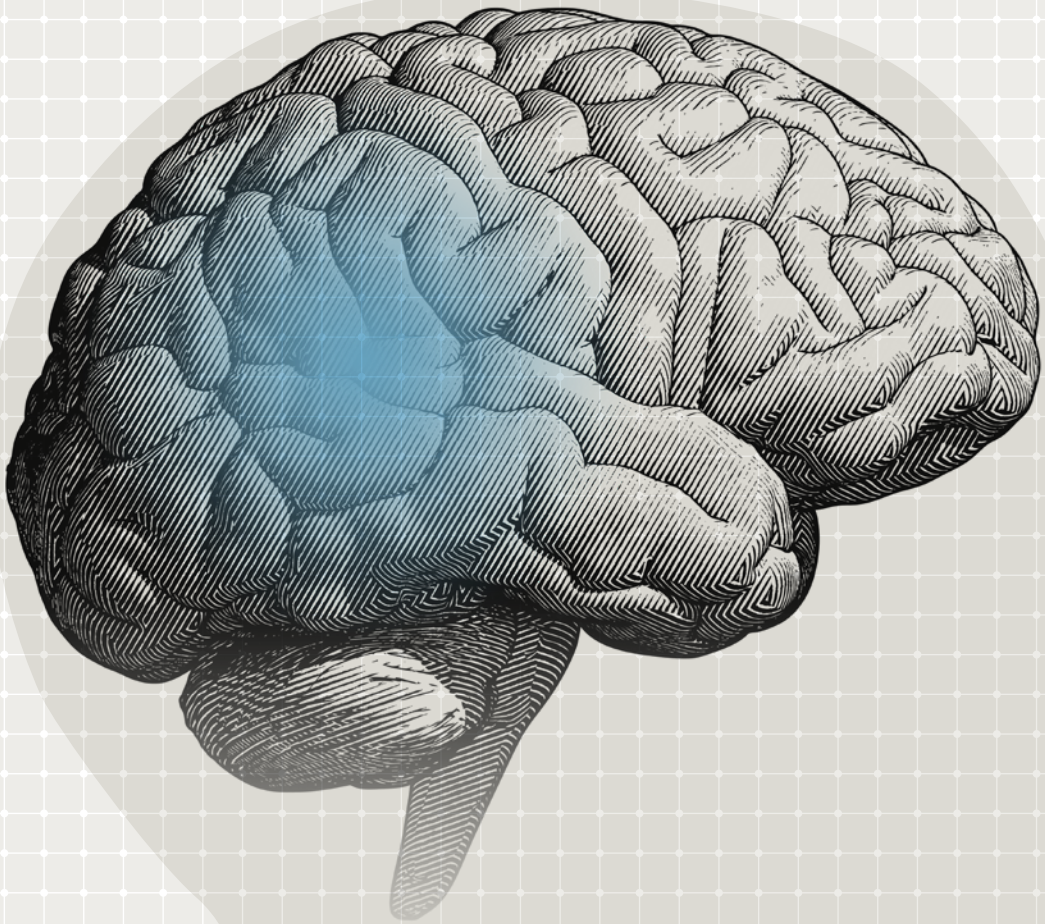
It's time for the

NEW PERSPECTIVE

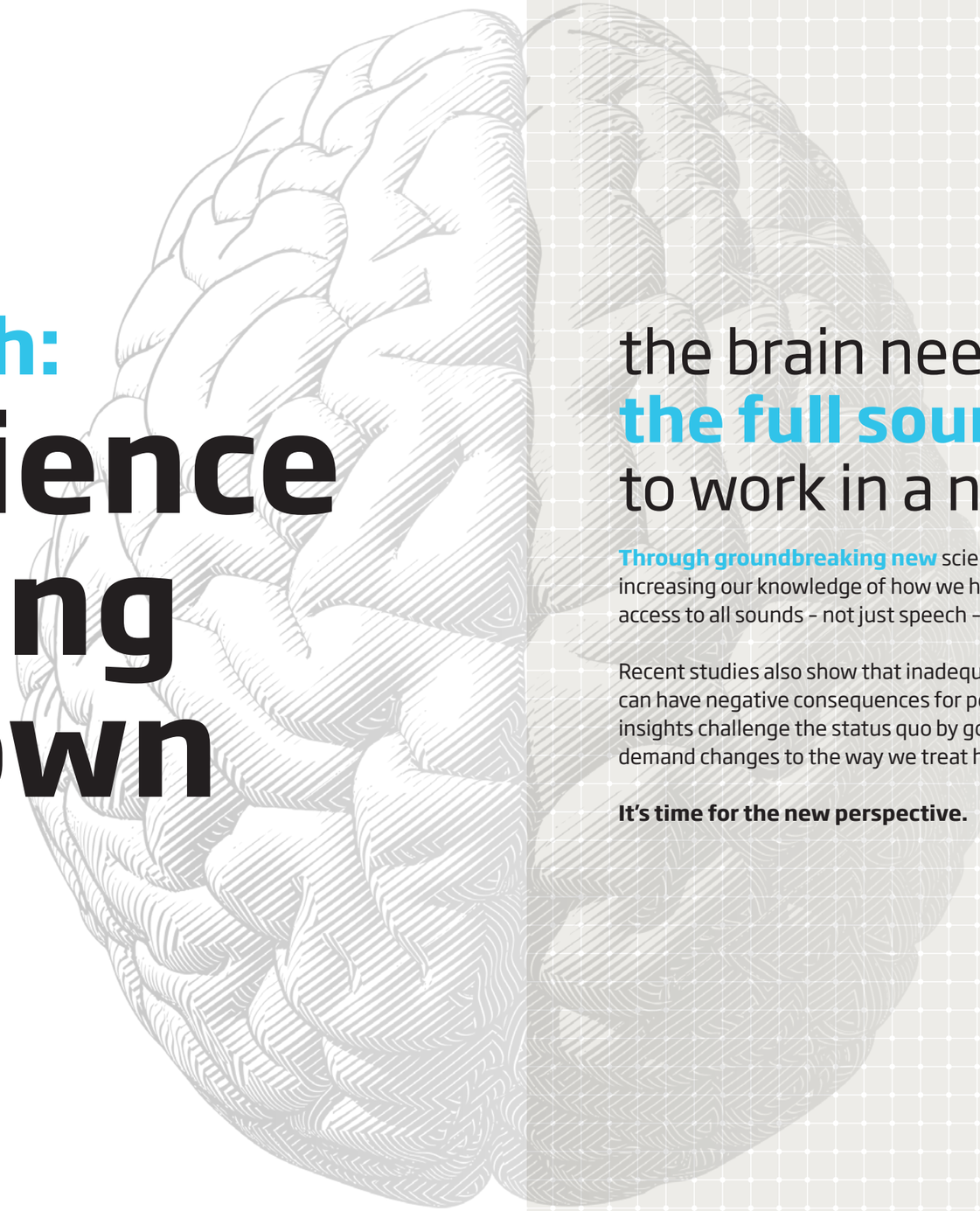
in BrainHearing™



oticon

life-changing technology

Breakthrough:
New science in hearing has shown

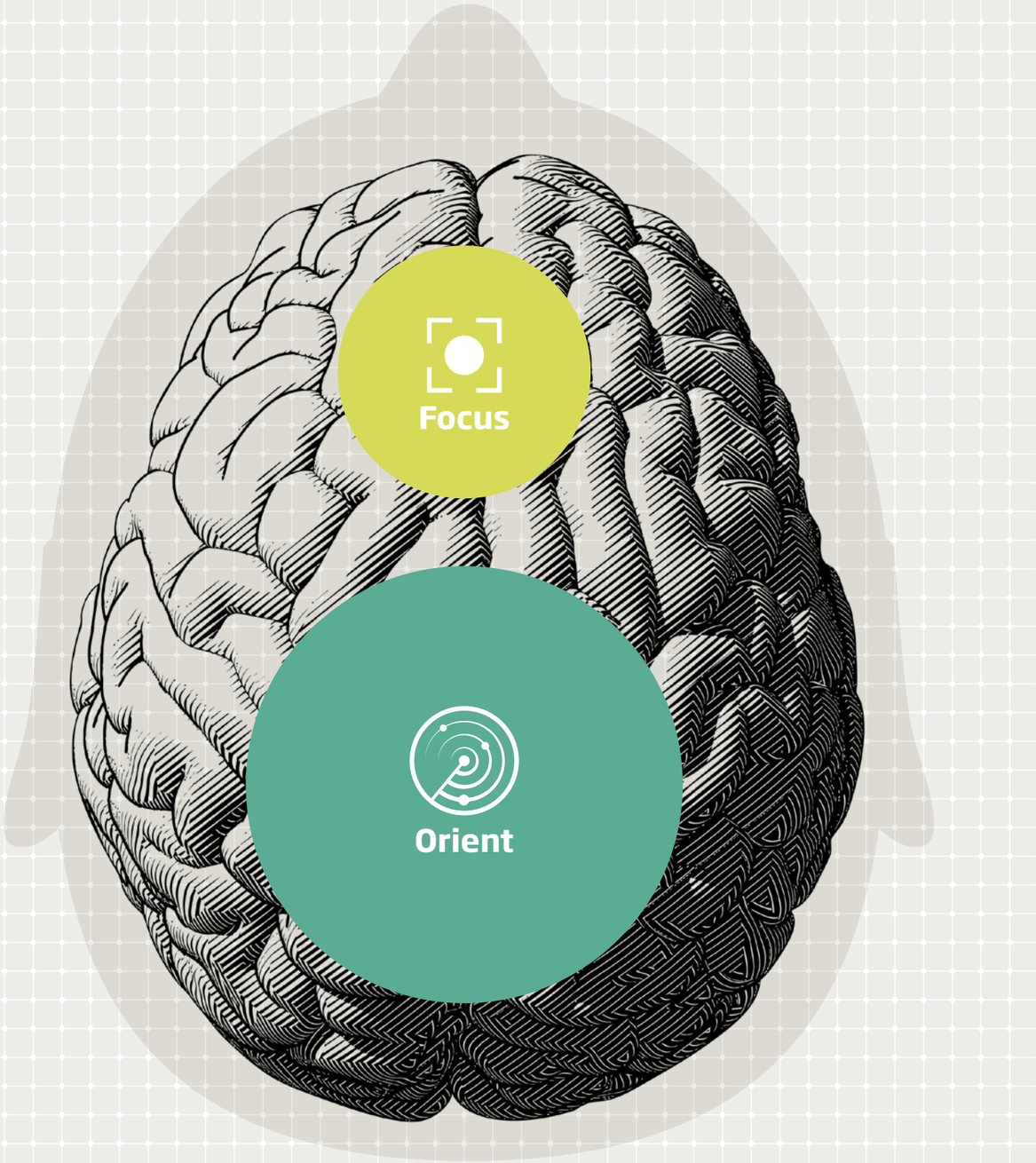


the brain needs access to **the full sound** scene in order to work in a natural way

Through groundbreaking new scientific discoveries in hearing, we are increasing our knowledge of how we hear. We now know that the brain needs access to all sounds – not just speech – in order to work in a natural way.

Recent studies also show that inadequate treatment of even mild hearing loss can have negative consequences for people's brains and lives. Together, these insights challenge the status quo by going against conventional thinking and demand changes to the way we treat hearing loss.

It's time for the new perspective.



The hearing centre in **the brain consists of two subsystems**

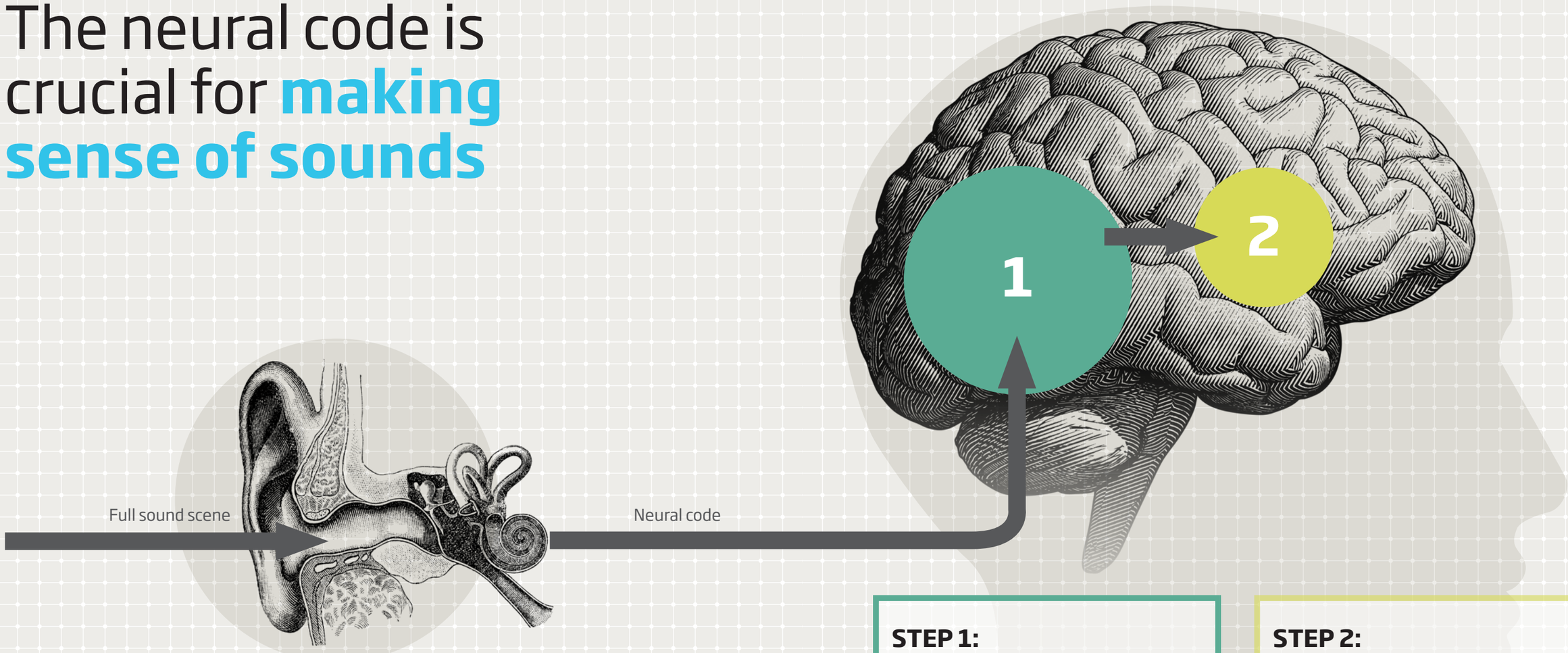
New research reveals* there are two subsystems that work together inside the brain to make sense of sound: the **orient subsystem** and the **focus subsystem**. While they are both responsible for different functions, our hearing depends on how well they work together.

Orient subsystem
The orient subsystem constantly scans all surrounding sounds – no matter their nature and direction – to create a full perspective of the sound scene.

Focus subsystem
The focus subsystem helps people select which sounds to listen to.

* O'Sullivan, et al (2019). Hierarchical Encoding of Attended Auditory Objects in Multi-talker Speech Perception. Neuron, 104(6), 1195-1209.Puvvada, K. C., & Simon, J. Z. (2017). Cortical representations of speech in a multitalker auditory scene. Journal of Neuroscience, 37(38), 9189-9196.

The neural code is crucial for **making sense of sounds**



How the hearing process works in the brain

When sounds reach the inner ear, they are converted into a neural code of information inside the cochlea. This neural code is then transported by the auditory nerve into the hearing centre of the brain – also known as the auditory cortex.

Inside the auditory cortex these neural codes become meaningful sound objects, which the orient- and focus subsystems can start working on.*

* O'Sullivan et al. (2019); Puvvada & Simon (2017).

STEP 1:

The orient subsystem creates an overview of the sound scene

The orient subsystem depends on a good neural code to create an overview of the sound objects and begin separating sounds to determine what is going on in the surroundings. This provides the brain with the best conditions to decide what to focus on and listen to.

STEP 2:

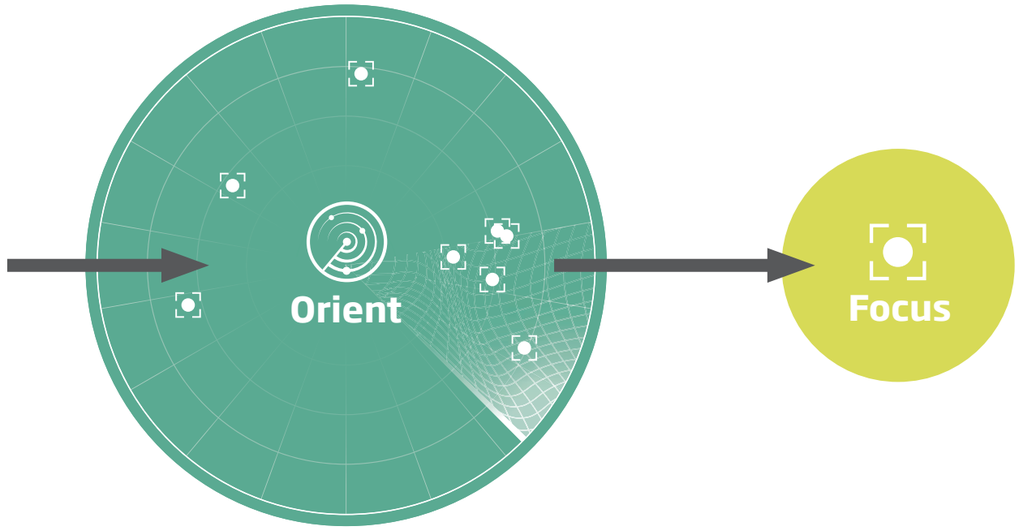
The focus subsystem allows us to focus on a point of interest

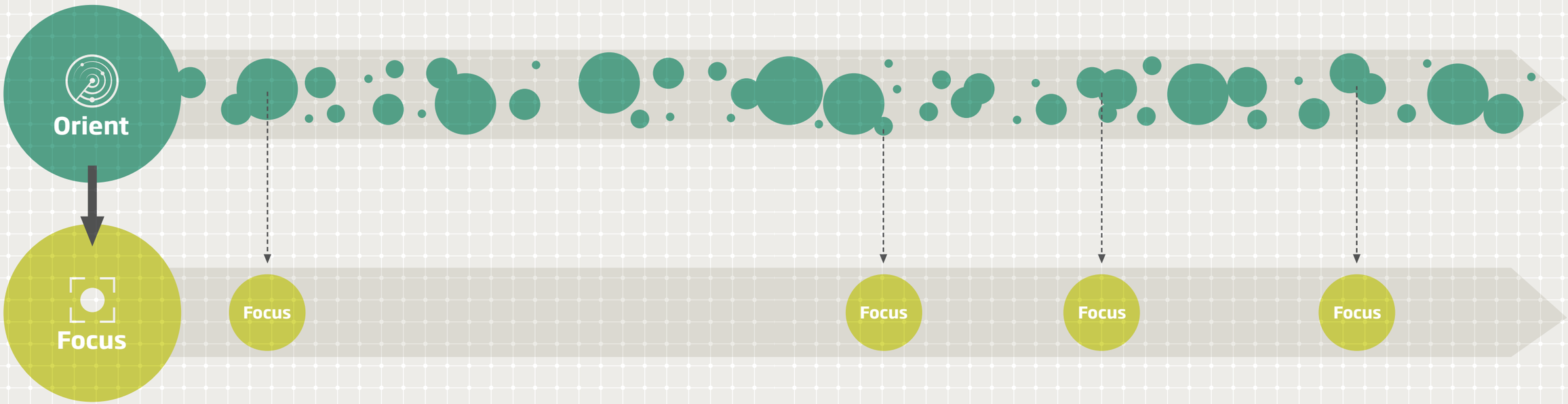
The focus subsystem navigates through the full perspective of the sound scene. It identifies the sound it wants to focus on, listen to, or switch attention to, while the irrelevant sounds are filtered out.

The two subsystems work together **continuously and simultaneously**

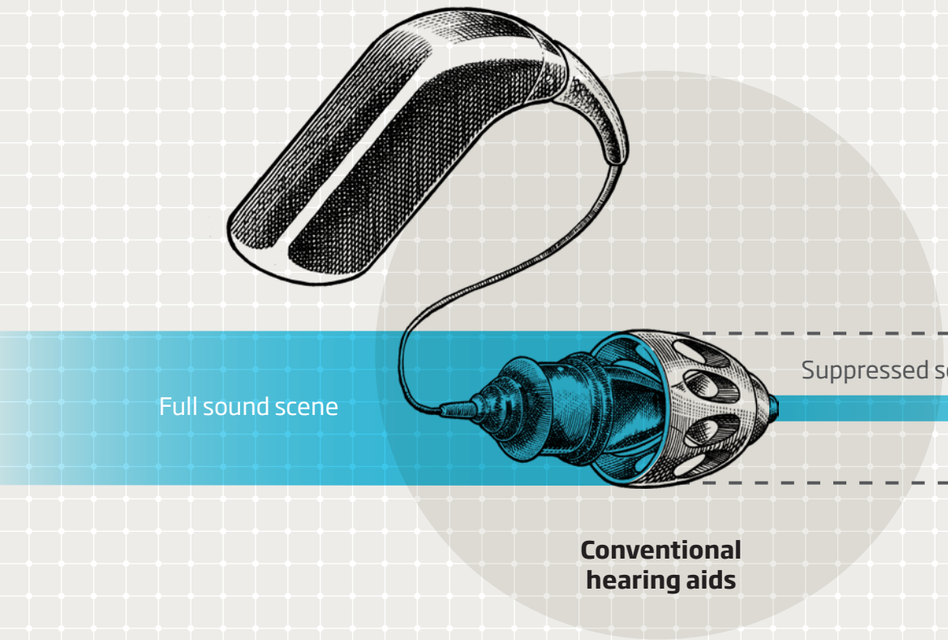
Sound processing by the brain involves a constant interaction between the orient- and focus subsystems. It is a continuous process that makes sure our present focus is always the most important. While maintaining focus, the brain actually distracts itself on purpose by checking in on the rest of the environment four times every second. This allows our focus hearing to switch attention if something important appears in the sound scene.

When the two subsystems work well together, the rest of the brain can work optimally, which makes it easier to recognize, store and recall sounds, and respond to what is happening.





Why we can no longer **use conventional technology**

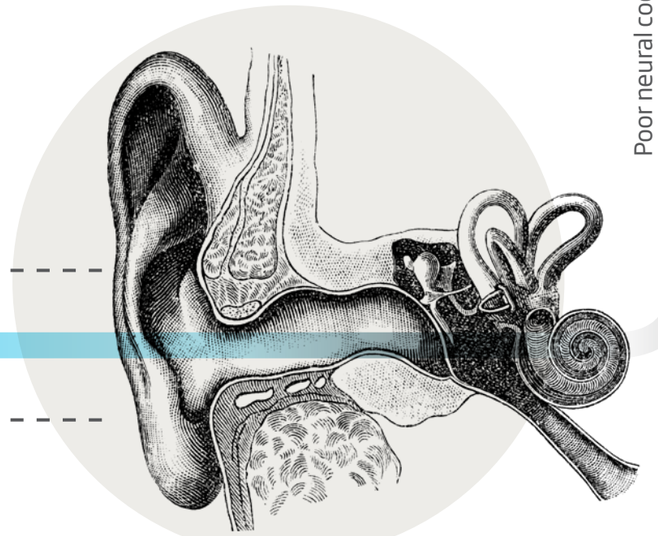


Suppressing the sound scene suppresses the hearing system

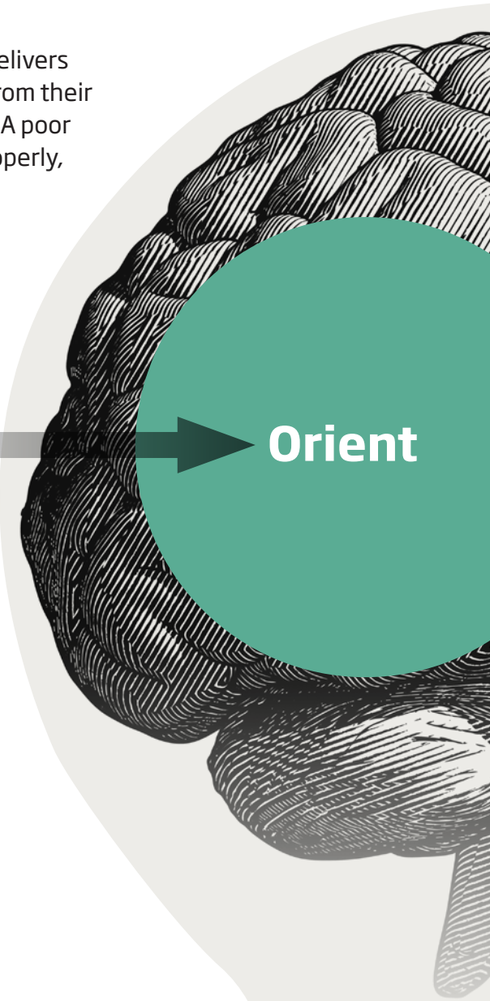
With its directionality, gain reduction, speech prioritization and traditional compression, conventional hearing aid technology restricts people's access to the full sound scene.

This limiting approach suppresses the natural sound input and delivers poor neural code to the brain. Not only does this cut people off from their surroundings, it goes against the brain's natural way of working. A poor neural code makes it harder for the orient subsystem to work properly, which then negatively impacts the focus subsystem.

This means it's not enough to use conventional hearing care technology to treat a hearing loss in a proper way.



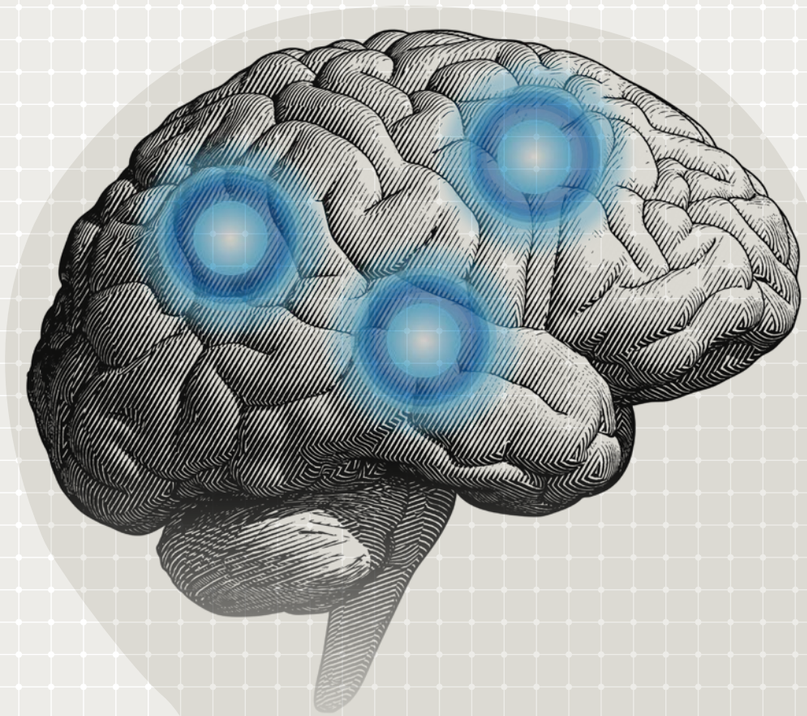
Poor neural code



When sounds are suppressed by the hearing aid, the ear sends a poor neural code to the brain.

A limited sound scene can turn a hearing problem into a **brain problem**

Downgrading input to the brain and failing to treat hearing loss in the correct way can have a variety of consequences



The consequences of inadequate hearing loss treatment:

1. **Increased listening effort**
With less sound information, it's harder for the brain to recognize sounds. It has to fill in the gaps, which requires more listening effort.

2. **Increased mental load**
Having to guess what people are saying and what's happening increases the mental load on the brain and leaves less mental capacity for remembering and performing.

3. **Reorganized brain functionality**
Without enough stimulation, in the hearing centre, the visual centre and other senses start to compensate, which changes the function of the brain.

4. **Accelerated cognitive decline**
Increased mental load, lack of stimulation and reorganized brain functionality is linked to accelerated cognitive decline, which affects the ability to remember, learn, concentrate, and make decisions.

5. **Accelerated brain volume shrinkage**
All human brains reduce in size with age, but the shrinkage process accelerates when the brain has to work against the natural way it processes sound.

1. Pichora-Fuller, M. K., Kramer, S. E., Eckert, M. A., Edwards, B., Hornsby, B. W., Humes, L. E., ... & Naylor, G. (2016). Hearing impairment and cognitive energy: The framework for understanding effortful listening (FUEL). Ear and Hearing, 37, 5S-27S. **2.** (Rönnberg, J., Lunner, T., Zekveld, A., Sörqvist, P., Danielsson, H., Lyxell, B., ... & Rudner, M. (2013). The Ease of Language Understanding (ELU) model: theoretical, empirical, and clinical advances. Frontiers in systems neuroscience, 7, 31.) **3.** Sharma, A., & Glick, H. (2016). Cross-modal re-organization in clinical populations with hearing loss. Brain sciences, 6(1), 4. **4.** Uchida, Y., Sugiura, S., Nishita, Y., Saji, N., Sone, M., & Ueda, H. (2019). Age-related hearing loss and cognitive decline–The potential mechanisms linking the two. Auris Nasus Larynx, 46(1), 1-9. **5.** Lin FR, Ferrucci L, An Y, Goh JO, Doshi J, Metter EJ, et al. Association of hearing impairment with brain volume changes in older adults. Neuroimage 2014;90:84-92.

And so, the brain problems can turn into **life problems**

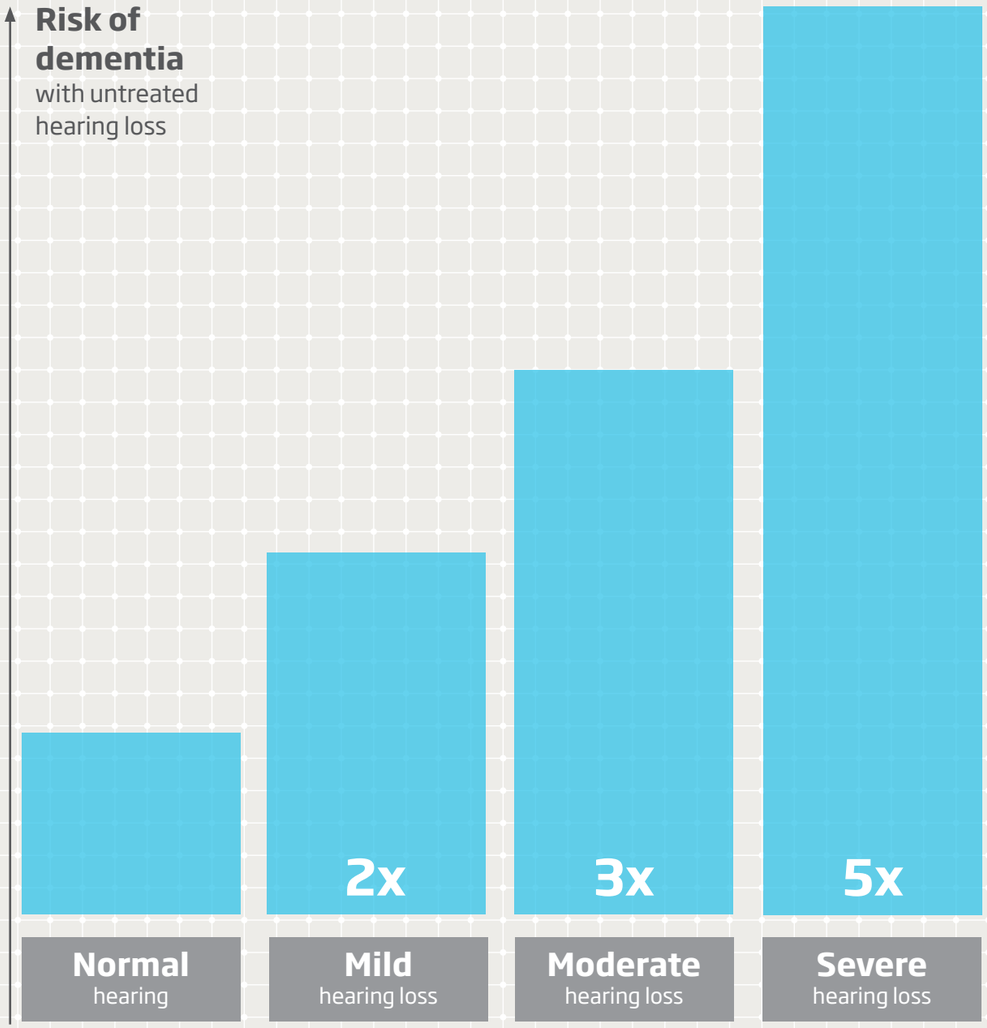
Inadequate treatment of a hearing loss, where access to the right input is limited, can lead to serious problems in life.

Increased risk of:

1. **Social isolation and depression**
People with untreated hearing loss may reach a stage where they avoid social gatherings because they are unable to cope with complex sound environments. This increases the risk of loneliness, social isolation, and depression.

2. **Poor balance and fall-related injuries**
An untreated hearing loss can affect balance, which increases the risk of fall-related injuries three-fold.

3. **Dementia and Alzheimer's disease**
The risk for dementia is increased five-fold for severe-to-profound hearing loss, three-fold for moderate hearing loss and two-fold for mild hearing loss.



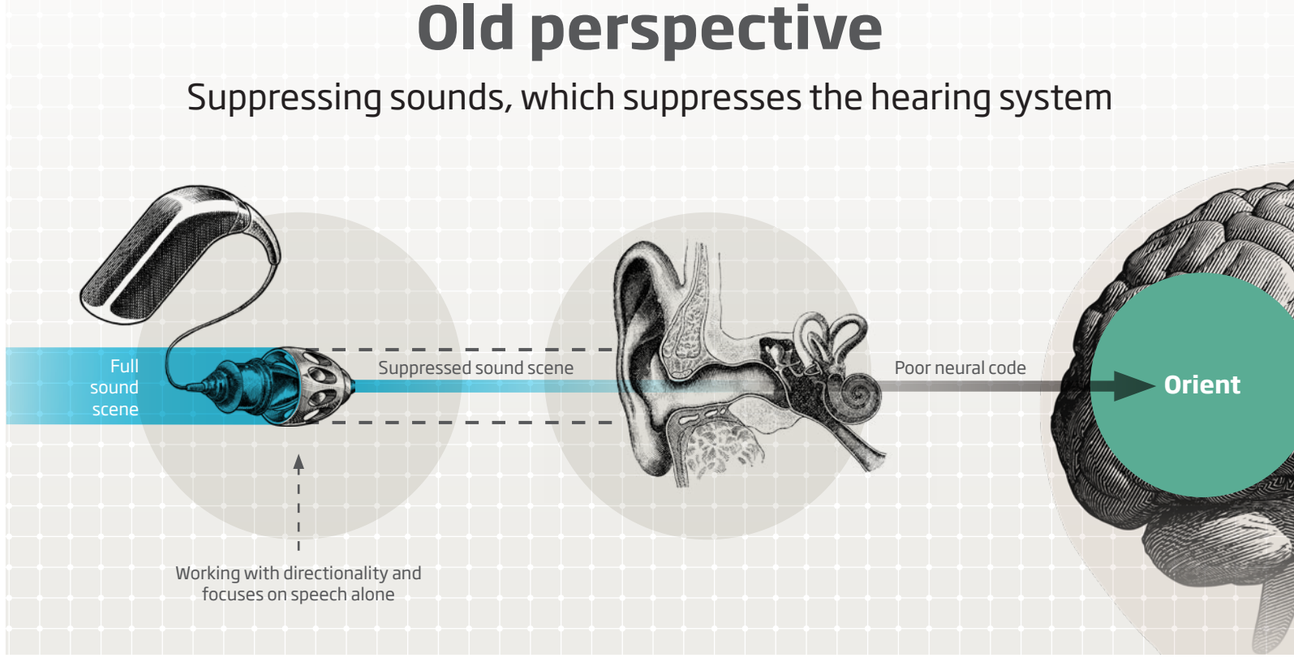
1. Amieva, H., Ouvrard, C., Meillon, C., Rullier, L., & Dartigues, J. F. (2018). Death, depression, disability, and dementia associated with self-reported hearing problems: a 25-year study. The Journals of Gerontology: Series A, 73(10), 1383-1389. **2.** Lin, F. R., & Ferrucci, L. (2012). Hearing loss and falls among older adults in the United States. Archives of internal medicine, 172(4), 369-371. **3.** Lin, F. R., Metter, E. J., O'Brien, R. J., Resnick, S. M., Zonderman, A. B., & Ferrucci, L. (2011). Hearing loss and incident dementia. Archives of neurology, 68(2), 214-220.

Changing perspective **to change lives**

Hearing aids must deliver a good neural code

These breakthroughs highlight the importance of hearing aids to delivering a good neural code that is easy for the brain to decode. And no matter the type of hearing loss, hearing aids must be able to ensure that all relevant sounds are accessible, clear, comfortable and audible in any situation.

This is necessary to be able to create the full perspective of sounds and the ability to maintain strong focus. As long as the neural code is of high quality, people with a hearing loss can handle the full sound scene. This is the new perspective in BrainHearing.



A visionary journey of Oticon's **BrainHearing philosophy**

Delivering life-changing technology that supports the brain's natural hearing process

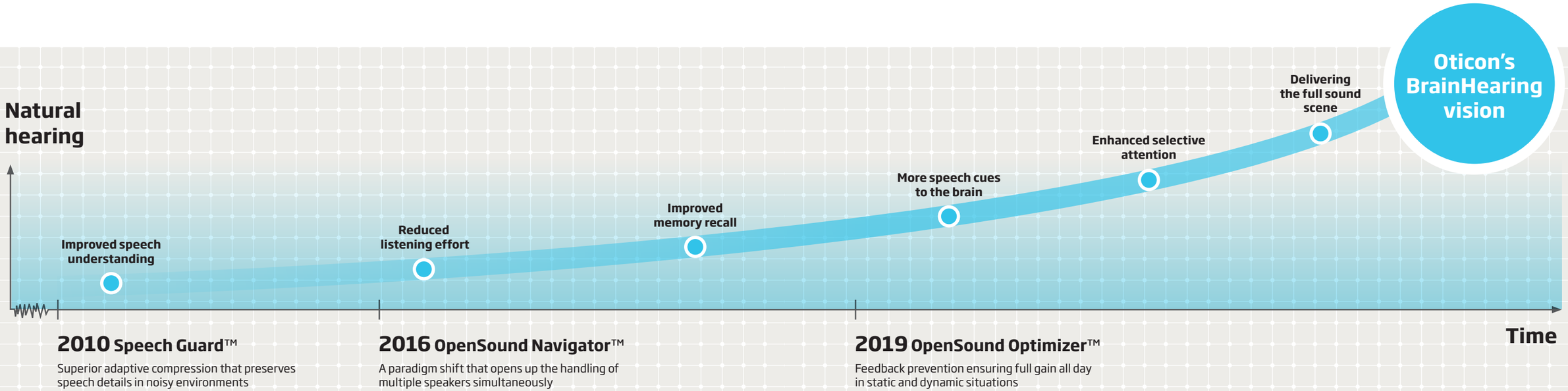
For too many years, the hearing care industry has addressed hearing care from a conventional perspective, limiting the stimuli provided to the brain. This approach is founded on outdated theories and mathematical assumptions without consideration for how the brain works and processes sound.

Oticon has always taken a different path in order to support the brain in how it makes sense of sound. Rather than focusing only on sound or the ears, we think brain first. It's a journey of constant research and discovery, as we, together with Eriksholm Research Centre, explore new scientific audiological territory.

This knowledge has led us to challenge conventions and develop hearing care technology that speaks the language of the brain. By improving speech details in noise, opening up to multiple speakers, and eliminating feedback*, our research has shown that innovations have enabled users to take part in social life like people with normal hearing**.

The latest scientific breakthrough demonstrates that providing the full sound scene is the best we can do for the brain to ensure it is able to perform naturally. This breakthrough defines our next step forward – one that will put our vision at the forefront of hearing care and make the new perspective in BrainHearing a reality.

* For hearing aid fittings according to best practice
** Closing a gap to normal hearing, see Oticon Whitepaper Juul-Jensen 2018



2010 Speech Guard™
Superior adaptive compression that preserves speech details in noisy environments

2016 OpenSound Navigator™
A paradigm shift that opens up the handling of multiple speakers simultaneously

2019 OpenSound Optimizer™
Feedback prevention ensuring full gain all day in static and dynamic situations

life-changing **technology**

Manufactured by:
Oticon A/S
Kongebakken 9
DK-2765 Smørum
Denmark
www.oticon.global

Imported and Distributed by:
Audmet Canada Ltd
1600-4950 Yonge St
Toronto, ON M2N 6K1
www.oticon.ca

oticon.ca/brainhearing

Oticon is part of the Demant Group.

oticon
life-changing **technology**

224604CA-US / 2020.07.21 / v1