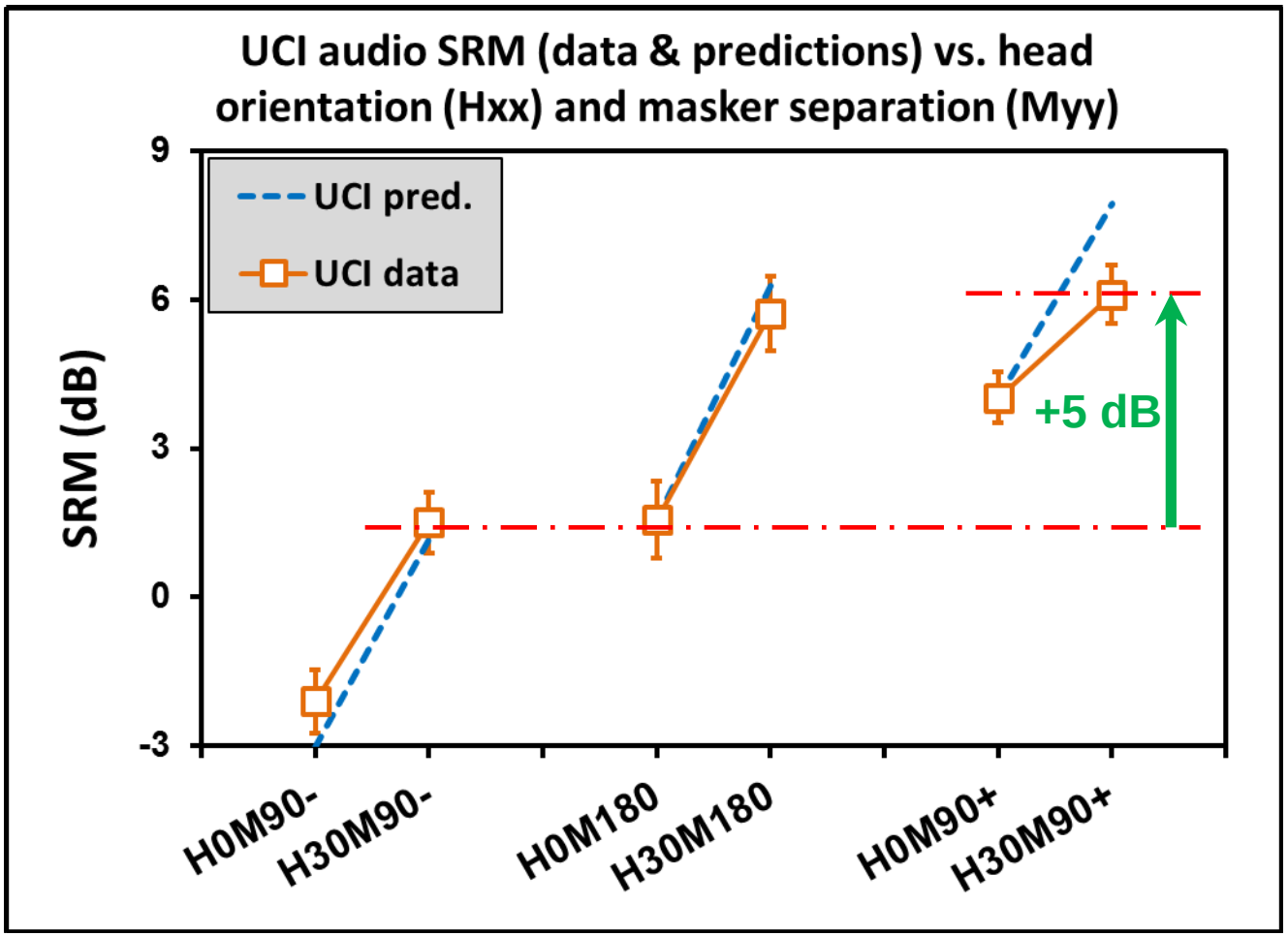
➢ 7dB predicted advantage of BCI over UCI !!

Expt. 4: Audio SRMs, 30 deg head turn benefit



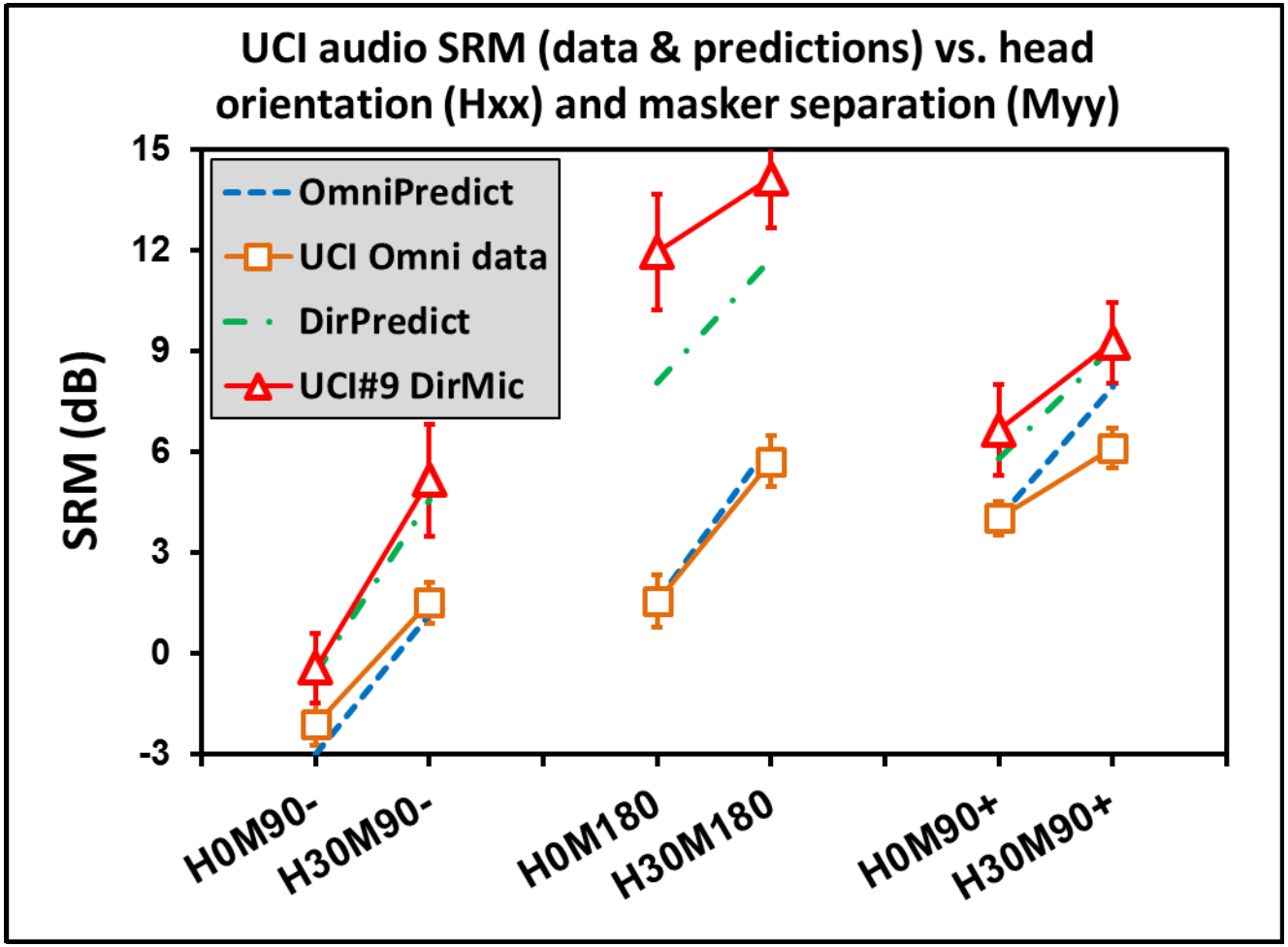
SPIN

Expt. 4: Audio SRMs, 30 deg head turn benefit



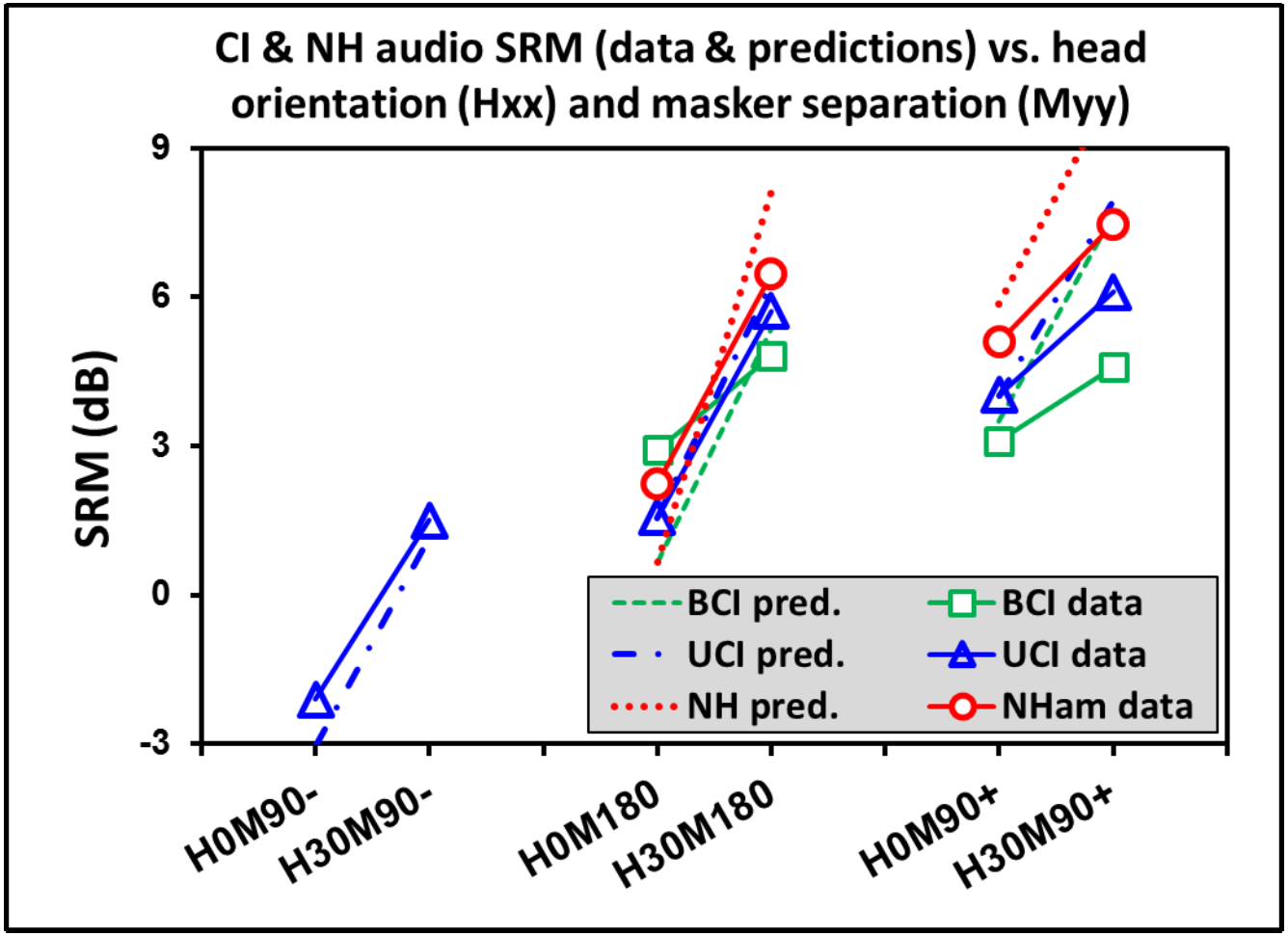
IEEE

Expt. 4: Audio SRMs, 30 deg head turn benefit



IEEE

Expt. 4: Audio SRMs, 30 deg head turn benefit



IEEE

All 30 deg head-turn SRM improvements statistically significant

Conclusions on CI Positioning & Head Orientation

UCIs:

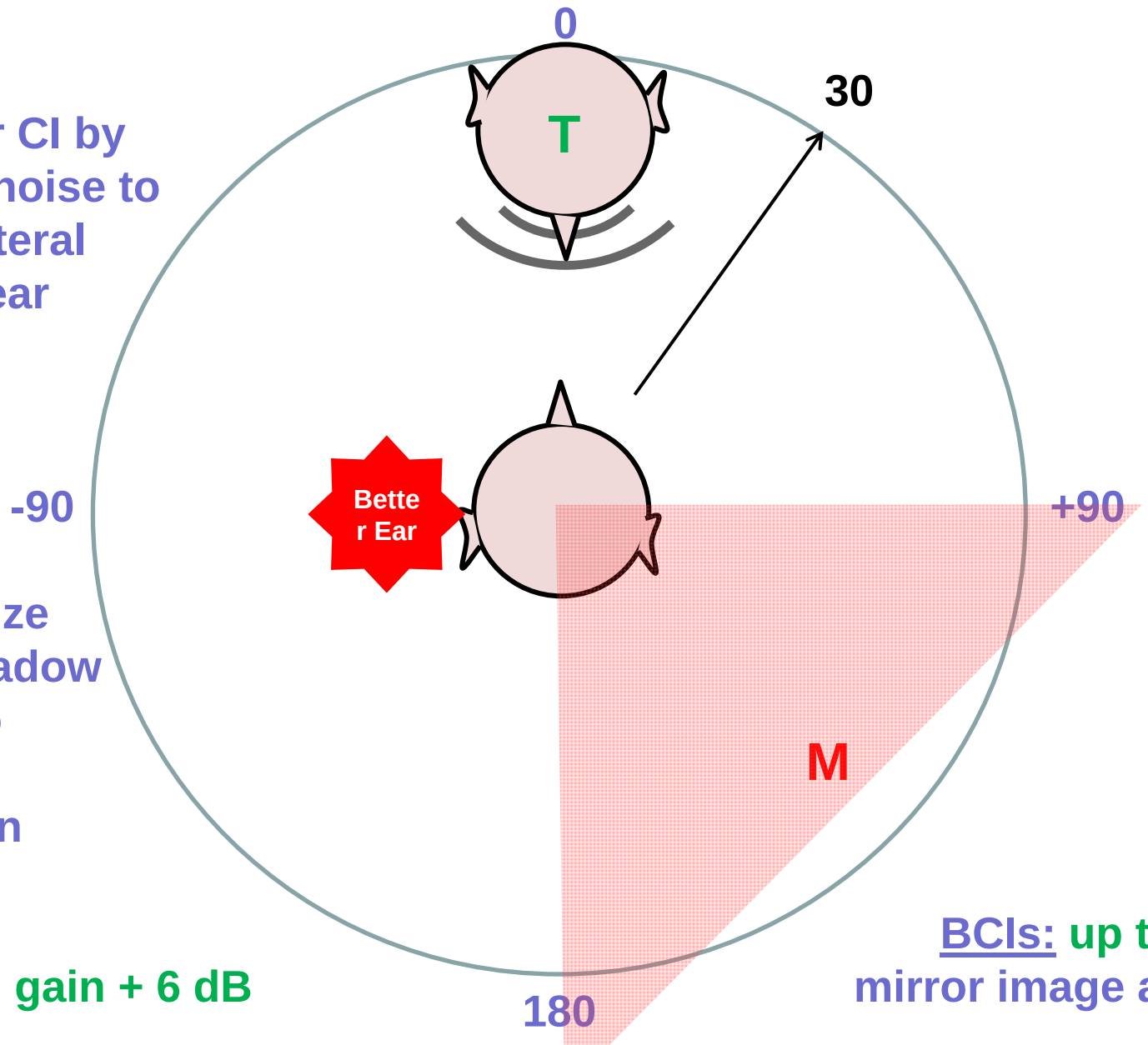
1. favour CI by moving noise to contralateral side & rear

+ 2-4 dB

2. optimize head shadow via up to 30 deg head turn

+ 4-2 dB

UCI total gain + 6 dB



BCIs: up to + 5 dB

mirror image also valid

Conclusions

Going from undirected to directed free head orientation paradigm,

CIs experienced up to 5 dB benefit within minutes

- Training CIs to make the best of their CIs is fast & easy
- Obvious translational applications

What comes next:

Prove with higher reverberations / more complex scene

CI Testimonies

- BT: " ...thank you for the advice about where and how to sit in noisy situations. ...in a pizzeria in Cannes, ... I chose to sit with my back to the other diners abut facing ...Peter. ... at about 20 deg Russell's voice started to become louder and clearer, this continued to about 30 deg. It was as if someone was turning the volume wheel on my processor... "

- RC: " Since working with you I, firstly, am wearing the implants more. Whereas I used to use just the nucleus for any short spells needed such as shopping etc., now I am more likely to use both. "

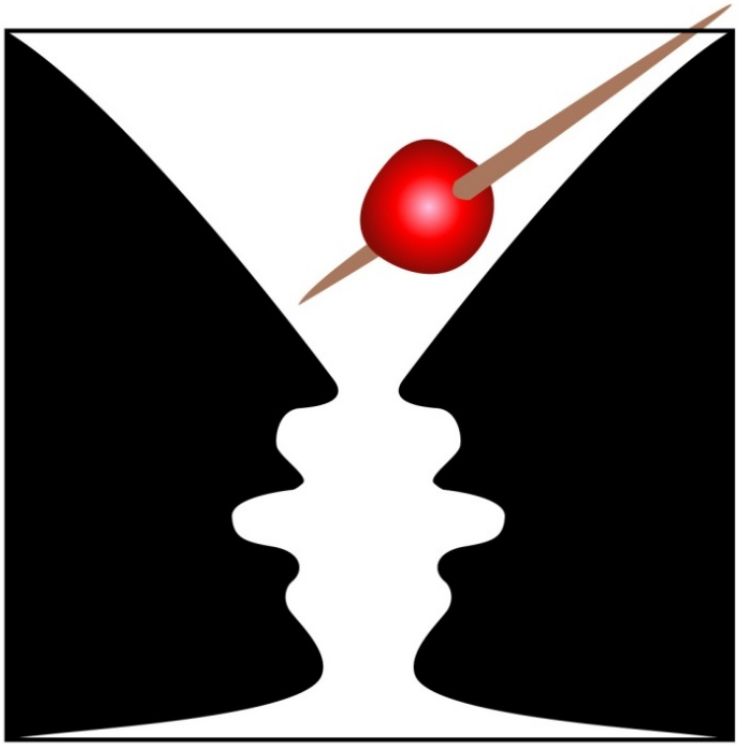
- LA: " ...Thanks to you I am much more conscious of where I seat myself in restaurants and other busy places. It has made life much easier!... "

Thanks to UCL staff, John, Tom, Matthieu, THE PARTICIPANTS and YOU!

How CI users can make the best of their implants in SpiN situations: POSITIONING IN A ROOM HEAD ORIENTATION & TRANSLATIONAL AVENUES

Thanks to UCL staff,

John, Tom, Matthieu, THE PARTICIPANTS!..... and YOU!



Research funded by ACTION ON HEARING LOSS