# BRIDGING THE GAPS IN TINNITUS SCIENCE: A REPORT ON EMERGING RESEARCH PRIORITIES

## BY TINNITUS QUEST

*In partnership with:*

RAINWATER Charitable Foundation

Cochlear®

*INSIGHTS FROM OUR TINNITUS HACKATHON*

Wiesbaden, Germany
15-17 October

2025

## Executive Summary

Tinnitus Quest's 2025 Tinnitus Hackathon brought together leading scientists, clinicians, funders, and patient advocates to rethink how tinnitus research is conducted and to chart a clearer path toward effective, mechanism-based treatments capable of silencing tinnitus. Unlike traditional conferences, the hackathon prioritized active problem-solving, cross-disciplinary debate, and the development of a shared research agenda.

Participants agreed that the field suffers from fragmentation, insufficient mechanistic understanding, lack of objective measures, and limited industry engagement. They emphasized the urgent need for a shared tinnitus model, precision interventions, rigorous biomarkers, biologically grounded subtyping, validated models, open data, and better integration of neural, genetic, and network-level insights.

Survey and workshop discussions reinforced that the "knowns" of tinnitus remain high-level, while the "unknowns" span core mechanistic, diagnostic, and therapeutic questions. Breakout groups explored potential solutions through big data, AI, drug and device repurposing, lessons from other fields, and global research infrastructures — all underscoring the need for coordinated funding and a unified research framework.

From the Tinnitus Hackathon, ten critical research priorities emerged. These include defining tinnitus mechanisms, resolving whether a final common pathway exists, establishing clinically meaningful subtypes, understanding chronification, validating biomarkers, and identifying precise (multimodal) therapy targets. Tinnitus Quest will now convert these priorities into concrete research questions, funding strategies, and collaborative structures, aiming to accelerate the development of impactful treatments for millions of sufferers worldwide.

## Introduction

We need to rethink how the scientific field approaches one of its most complex, underfunded, and poorly understood conditions. The tinnitus research field is comparatively small yet operates in silos. There is no shared research agenda. We want the field to be laser focused on improving the lives of tinnitus sufferers by charting the quickest path to new and better treatments – treatments with the potential to silence tinnitus. What needs to be done to get there? What should the future of tinnitus research look like?

Tinnitus Quest's very first Tinnitus Hackathon took place in Wiesbaden, Germany, on 15-17 October 2025. Unlike traditional academic conferences, where findings are presented after the fact and there is little room for discussion, this event brought together leading scientists, clinicians, patient advocates, and research funders for an intensive, collaborative exploration of what is known, unknown, and what is needed to accelerate progress toward effective treatments.

The aims of the event were threefold:

- ⇒ **Challenge entrenched assumptions about tinnitus mechanisms, models, and research methodologies.**
- ⇒ **Identify critical gaps – biological, technological, and organizational – that currently obstruct large-scale progress.**
- ⇒ **Catalyze new collaborations and ideas that can drive the field in bold, innovative directions.**


What made this gathering fundamentally different was its structure and culture. Instead of one-way delivery of information, the hackathon fostered real-time brainstorming and problem-solving, including healthy disagreement. Participants were encouraged to question prevailing models and merge perspectives across neuroscience, biomedical science, AI, clinical practice, and patient advocacy. Unconventional approaches were explored, from digital twin simulations to AI-driven data analysis, drug repurposing, and global open-data frameworks.

The discussions documented in this report reflect the complexity of tinnitus and the collective determination to overcome fragmentation and accelerate discovery. We are acutely aware, however, that this changes nothing unless we follow through with action. More about that in the conclusions of this report.

## Three Perspectives on Moving the Field Forward

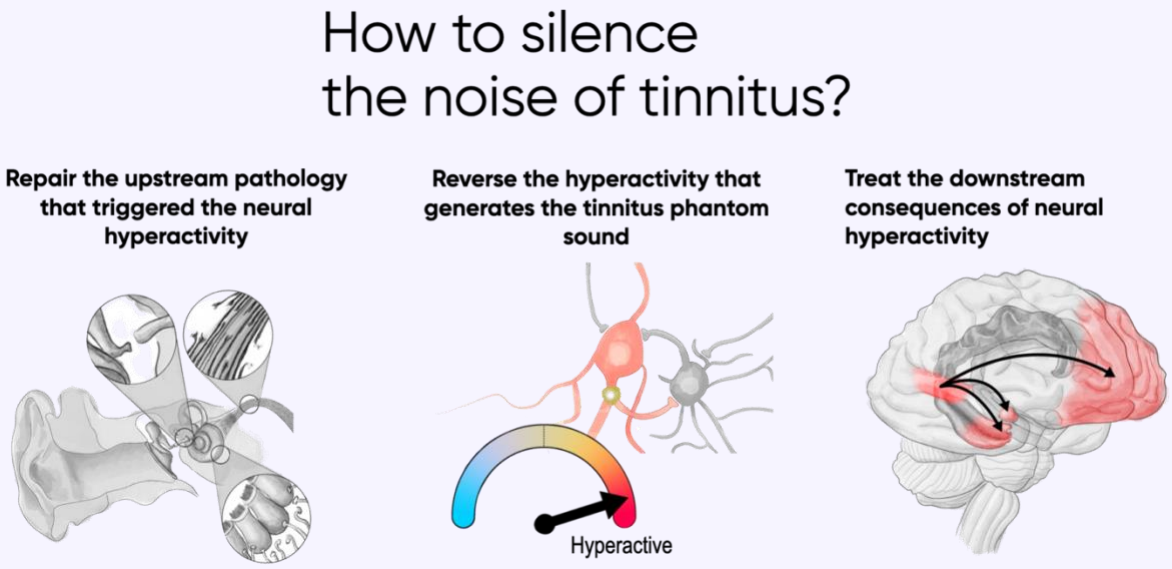
After a welcome dinner the night before, we kicked off the scientific program with three presentations on the future of tinnitus research.

### Dan's Perspective: Precision, Not Oversimplification

**Dr. Daniel (Dan) Polley** – Professor of Otolaryngology at Harvard Medical School, Vice-Chair for Basic Science at Massachusetts Eye and Ear, and Director of the Lauer Tinnitus Research Center – emphasized that many current tinnitus research models rely on oversimplified assumptions about how the brain works. He argued that animal models rarely capture the true human condition and stressed the need for:

- Targeting endogenous repair processes and well-defined neural circuits
- Biomarker-driven precision interventions rather than broad interventions
- Placebo-controlled study designs
- Adopting rigor and standards seen in fields like oncology

His message: to make progress, tinnitus research must move beyond generic, non-mechanistic interventions.



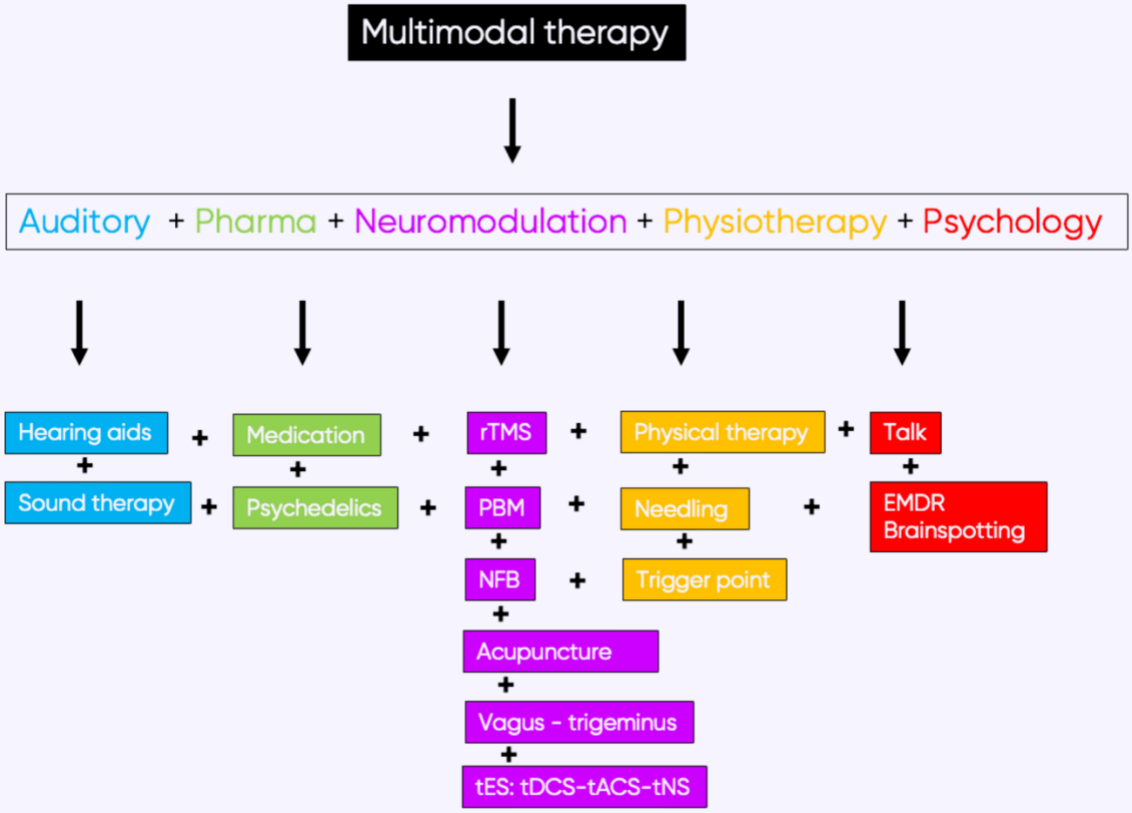

*Daniel Polley (2025)*

## Dirk's Perspective: Tinnitus as a Network Disorder

**Dr. Dirk de Ridder** – Professor of Neurosurgery at the Dunedin School of Medicine, University of Otago (NZ), specializing in neuromodulation for phantom perceptions such as tinnitus and pain – framed tinnitus as an emergent property of interacting brain networks rather than a localized abnormality. He advocated:

- Mechanism-based, multimodal, multitarget therapies
- Insights from network science to disrupt pathological hubs
- Development of a "digital twin brain" — a virtual, individualized simulation to personalize treatment
- Less reliance on averaging across subjects; more focus on individualized modeling

His framework positions tinnitus as a dynamic systems disorder requiring tailored, network-level solutions.




*Dirk de Ridder (2025)*

## Amy's Perspective: A Blueprint for Collaborative Success

**Amy Rommel** – Scientific Program Director at the Rainwater Charitable Foundation, overseeing medical-research portfolios including tinnitus biomarker initiatives – encouraged us to draw insights from successful global efforts in tauopathy research, highlighting the transformative power of:

- Open data
- Cross-border collaboration
- Unified criteria, biomarkers, and shared diagnostic frameworks

Her foundation's achievements, such as the first tau PET biomarker (Tauvid) and PSP diagnostic criteria, serve as a model for tinnitus research. She emphasized that funders must work together, not in silos.

Amy introduced the TIDE Consortium, a global effort to develop a quantitative tinnitus biomarker. Seven labs across five countries collaborate to overcome the limitations of subjective

self-reporting. The initiative underscores the field's most urgent need: a reliable, objective measure of tinnitus.

## Discussion: Complexity, Heterogeneity, and Paths Forward

Participants agreed that tinnitus is highly heterogeneous and that current approaches fail to capture this complexity. While evidence-based medicine remains essential, mechanism-based reasoning must play an equal role. There was particular enthusiasm for combining pharmacological and neuromodulatory interventions, while borrowing strategies from pain, HIV, and cancer research. The concept of a digital twin for the auditory system was widely regarded as promising but requires careful consideration of ethics, patient expectations, and data needs.

Participants agreed that fragmentation of efforts across countries and institutions is a serious problem. Also, the field struggles to attract investment from industry due to lack of biomarkers and validated models. Open questions included which milestones would unlock commercial interest. Everyone agreed on the need for standardization, coordinated funding, shared protocols and data sharing mechanisms.

## The Biomarker Debate

A central debate revolved around what a tinnitus biomarker should be and do:

- Should it measure loudness, distress, neural activity, or treatment response?
- Should it be objective, subjective, or both?
- How should it interface with clinical trials?

The group agreed that defining the biomarker concept itself is a necessary first step.

## Workshop: The Knowns and Unknowns of Tinnitus Science

The workshop identified consensus “knowns” and major “unknowns”. We started by going through the results of survey participants filled out before the event. Analysis of the survey results clearly showed that the list of knowns was much shorter than the list of unknowns.

**SURVEY RESULTS: THE ‘KNOWNS’ OF TINNITUS SCIENCE**

**Models:**

- Tinnitus is a phantom percept or a central auditory phenomenon that arises when the brain compensates for reduced or missing auditory input through maladaptive neuroplastic changes
- Tinnitus is a “network problem” involving central auditory and non-auditory (emotional, attentional) systems

**Relation to hearing loss:**

- Deafferentation: loss of auditory nerve input triggers the abnormal neural activity that can be perceived as tinnitus
- Hearing loss or cochlear damage is the most common trigger/risk factor
- In most cases, tinnitus is initiated in the ear (peripheral damage) but maintained or amplified in the brain
- Restoring auditory input can sometimes reduce symptoms

**Heterogeneity:**

- Some forms of tinnitus may be somatosensory-related while others are purely auditory or neurologically driven
- Emotional and psychological factors affect severity and distress

The group agreed that this is quite a meager outcome, as the areas of agreement are all quite high-level. The list of “unknowns” from the survey, on the other hand, was much longer. We will only summarize it here, as the list will be revisited in our Conclusions section where we will identify the key gaps that we need to resolve in order to move the field forward.

**SUMMARY OF TINNITUS SCIENCE 'UNKNOWNS'**

- Precise neural mechanisms of tinnitus
- Genetic and biological predispositions
- How tinnitus subtypes differ and converge
- Lack of objective diagnostic tools
- What determines the chronification of tinnitus
- Lack of clear therapeutic targets

A central debate emerged on whether a final common pathway exists. In other words, do all tinnitus types converge into a shared central mechanism or do different peripheral injuries/etiologies create different brain-state end-points? Opinions were divided, reflecting the field's unresolved foundational questions. This question matters for developing effective treatments.

## Breakout Groups: How Would You Cure Tinnitus If…

Participants were divided into five groups, each of which explored different hypothetical strategies, based on the question: "How would you cure tinnitus if …". The groups then reported their thoughts and findings, summarized below:

### If you could only study tinnitus through large-scale population data:

- Longitudinal, high-frequency population data are crucial
- We should mandate open data in funded research
- Need to develop a canonical model that represents a way in which this data can be interpreted in common ways and methods
- Concerns about data security but consensus that benefits outweigh risks

### If you had to borrow solutions and insights from other fields:

- Pain and tinnitus share mechanistic overlaps
- Explored thalamocortical dysrhythmia as a shared mechanism across pain/epilepsy/depression/Parkinson's/tinnitus
- Requires formal trials, validated animal models, clear outcome measures, and a clearer understanding of shared pathways


**If you could only repurpose existing drugs, devices, and technologies:**

- **Drugs:**
    - All drugs that restore hearing have potential for tinnitus, e.g. AC102 from AudioCure Pharma, currently in Phase 2 trials, which is meant for sudden sensorineural hearing loss treatment and seems to restore the ribbons synapses at the inner hair cells
    - Drugs that restore inhibition in the brain, e.g. anticonvulsants, KCC2 modulators
    - Drugs that normalize abnormal neuronal activity/restore inhibition, e.g. potassium channel modulators or modulators of KCNQ4
    - Drugs that modulate inflammation, for example in patients that have an acute noise trauma, e.g. a TNF-alpha blocker (now also in a clinical trial); here the timing would be extremely relevant
    - Serendipitous discoveries: develop a monitoring system for case reports that mention when using drug x in a specific patient, the tinnitus vanishes or is reduced
- **Devices/Technologies:**
    - Cochlear implants and more broadly electrical stimulation of the auditory nerve – experiences from cochlear implant patients are promising
    - Hearing aids can reduce tinnitus in some patients
    - Brain stimulation techniques like TMS, tDCS have been tested for tinnitus, with mixed results

**If you went all-in on AI:**

- AI can fill data gaps, and according to a recent Nature paper, it does a much better job than typical imputation regression models
- When it comes to identifying genes, the number of possible genes is so large that AI could automate such processes and find patterns – the same principle applies to any other pattern recognition tasks, e.g. imaging studies
- Wearables and smart devices may provide real-world monitoring and intervention

### If you had unlimited funding and resources:

- Envisioned global infrastructures for shared data, resources, and technology
- Key restriction is time, so allow people to focus on what they're best at and apply the 80/20 rule
- Create pillars from basic to clinical/applied research and move research along the pillars quickly – fail fast
- Leverage PR and social media to create awareness and urgency

## Tinnitus Hackathon Conclusions

The hackathon highlighted both the tremendous potential and the critical obstacles in tinnitus research today. There are some fundamental unknowns to resolve, and tackling these will be

critical to moving the field forward and developing more effective solutions that could silence tinnitus.

### 1. What are the precise neural mechanisms that generate tinnitus?

- Whether tinnitus originates primarily in the ear, the brain, or through interactions across both
- Which neural circuits are causative vs. compensatory
- How auditory and non-auditory networks (attention, limbic, default mode, salience) interact to produce the percept

A definitive mechanistic model is foundational for targeted therapies.

### 2. Is there a "final common pathway" for tinnitus — or multiple distinct pathways?

Do all tinnitus types converge into a shared central mechanism?

Or do different peripheral injuries/etiologies create different brain-state end-points?

This question matters because:

- If one pathway → a universal treatment may be feasible
- If multiple → subtyping becomes essential for precision medicine

### 3. How should tinnitus be subtyped in a clinically meaningful way?

Current subtyping is crude (e.g., tonal vs. noise-like; with vs. without hearing loss).

Needed are biologically grounded subtypes based on:

- Neural signatures
- Genetic predispositions
- Peripheral vs. central pathology
- Chronification mechanisms
- Network-level dysfunction

Without subtyping, trials are noisy and treatments appear ineffective even when they work for subsets.

### 4. What is the biological basis of tinnitus chronification?

A central unknown is why:

- Some people recover

- Some develop persistent tinnitus
- Some worsen over time

Hence, we need to figure out:

- Which early neural changes predict chronicity
- Whether chronification reflects maladaptive plasticity, network reorganization, or other processes
- What time window exists for intervention

Understanding chronification is critical for prevention and treatment.

### 5. What should a tinnitus biomarker measure — and how can it be validated?

There is significant confusion around the purpose of a biomarker:

- Should it detect the presence of tinnitus?
- Quantify loudness?
- Track severity or distress?
- Identify mechanisms or subtypes?
- Serve as a treatment response indicator?

Resolving this conceptual issue is essential before a biomarker can be designed or funded.

A validated biomarker is arguably the single biggest accelerator for:

- Clinical trials
- Drug development
- Industry participation and investment
- Personalized interventions

### 6. How can we develop valid and translatable animal or computational models?

Dan Polley strongly emphasized that current animal models do not reflect the human condition.

- Can an animal model reliably reproduce human tinnitus percepts or neural activity?
- If not, should the field shift to computational or hybrid models (e.g., digital twins)?
- What minimal criteria must a model satisfy to be useful for drug or device testing?

Without a validated model, most potential treatments will not survive the translation to human models, and industry investment remains limited.

### 7. What endogenous repair or plasticity mechanisms can be therapeutically targeted?

There was enthusiasm for:

- Manipulating specific neural circuits
- Enhancing natural plasticity
- Activating self-repair pathways
- Combining neuromodulation with pharmacology
- Borrowing from pain and epilepsy models

But the precise targets remain unknown. Identifying them is crucial for mechanism-based therapies.

### 8. What shared mechanisms exist between tinnitus and related conditions (pain, epilepsy, depression, anxiety)?

Possible shared mechanisms include:

- Thalamocortical dysrhythmia
- Network hyperexcitability
- Shared neurotransmitter pathways
- Emotional/attentional modulation

If a shared pathway exists, existing drugs might be repurposed quickly. But this requires clearer mechanistic mapping.

### 9. How can consolidation and expansion of datasets illuminate tinnitus models and dynamics?

A lot of data lives in silos and cannot be accessed by other researchers. Gathering similar datapoints across studies for meta-analysis (perhaps with AI) could elevate the field by allowing analysis of much larger datasets. We could, for instance, gather brain images from various studies to get closer to a common understanding of the brain regions involved in tinnitus. Or consolidate clinical trials results for treatments that have been tested repeatedly by different teams, like TMS, to generate new insights on effective treatment protocols.

Furthermore, longitudinal (population) data is key to finding:

- Predictors of onset, remission, and relapse
- Daily or hourly fluctuation patterns
- Relationships with sleep, stress, noise exposure, and neural state
- Identifying “tipping points” in chronification

Wearables, smartphone-based sampling, and AI can transform this domain, but the field hasn't yet defined what patterns matter most.

### 10. What combination therapies are most effective — and for which subtypes?

Several discussions recognized the need to study:

- Drug + neuromodulation combinations
- Behavioral + biological treatments
- Multitarget approaches across networks

But key questions remain:

- Which combinations meaningfully interact?
- Which subgroups benefit from which combinations?
- How should trials be structured to test multimodal interventions?



## Next Steps

Tinnitus research is, in many ways, still in its infancy. There are major hurdles to clear, as illustrated in this report.

Tinnitus Quest will be working hard over the coming months to translate the above-mentioned unknowns into actionable items. This includes key research questions that need to be tackled and an institutional framework to tackle them. Our own grants program will be geared towards this, but we will also seek far-reaching alignment with other research funders to ensure a clear common focus. Furthermore, we will explore the potential of open data and AI to accelerate the path to real solutions for sufferers.

The event – a first of its kind – ultimately reinforced a shared commitment to accelerating progress toward meaningful tinnitus treatments. But it's only the first step in a longer endeavor to take tinnitus research to the next level, to meaningfully improve the lives of millions of sufferers.

## ANNEX: List of Attendees

| NAME | AFFILIATION(S) |
|---|---|
| SVEN KÖLLMANN | Tinnitus Quest, Fibona |
| HAZEL GOEDHART | Tinnitus Quest, Tinnitus Hub |
| DIRK DE RIDDER | Tinnitus Quest, Brai3n, University of Otago |
| DANIEL POLLEY | Tinnitus Quest, Mass Eye and Ear (Harvard), American Tinnitus Association |
| BERTHOLD LANGGUTH | Tinnitus Quest, University of Regensburg |
| WINFRIED SCHLEE | Tinnitus Quest, Eastern Switzerland University of Applied Sciences |
| KURT STEINMETZGER | Tinnitus Quest, Tinnitus Center Charité |
| ARNAUD NORENA | Tinnitus Quest, Aix-Marseille University |
| INGE STEGEMAN | Tinnitus Quest, University of Utrecht |
| JACK RUBINACCI | Tinnitus Quest |
| AMY ROMMEL (REMOTE) | Rainwater Charitable Foundation |
| RALPH HOLME | RNID |
| ALEX BROOKS-JOHNSON | Tinnitus UK |
| YISHANE LEE | Hearing Health Foundation |
| JEFFERY REAGAN | Tinnitus Learning Health Network |
| KELLY ASSOULY | Cochlear |
| NICOLAS GNINENKO | Neurosoft Bioelectronics, University of Bern |
| MARLIES KNIPPER | University of Tübingen |
| KONSTANTIN TZIRIDIS | University of Erlangen |
| ALAIN LONDERO | European Hospital Georges Pompidou, France Acouphènes |
| PETER MCNAUGHTON | King’s College London |
| FELIX STÜBNER | Lufthansa, CDU |

## QUESTIONS?

CONTACT US AT
INFO@TINNITUSQUEST.COM

JOIN THE QUIET REVOLUTION

*We thank our partners at the Rainwater Charitable Foundation and Cochlear for making the Tinnitus Hackathon possible.*



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