CAA Webinar

The Future of Hearing Aid Technology

Filip Roenne, WSaudiology
Thomas Behrens - Oticon
Jill Mecklenburger - ReSound
Sara Burdak - Starkey
Gurjit Singh – Sonova

Moderator – Steve Aiken

Dec. 4, 2021

CAA Canadian Academy of Audiology
Heard. Understood.

Academie canadienne d'audiologie ACA
Entendus. Compris.

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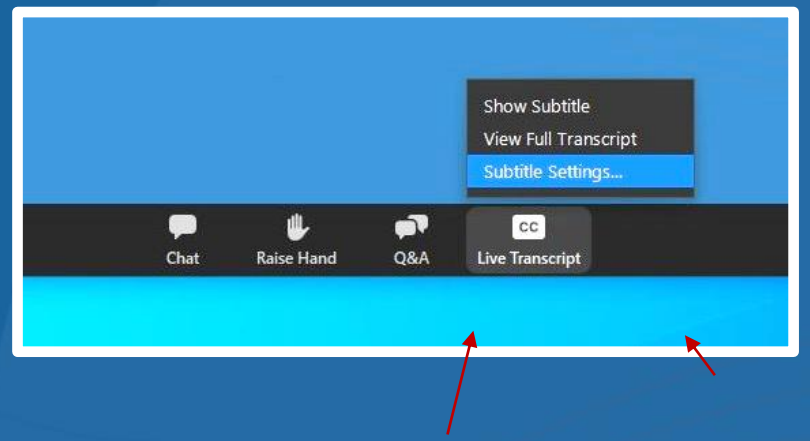

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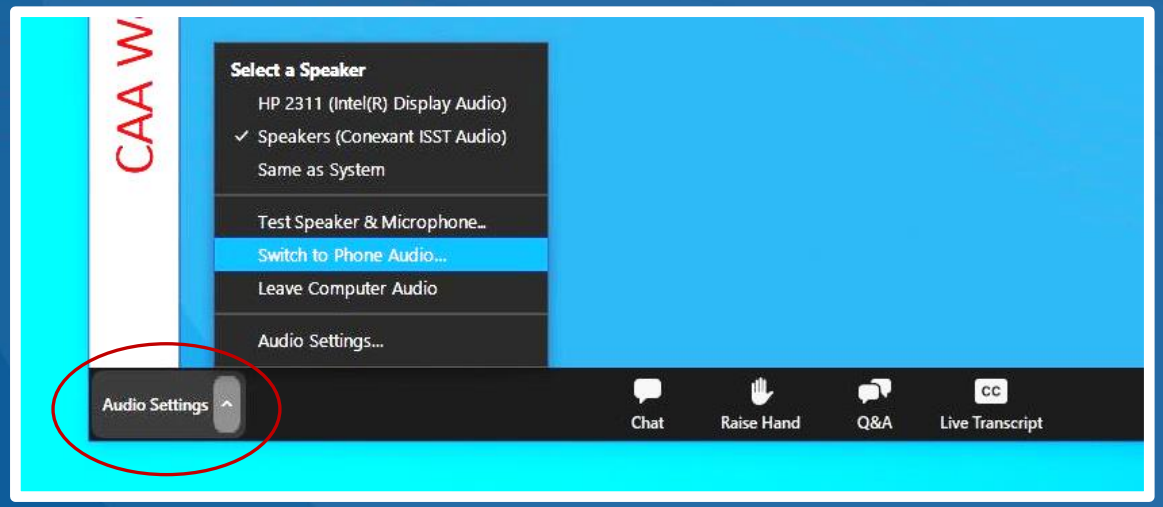

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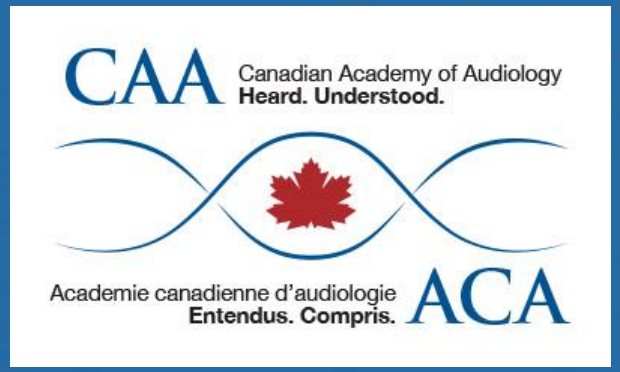


Canadian Academy of Audiology is a professional association dedicated to enhancing the role of audiologists as primary hearing health care providers through advocacy, education and research.

Moderator – Steve Aiken

Dr. Steve Aiken is an Associate Professor of Audiology, Surgery, Psychology and Neuroscience at Dalhousie University. He holds a master’s degree in Audiology from the University of Western Ontario and a PhD in Medical Science from the University of Toronto.

Agenda

11:00 Welcome and Introduction

11:05 Steve Aiken gives overview of the VCM and introduces speakers in turn:

- Filip Roenne, WSaudiology
- Thomas Behrens - Oticon
- Jill Mecklenburger - ReSound
- Sara Burdak - Starkey
- Gurjit Singh - Sonova

12:00 Steve Aiken – Questions from the audience

12:15 Steve Aiken presents the Richard Seewald Award to JP Gagne

12:20 Panel Discussion moderated by Steve Aiken

12:45 Questions from the audience

1:00 End

Moderator – Steve Aiken

The Future of Hearing Aid Technology

This session will include individual talks followed by a roundtable discussionz.

Learning Objectives:

- List at least three advancements coming to hearing aid technology
- Describe how sensors can be used to adapt to listener needs
- Describe processes that inform decision making about hearing aids

Industry Speaker Presentations:

From Real-Life Hearing to Real-Life Participation

Filip Marchman Rønne, Global head of Scientific Audiology, WS Audiology

Future hearing aid technology

Filip Marchman Rønne
Global Head of Scientific Audiology

WSAudiology

From listening

It is important that you can hear everything in your important life situations.

To participating

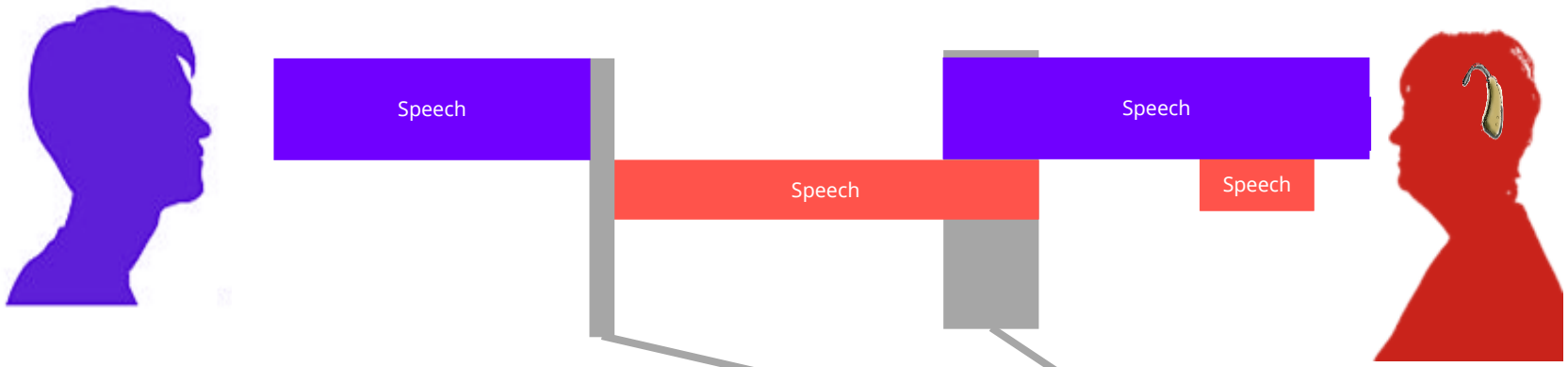
It is important you can participate in your important life situations.

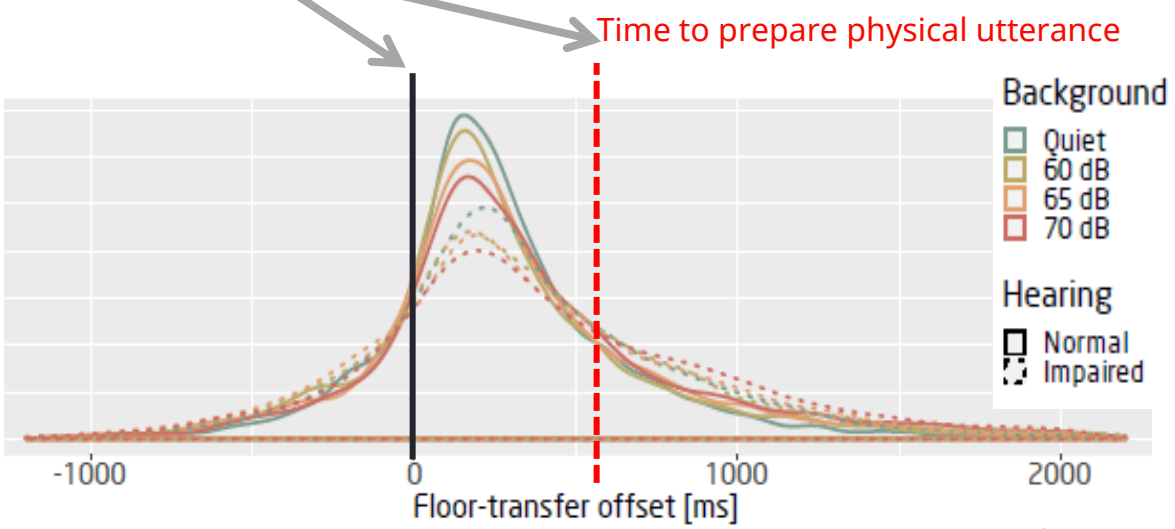
Focused listening or speech communication?

Conversations in noisy environments remains a key challenge for hearing aid users. However, most tests only cares about the focused listening part of a conversation, and thus hearing aids are developed and optimized for listening. We want to enable people to participate not just listen.

What are the dynamics of a conversation?

How do we measure, how do we optimize?





Sørensen et al, 2019, ISAAR poster

WSAudiology

Conversational Dynamics: How could we measure it?

Borch Petersen et al, submitted

Task performance [pair]:

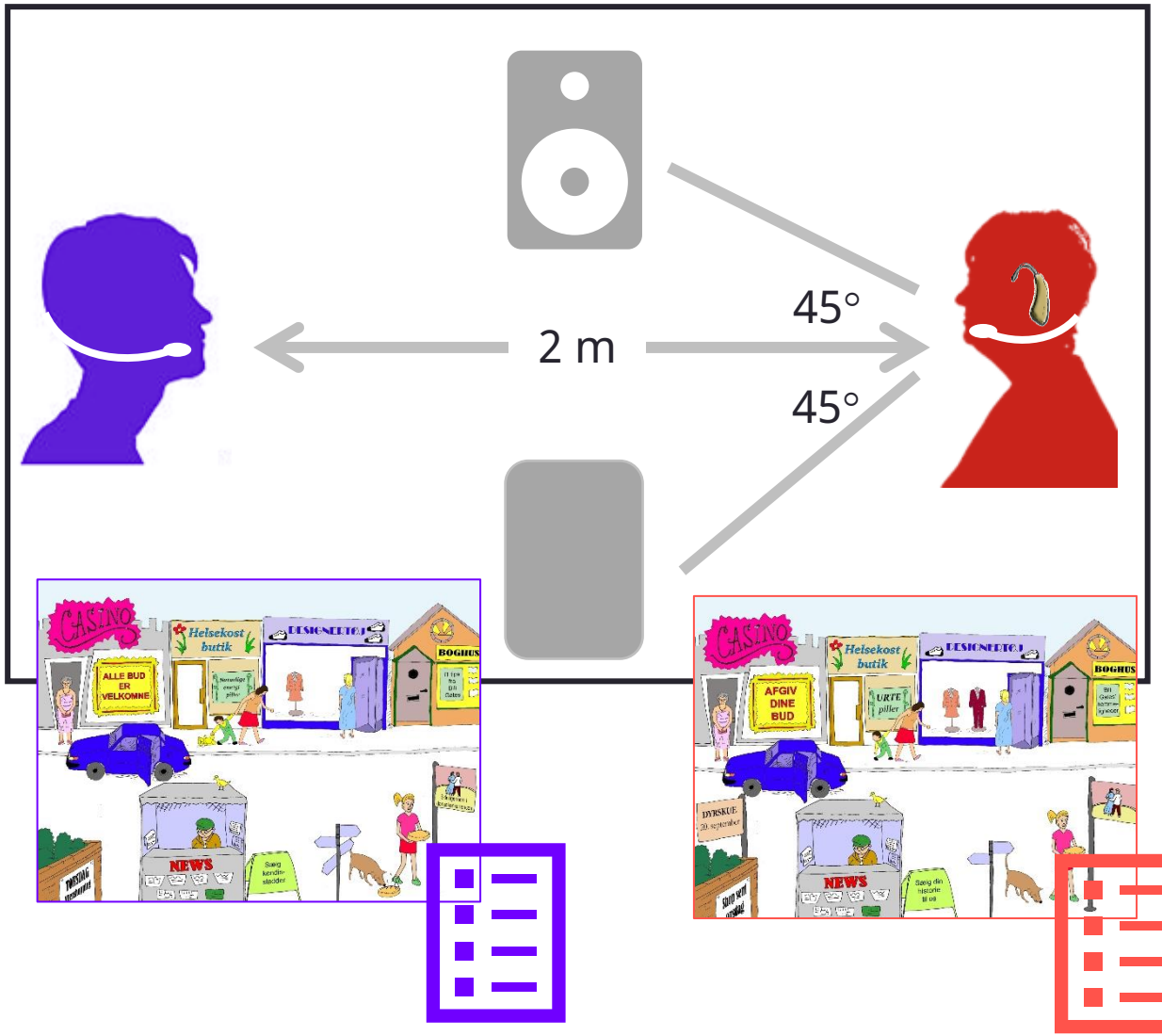
Completion time [corrected]
Speaking time between

Subjective ratings [individual]:

- How successful was the conversation
- How likely would you be to remove yourself from the situation if it occurred in your everyday life
- What was you talking effort
- What was your listening effort

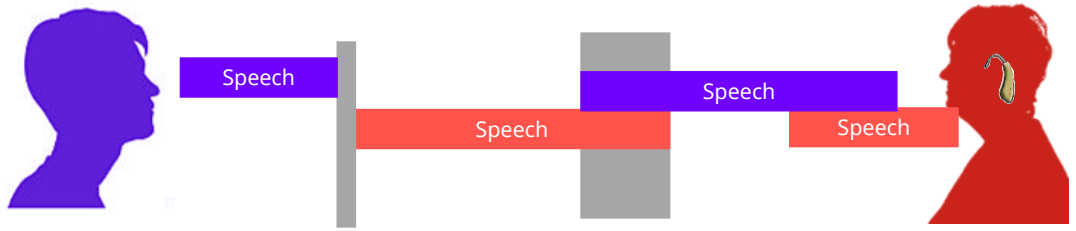
Conversational dynamics [individual]:

Floor Transfer Offset → How timed
Speech level → How loud
Articulation rate → How fast
Median utterance duration → For how long



WSAudiology

Conversational Dynamics: Early findings



Borch Petersen et al, submittted

Effects of Noise:

→ Noise reduces the conversation efficiency

Effects of Hearing Loss:

→ Person with hearing loss struggle to time their communication

Effects for Normal Hearing:

→ person with normal hearing adapt their communication

Effects of Wearing a Hearing-Aid:

→ Amplification makes the person with a hearing loss 'more normal' – at least in quiet

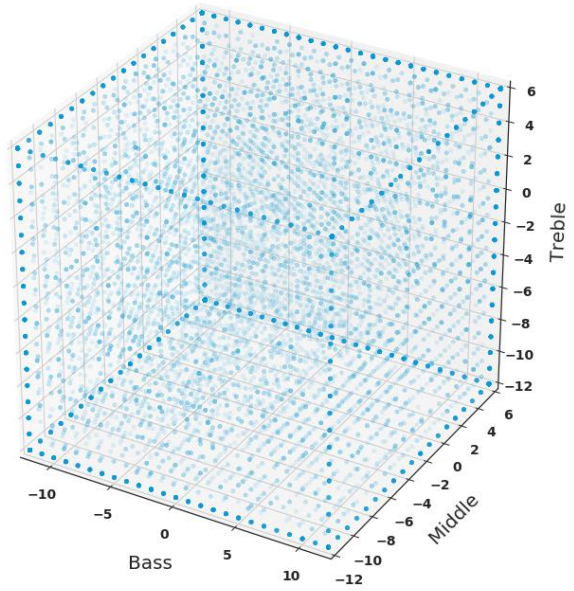
WSAudiology

People have different needs and preferences.

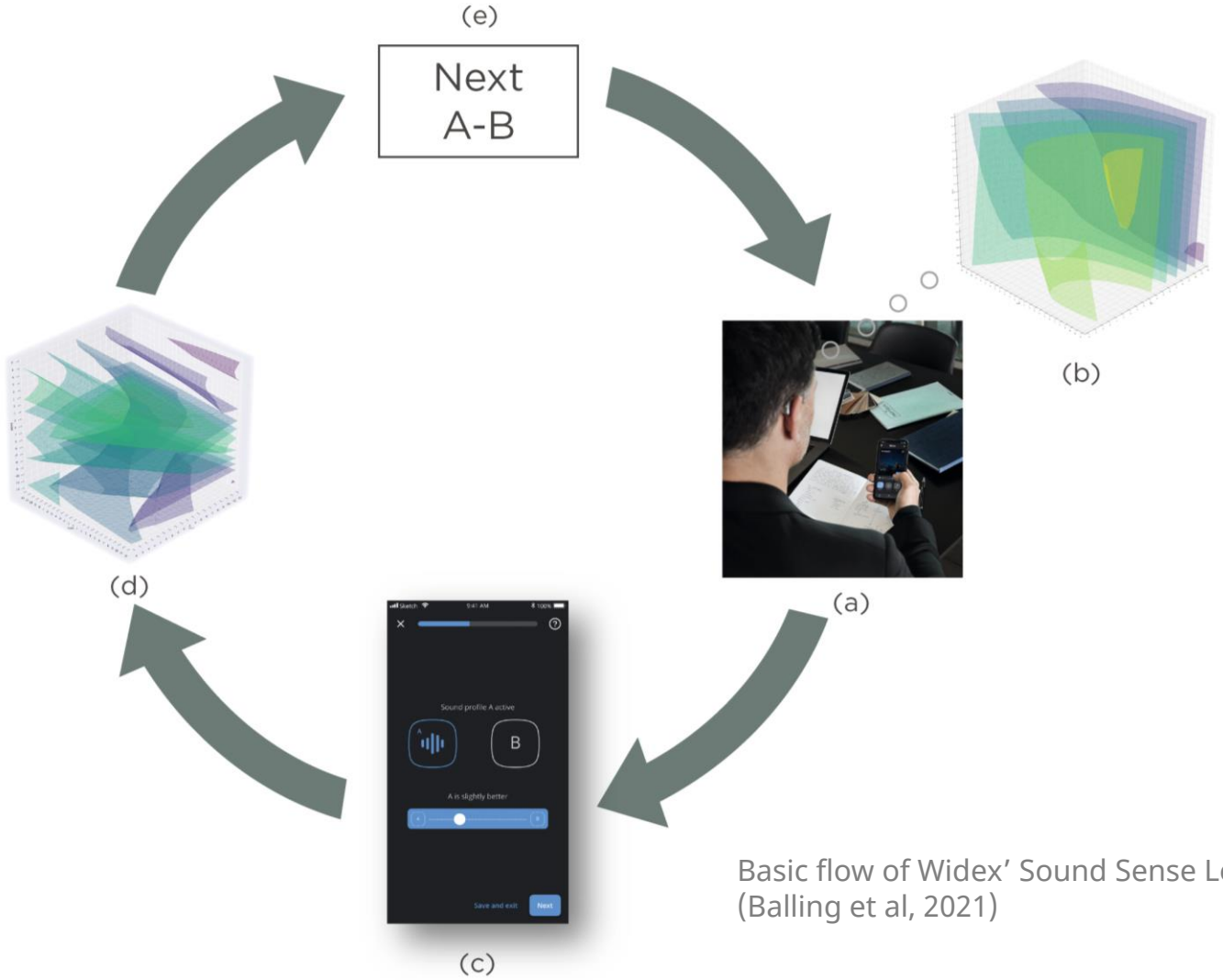
A solution: ”Sound Sense Learn”

To cater for individual needs and preferences, user input and machine learning can be combined to optimize the sound.

People have widely different preferences. There is not a one-fits-all solution.



Sample of 20,000 SSL programs
(Balling et al, 2021)



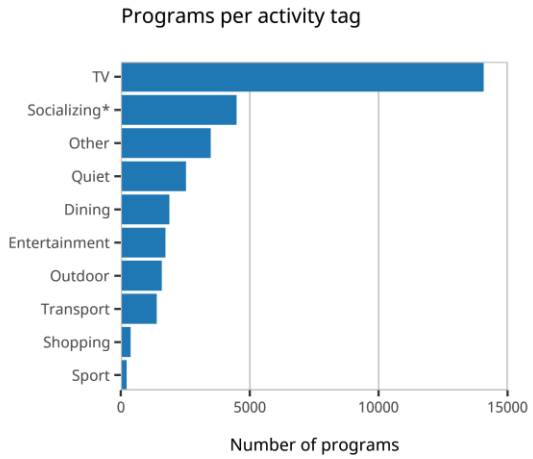
Basic flow of Widex’ Sound Sense Learn
(Balling et al, 2021)

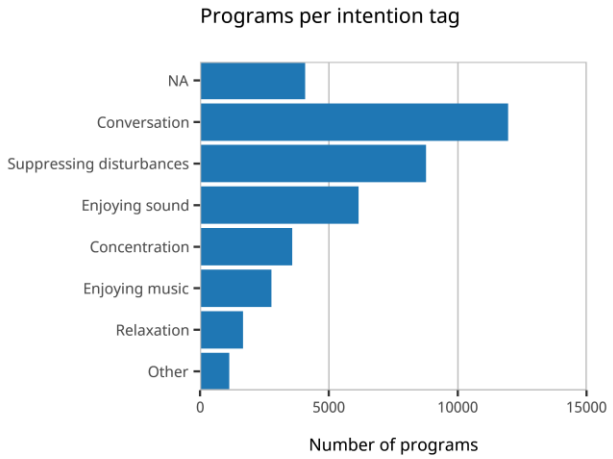
WSAudiology

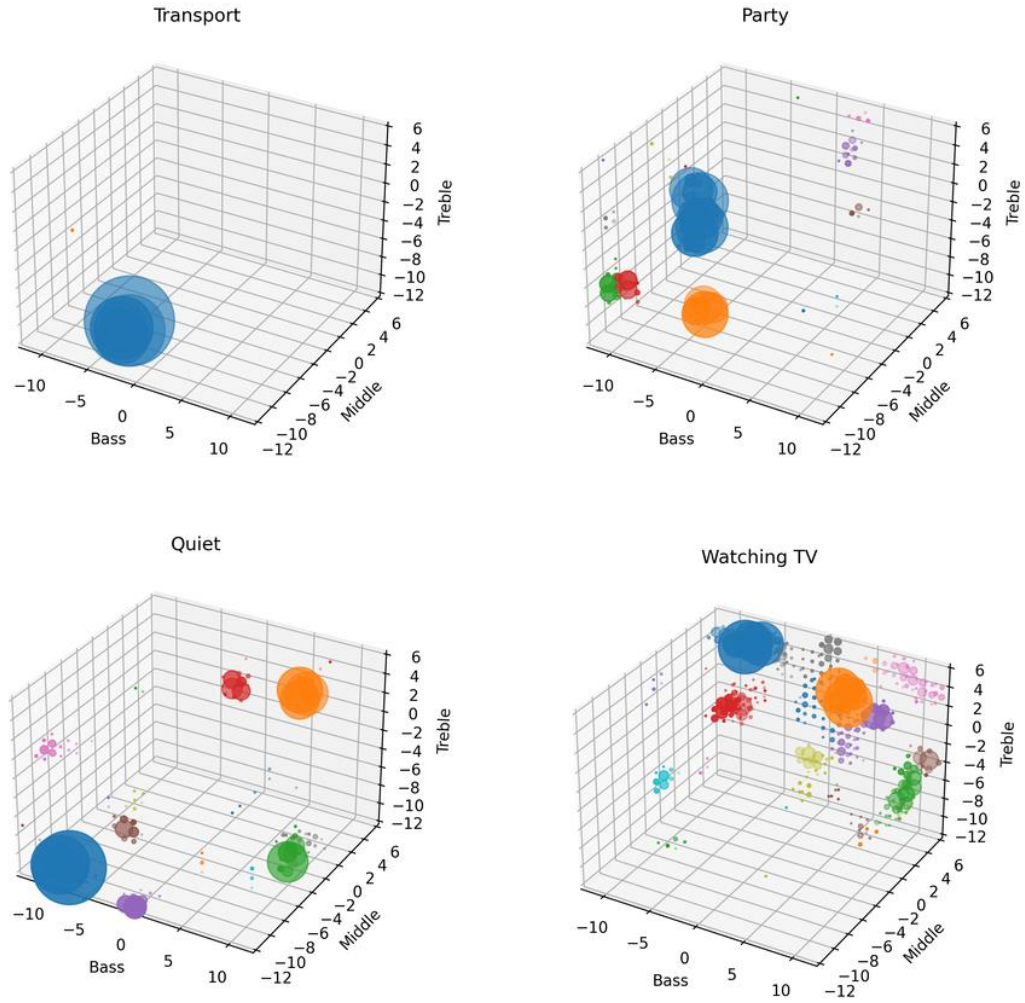
Sound Sense Learn, and excellent solution to optimize listening

If created programs are sorted according to their “activity” or “intention” tag, clusters appears.

Are we lacking some of the most critical moments?







Clusters of programs within activity tag (Balling et al, 2021)

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Can we extract people's intent without asking?

Possible solution: Auricular EMG

Speech in speech remains the key challenge for people with hearing loss, and for hearing aid users.

Speech separation	Source selection	Source presentation

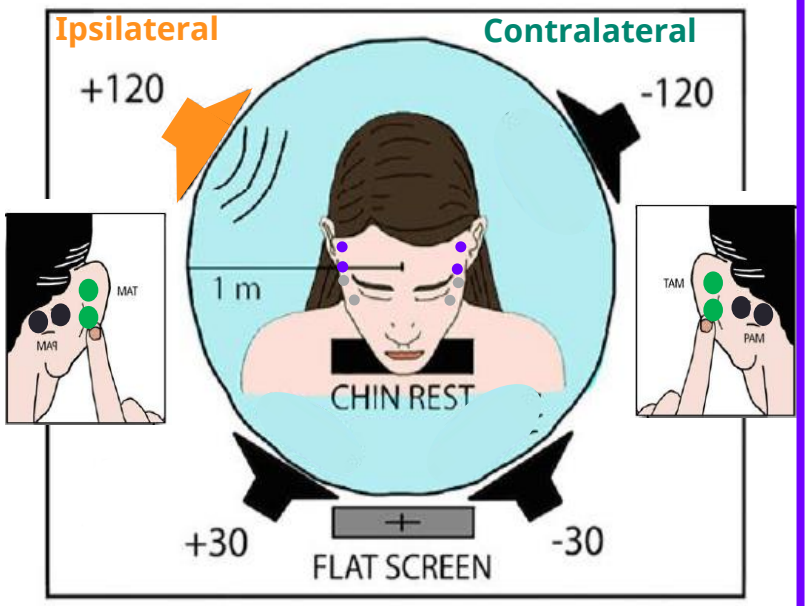
This is you!

But are you listening to Green or Grey?

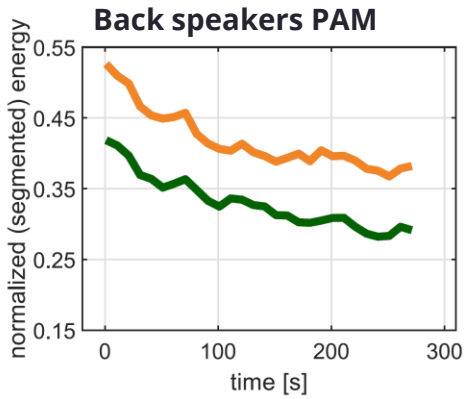
And what should the HA do?

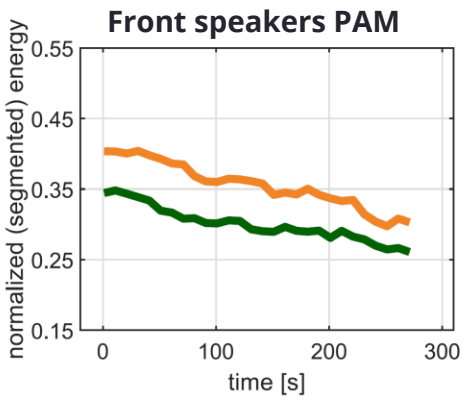
Estimating the direction of attention using auricular EMG

Task: Attend to one of two simultaneous audiobooks

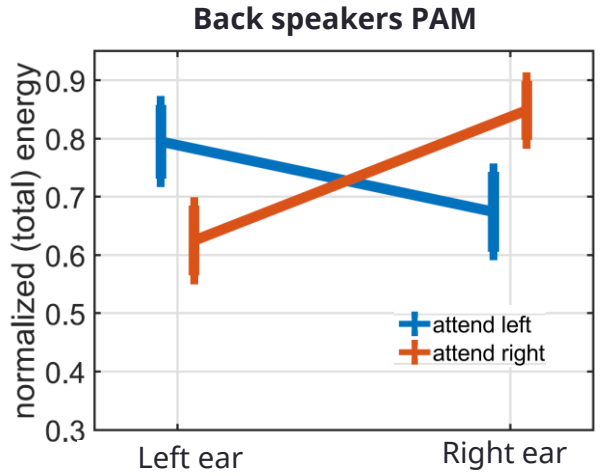


Attention direction affects the EMG





Responses between ears indicates the direction of attention



Strauss et al 2020

WSAudiology

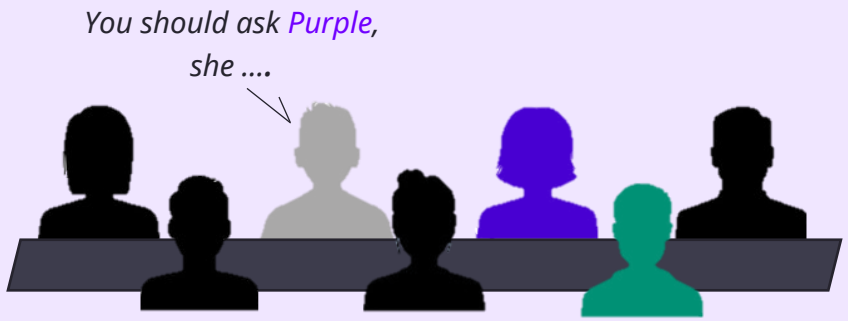
Potential use cases for EMG controlled hearing-aids

By utilizing recorded EMG responses, use-intent can control the directionality of the hearing aid

Use case 1: Triggered attention

You are talking to **green**, but suddenly **grey** catches your attention

Do **you** prefer to stay focused on **grey** or return to **green**?



Use case 2: Asserted attention

Two conversations are ongoing.

Do **You** turn your attention to either one, or none of them?

WSAudiology

From listening

It is important that you can hear everything in your important life situations.

To participating

It is important you can participate in your important life situations.

BrainHearing Technologies Expanding the Reach of the Clinic and the Patient Benefits

Thomas Behrens, Vice President, Audiology and Applied Research, Oticon A/S

BrainHearing Technologies

Expanding the reach of the clinic and improving patient benefits

Thomas Behrens
Vice President
Audiology & Applied Research

oticon
life-changing technology

BrainHearing

Hearing

Neural Code

From ear to brain

Orient

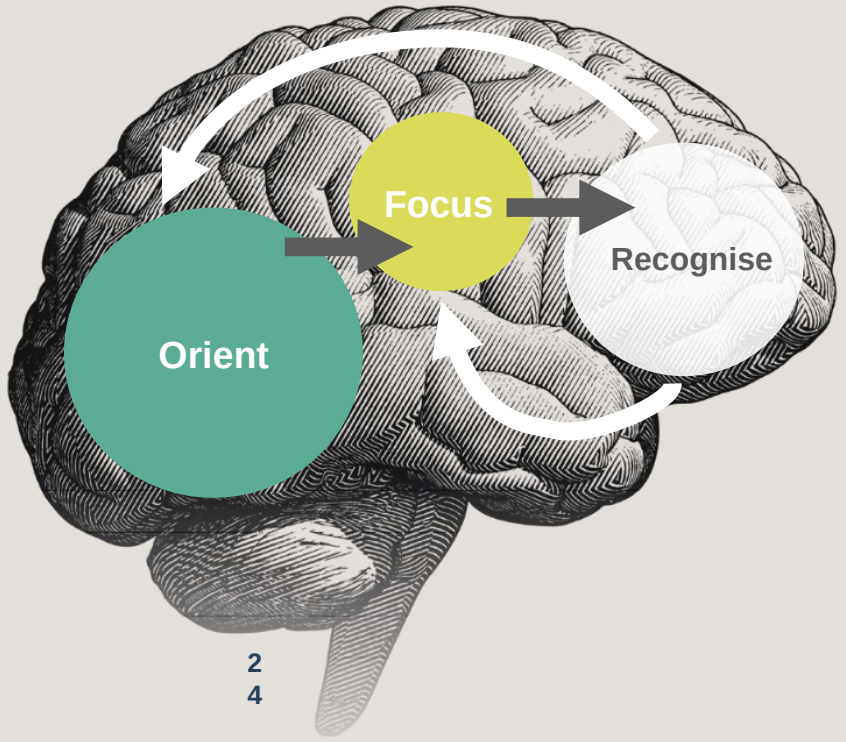
Focus

Hearing system in the brain

Recognise

Cognition

Increasing separation



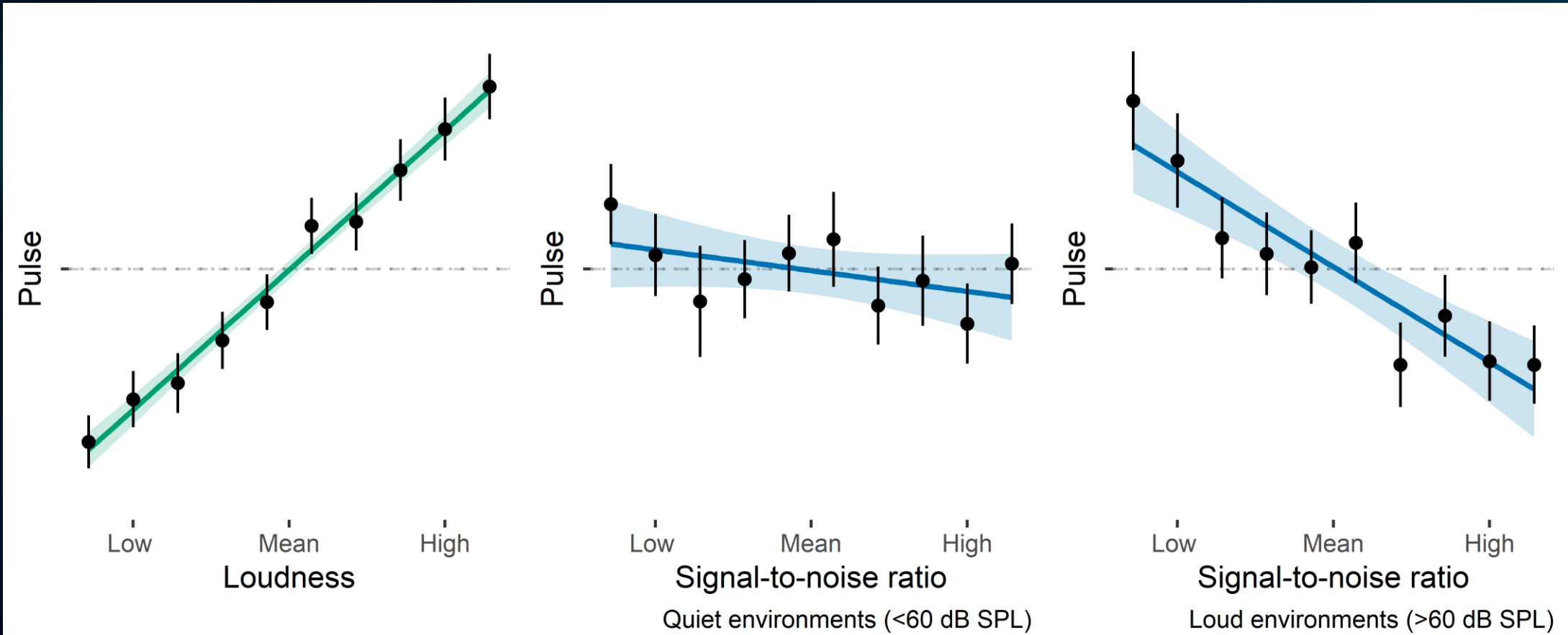
Alickovic et al. (2021), O'Sullivan et al. (2019), Puvvada & Simon (2017)

oticon

Deep learning in health care driving user benefits

- Medical imaging & diagnostics
  - Well-known stronghold of deep learning; identity patterns/anomalies that humans cannot see – also applies to sound
- Personalised treatment
  - Understanding the individual patient from many types of data
- Improved health monitoring
  - Including wearables with real time data
- Natural language understanding
  - Chat bots

Deep Learning: Potential future application



Christensen et al, 2021, ”The everyday acoustic environment and its association with human heart rate: …”, Royal Society Open Science.
Data from 98 hearing aid users and 1 month use each, gathered between June and December 2019.

Succesful deep learning

Capturing details humans cannot describe

Providing the right feedback during training will allow the deep neural network to capture the important details

Deep Learning requires rich data

DNN drives large improvements in clarity

Peer reviewed data

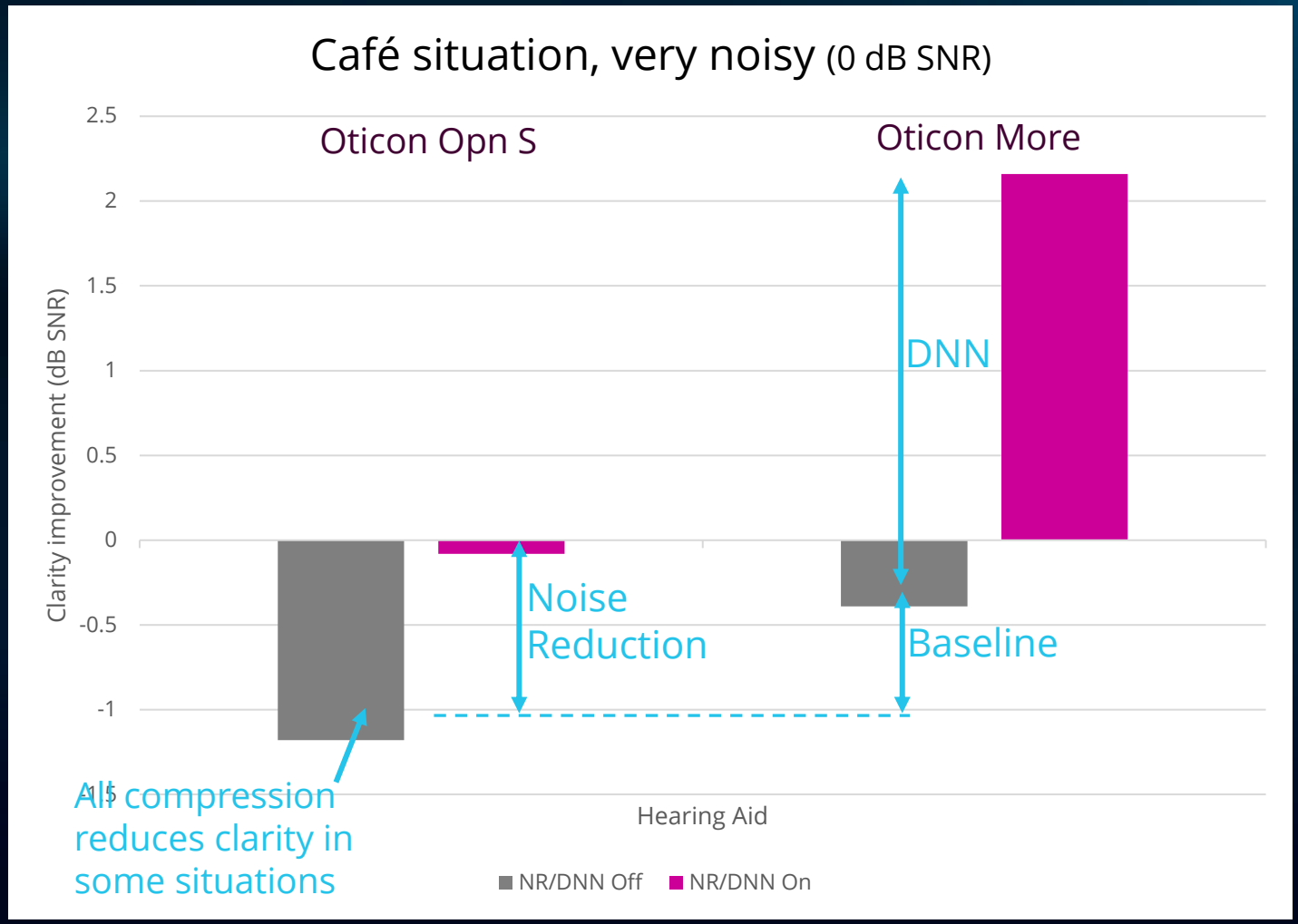
THIEME OPEN ACCESS

Creating Clarity in Noisy Environments by Using Deep Learning in Hearing Aids

Asger Heidemann Andersen, Ph.D.,[1] Sébastien Santurette, Ph.D.,[1] Michael Syskind Pedersen, Ph.D.,[1] Emina Alickovic, Ph.D.,[2] Lorenz Fiedler, Ph.D.,[2] Jesper Jensen, Ph.D.,[1] and Thomas Behrens, M.Sc.[1]

Table 1 SII-weighted output SNR improvement in dB, relative to the unaided output SNR, for HA1 and HA2 at two different input SNRs when noise reduction is deactivated ("off"), the postfilter only is activated ("PF only"), and both beamformer and postfilter are activated ("BF + PF")

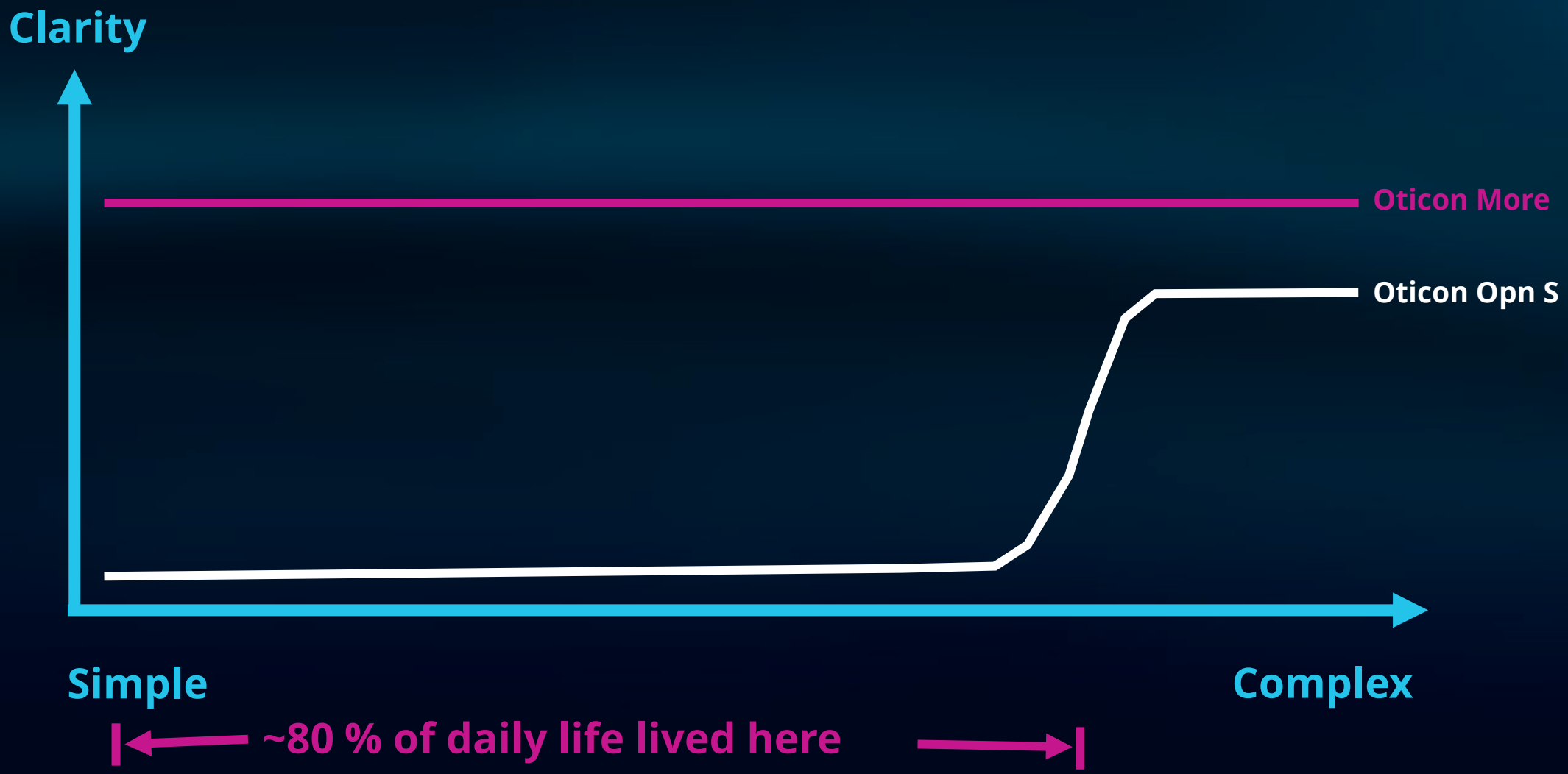
	−5 dB input SNR		0 dB input SNR	
	HA1	HA2	HA1	HA2
Off	−0.75	−0.16	−1.18	−0.39
PF only	0.11	1.81	−0.08	2.16
BF + PF	4.04	4.54	3.82	4.65



Seminars in Hearing, Volume 42, No. 3, 2021

DNN drives large improvements in clarity

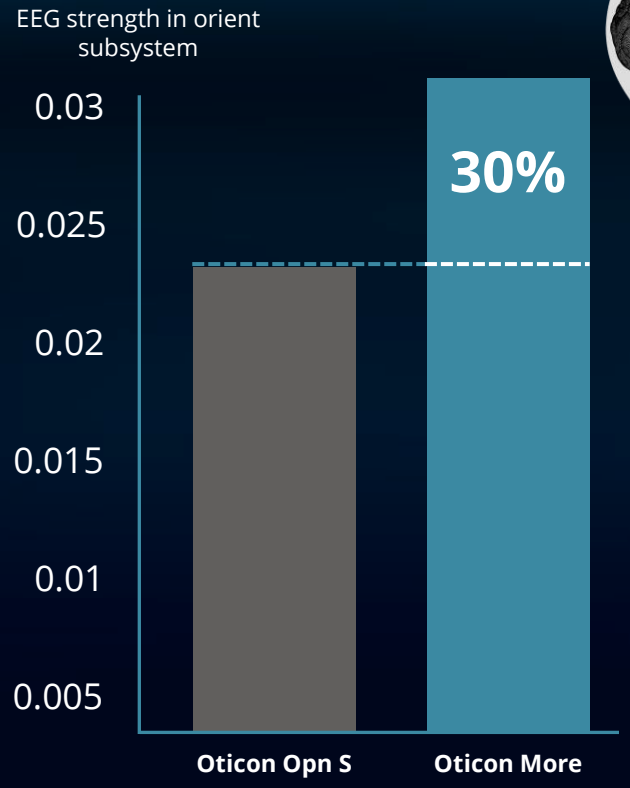
Peer reviewed data

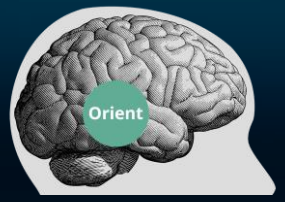


Andersen et al, Seminars in Hearing, Volume 42, No. 3, 2021 + Garnæs & Santurette 2021, Internal Data, Manuscript under preparation

BrainHearing technology delivers 30% more sound to the brain

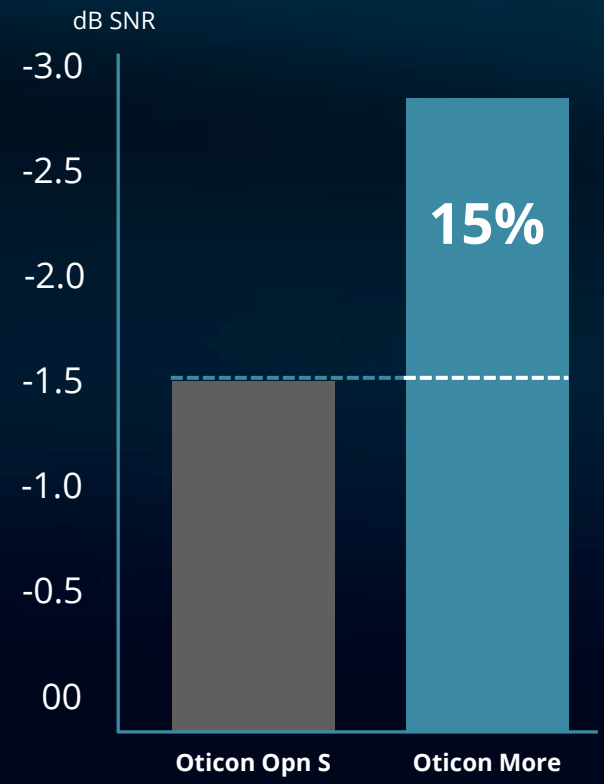
MoreSound Intelligence is proven to make the full sound scene **clearer**





Better speech understanding with even less effort

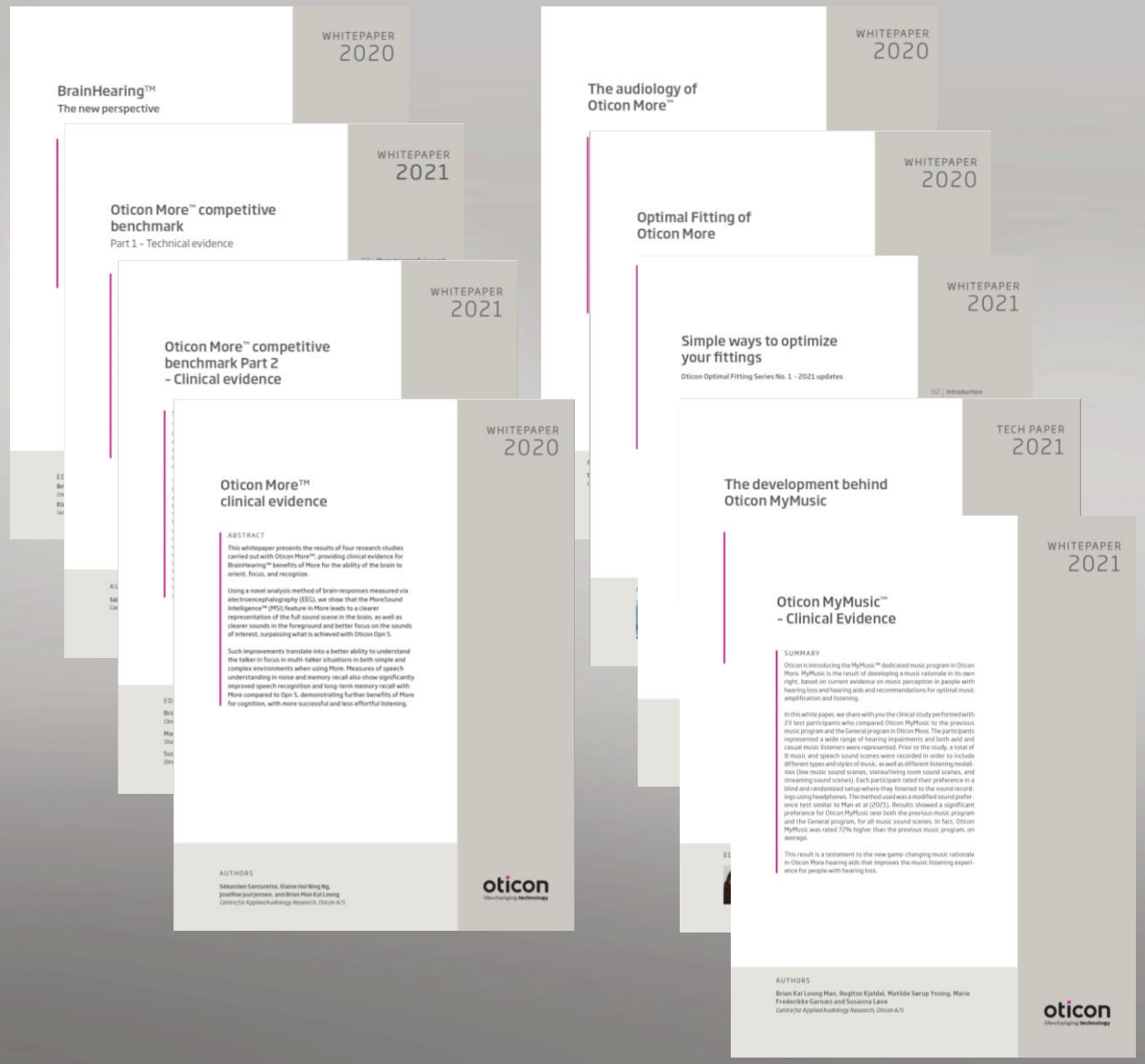
Resources are freed for **remembering**, **responding** and **engaging**

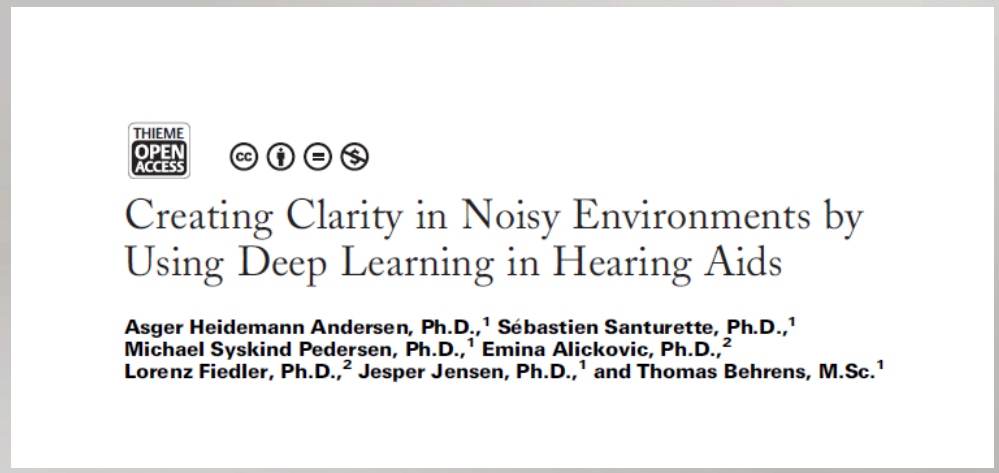


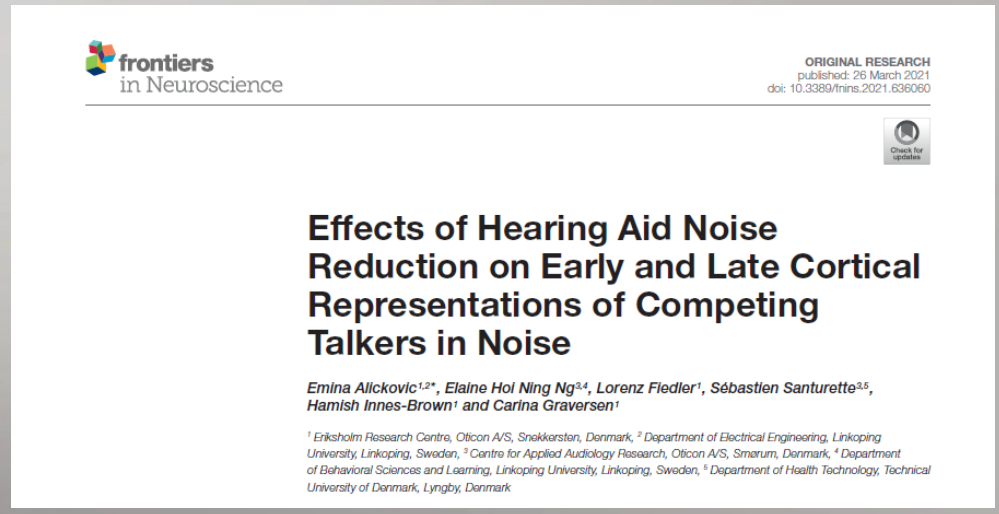
Alickovic et al (2021), Santurette et al. (2020)

Oticon BrainHearing Technologies

Publications & Whitepapers







Patient Benefits of Microphone and Receiver-in-the-Ear (M&RIE) Technology

Jill Mecklenburger, Principal Audiologist, ReSound

Patient Benefits of Microphone and Receiver In the Ear (M&RIE) Technology

Jill Mecklenburger, Au.D
ReSound Global Audiology

Receiver In The Ear

Advantages

- Comfortable and cosmetically appealing
- Ability to provide a wide range of features
- Robust wireless connectivity
- Convenient for audiologists to stock
- Instantly fit with domes, selectable power level of receiver

Drawbacks

- Microphone location above or behind pinna
- Unnatural sound quality for some individuals

Spatial Hearing: Externalization of Sounds

No Spatialization

True Spatialization

Pinna Compensation and Restoration Algorithms

- Created to compensate for potential negative effects of microphone location on localization and sound quality
- Utilize the hearing aid microphones to replicate the spatial directivity patterns of an average ear
- Improvement seen for front-back localization
- However, these algorithms work best for sounds from the front on the horizontal plane – unlike the human ear
  - ILD errors of up to 30 dB depending on the location at the pinna (Udesen et al, 2013)

M&RIE

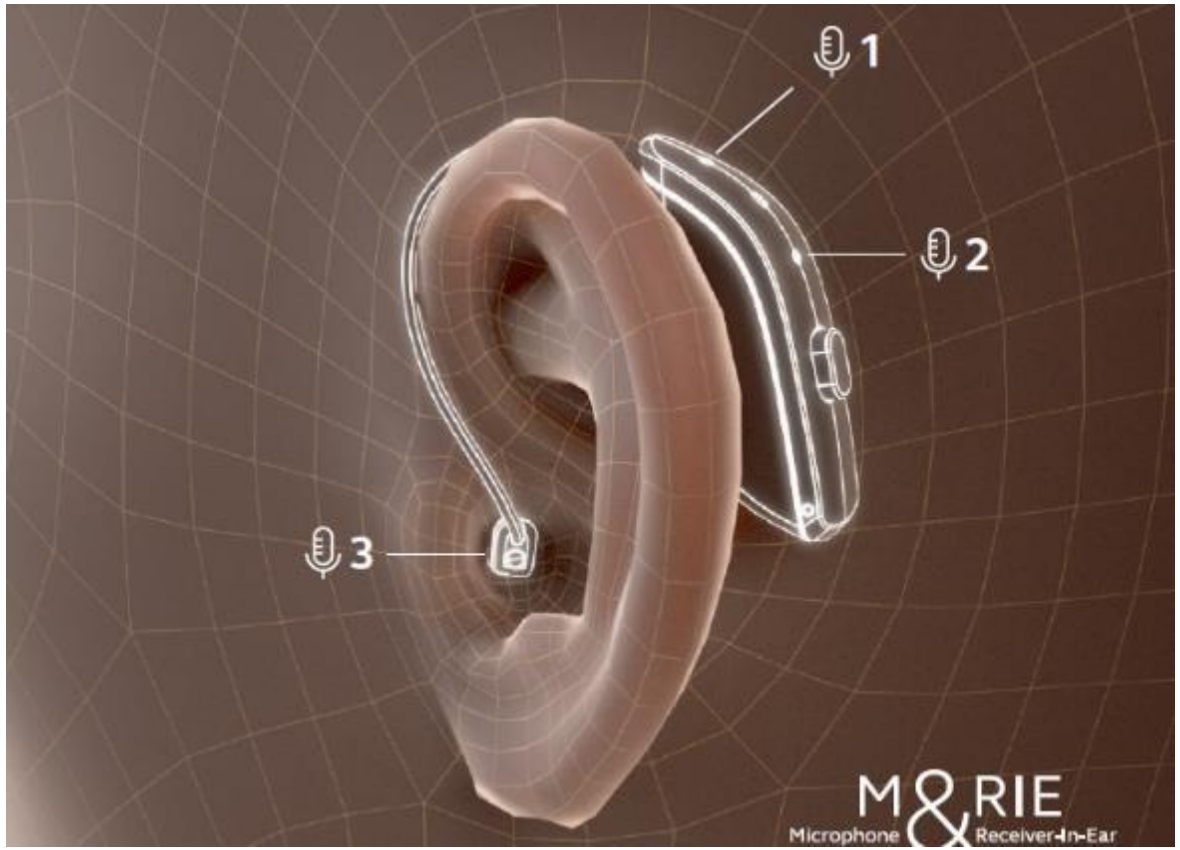
Our individual ear provides

- Our own unique acoustics
- Localization
- Spatialization

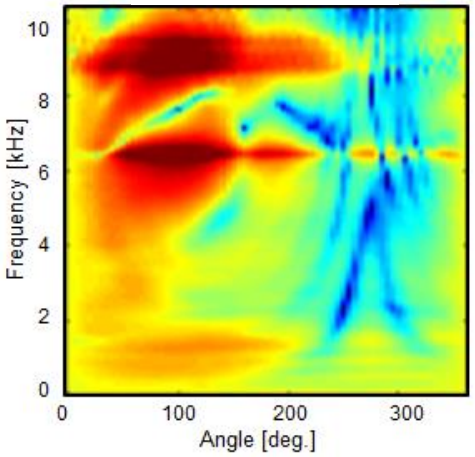
Organic hearing as a baseline for the design of a new receiver-type

M&RIE Benefits

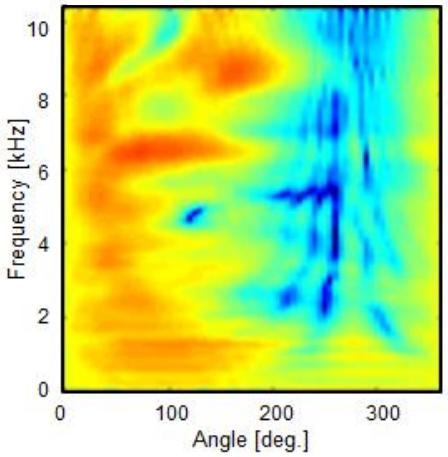
- Better SNR
- Better estimation of direction of arrival of sound
- Better depth and distance perception
- Synergy between the visual and auditory systems



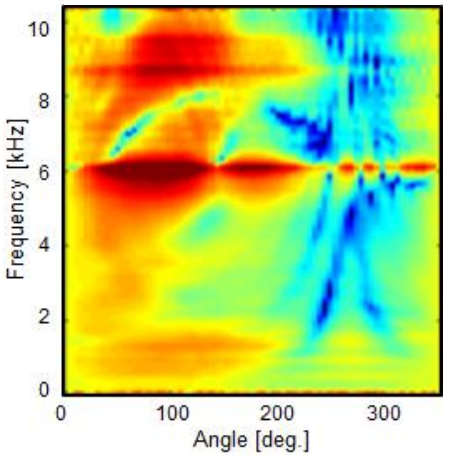
Open Ear



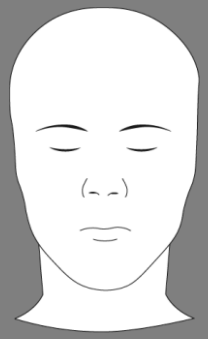
Pinna Restauration [PR]



Microphone in Ear [MIE]

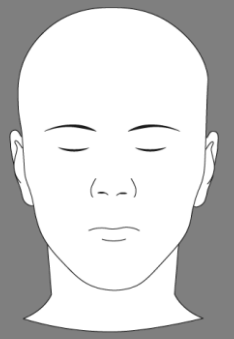


Sound Quality



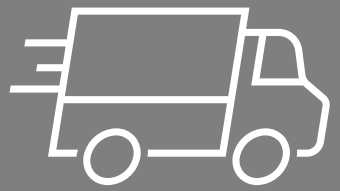
Program 1
Omnidirectional

Program 2
Spatial Sense

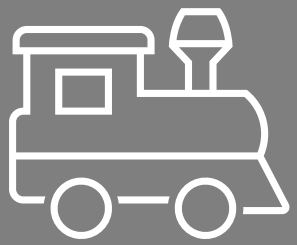


Program 3
M&RIE

Cafeteria with
added speaker



Traffic
intersection
in city



Train station

Jespersen et al., 2020 – White paper: “M&RIE receiver preferred for sound quality and localisation”

Sound Quality

Strong preference for M&RIE

listeners with normal hearing

87%

Preferred M&RIE over omnidirectional

70%

Preferred M&RIE over Spatial Sense

listeners with hearing loss

70%

Preferred M&RIE over omnidirectional

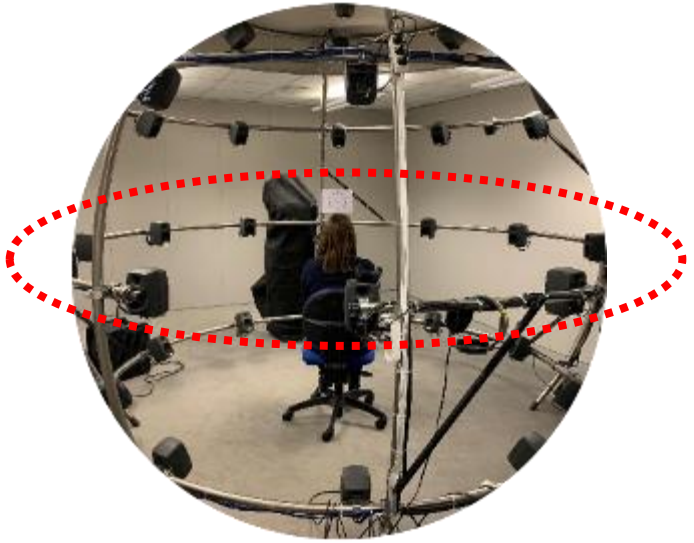
57%

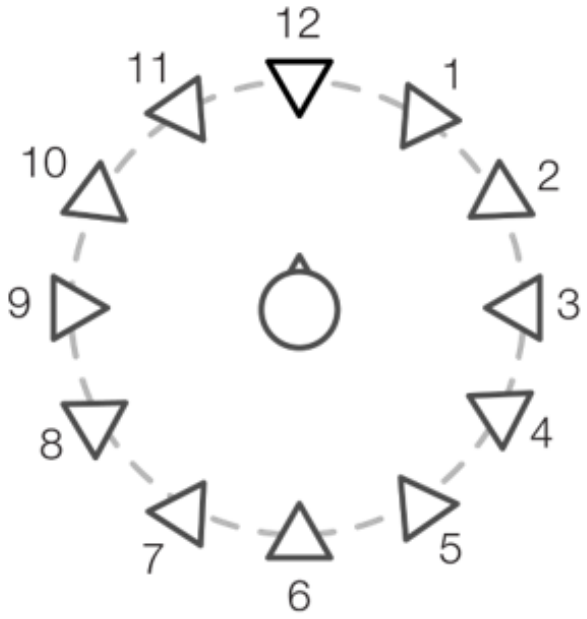
Preferred M&RIE over Spatial Sense

Jespersen et al., 2020 – White paper: “M&RIE receiver preferred for sound quality and localisation”

Localization

Test-conditions:
Unaided
M&RIE
Pinna restoration algorithm
Omnidirectional
Brand A Default Program
Brand B Default Program
Brand C Default Program
Brand D Default Program

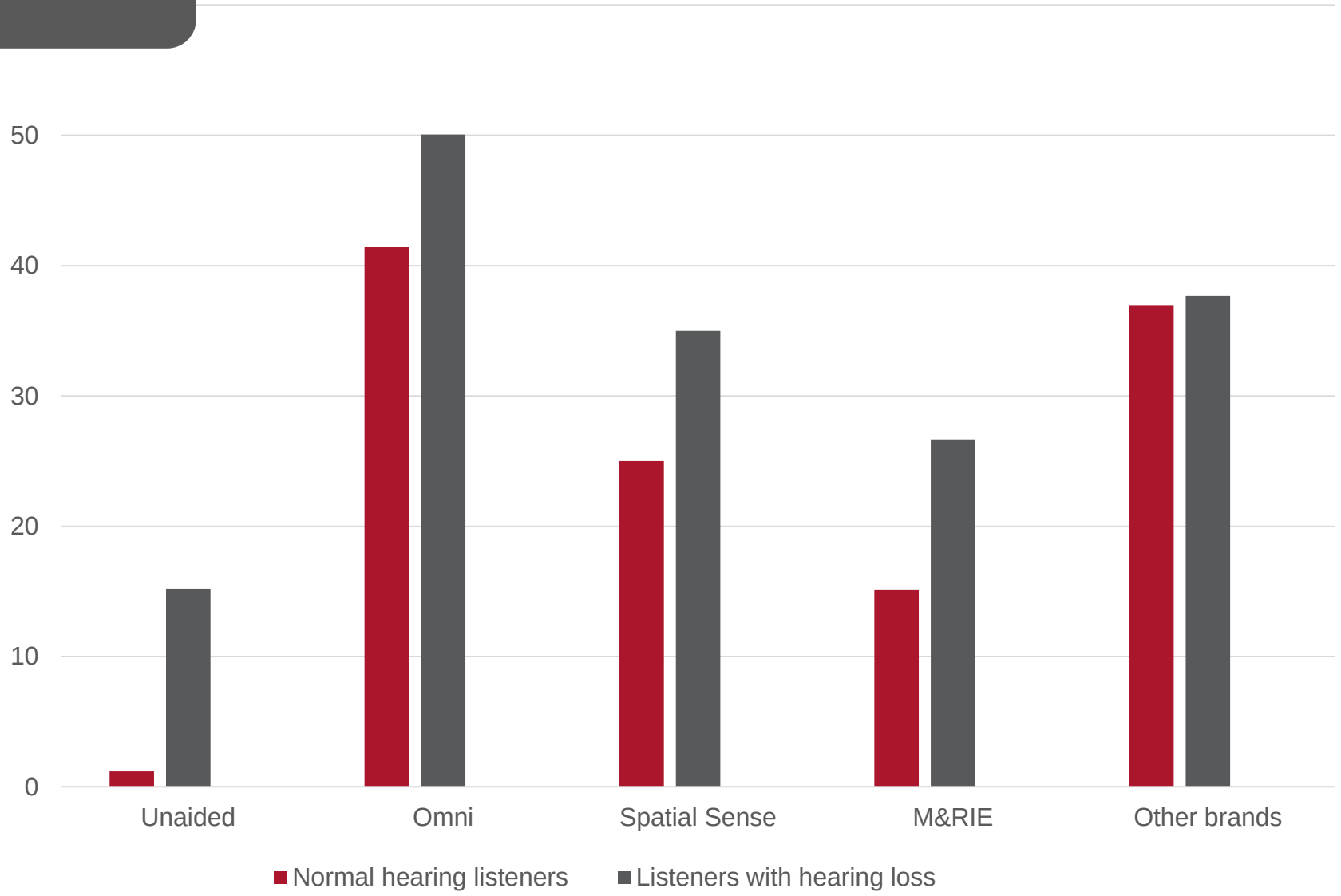




*Jespersen, Kirkwood, Schindwolf 2020

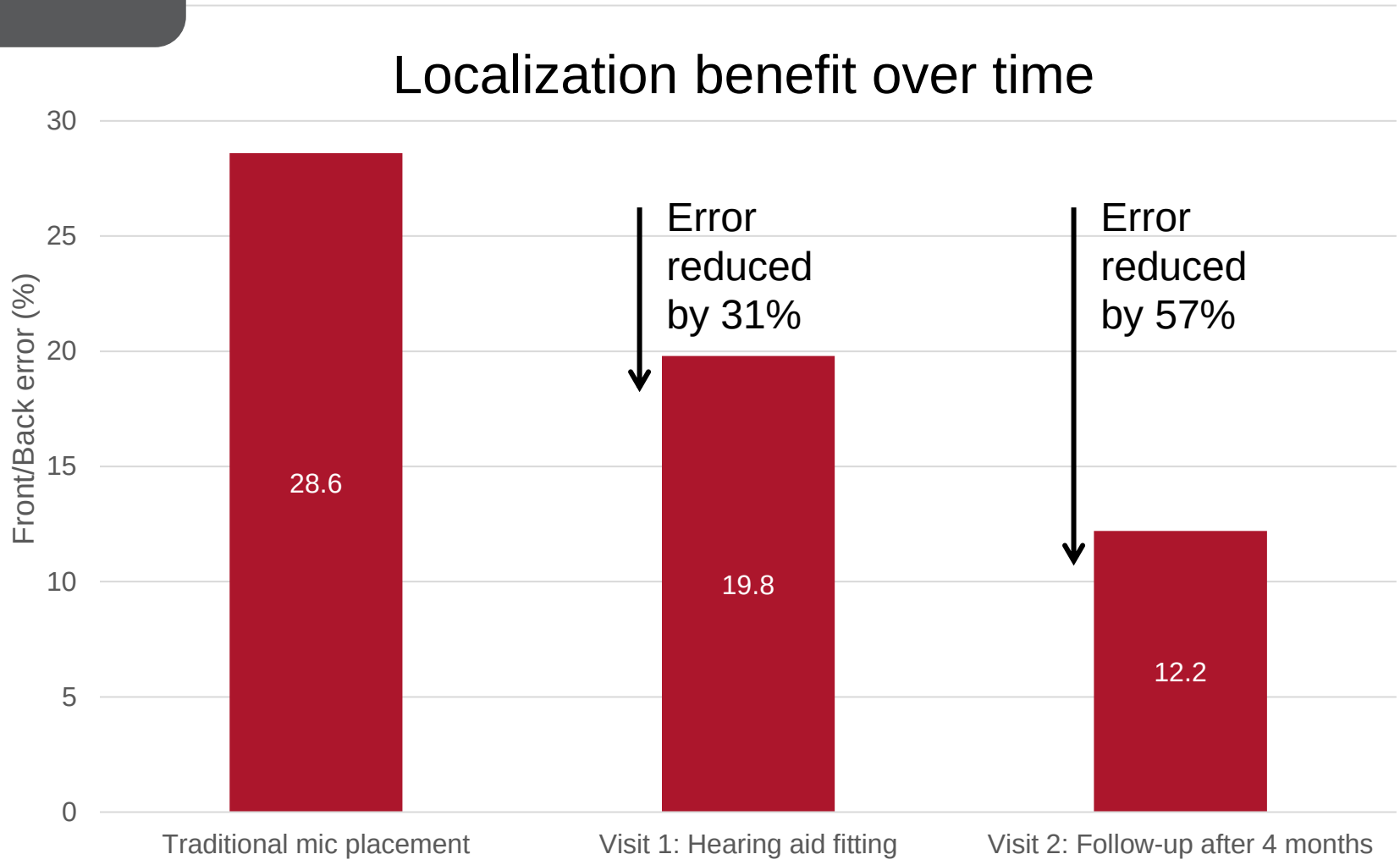
Localization

Average localization error



Jespersen C, Kirkwood B, Schindwolf I. M&RIE receiver preferred for sound quality and localisation. ReSound white paper, 2020.

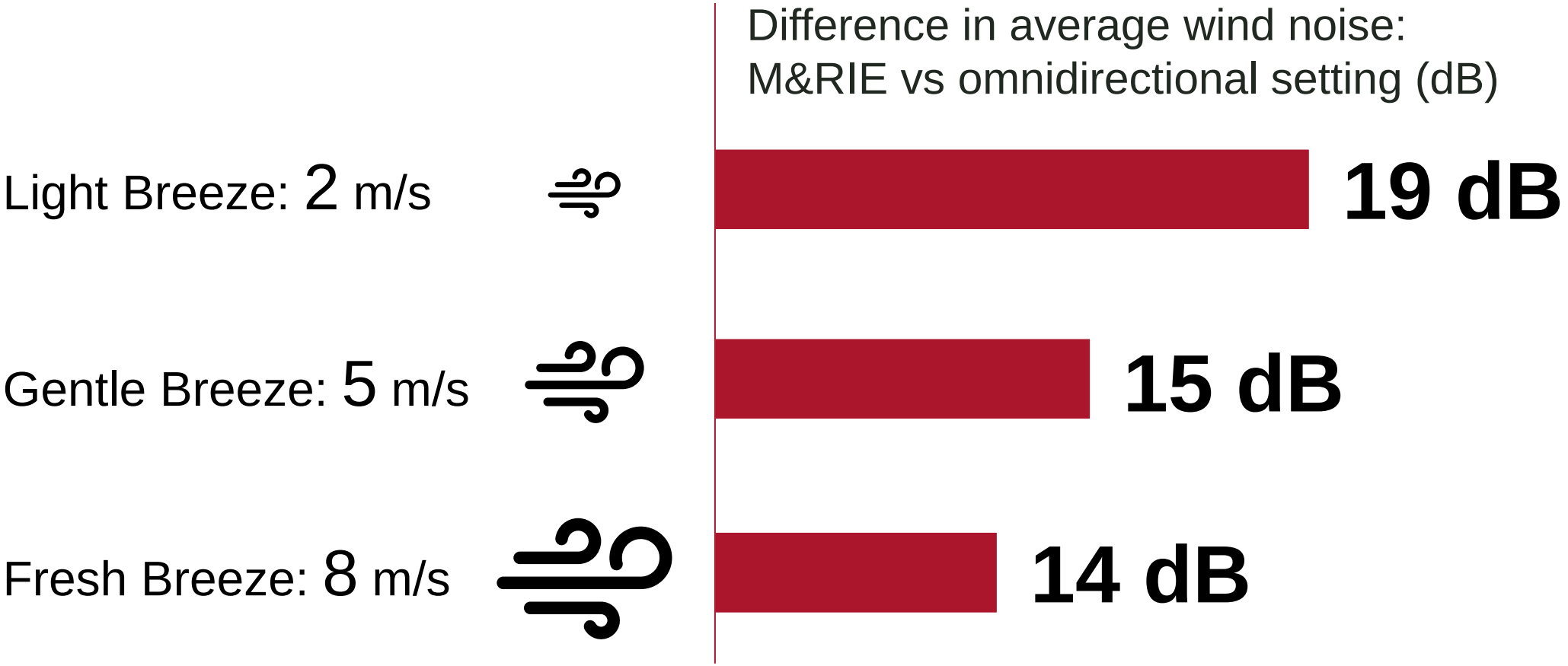
Localization



Jespersen C, Schindwolf I, Groth J. Benefits of M&RIE with long-term use. ReSound white paper, 2021. Write up in progress, title subject to change

Wind Noise Reduction

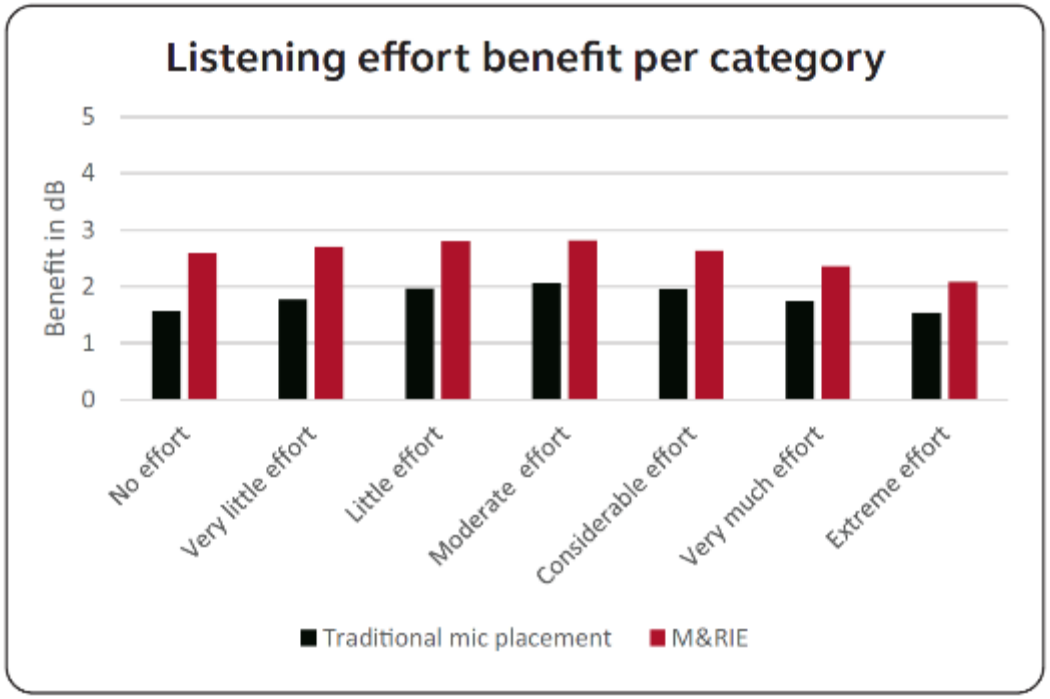
Wind noise

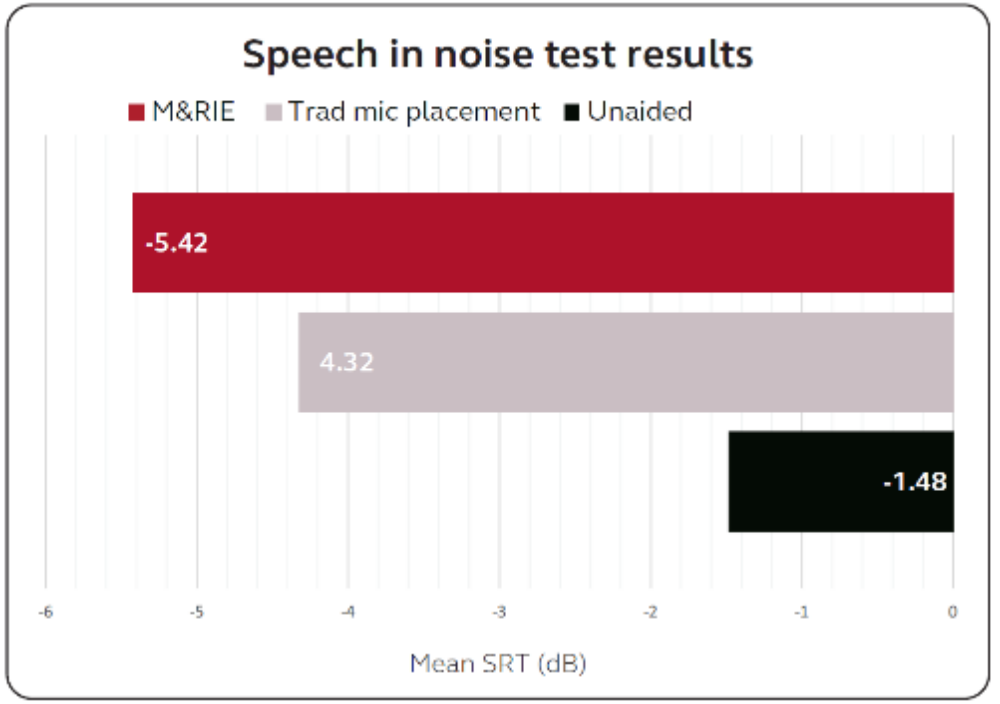


Groth J. An innovative RIE with microphone in the ear lets users “hear with their own ears”. ReSound white paper, 2020.

Listening Effort

Listening Effort





- 2.6 dB overall listening effort benefit with M&RIE
- Only 1.8 dB benefit with traditional mic placement

- Speech recognition better with M&RIE than with traditional mic placement

User benefits of M&RIE?

Reduced wind noise

Localization

Less listening effort

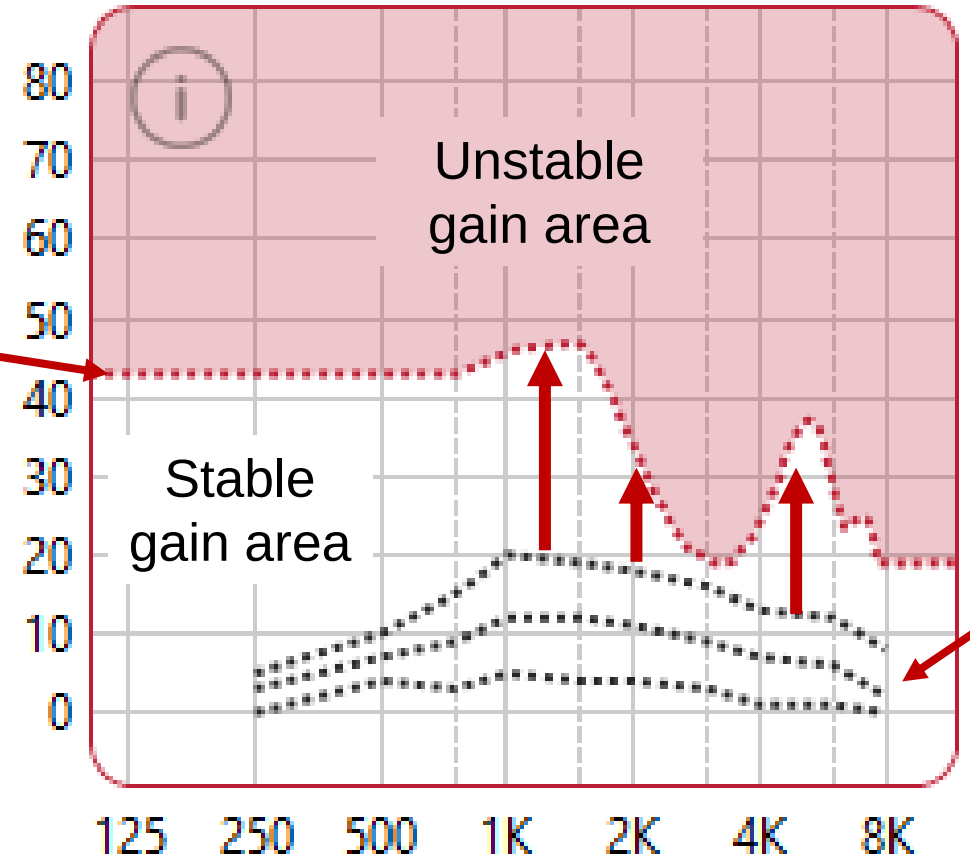
Sound quality

M&RIE

Microphone & Receiver-In-Ear

Maximum Stable Gain (MSG) curve information

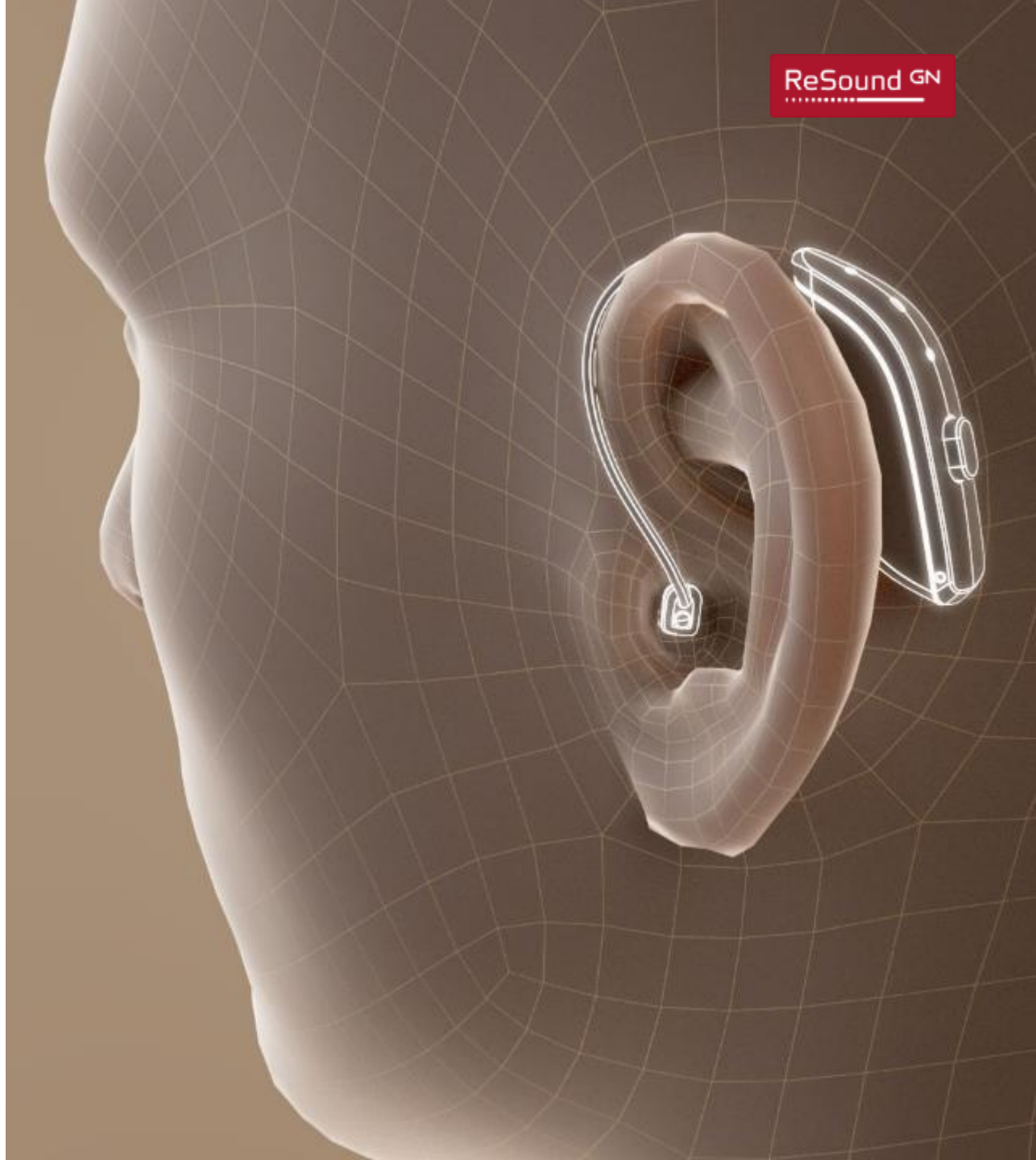
Max stable gain curve



Target gain curves calculated based on the HL

Key Takeaways

- Proof of benefit study results show a sound quality preference for M&RIE over Omnidirectional and a Pinna Restoration algorithm
- M&RIE preserves valuable information that aids in localization
- Wind noise reduction improvements are significant with the placement of a microphone in the ear
- M&RIE combines the advantages of the RIE style with the benefits of personalization by collecting sound in the ear canals of the user



The Future of AI and the Path to Effortless Experiences

Sara Burdak, Chief Audiology Officer and Executive VP of Marketing, Starkey

The Future of AI and the Path to **Effortless Experiences**

Sara Burdak, Au.D
Chief Audiology Officer

Starkey

HEARING PERFORMANCE
HEALTHABLE TECHNOLOGY
INTELLIGENT ASSISTANT

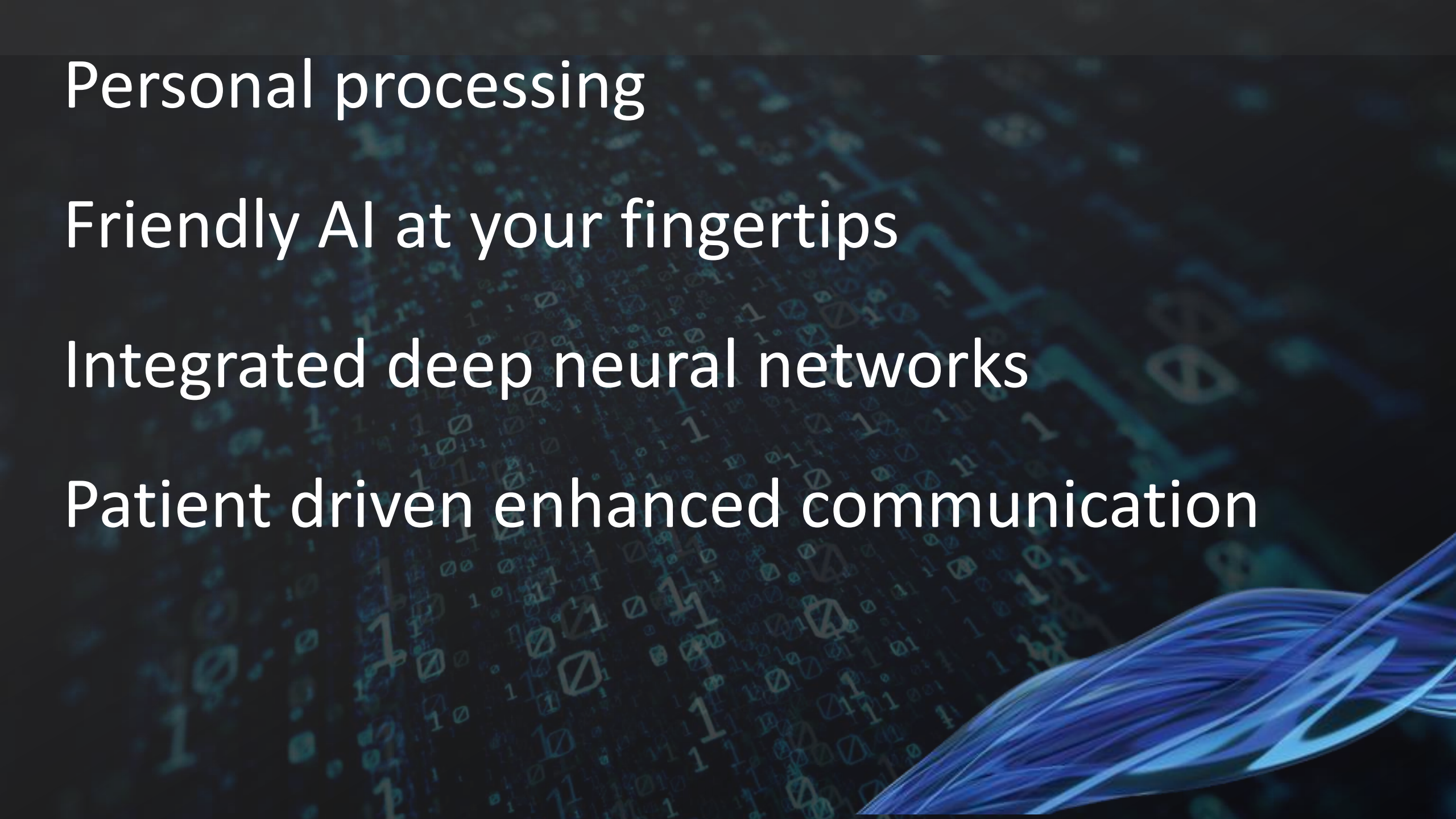
Exceptional
Hearing

Personal processing

Friendly AI at your fingertips

Integrated deep neural networks

Patient driven enhanced communication



Convenience and connectivity are expected

Commitment to connection and connectivity

Comprehensive tele-audiology services

Digital patient experiences

Healthable collaborations

Power for more patients

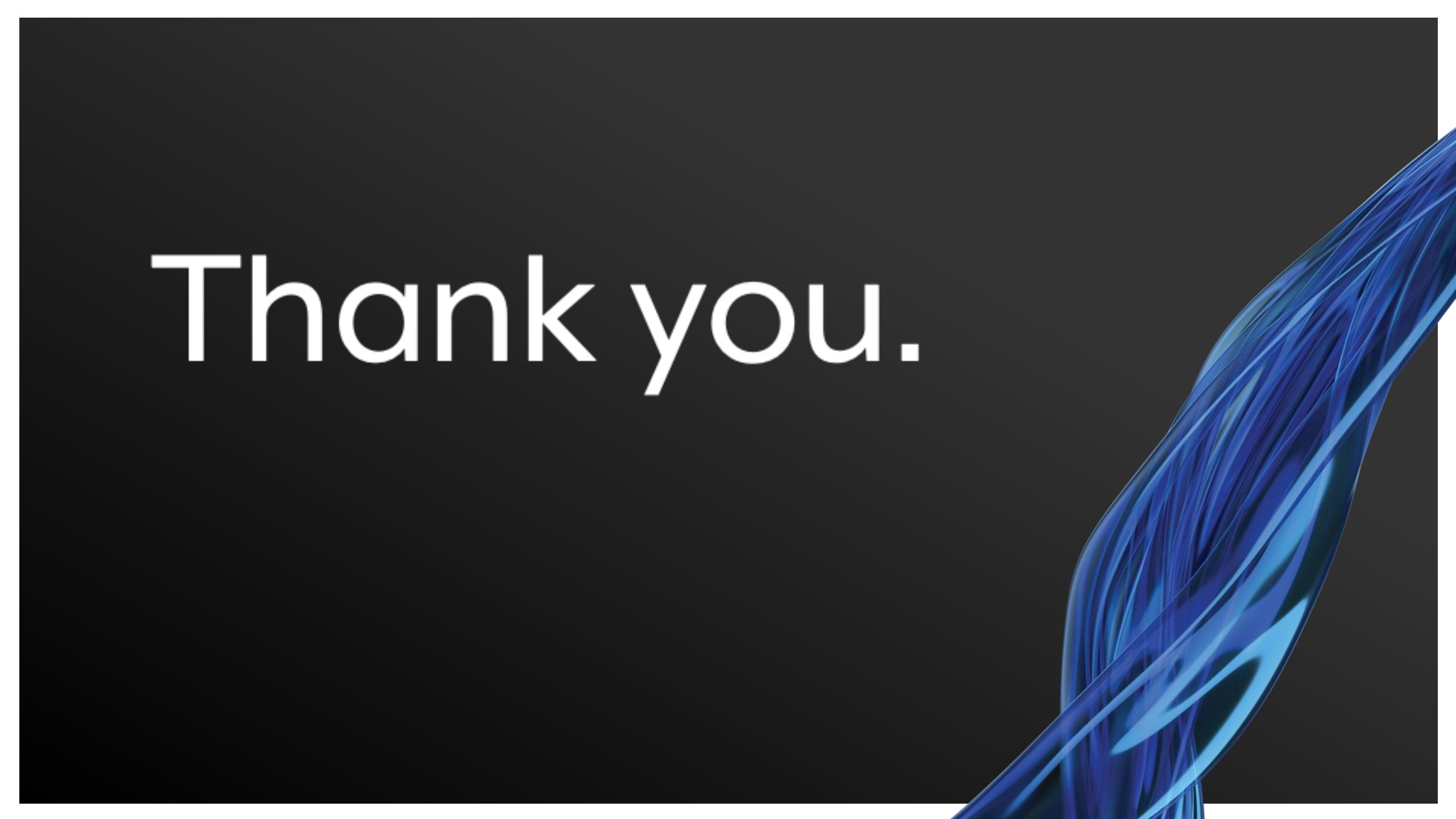
Custom craftsmanship evolution

Shattering the stigma

Caring

makes the difference

Thank you.



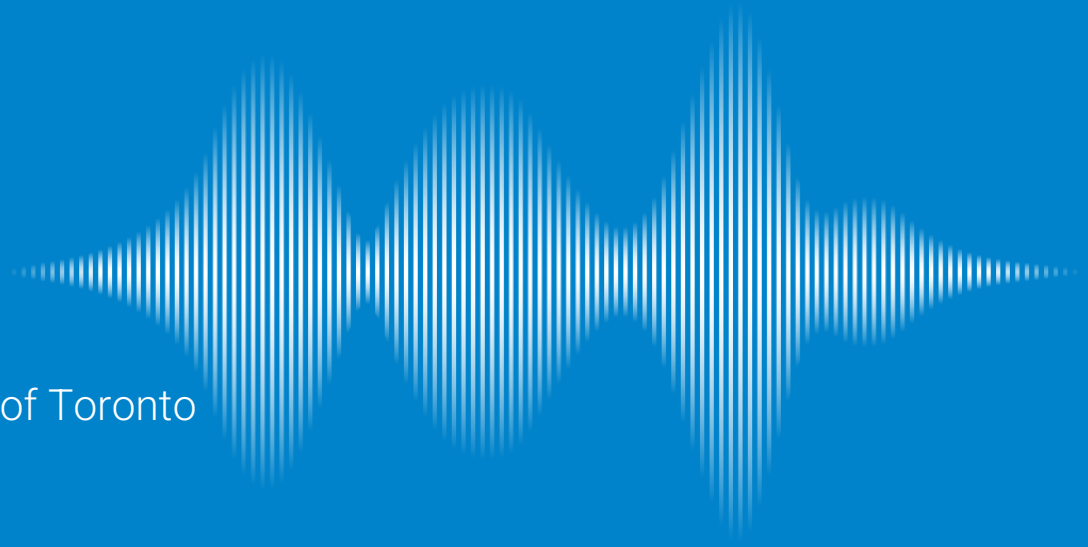
How Can Psychology Inform Outcomes in Audiology?

Gurjit Singh, Senior Research Audiologist, Phonak Canada

Canadian Academy of Audiology
December 4, 2021

The Future of Hearing Aid Technology

Gurjit Singh, PhD, Reg. CASLPO
Senior Research Audiologist, Phonak Canada
Adjunct Professor, Dept. of Speech-Language Pathology, University of Toronto
Adjunct Professor, Dept. of Psychology, Ryerson University



The Arc of Innovations in Hearing Care: Better Understand the Lived Experience of Persons with Hearing Loss

Audiometer capable of generating **pure-tones** *(Jones & Knudsen, 1924)*	→	**Speech materials** for recognition tests *(eg, Fletcher & Steinberg, 1929)*
Words in **Isolation** *(eg, Fletcher & Steinberg, 1929)*	→	Words in **Sentences** *(eg, Egan, 1944)*
Speech in **Quiet** *(eg, Carhart, 1951)*	→	Speech in **Noise** *(eg, Broadbent, 1958)*
Auditory speech *(eg, Fletcher & Steinberg, 1929)*	→	**Audio-Vision** speech *(eg, Sumby & Pollock, 1954)*
Speech in **Sentences** *(eg, Egan, 1944)*	→	Speech in **Low and High Contexts** *(eg, SPIN; Kalikow et al, 1977)*
Targets at a **Single Location**	→	Targets at **Multiple Locations** *(eg, Freyman, Balikrishnan, & Helfer, 2001; Singh, Pichora-Fuller, & Schneider, 2008)*
Speech spoken in a **Neutral Tone**	→	Speech spoken with **Emotion** *(eg, TESS; Dupuis & Pichora-Fuller, 2010; RAVDESS; Livingstone, Peck, & Russo, 2013))*
Evaluations conducted in the **Lab**	→	Evaluations conducted in the **Field** *(eg, Holube et al., 2020)*

Integrated People-Centred Care Systems

World Health Organization, WHO global strategy on integrated people-centred health services 2016-2026

Integrated People-Centred Care:

- Care approaches and practices that see the person as a whole with many levels of needs and goals, with these needs coming from their own personal social determinants of health.
- Adopts and responds to the perspectives of individuals', carers', families' and communities' perspectives as participants in their care.
- It is organized around the health needs and expectations of people rather than diseases.
- The management and delivery of health services such that people receive a continuum of health promotion, disease prevention, diagnosis, treatment, disease-management, rehabilitation and palliative care services, through the different levels and sites of care within the health system, and according to their needs throughout the life course.

The Future of Hearing Aid Technology

eAudiology/Connectivity

- eScreener
- eAssessment
- eFitting
- Ecological Momentary Assessment
- eCoach/Assistant
- "Digital Assistant"
- Language translation
- Connected Technologies "Smart Devices"
  - Access to more processing power (AI systems)
  - Access to more data transfer capabilities
    - 1G: 1st cell phones
    - 2G: Texting now available
    - 3G: Access to the internet
    - 4G: Current standard
    - 5G: "VR"; "Autonomous Driving" – Deliver promised 4G speeds?

Sensors & Well-Being Indicators

- Heart rate/heart rate variability
- Body temperature
- Blood oxygenation
- Respiration
- Blood pressure
- Accelerometer
- Microphones
- Photoplethysmography (PPG)
- Ear-level Electrocardiogram (ECG)
- Electroencephalography (EEG)

Socio-Emotional Well-Being: Social functioning & integration, mood disorders, stress, anxiety, emotional functioning, loneliness

Physical Well-Being: Falls prevention, activity monitoring, diabetes, sleep quality, fatigue, cardiovascular disease, diet

Cognitive Well-Being: Everyday functioning to neurodegenerative monitoring

World Health Organization

Policy Framework for Delivering Integrated Person-Centred Health Care

sonova
HEAR THE WORLD

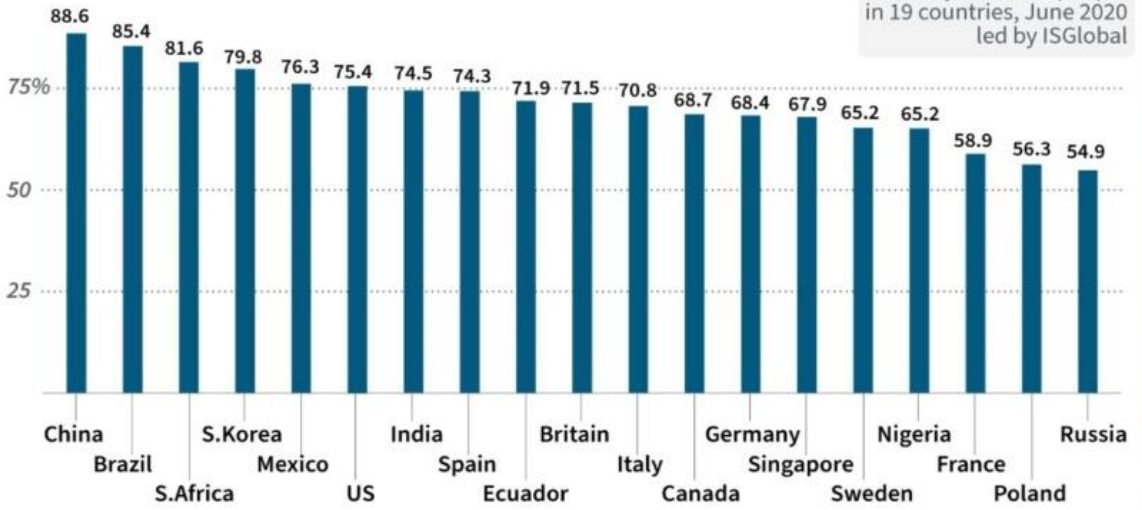
"Health systems and services have become overly biomedical oriented, disease focused, technology driven and doctor dominated." (p. 6)

Covid-19 vaccine willingness

Percent of people who responded positively to the statement:

"If a Covid-19 vaccine is proven safe and effective and is available, I will take it"

Survey of 13,400 people in 19 countries, June 2020 led by ISGlobal

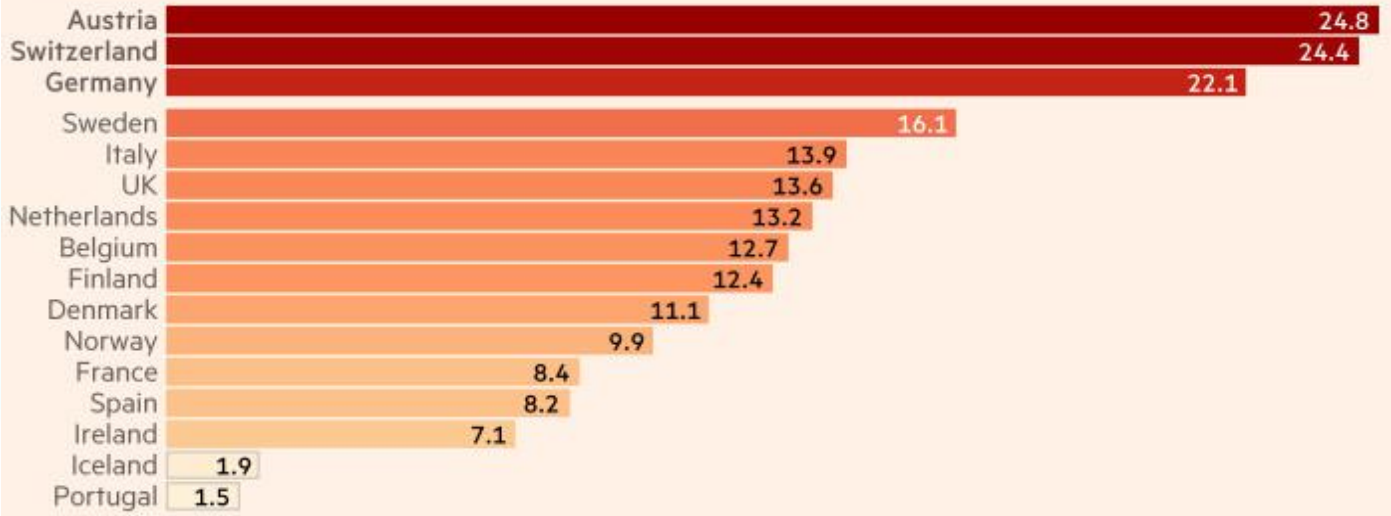


Source: A global survery of potential acceptance of a Covid-19 vaccine, Lazarus et al, Oct 20

AFP

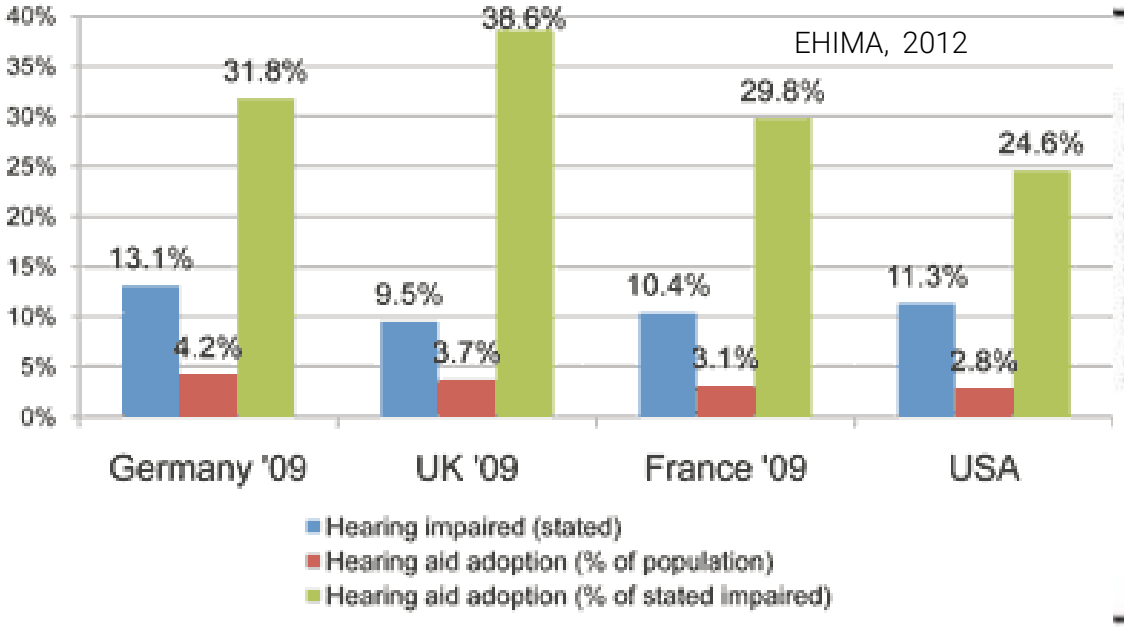
German-speaking countries have the highest shares of unvaccinated people in western Europe

Share of population aged 12+ that has not had any Covid vaccine dose (%)

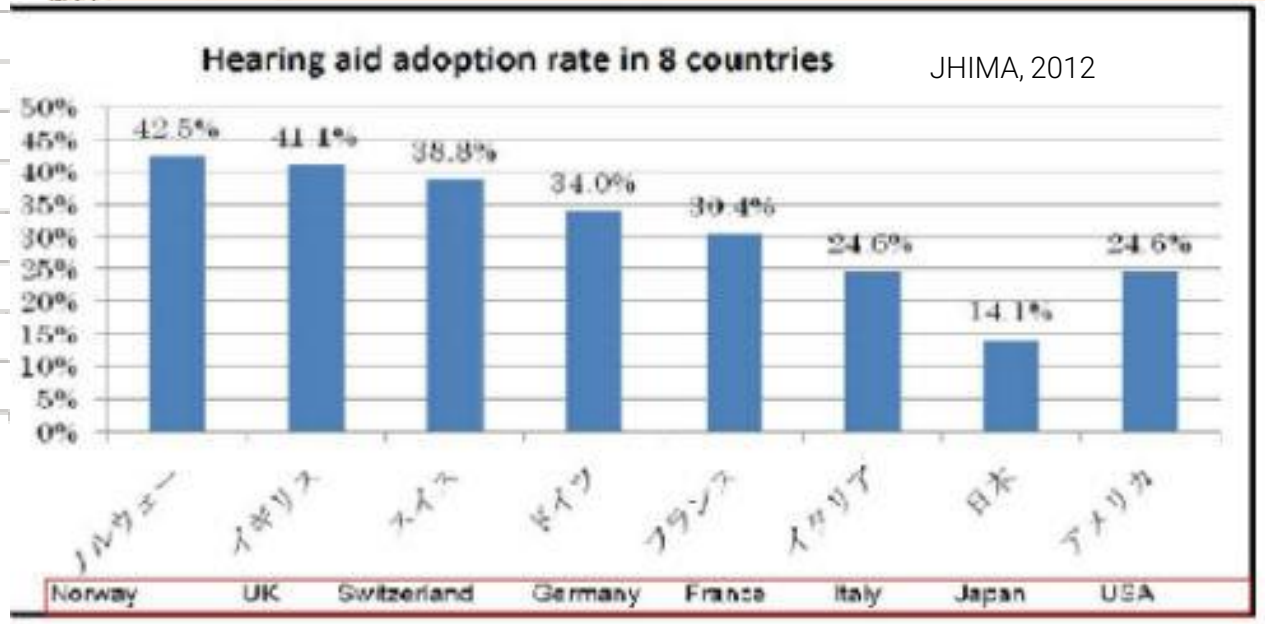


Source: FT analysis of figures from national sources and Our World in Data. Rates shown are as of November 9

EHIMA, 2012



JHIMA, 2012



World Health Organization

Policy Framework for Delivering Integrated Person-Centred Health Care

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HEAR THE WORLD

"Health systems and services have become overly biomedical oriented, disease focused, technology driven and doctor dominated." (p. 6)

Which would you prefer?

A city of 600 people is likely to be attacked by a deadly disease, that might result in the deaths of its inhabitants. You've been asked to select a strategy out of these that will help the city combat the epidemic.

Option A: This program ensures that 200 people will be saved. 72%

Option B: With this program, 1/3 probability that all of them will be saved; 2/3 probability that none will be saved 28%

Option C: This program ensures that 400 people will perish. 22%

Option D: With this program, 1/3 possibility that no one will die; 2/3 probability that all 600 will die. 78%

RESEARCH ARTICLE: PDF ONLY

Descriptions of Hearing Aids Influence the Experience of Listening to Hearing Aids

Rakita, Lori; Goy, Huiwen; Singh, Gurjit

September 22, 2021

Abstract ☆ Favorites PDF © Get Content & Permissions

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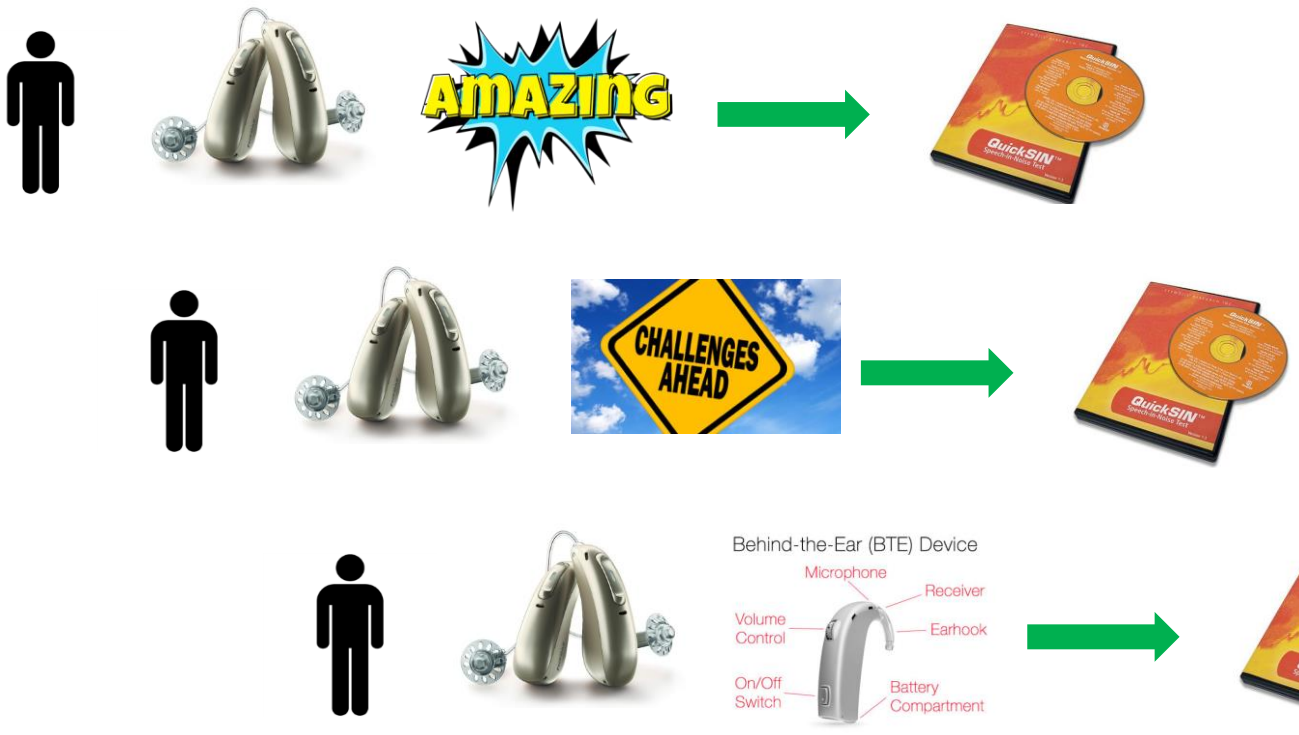
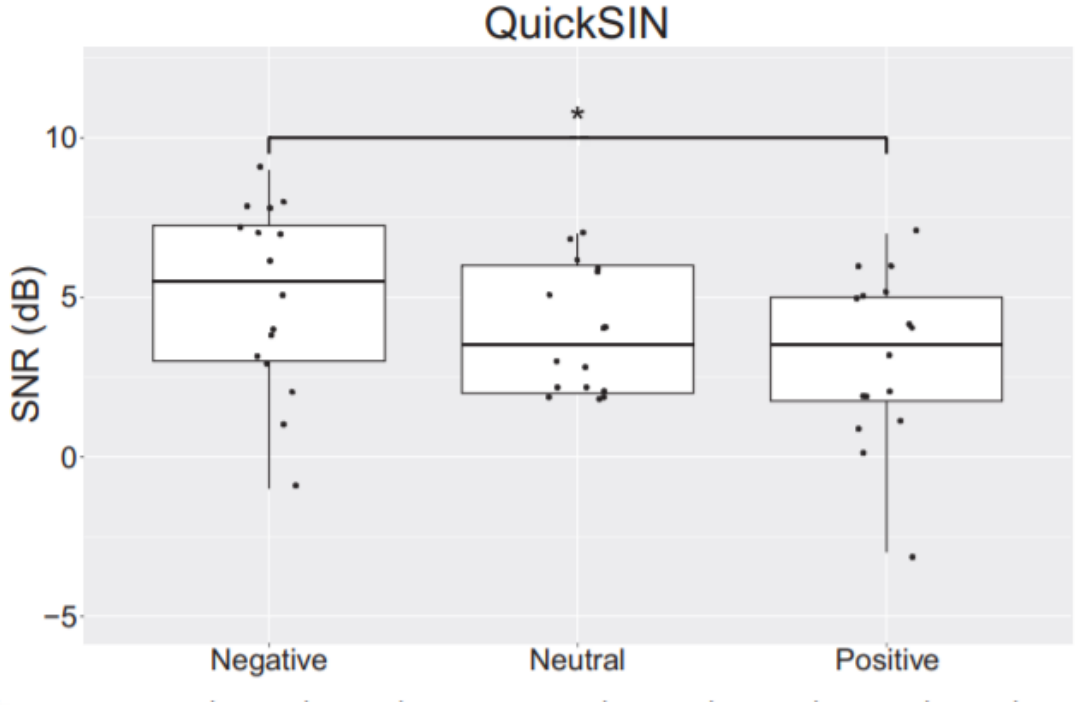
HEAR THE WORLD

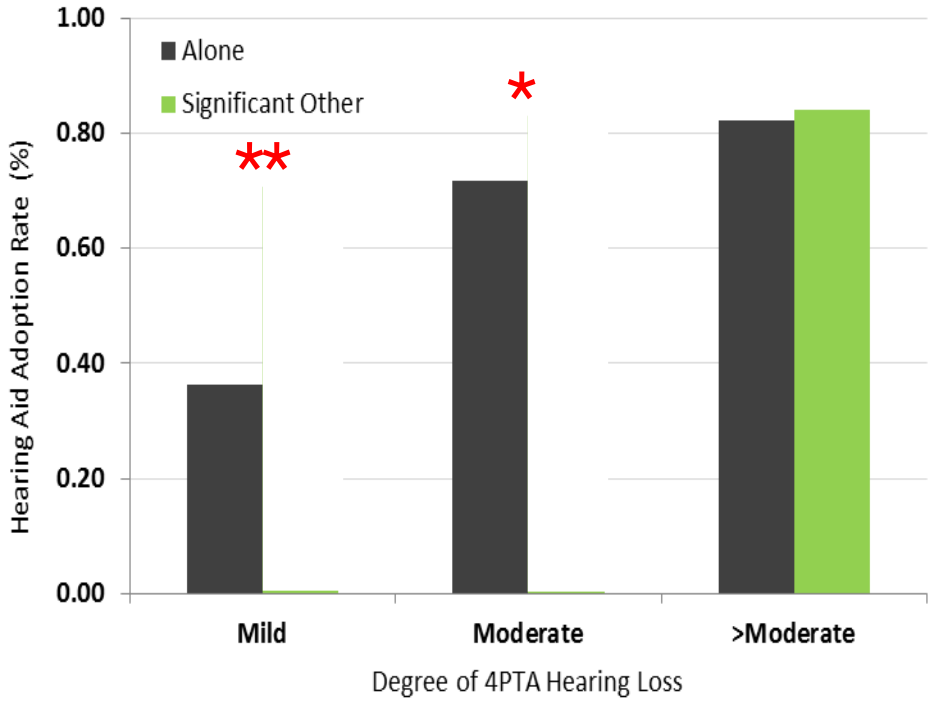




"Measured in real-life situations, directional microphones in hearing aids improve SNR by approximately 3 dB."

Christensen, Canadian Audiologist, 2017

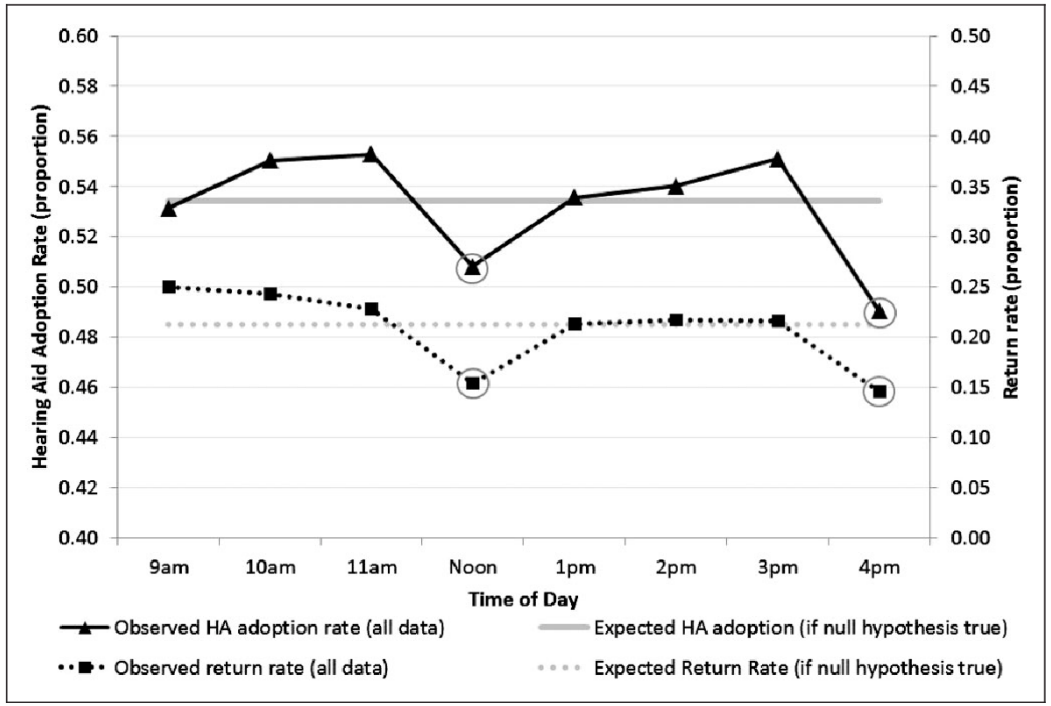
Decision Making & Risk Perception



N = 60,964 1st time patients of audiology clinics

**participants were not randomly assigned to condition*

Singh & Launer, 2016



Singh & Launer, 2018

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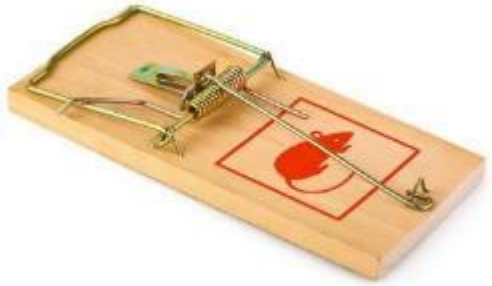


Technology

Person
Decision-making

Health Outcomes

Short Break – 5 minutes

Award Presentation

Steve Aiken presents the Richard Seewald Career Award to Dr. Jean-Pierre Gagné.

Awarded to recognize a career in research, clinical practice, teaching, and/or mentoring young people. The candidate must have made significant contributions to the knowledge base, practice and/or teaching of audiology or a related field and have had a long term professional career.

Panel Discussion Moderated by Steve Aiken

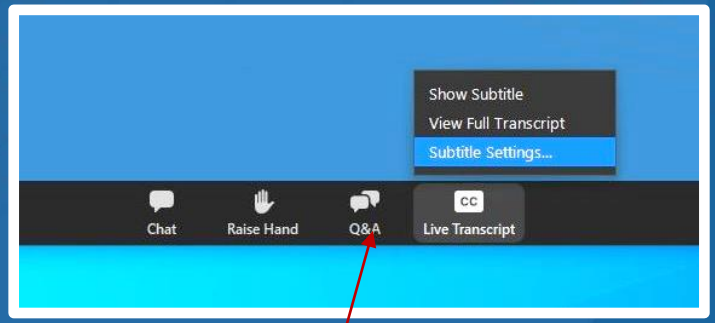
Filip Roenne, WSaudiology

Thomas Behrens - Oticon

Jill Mecklenburger - ReSound

Sara Burdak - Starkey

Gurjit Singh - Sonova



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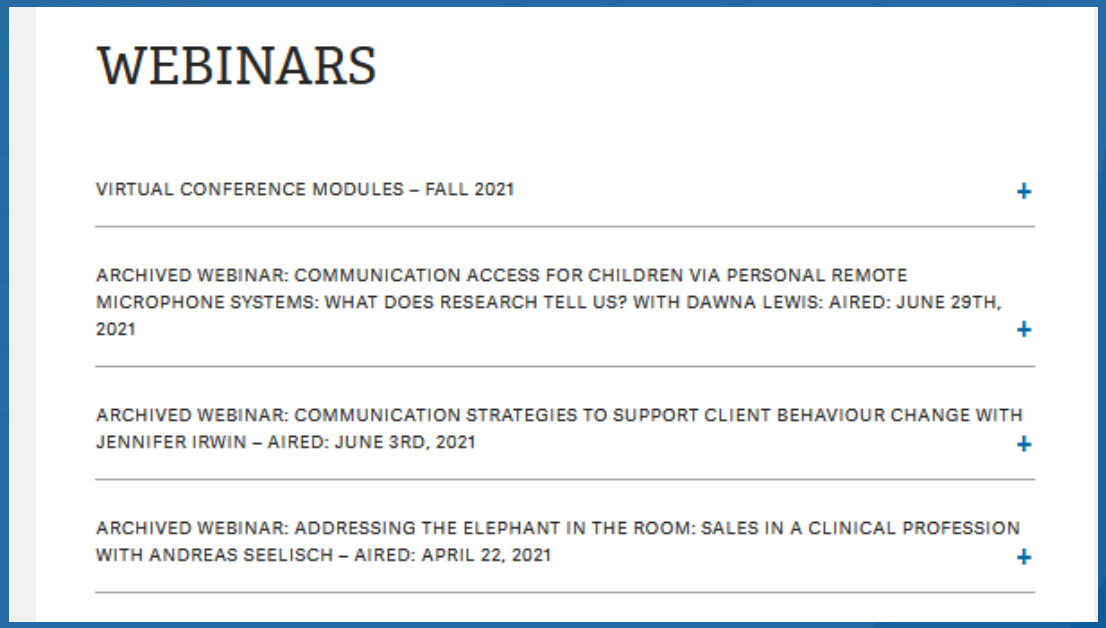

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- Webinar recording, and PDF will be posted to the CAA website within a few business days.
- For those attending this session live you will receive a thank you for attending email. That is your record of attendance and CEU.

Thank You For Attending