Welcome to a new world of sound

Søren Nielsen
President of Oticon A/S

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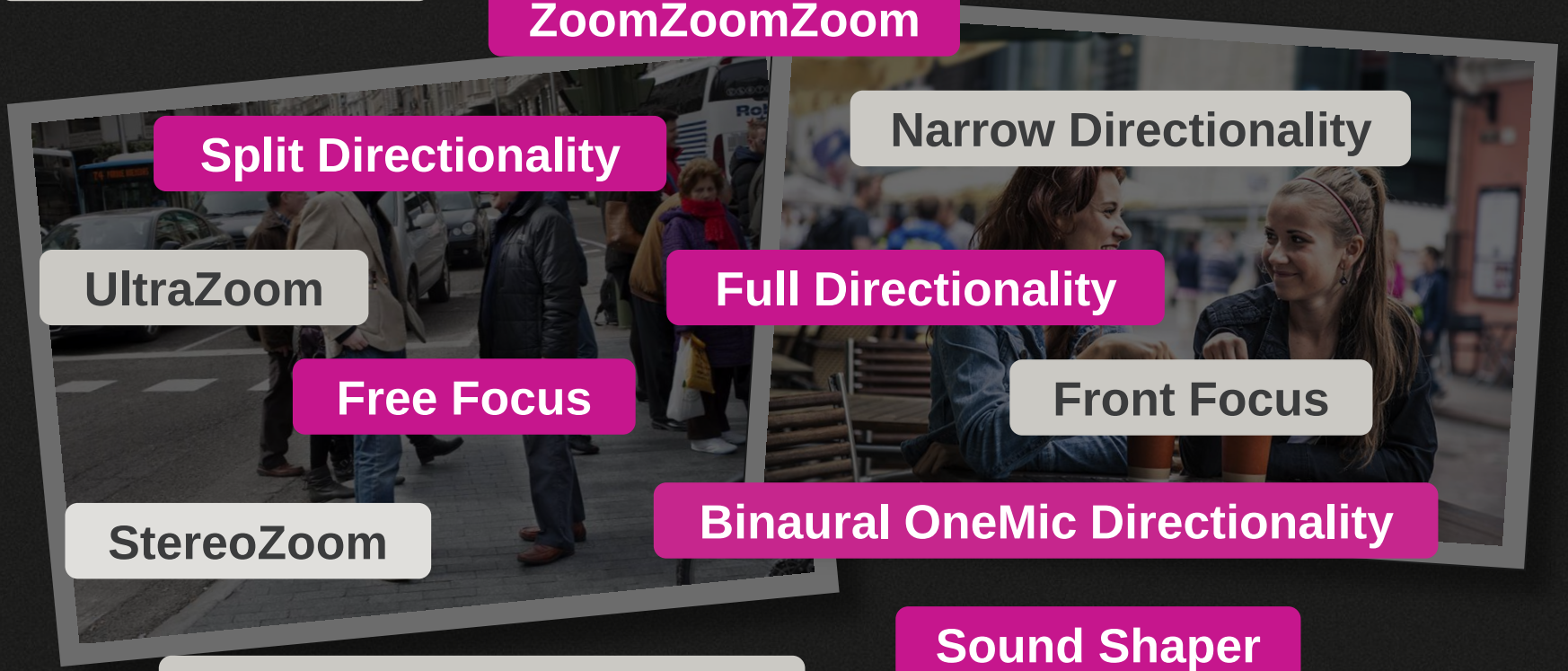
Speech Focus

Acuity Directionality

ZoomZoomZoom



Split Directionality

Narrow Directionality

UltraZoom

Full Directionality

Free Focus

Front Focus

StereoZoom

Binaural OneMic Directionality

Sound Shaper

Binaural Directionality II

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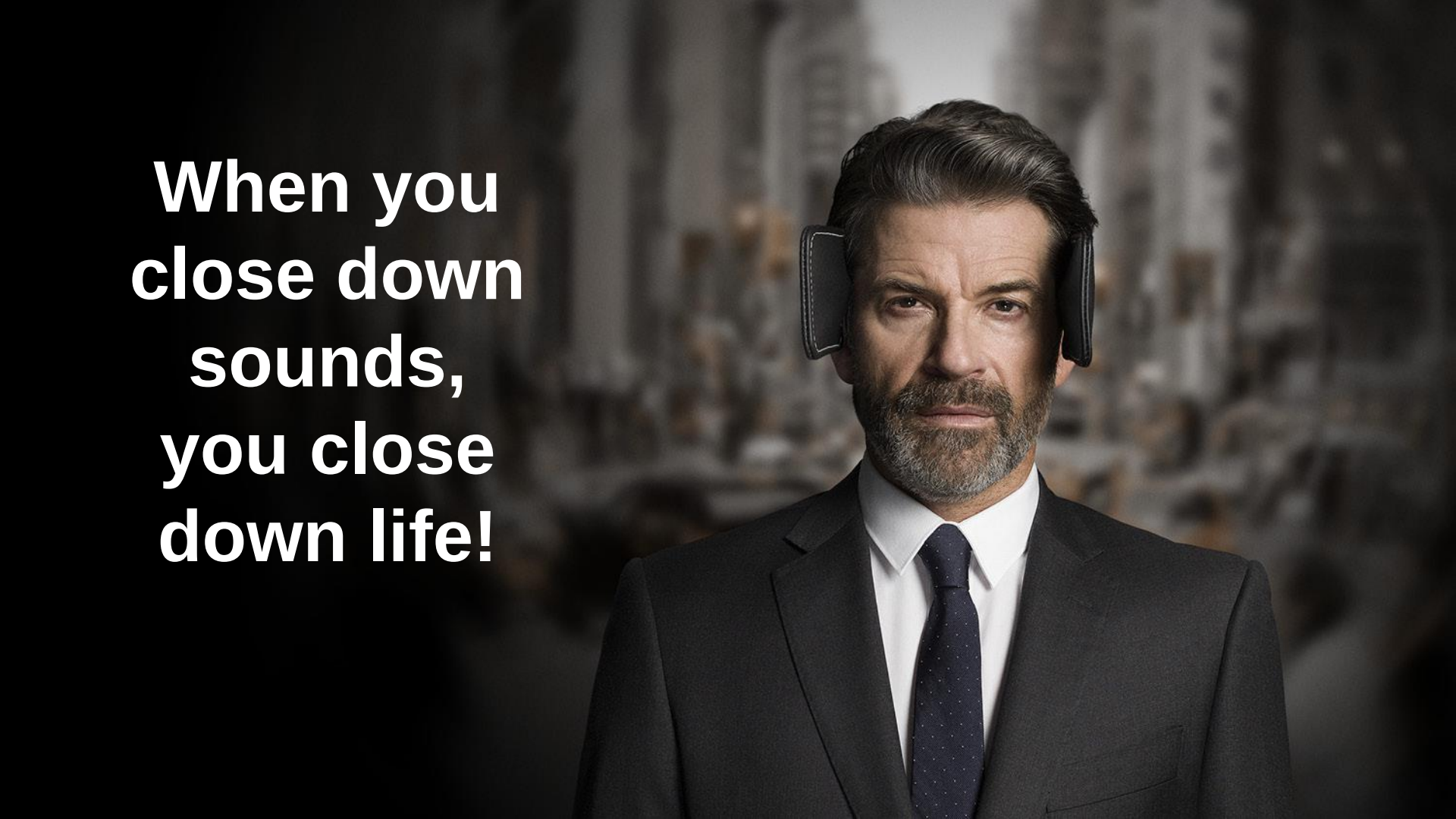
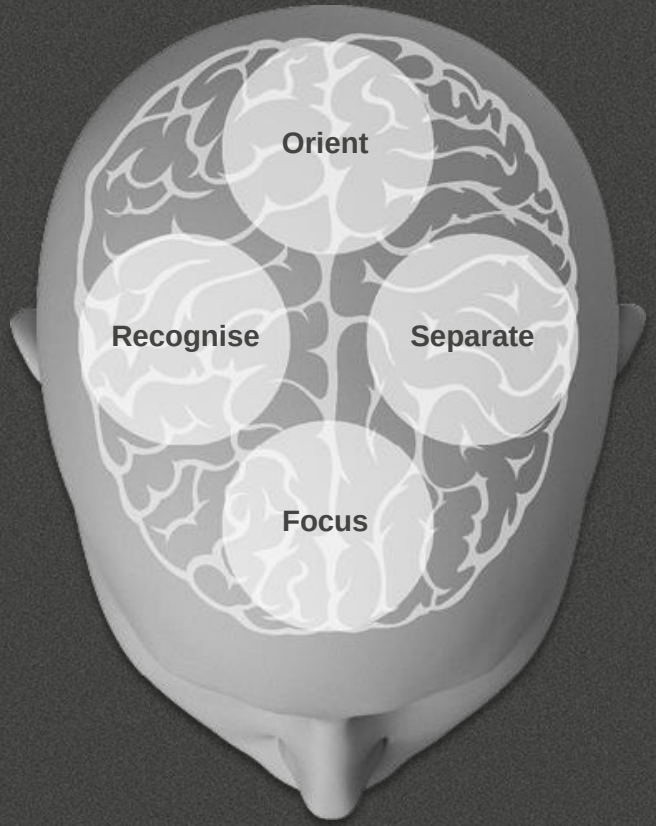
Today’s
challenge

Today's directional technology …


When you close down sounds, you close down life!

It’s your brain that hears, not your ears

Oticon BrainHearing™ Technology



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Oticon Opn empowers the brain!

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Directionality as we know it is now a thing of the past!

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Made for
iPod iPhone iPad
TwinLink
NFMI + 2.4 GHz
For the first time ever,
a hearing aid with two communication systems
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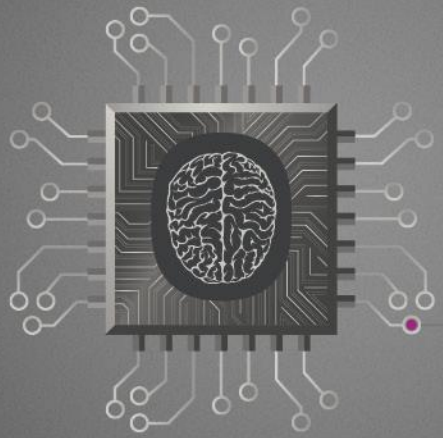
New Velox platform

Power and speed



50 times faster

TwinLink

64 frequency channels

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New OpenSound experience

OpenSound Navigator

- Analyses the sound environment 100 times per second
- Balances individual sounds
- Attenuates remaining noise

Spatial Sound LX

- Total capacity: 320 kbit per second
- Exchange rate: 21 times per second
- Frequency bands: 4 bands

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Proven benefits!

20% less listening effort

Remember **20%** more

30% better speech in speech understanding

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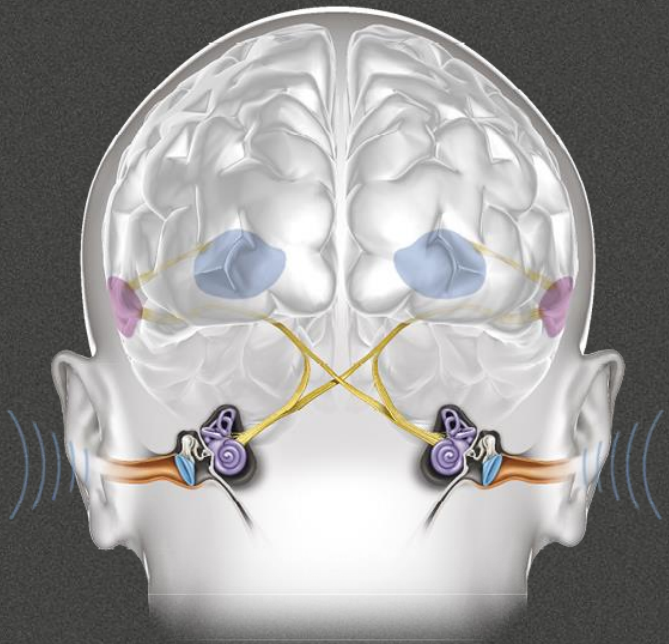
Hearing Care is
Health Care™

Insufficiently treated hearing loss

Isolation

Accelerated mental decline

Higher risk of dementia



Treated hearing loss

Socially active

Stimulation of the brain

Keeps your brain fit

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"*This is the biggest innovation for many, many years – this will be perfect for my patients.*"
Canadian dispenser

"I enjoy being able to continue to hear background noise and still be able to hear clearly the person I'm speaking with – even if it's in a noisy restaurant."
Female (user)

"The clearness of the sound is so natural, I find it as having natural hearing and no need for the hearing aids and ability to hear speaking from all quadrants of the table."
Male (user)

"This is a fantastic product. We must ensure to make it known A.S.A.P. to the market!"
Italian dispenser

"I am an attorney and conducted a trial last week. My ability to listen and interact with witnesses was greatly improved, and my examinations were much more effective because I can hear all the words"
Male (user)

"Magnificent sound, I am now able to hear conversations from behind"
Male, 64 (user)

"Today, I´m letting the patient choose between two different instruments. With Opn, I will only recommend Opn – simply the best"
Canadian dispenser

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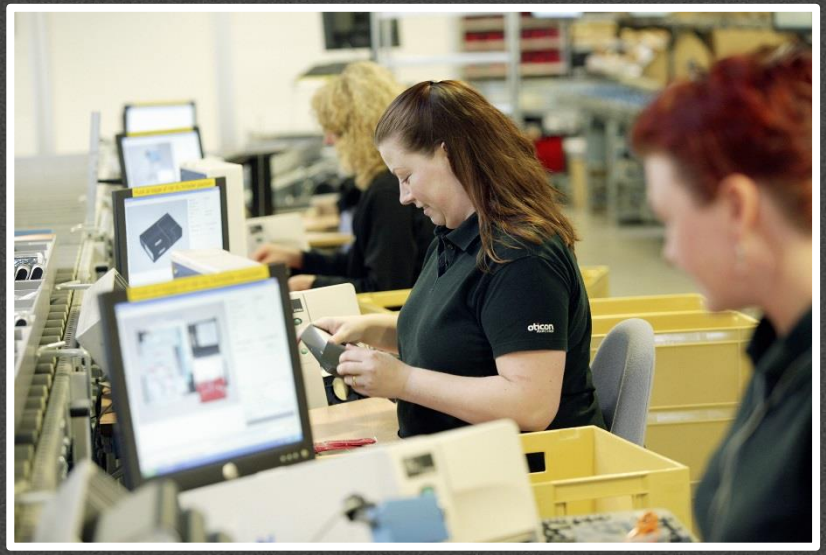
Full steam on shipment!

15 countries
launched already



... and more coming
up in June

Canada

Denmark

Japan

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Welcome to a new world of open sound experience

21 May 2016

BrainHearing – benefit for the patient

Thomas Behrens
Head of Audiology
Director, Centre for Applied Audiology Research

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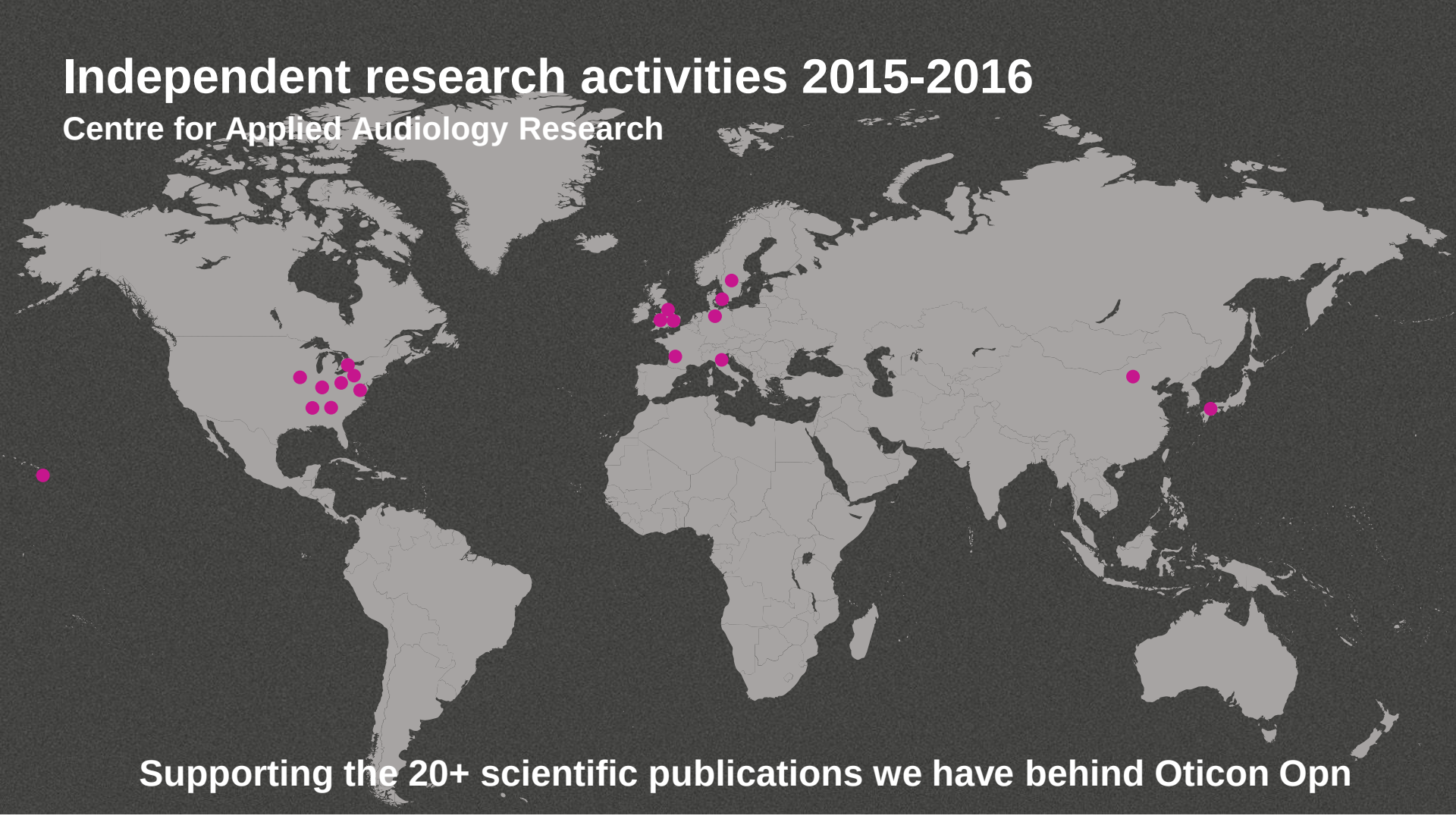
Independent research activities 2015-2016

Centre for Applied Audiology Research



Supporting the 20+ scientific publications we have behind Oticon Opn

A BrainHearing solution for speech in speech and noise

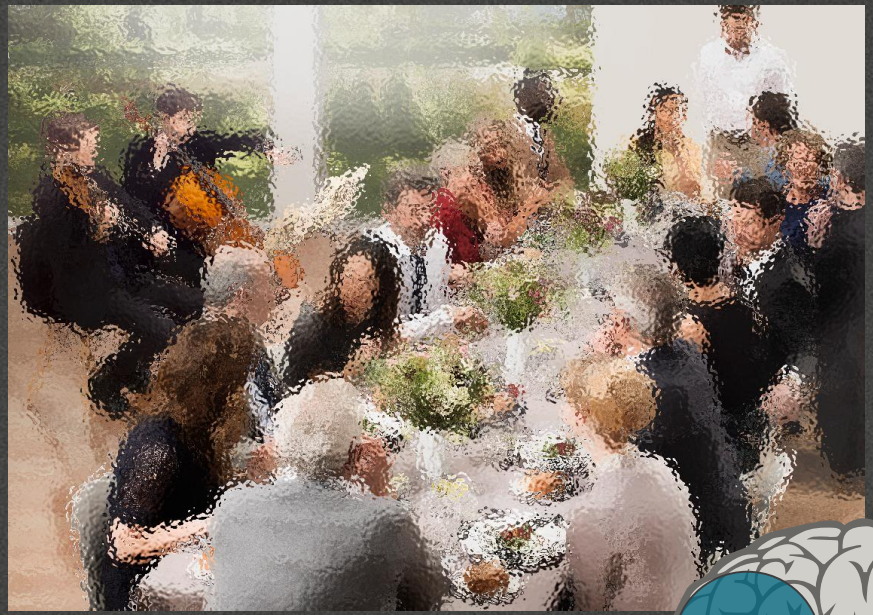
From zero to when it really gets tough!

- Complex situations
  - Many sound sources
  - Moving around
  - Dynamically coming and going
  - Unpredictable
- This is where people with a hearing impairment have the largest unmet need!

Gatehouse & Akeroyd, 2006

The hidden cognitive load of hearing loss

The path to improved ability to listen to speech in speech and noise



Rönnberg et al 2013, Wendt et al 2015

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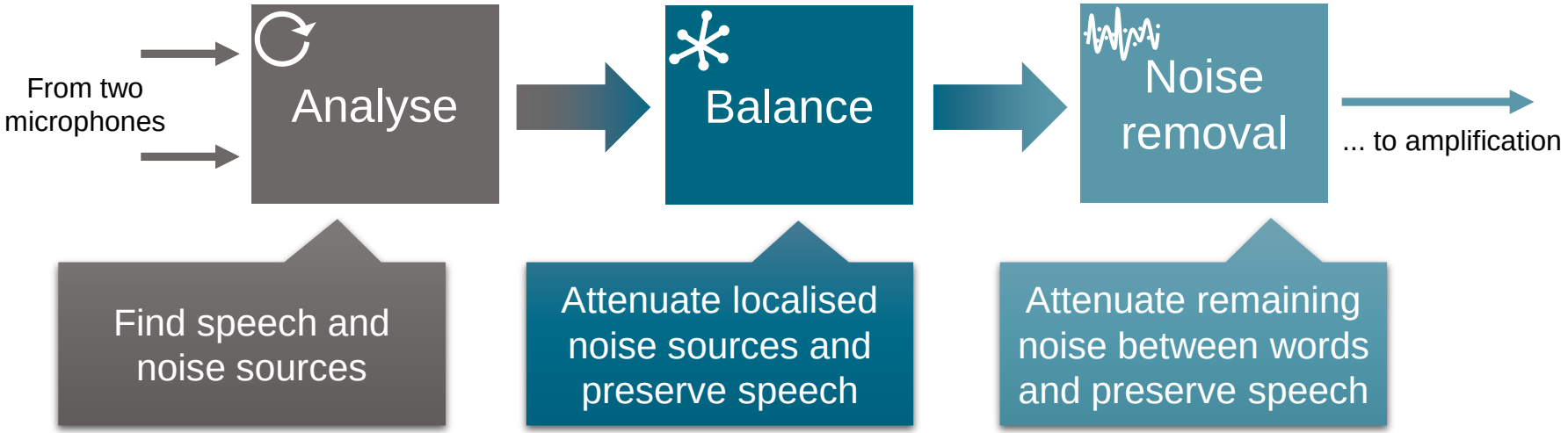
OpenSound Navigator



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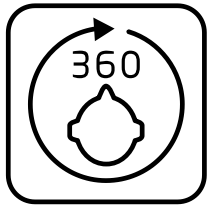
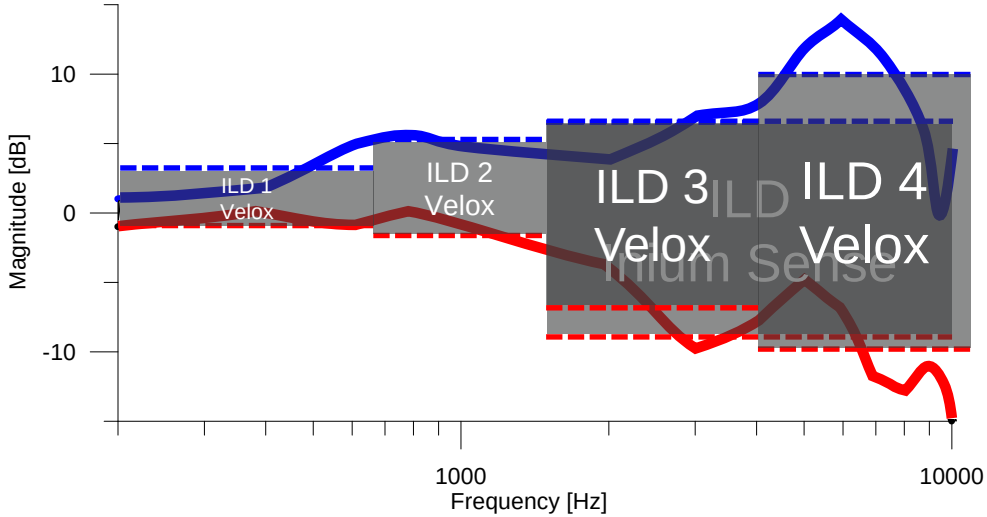
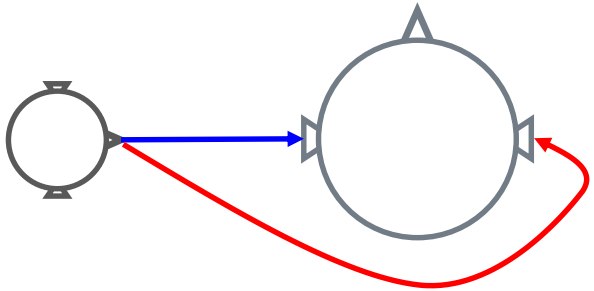
Spatial Sound^{LX}

Powered by TwinLink



- 200%+ increase in binaural communication capacity
  - Total capacity: 320 kbit/sec vs. 96 kbit/sec in Inium Sense
  - Exchange rate: 21 times per second vs. 5 in Inium Sense
  - Frequency bands: 4 bands vs. 1 band in Inium Sense
- OpenSound:
  - More accurate and updated information on where the sounds are coming from
  - Supports the **OpenSound** experience by making it easier to **locate** sounds





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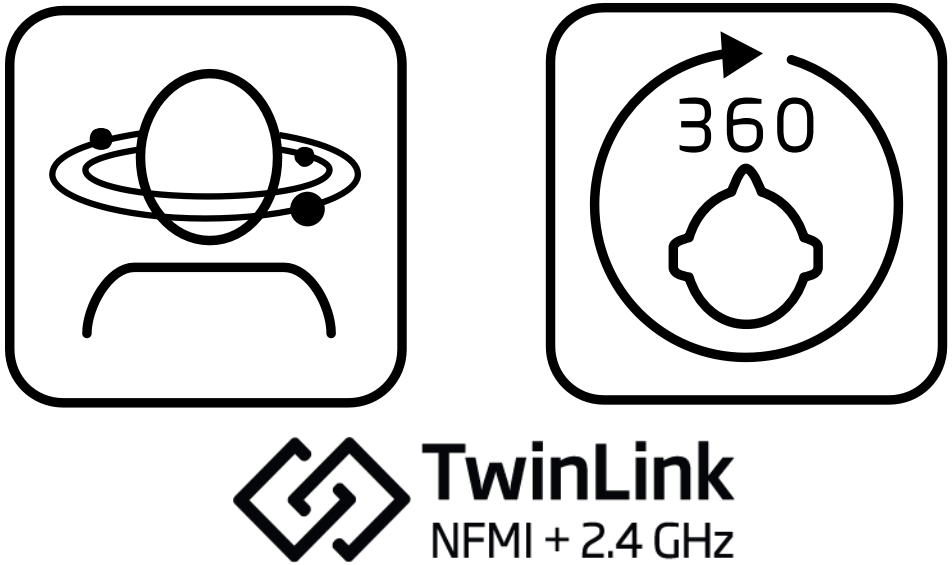
Platform and features to deliver OpenSound experience

Ensure that the elements of a sound scene continue to be accessible

OpenSound Navigator + Spatial Sound^{LX} = OpenSound experience



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Oticon Opn has the following new or updated functionality

BrainHearing benefits 2.0

New objective and proven methods for hearing research

Pupillometry to document reduced load on the brain

Recall more from conversations to enrich social interaction

Speech understanding to continue to improve well-known benefits

The hearing aid that makes it easier on the brain

Tested in conditions representing everyday communication

20% less load on the brain*

helps remember 20% more**

and understand 30% more***

* Wendt et al 2016
** Ng et al 2016, Individual benefit will depend on prescription
*** Ng et al 2016

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Pupillometry study at Eriksholm

The first of six Opn research studies completed

Pupil reacts to changes in sympathetic nervous system (SNS)

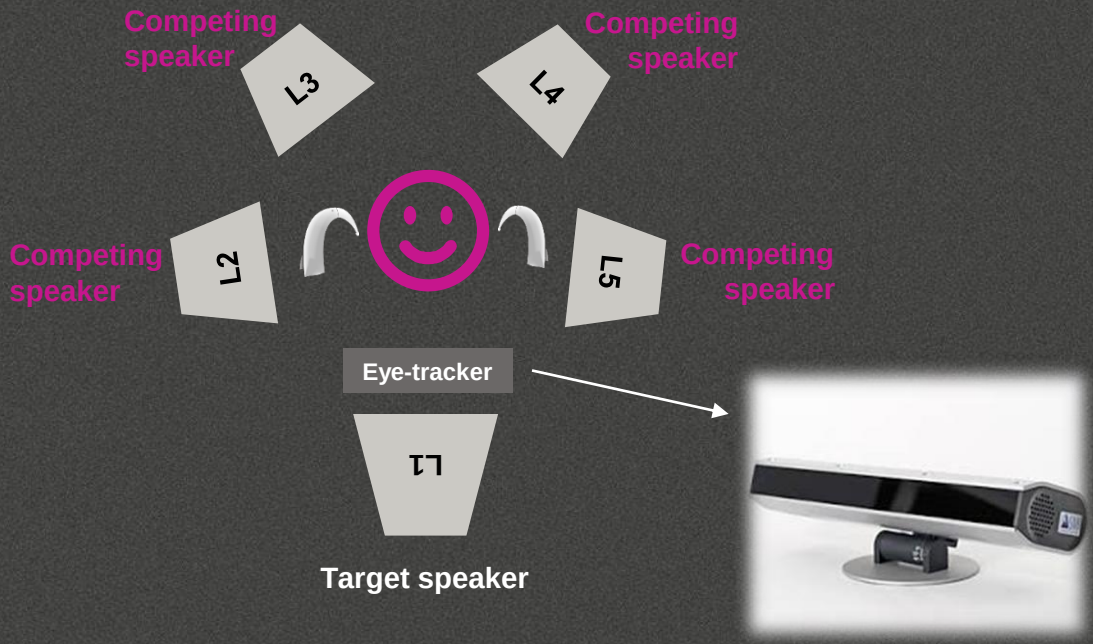
- A reaction due to perceived stressful conditions

Pupillometry in audiology and hearing science

- More challenging task indicated by a larger pupil (*Kahneman,1973*)
- Pupil size can quantify effort required for speech recognition in noise *(e.g. Kramer et al., 1997, Koelewijn et al., 2012, 2014)*
- Pupillometry is a sensitive and valid cognitive load index (Zekveld et al 2012)

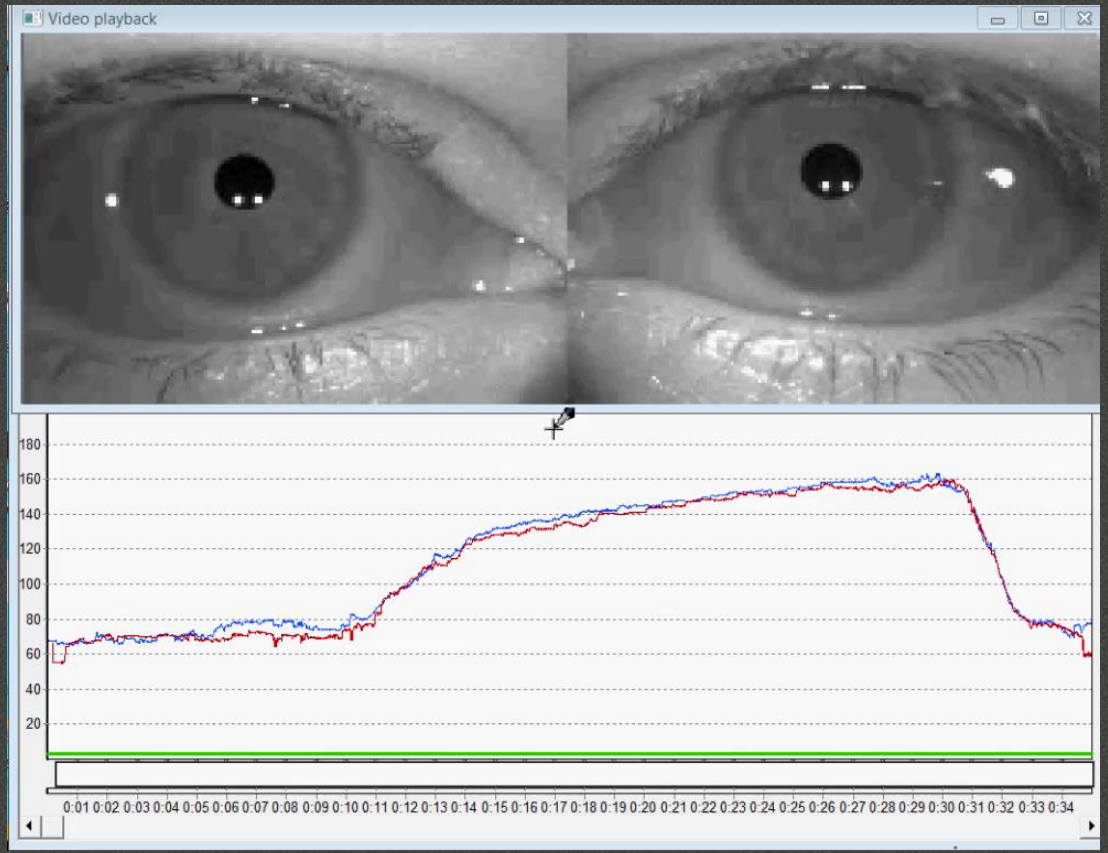
Set-up to mimic complex listening environment

24 people with hearing loss tested in the Cognitive Hearing Science lab at Eriksholm



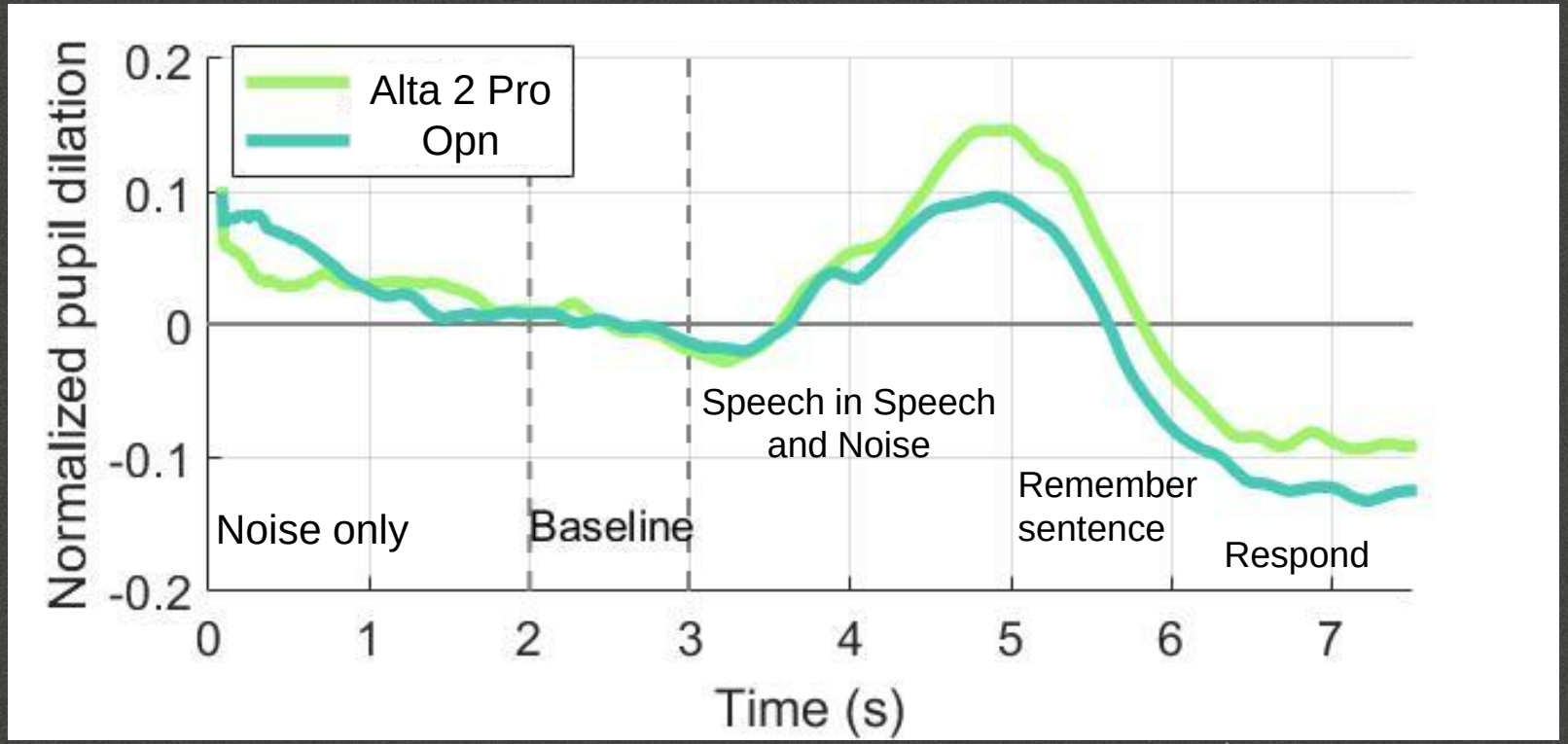
 Wendt et al 2016

Pupillometry for testing listening effort



Results: Opn versus Alta2

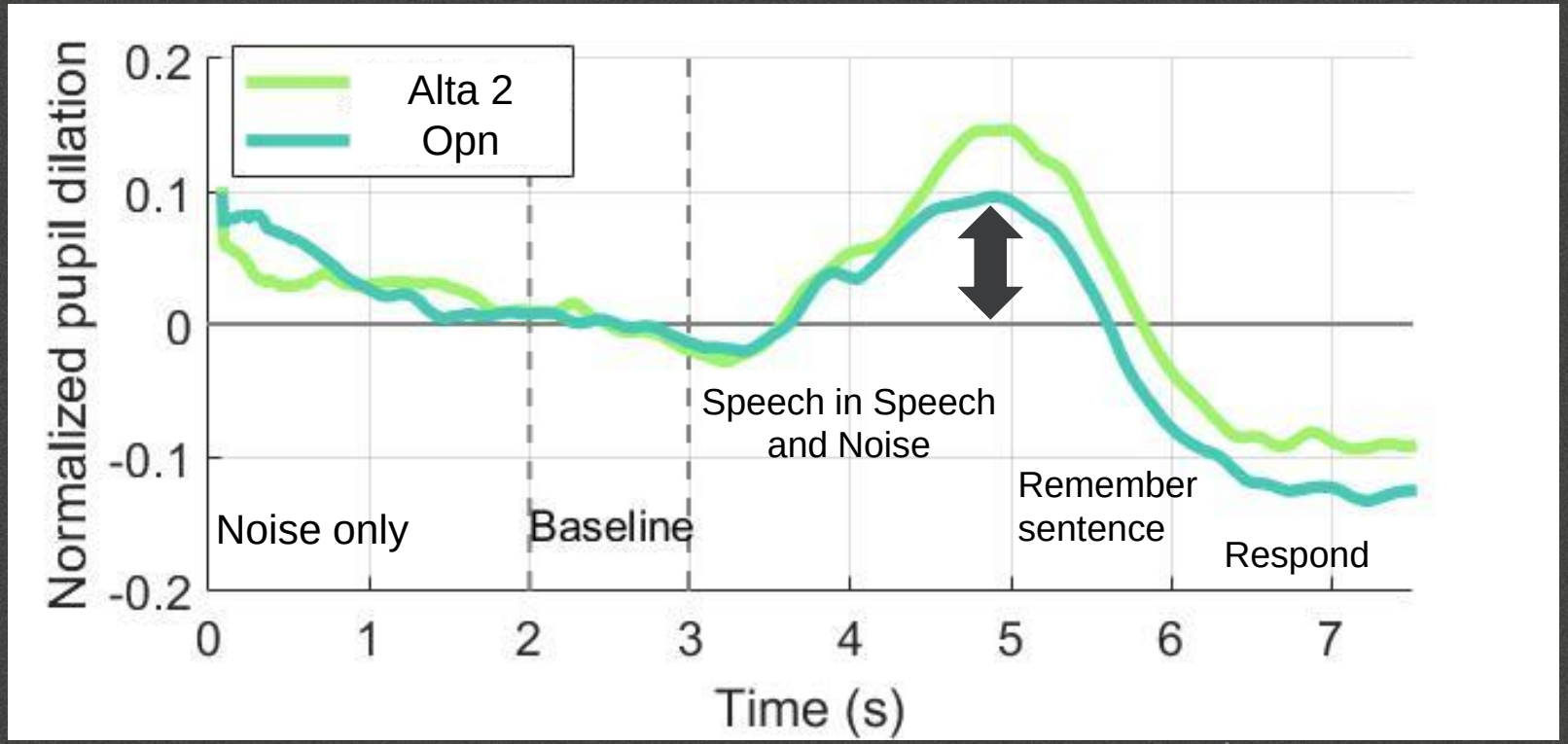
Speech understanding is at 95% or above during testing



 Wendt et al 2016

Results: Opn versus Alta2

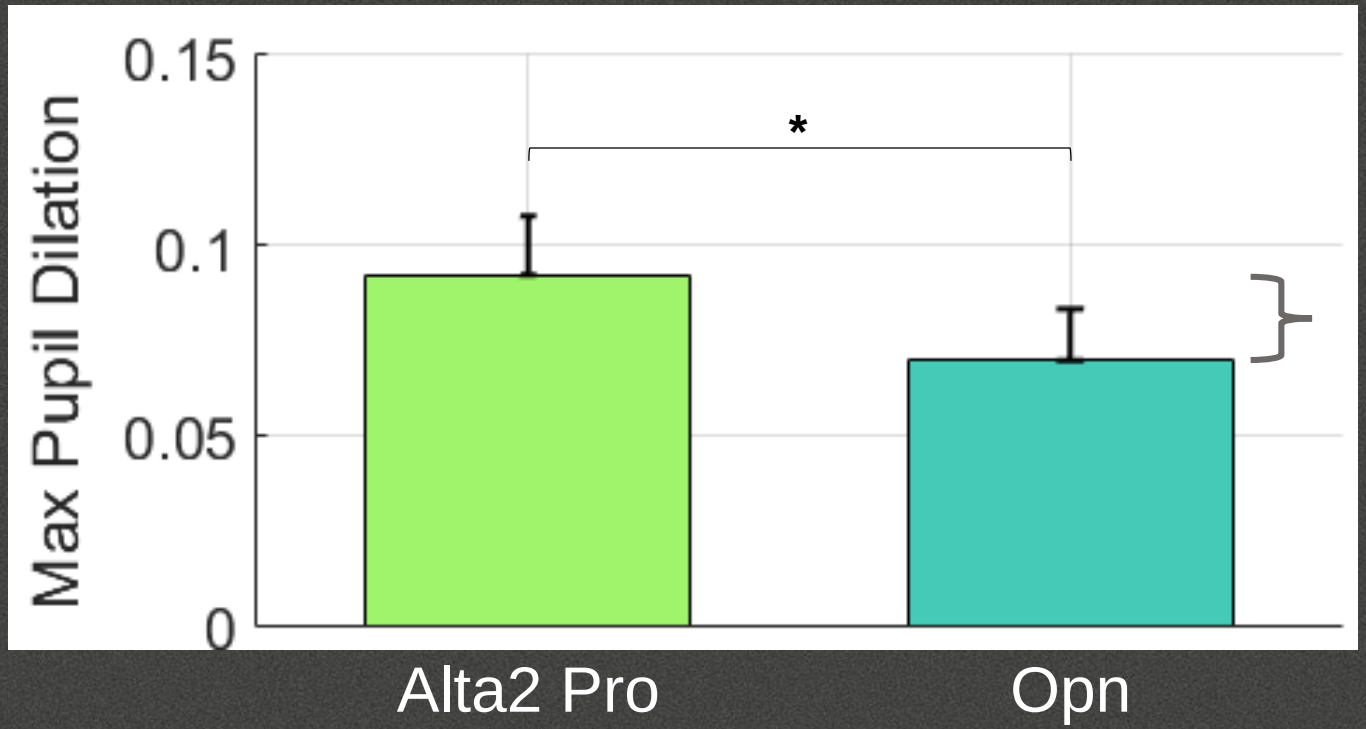
Speech understanding is at 95% or above during testing



Wendt et al 2016

Results: Opn versus Alta2 Pro

Speech understanding is at 95% or above during testing – 24 participants



Significant difference

28% reduction in pupil size

 Wendt et al 2016

First study showing noise reduction can improve recall!

The second of six Opn research studies completed

- Test conditions representing everyday communication

- Two types of situations tested:
  - Medium difficulty (95% speech recognition)
  - Increased difficulty (70% speech recognition)
- OpenSound Navigator on versus off
- 26 participants

Improved memory for speech heard in noise using a real-time noise reduction algorithm in hearing aids

Elaine H. N. Ng[1], Thomas Lunner[1,2], Jerker Rönnberg[1]

Background

Noise impairs speech understanding and has a negative impact on remembering the heard speech. Use of noise reduction signal processing in hearing aids may potentially improve memory for target speech heard in noise.

Ng et al. (2013, 2015) demonstrated that, using the Sentence-final Word Identification and Recall (SWIR) test, a hearing aid signal processing algorithm improved memory for speech heard in noise. In these two studies, auditory stimuli were pre-processed with the signal processing.

The present study aimed to measure the benefit of a noise reduction algorithm implemented in hearing aids. All auditory stimuli were processed real-time. Another aim of the study was to compare the benefit in terms memory performance at different presentation levels (SNRs predicting 95% and 70% speech intelligibility in noise). These levels were chosen because the auditory stimuli would be presented in an average positive SNRs, at which everyday communication (ecological listening condition) takes place (Lunner et al., 2016; Sahlin et al., 2016).

Methods

Participants

Twenty-six experienced hearing aid users of 38 to 86 years of age (mean=63.1, SD=12.5) with symmetrical sensorineural hearing loss of 37 to 66 dB HL (mean=49.1, SD=7.0) were tested.

Sentence-final Word Identification and Recall test

- All participants listened to 40 lists of sentences in the presence of a 4-talker babble. Each list contained 7 sentences.
- The task was to 1) repeat the final word after listening to each sentence, and after listening to all 7 sentences, 2) report back in any order, all final words in a list.

Presentation levels were individualized to optimize equality in listening effort across participants. Auditory stimuli were presented at SNRs predicting 95% (mean=4.0 dB SNR, SD=2.44) and 72% (mean=-1.8 dB SNR, SD=2.22) speech recognition in 4-talker babble.

- Two signal processing conditions were employed:
  1) OSN Pirrna (noise reduction off)
  2) OSN Max (noise reduction on)

Procedure

Listeners were seated in an anechoic room equipped with five loudspeakers on a circle with radius of 1 meter and the listener in the center. Speech stimuli were presented from the front (0°), four talks of one-talker babble were presented from loudspeakers placed at 90°, 135°, 225° and 270°.

Results

Figure 1. Percentage of correctly recalled words in OSN Pirrna and OSN Max at both 95% and 72% speech intelligibility across all participants. In general, recall performance was significantly higher, $F(1, 25)=15.2$, $p<0.01$, in OSN Max (bars in red) than in OSN Pirrna (bars in black).

Figure 2. Percentage of correctly recalled words in OSN Pirrna and OSN Max at both 95% and 72% speech intelligibility as a function of list position. Statistical analyses reveal that at 95%, OSN Max improved recall across all list positions. At 72%, similar results were found and, in particular, the improvement was the greatest in primacy position (1st and 2nd final words).

Conclusions

- This is the first study showing that a real-time noise reduction algorithm significantly improves memory for speech heard in noise.
- At 95% speech understanding. When speech understanding approaches 100%, noise reduction improves memory across all list positions. This suggests that noise reduction frees up cognitive resources and reduces the adverse effect of noise on memory for heard speech.
- At 72% speech understanding. Such benefit was greatest in remembering words in early-list positions when speech understanding is relatively more challenging. Better performance in early-list positions corresponds to better encoding of words into long-term memory, which is an ecologically important aspect of speech understanding under adverse conditions.

SWEDISH INSTITUTE FOR DISABILITY RESEARCH
LINNAEUS CENTRE HEAD GRADUATE SCHOOL

Ng et al, 2016, manuscript under preparation

Testing for recall from memory

SWIR (Sentence-final Word Identification and Recall)

- Listen to HINT sentence in background speech
- Repeat what you heard
- …
- Seven sentences in total
- Remember the last word
- …
- Recall as many last words as you can

Number	Word	Recalled from	Used for outcome
1	Garden	Long term memory	Yes
2	Mirror	Long term memory	Yes
3	Lunch	In transfer	?
4	Sister	In transfer	?
5	Train	In transfer	?
6	Box	Short term memory	Yes
7	Driver	Short term memory	Yes

Ng et al., 2013 + Ng. et al., 2015

Testing for recall from memory

SWIR (Sentence-final Word Identification and Recall) – 26 participants

- 25% improvement in long-term memory (70% condition, less in 95% condition)
- 5% improvement in short-term memory

Number	Word	Recalled from	Used for outcome
1	Garden	Long term memory	Yes
2	Mirror	Long term memory	Yes
3	Lunch	In transfer	?
4	Sister	In transfer	?
5	Train	In transfer	?
6	Box	Short term memory	Yes
7	Driver	Short term memory	Yes

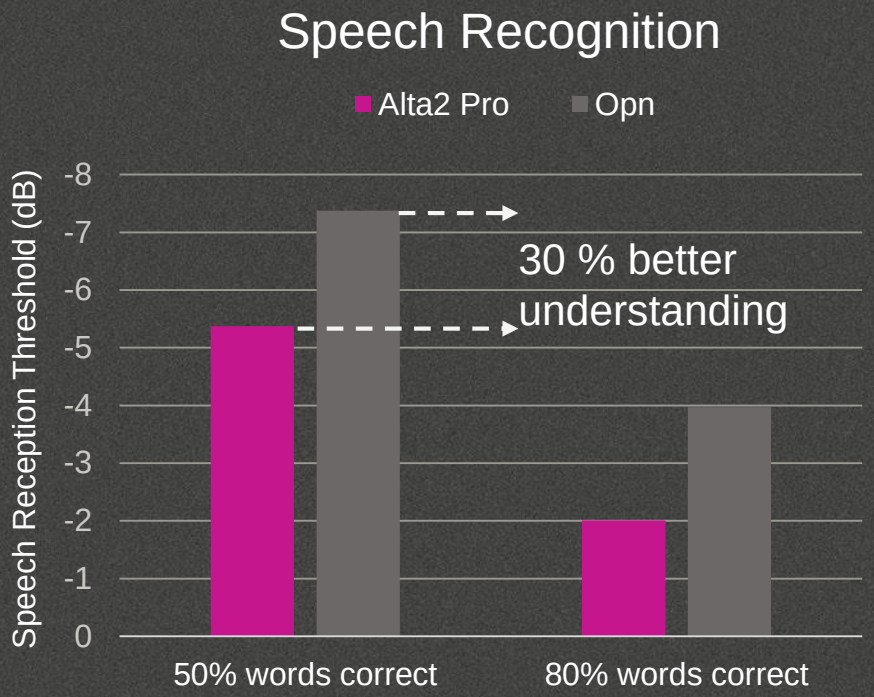
Ng. et al. 2016

Speech understanding

Also improvements in standard measures of speech recognition

- Test representing everyday communication

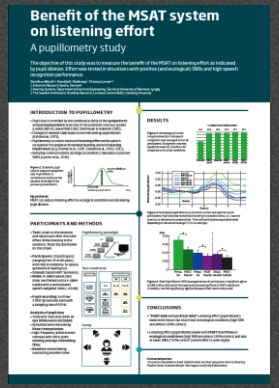
- Two types of situations tested:
  - Difficult (80% speech recognition)
  - Very difficult (50% speech recognition)
- 26 participants

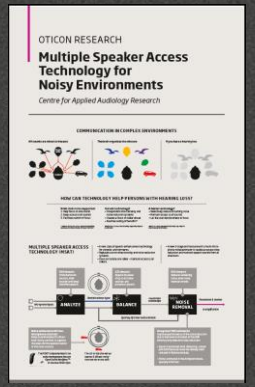


 Ng. et al 2016

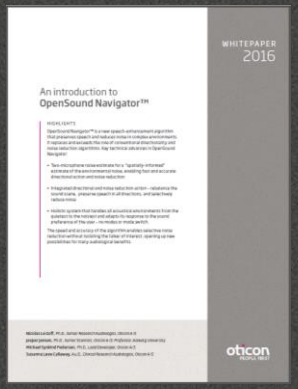
Evidence overview

Opn BrainHearing research





Opn audiology white papers



Acknowledgement: Ng et al, Kramer et al, Wendt et al, Le Goff, Weile

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The hearing aid that makes it easier on the brain

Clinically proven by scientifically recognised and published research methods

20% less load on the brain*

helps remember 20% more**

and understand 30% more***

* Wendt et al 2016
** Ng et al 2016, Individual benefit will depend on prescription
*** Ng et al 2016

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