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Precision Audiology: Advanced Diagnostics to Individualize Treatment for Sensorineural Hearing Loss, in partnership with the University of Pittsburgh

Samantha Hauser, AuD, CCC-A



Samantha Hauser, AuD, CCC-A

Samantha Hauser is a PhD candidate in the Department of Speech, Language, and Hearing Sciences at Purdue University. She is co-mentored by Drs. Hari Bharadwaj and Michael Heinz. Her current research explores diagnostic tools sensitive to the individual differences in cochlear pathology that underlie sensorineural hearing loss. Samantha received her AuD from Vanderbilt University in 2018 and worked as a clinical audiologist in Connecticut before beginning her PhD.

Disclosures

- **Presenter Disclosure:** Financial: Samantha Hauser's research and PhD training are supported by funding from the National Institutes of Health (NIH). Non-financial: Samantha Hauser has no relevant non-financial relationships to disclose. AudiologyOnline is making a donation to the audiology program at the University of Pittsburgh for this presentation.
- **Content Disclosure:** This learning event does not focus exclusively on any specific product or service.
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- The applicability and accuracy of the course content may vary by the clinical, geographical, and cultural context; you should evaluate the course accordingly.
- As healthcare is rapidly evolving, new findings may change the validity of the information presented in this course. Providers should always consult the latest research and guidelines from professional associations.
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- Healthcare providers should apply cultural competence and sensitivity to ensure effective and respectful care based on their patients' diverse needs.
- Providers should always evaluate the limitations of diagnostic and screening tools, considering their potential for false results as well as any ethical implications.
- It is the responsibility of course participants to critically evaluate the evidence from multiple sources to guide professional practice.

Learning Outcomes

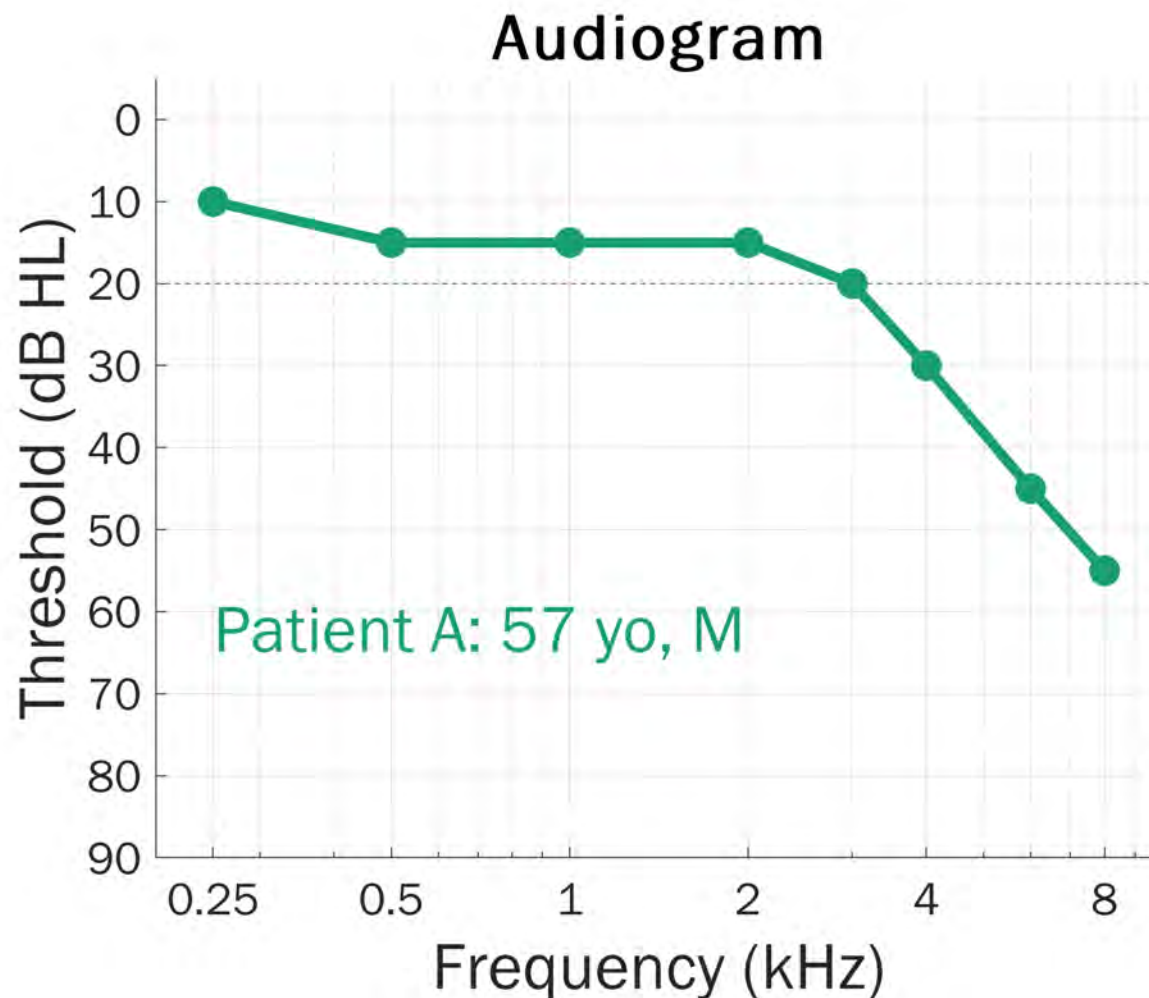
After this course, participants will be able to:

- Identify limitations of current audiological diagnostics in characterizing the heterogeneity of pathologies that underlie sensorineural hearing loss.
- Define the fundamental principles of precision medicine and how its core concepts can be applied to audiological practice.
- Describe emerging approaches for improving precision in diagnostic assessments and their role in personalizing treatments for hearing loss.

Overview

- Limitations of current diagnostics and their effect on how we treat hearing loss
- Precision Medicine
- Applying Precision Medicine to Audiology
- Approaches to Precision Diagnostics
 - Examples from Cross-Species Studies
- Preparing for the Future

A Common Clinical Scenario

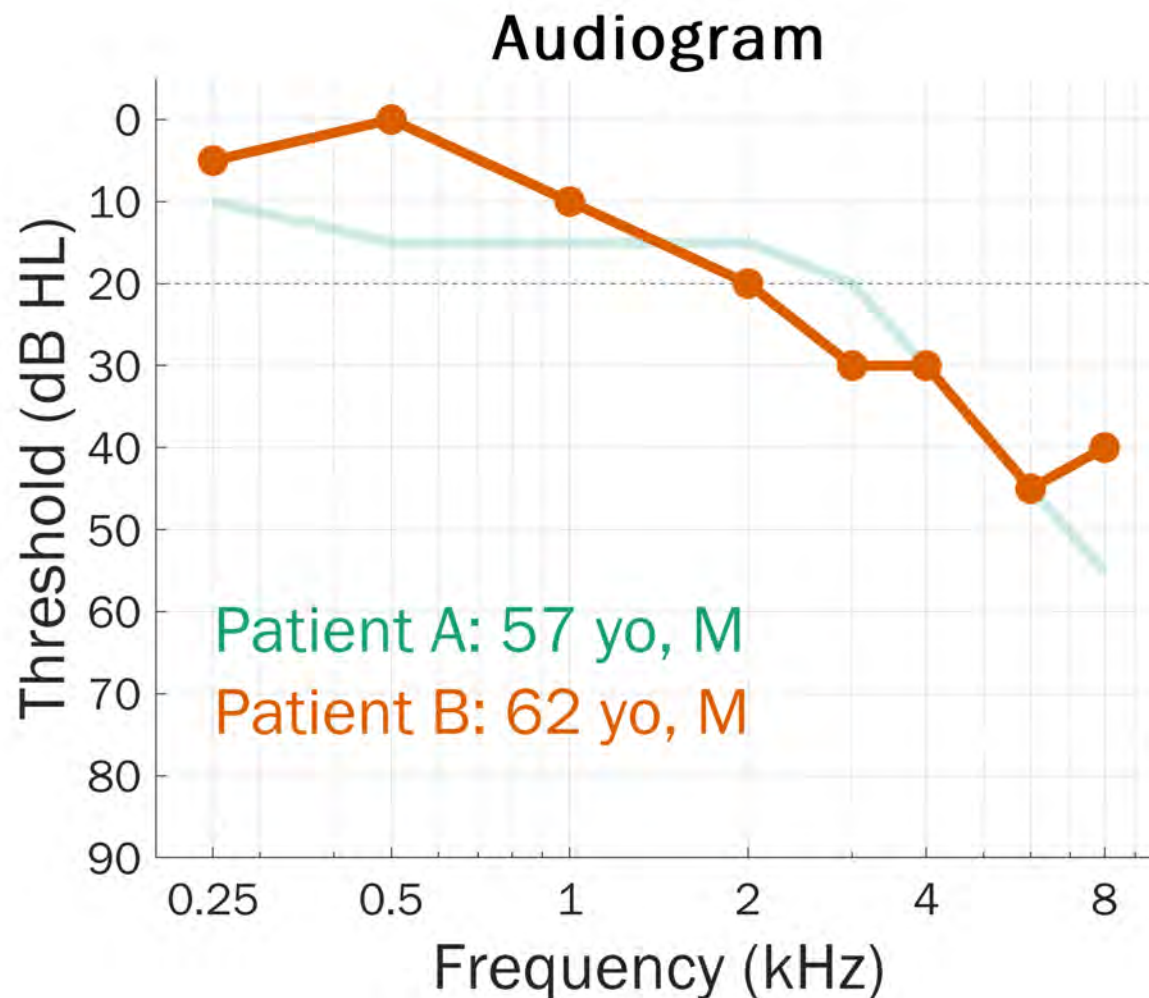


Interested in
hearing aids

Can't follow the
conversation if
there is more than
1 person talking

QuickSIN: -1 dB
SNR Loss

A Common Clinical Scenario

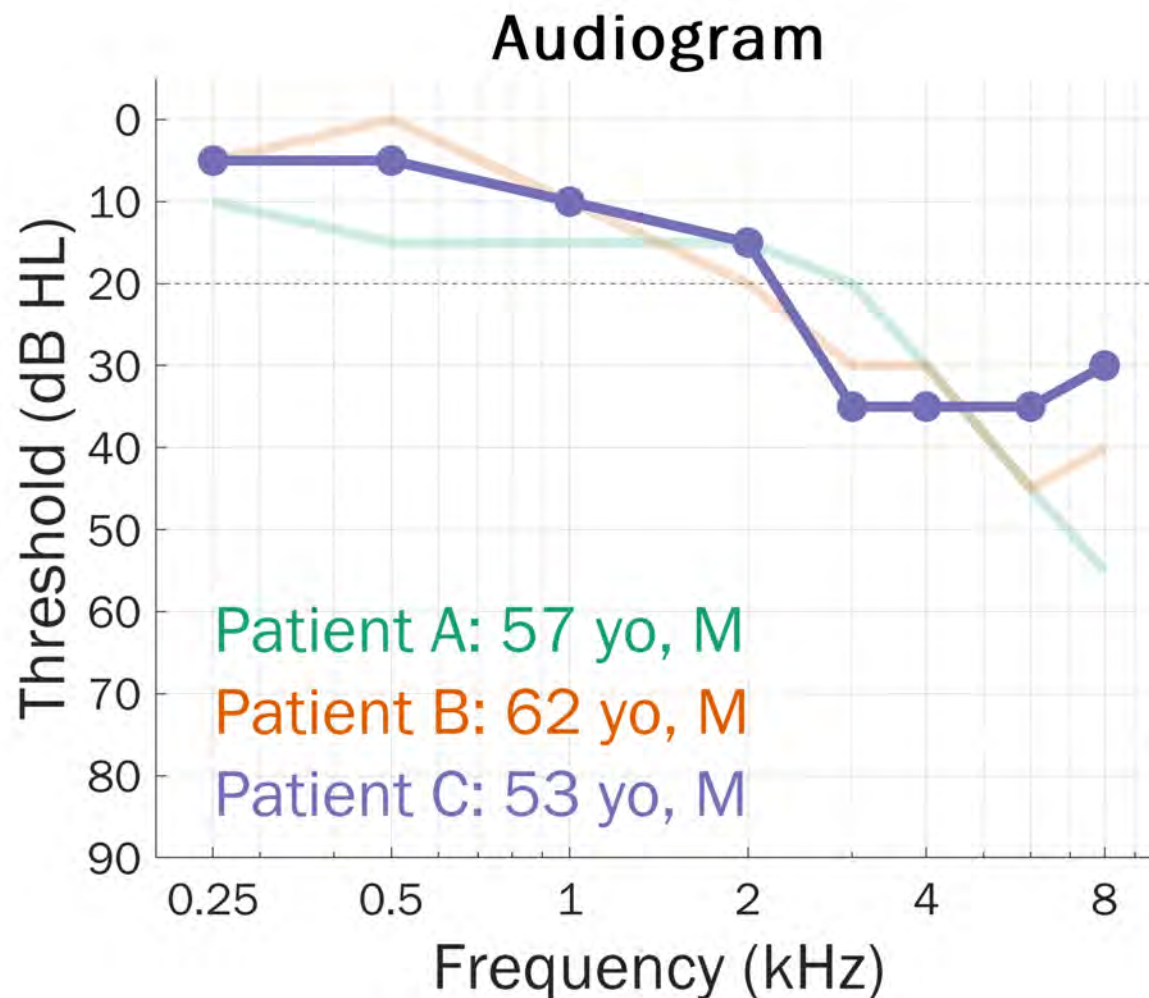


VERY Interested in
hearing aids

Struggles in many
situations,
especially at work
as a physician)

QuickSIN: 9 dB
SNR Loss

A Common Clinical Scenario



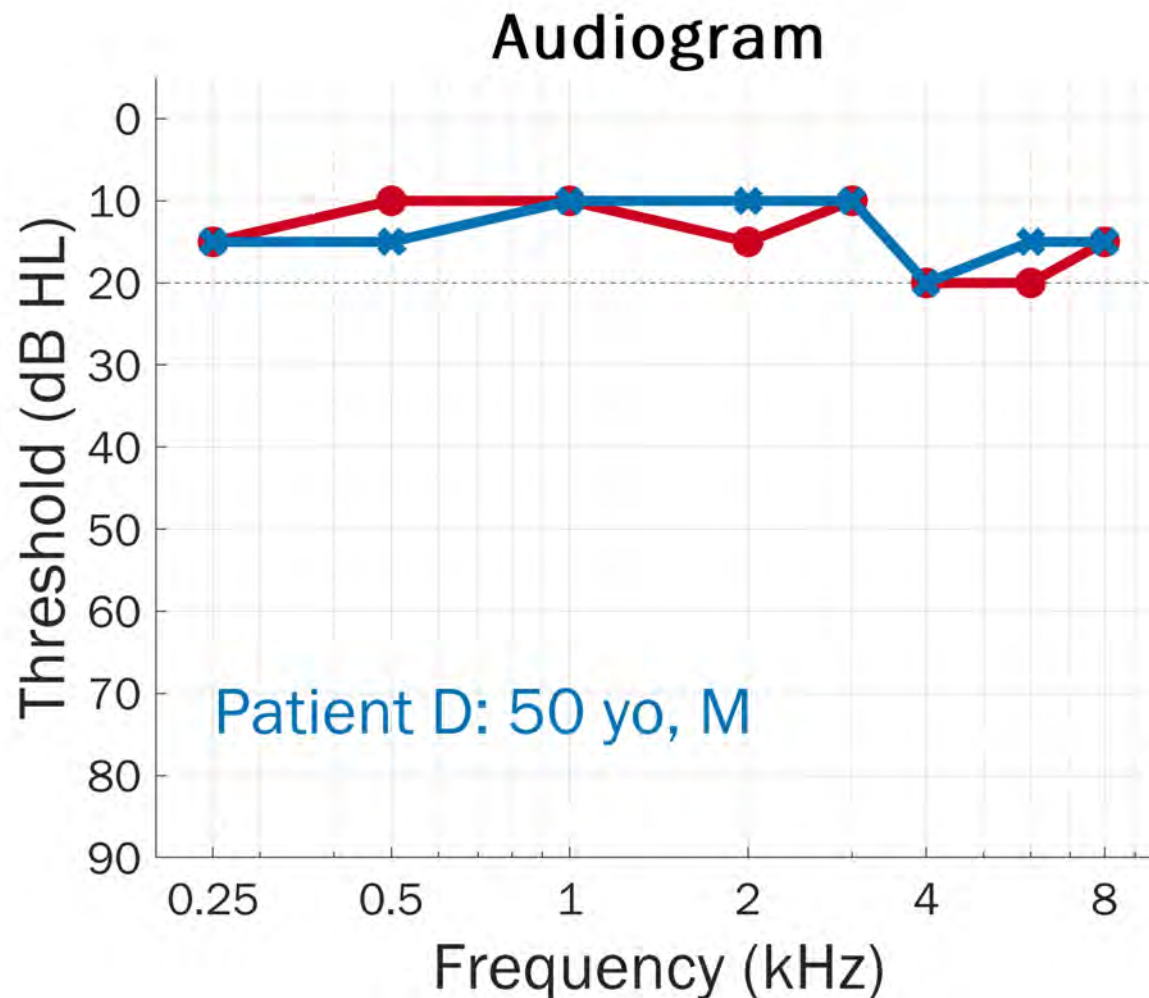
Does not have any concerns about hearing

Just here for a free hearing test

Rated all SSQ questions as no problem at all

QuickSIN: 3 dB SNR Loss

Another Common Clinical Scenario



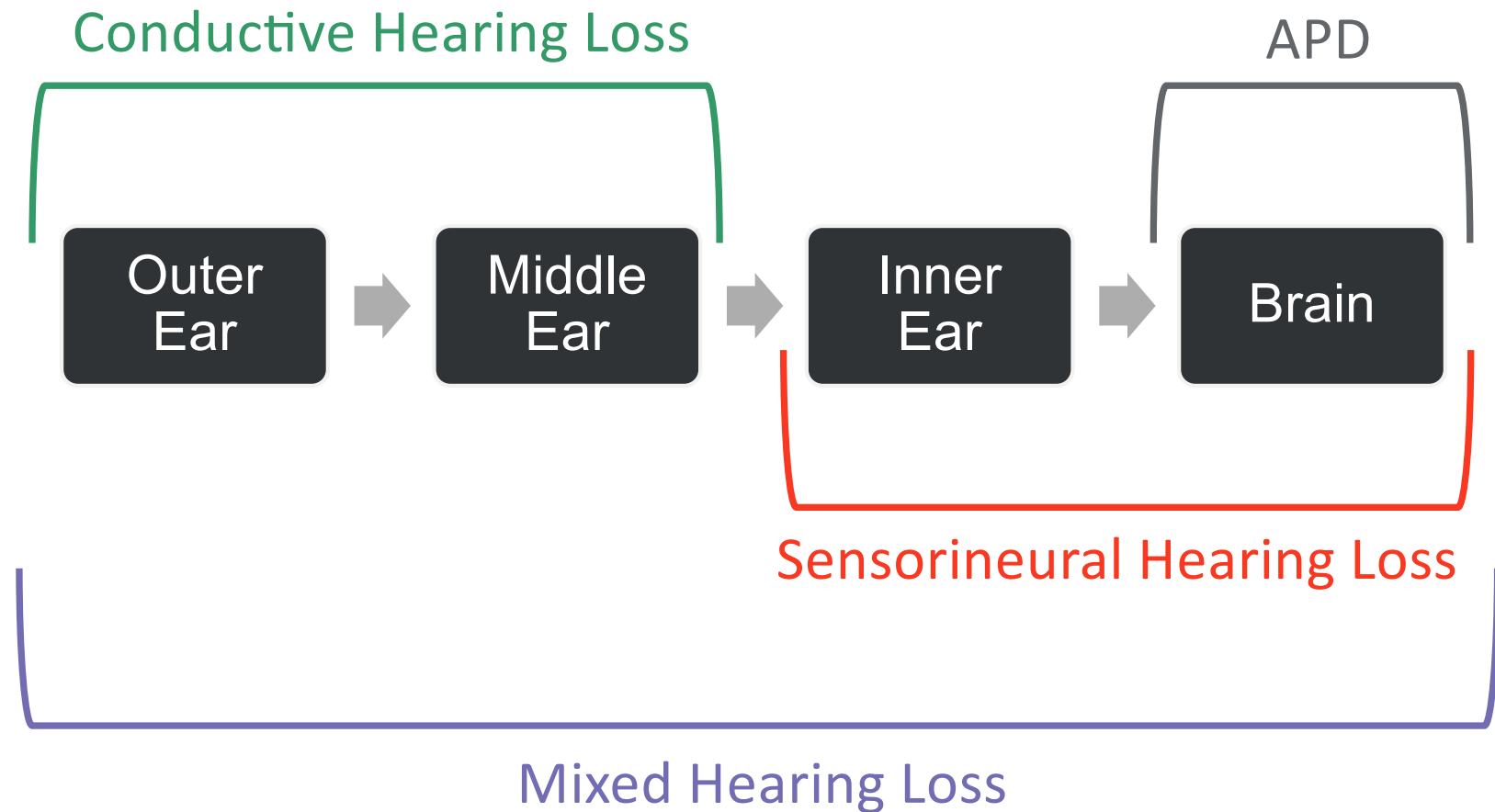
Concerned about
hearing, especially
in noisy situations

QuickSIN: 6 dB
SNR Loss

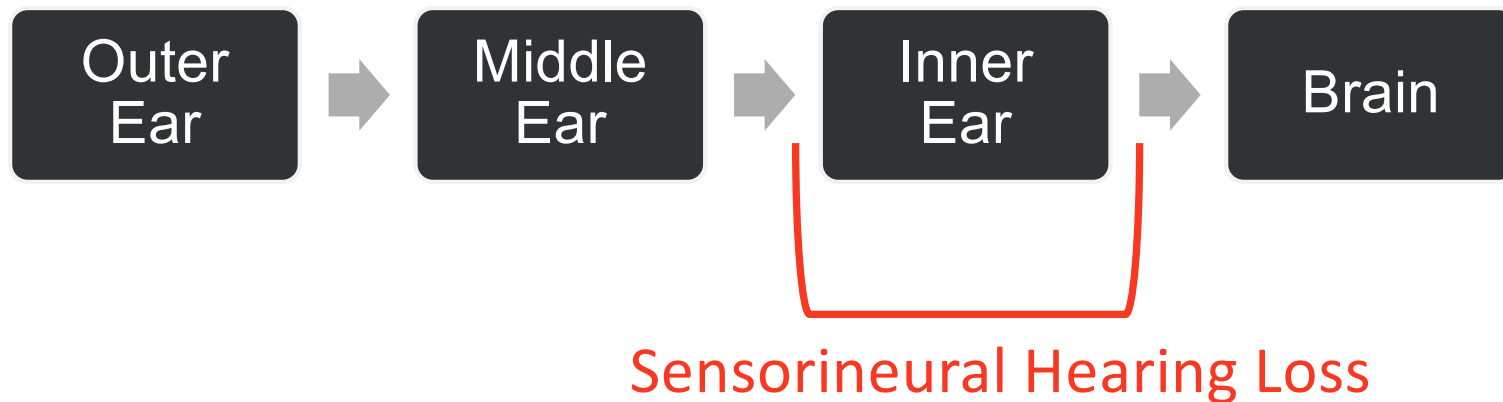
Common Clinical Scenarios

- Why do people with similar audiograms have differing speech-in-noise abilities?
- Why do some people with normal hearing thresholds still have trouble hearing in noise?
- How can I tailor my treatment plan to individual patients if diagnostic test results are similar?
- As a field, how can we standardize care without relying on “clinical intuition”?

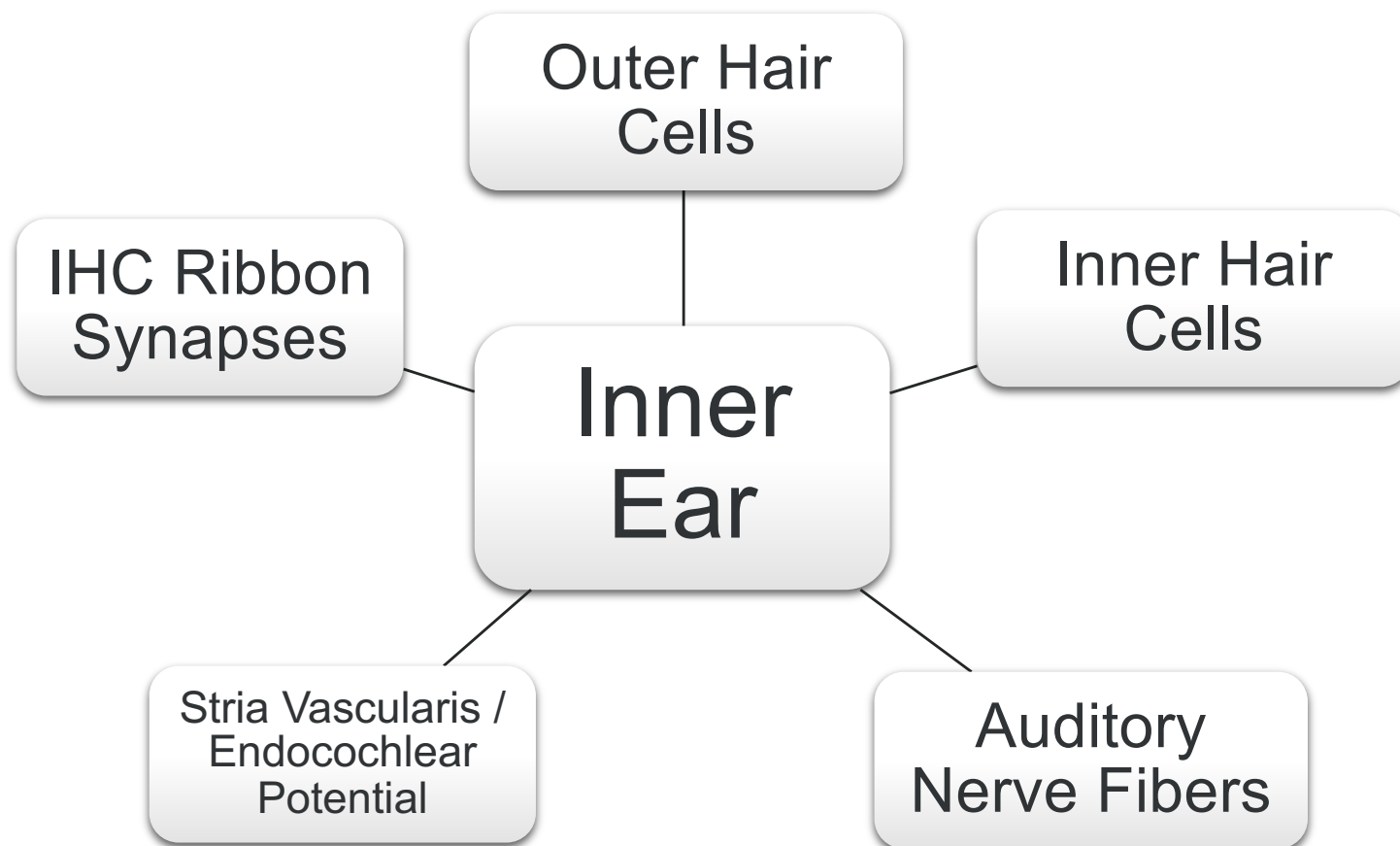
Diagnosing Hearing Loss



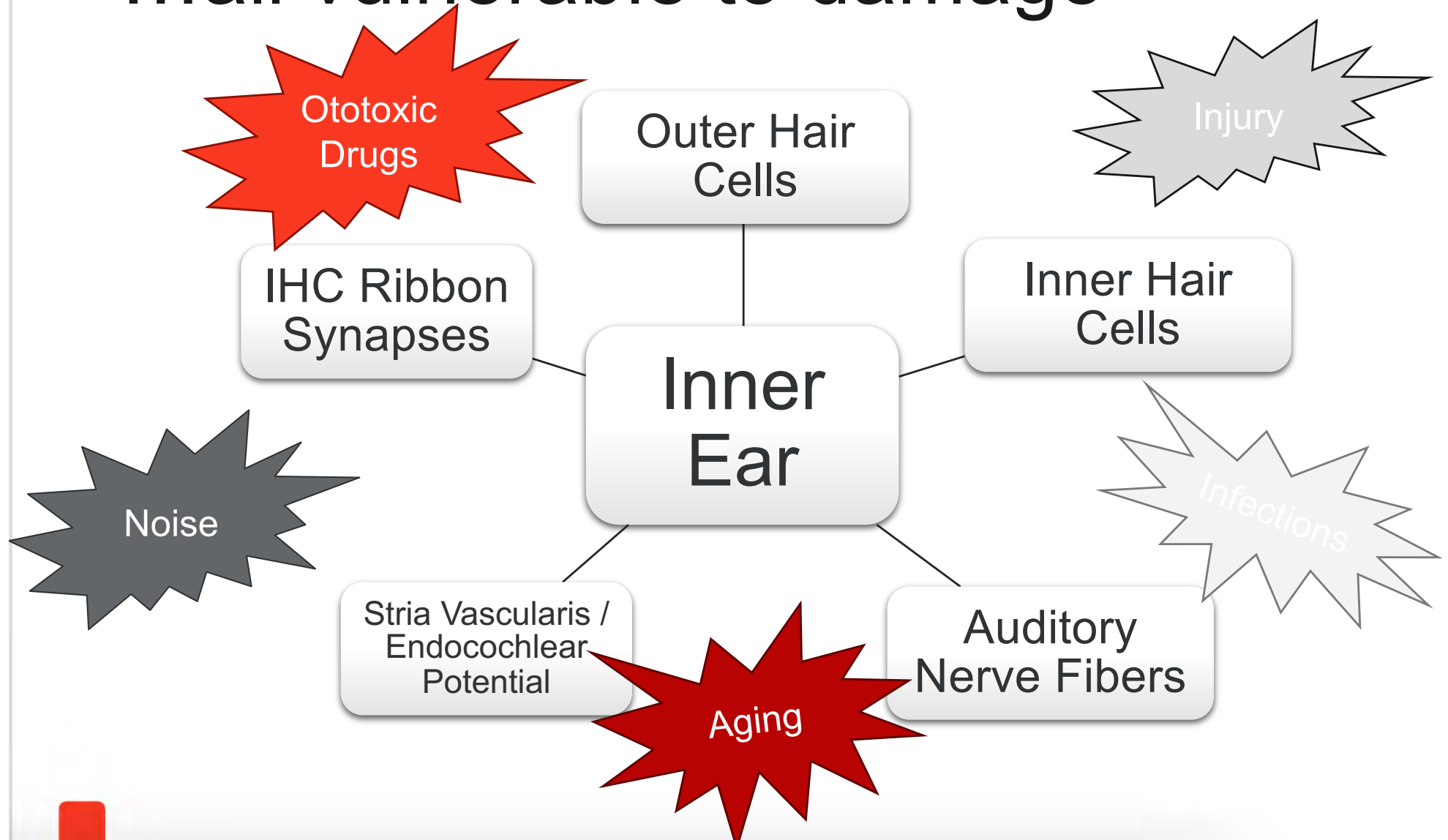
Diagnosing Hearing Loss



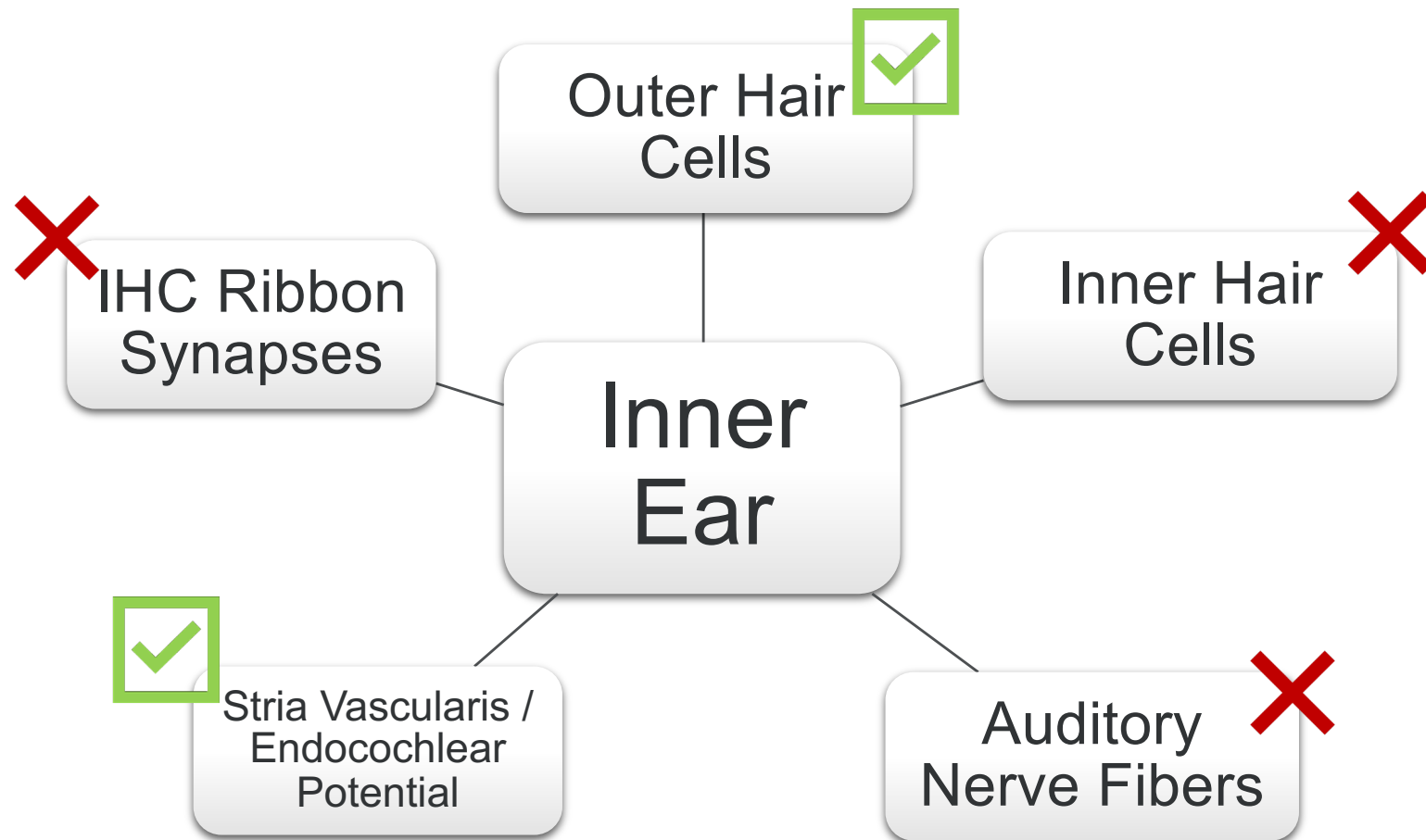
Multiple Sites of SNHL...



...all vulnerable to damage

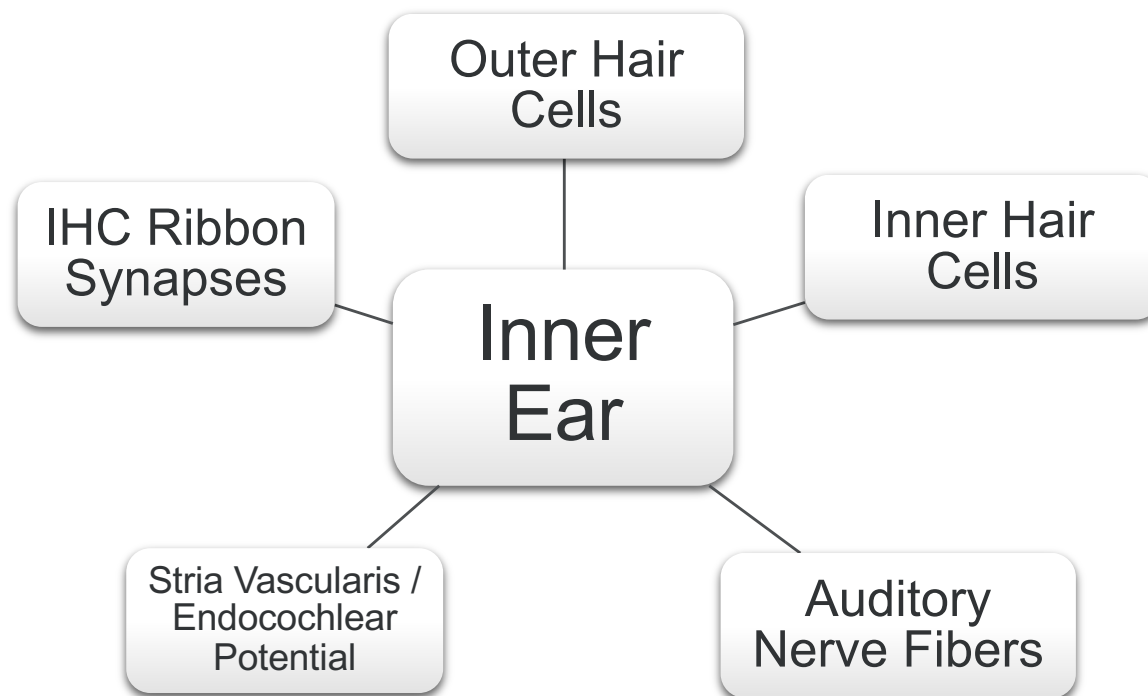


What does the audiogram detect?



Lobarinas et al., 2013 (IHC), Kujawa & Liberman, 2009 (CS),
Schmiedt et al., 2002 (SV), Kujawa & Liberman, 2015 (ANF)

Anything else?



Tympanometry

OAEs

Word Rec in
Quiet

Speech-in-
Noise

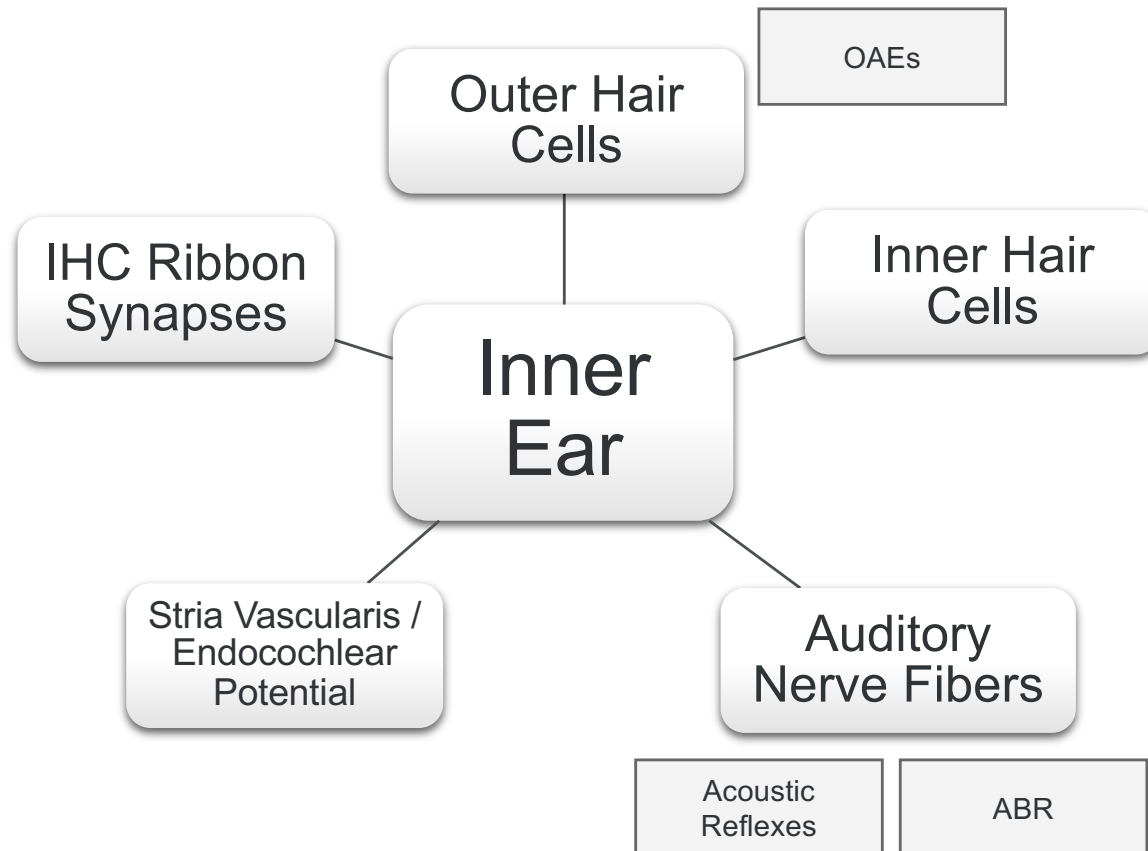
SRT

ABR

Acoustic
Reflexes

Genetic Tests,
Imaging

Anything else?



Other

Genetic Tests,
Imaging

Perception

Word Rec in
Quiet

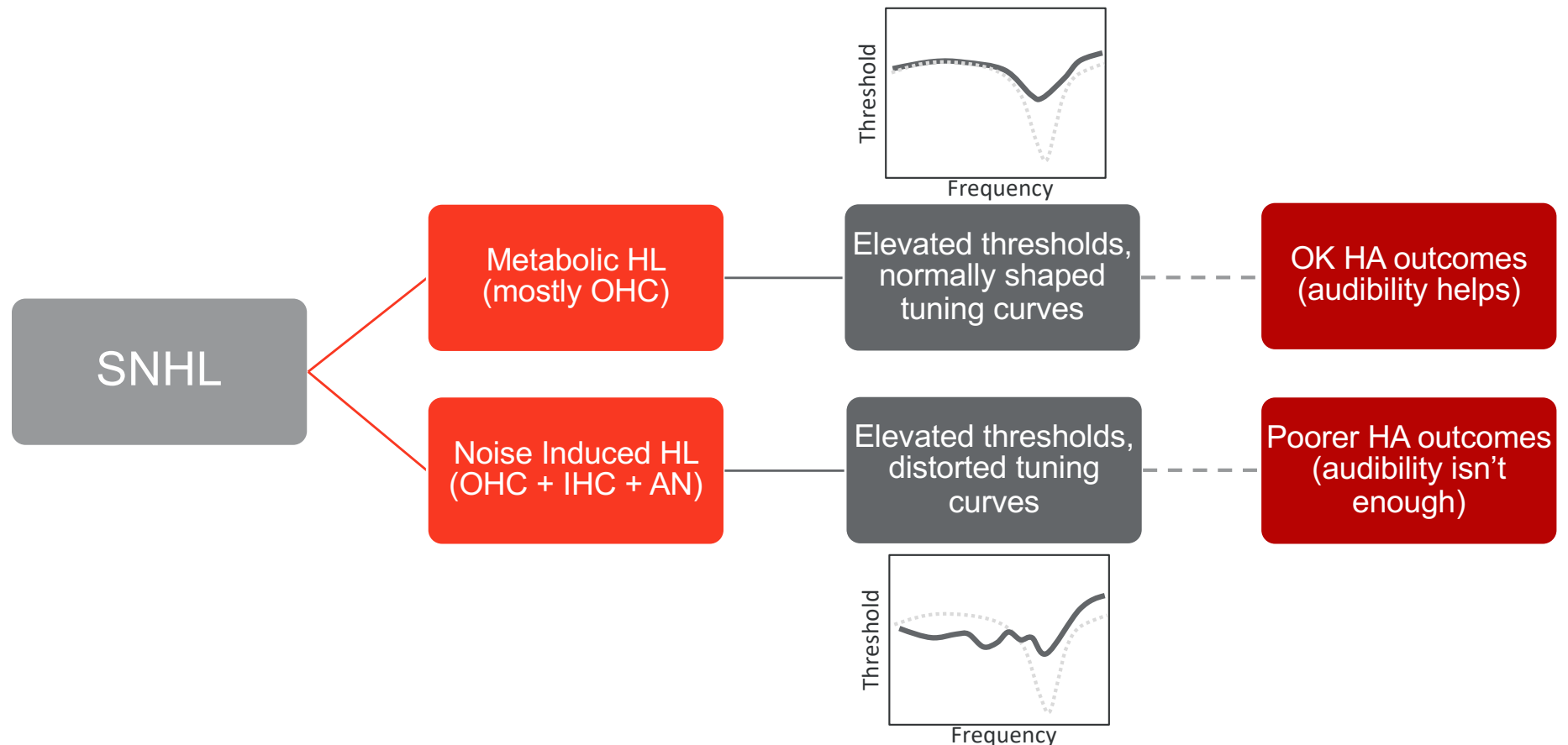
Speech-in-
Noise

SRT

Middle Ear

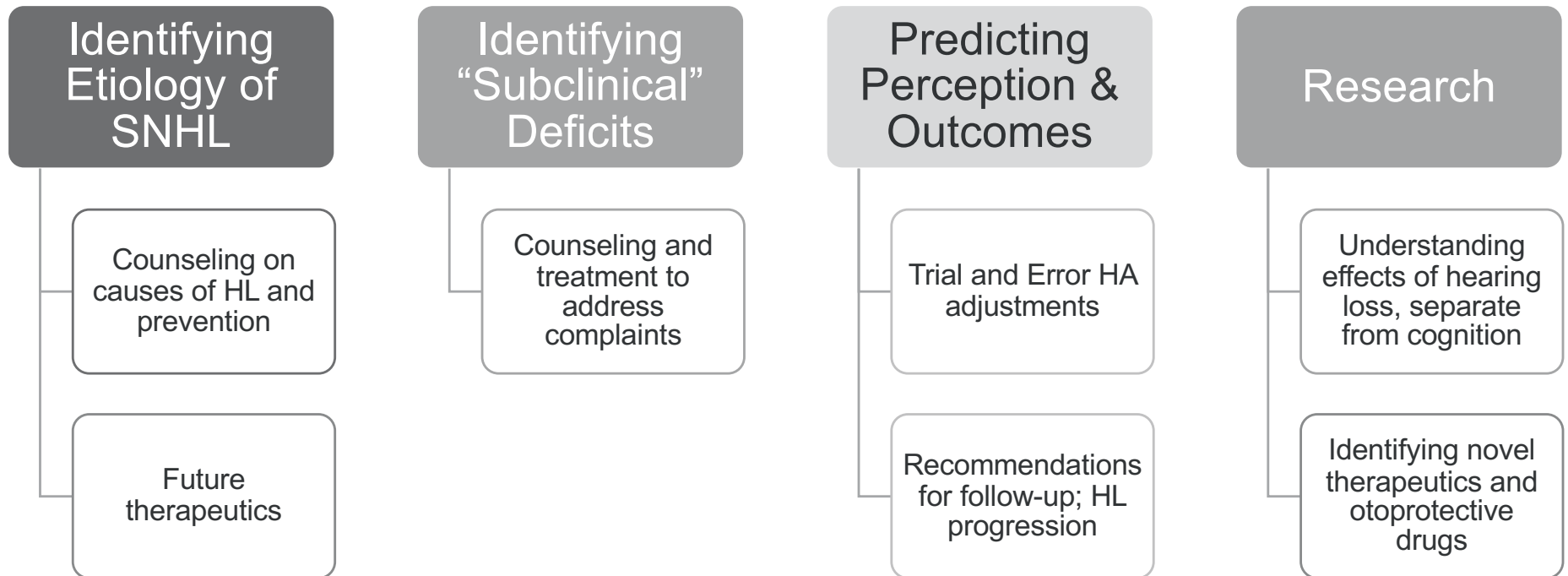
Tympanometry

Does the specific pathology matter?



Each pathology can affect neural coding of sound **in different ways.**

Limitations in Diagnostics Matter



We can only treat what we know is there!

Precision Medicine

PATIENT

TREATMENT

TIME

Genetics,
Anatomy &
Physiology

Environment &
History

Surgical &
pharmaceutical

Rehabilitation

Prevention

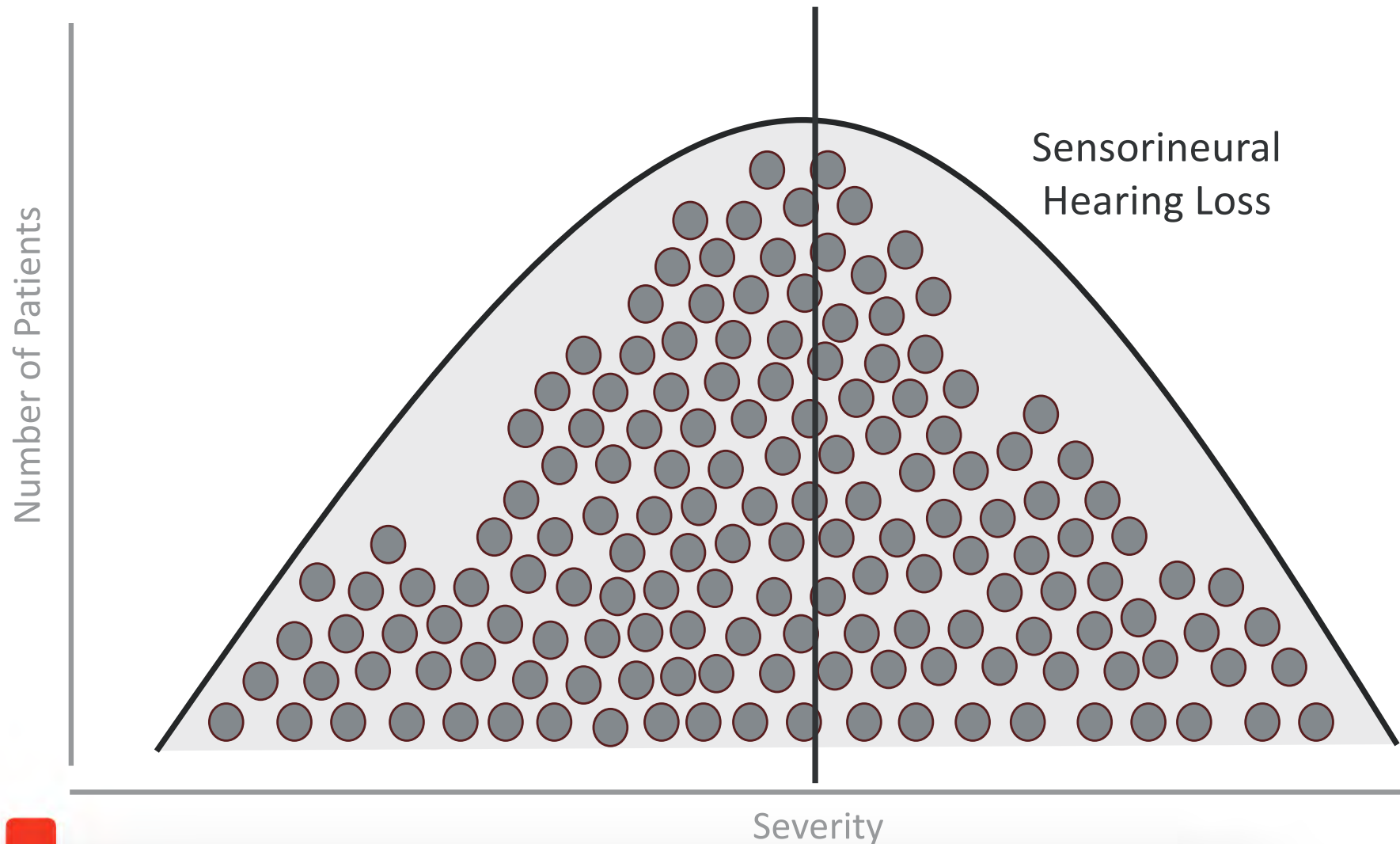
Likelihood of
Success

Precision Diagnostics

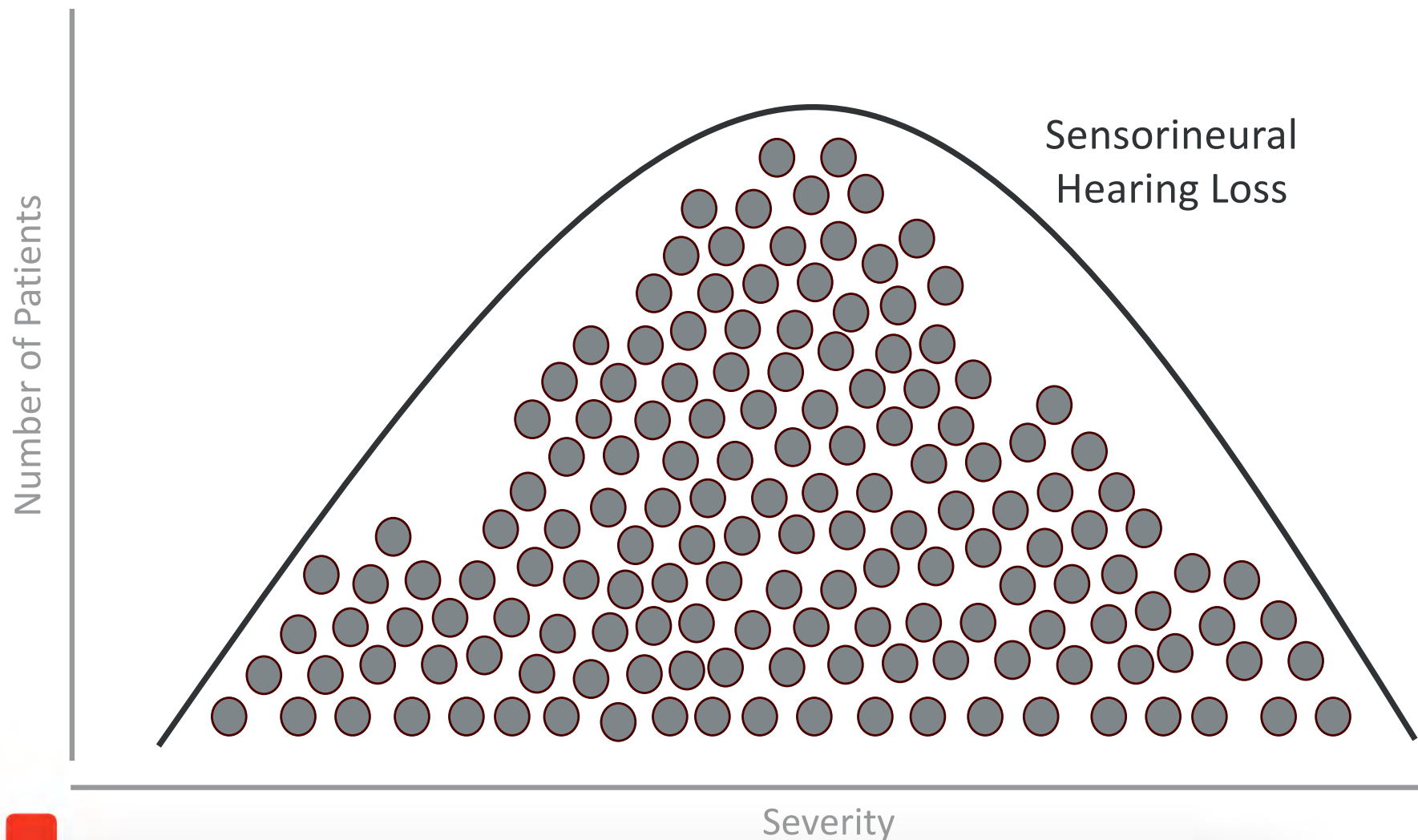
Precision
Therapeutics

Access to Care

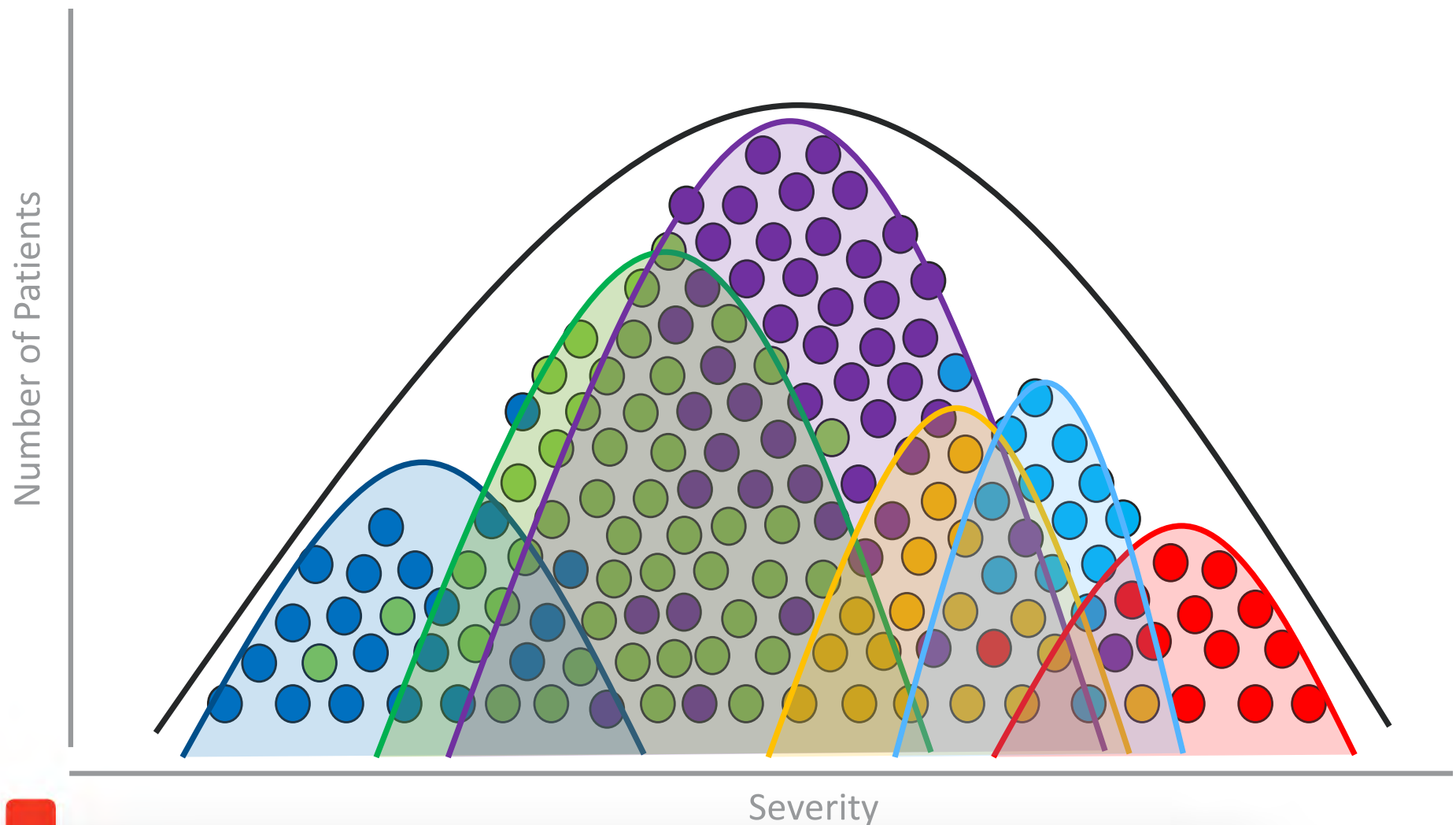
The Traditional Approach



What's really going on...

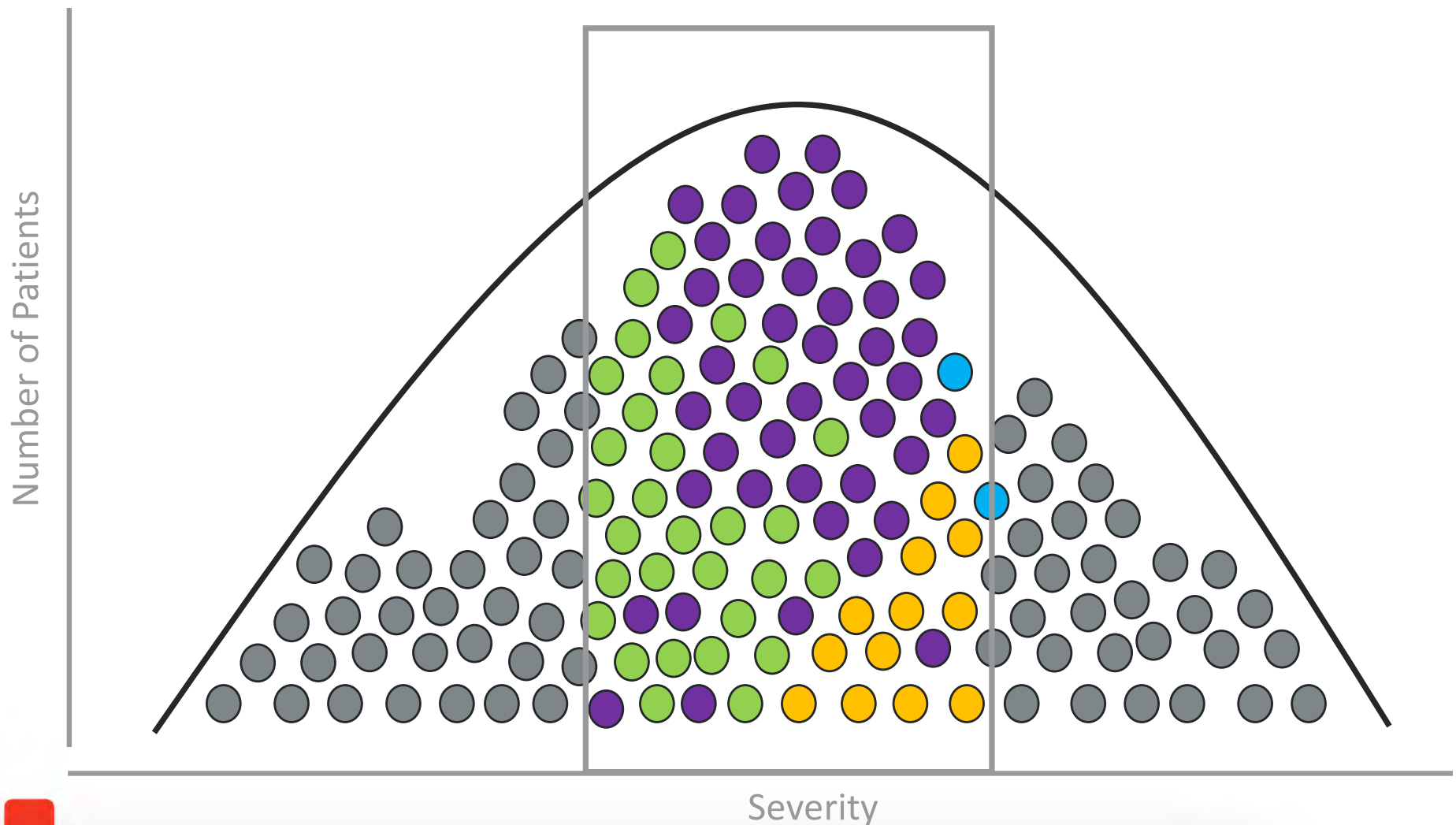


What's really going on...



What about treatments?

Variable Group → Variable Outcomes!



What about treatments?

Variable Outcome Variable Outcome

Number of Patients

Frequency Therapeutics shares plummet after FX-322 Phase 2b failure

By Brian Buntz | February 13, 2023



Frequency Therapeutics (Nasdaq:FREQ) shares were down more than 80% on Monday afternoon after the company announced the failure of the Phase 2b study for FX-322, its lead candidate drug for hearing loss. As a result, the Lexington, Massachusetts-based biotech company will discontinue its hearing loss program and cut its workforce by 55%.

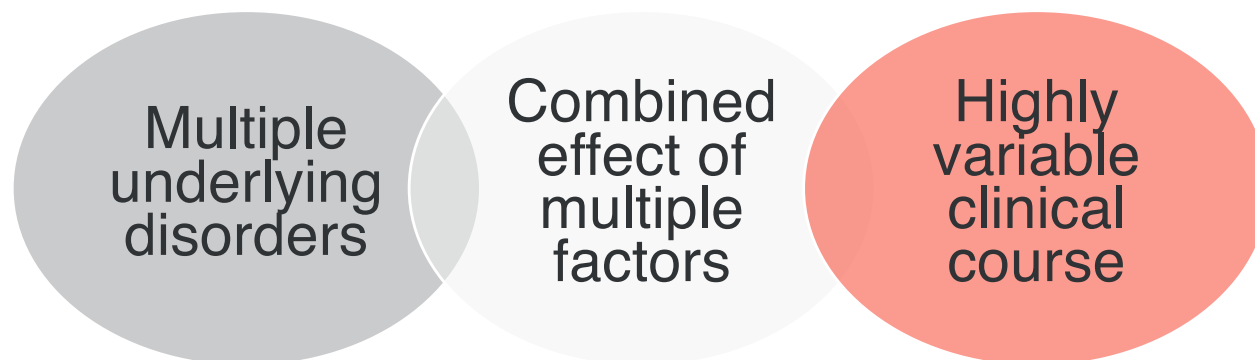


Severity

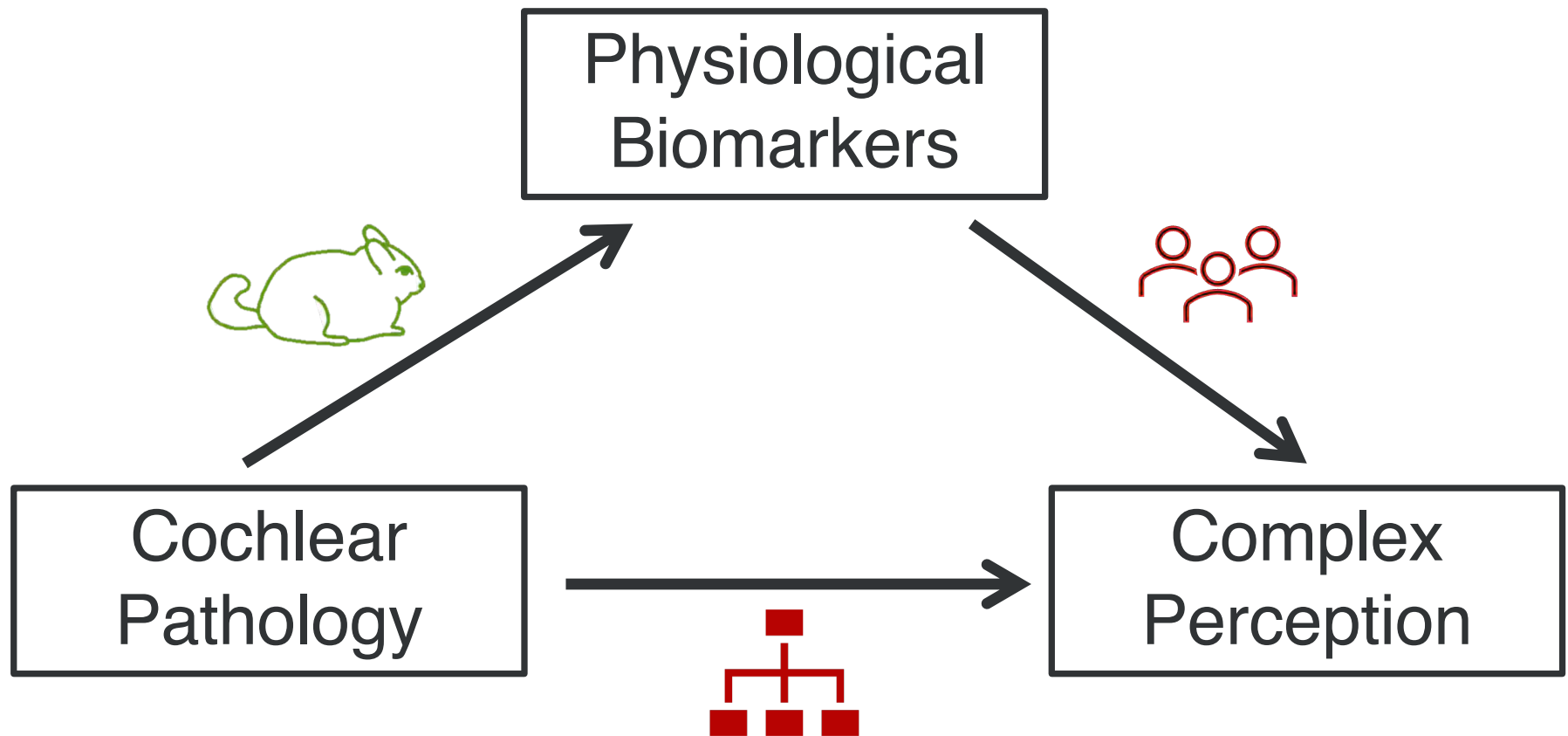
Precision Medicine for Audiology

- Comprehensive characterization of hearing across multiple physiological and perceptual dimensions to provide personalized interventions for auditory challenges.

Complex SNHL



How do we get there?



Cross-Species Precision Diagnostics

1. Measurement Precision

Improving our measurements

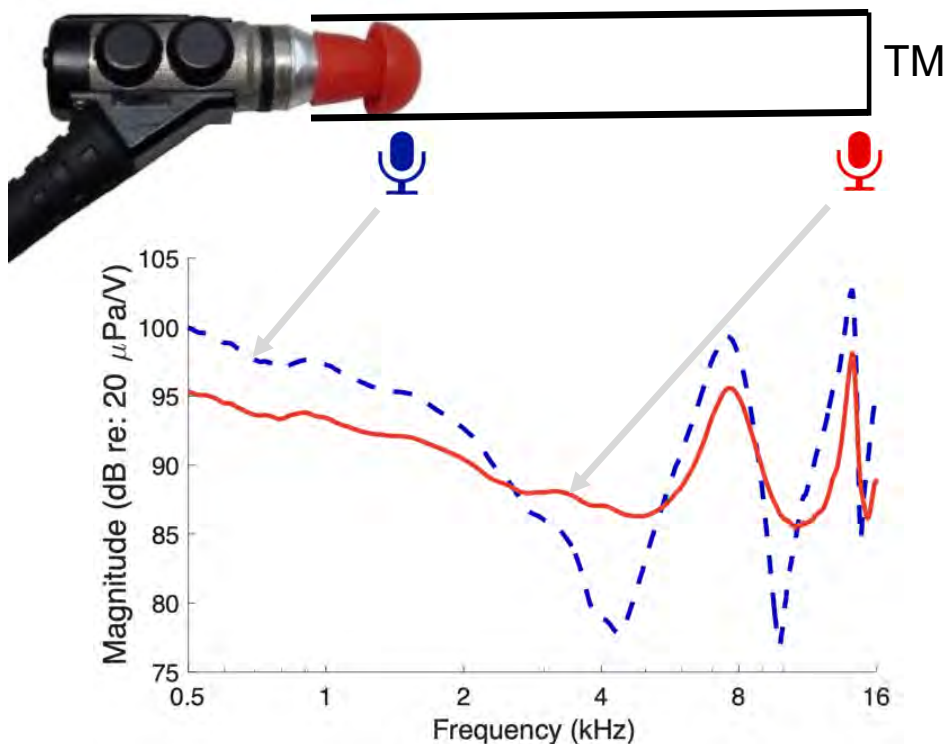
2. Two Hidden Pathologies

Multi-metric approach to diagnosis

3. Precision Diagnostics for Humans

Relating pathology to perception

1. Measurement Precision



Reduce irrelevant sources of “noise”

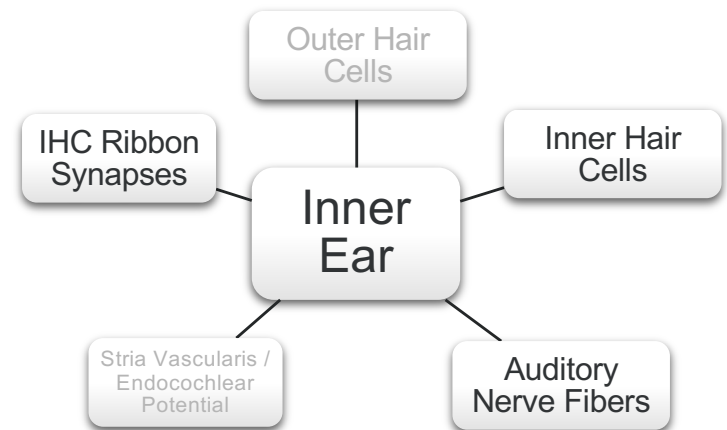
Forward Pressure Level (FPL) for OAEs

- Better test-retest reliability Maxim et al., 2020
- Better correlations with audiometric thresholds Hauser et al., 2025



2. Two Hidden Pathologies

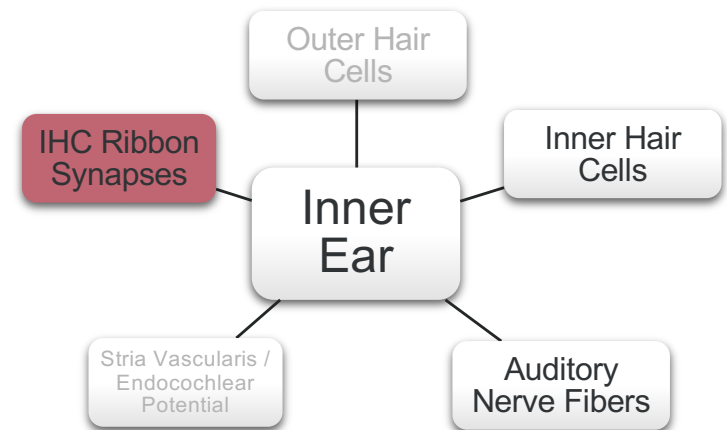
- **Hidden Hearing Loss**
 - Deficits despite normal audiogram
- **Cochlear Synaptopathy**
- **Inner Hair Cell Dysfunction**





2. Two Hidden Pathologies

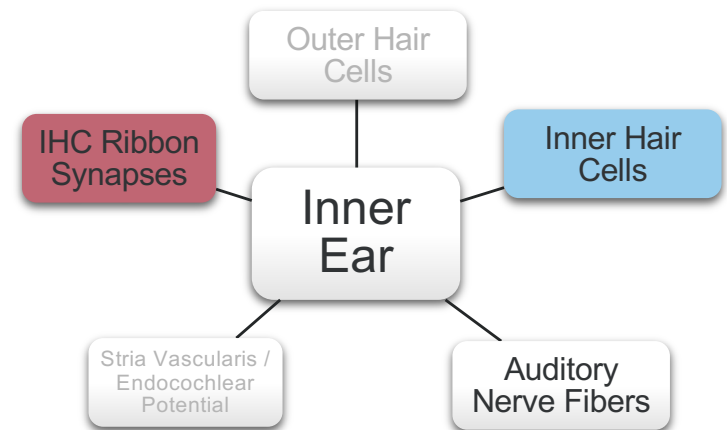
- **Hidden Hearing Loss**
 - Deficits despite normal audiogram
- **Cochlear Synaptopathy**
 - Noise induced temporary threshold shift (**TTS**)
- **Inner Hair Cell Dysfunction**





2. Two Hidden Pathologies

- **Hidden Hearing Loss**
 - Deficits despite normal audiogram
- **Cochlear Synaptopathy**
 - Noise induced temporary threshold shift (**TTS**)
- **Inner Hair Cell Dysfunction**
 - Carboplatin (**CA**) induced IHC dysfunction and stereocilia damage





2. Two Hidden Pathologies

- **Measures:**

- ABR, DPOAE, EFR, Click ABR, SFOAE, TEOAE, MEMR

- **Questions:**

- Can any measures ***detect*** animals with “hidden” pathologies?
- Can any measures ***differentiate*** between the two pathology groups?

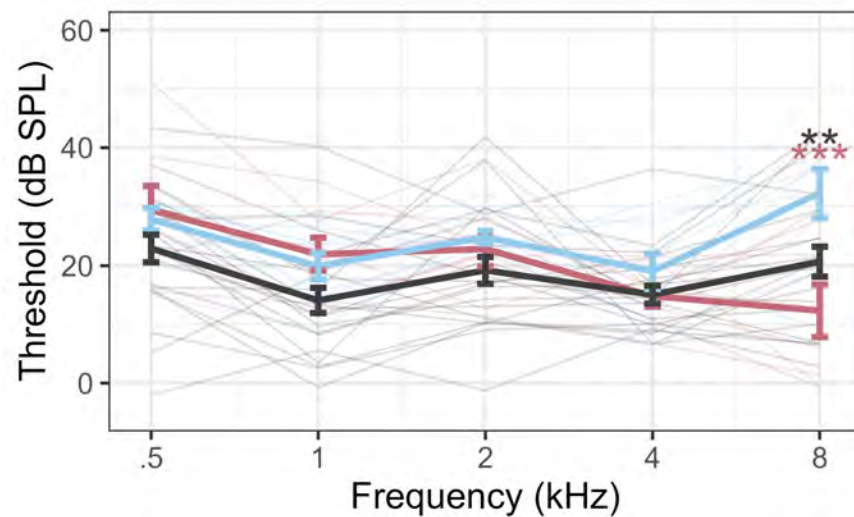
Normal Hearing
(NH)

Cochlear
Synaptopathy (CS)

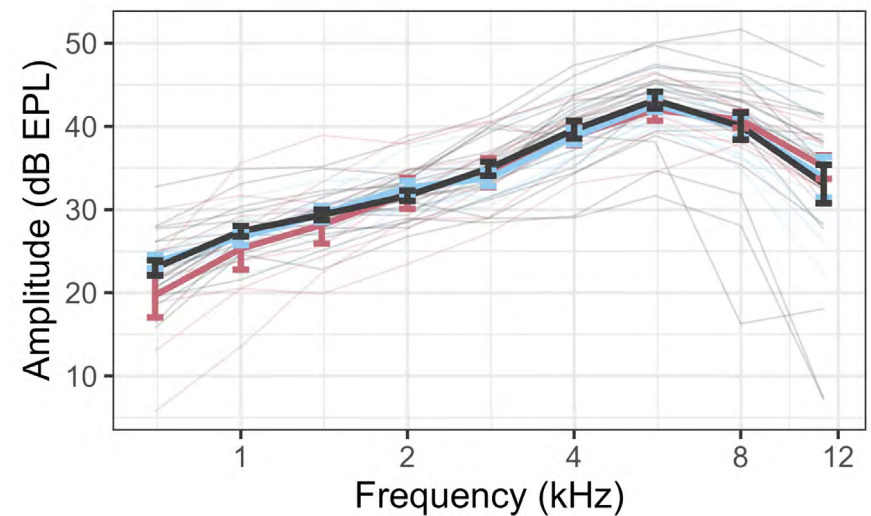
Inner Hair Cell
Dysfunction (CA)

Results: ABR thresholds and DPOAES are unchanged

ABR Thresholds



DPOAE Amplitude

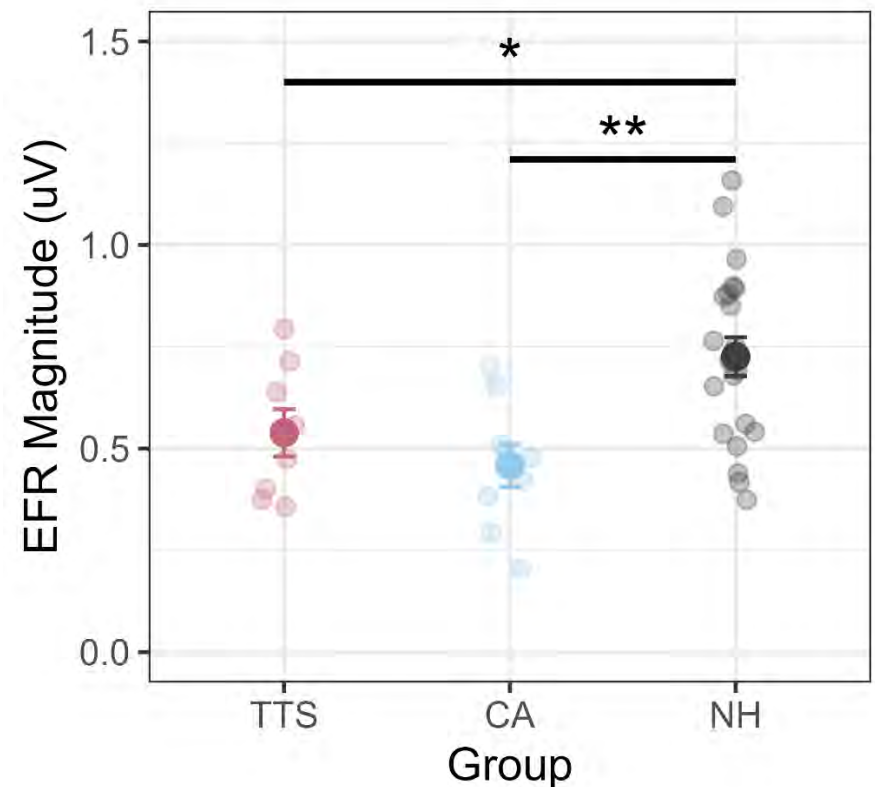
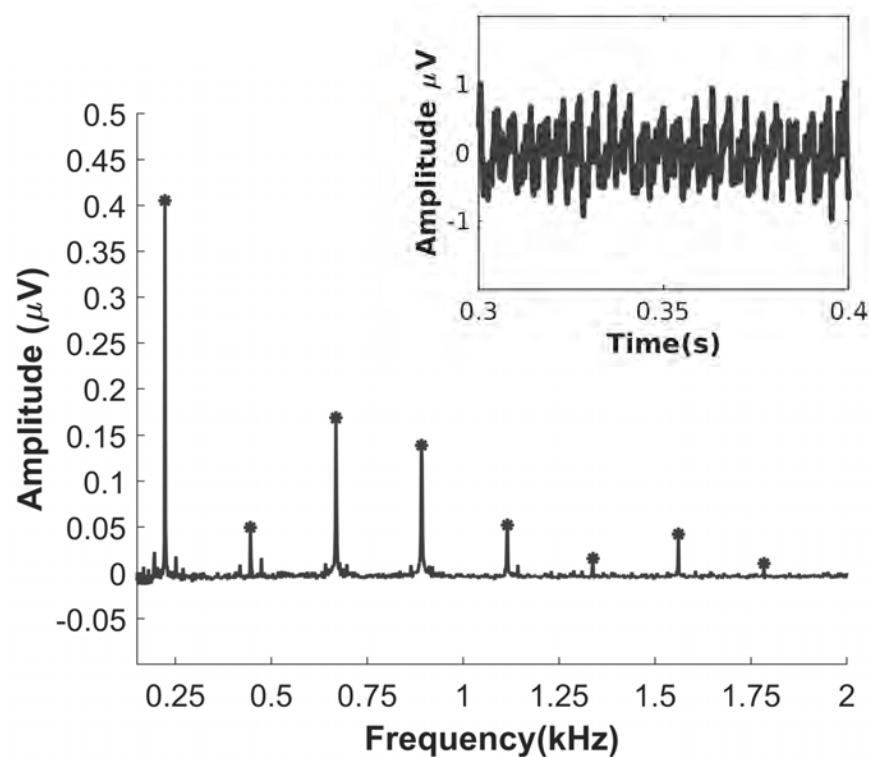


— TTS

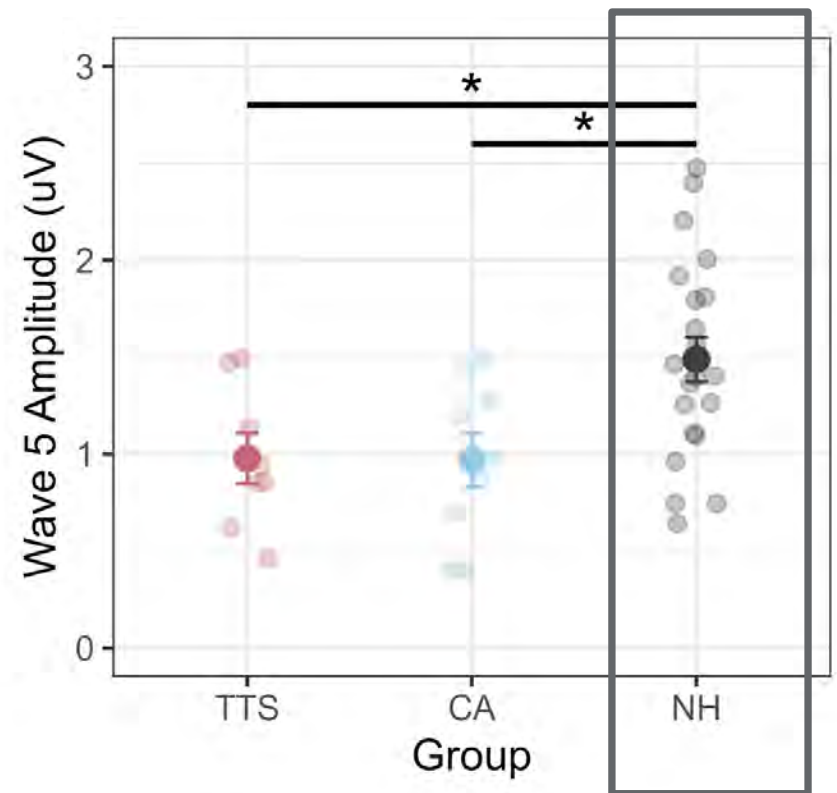
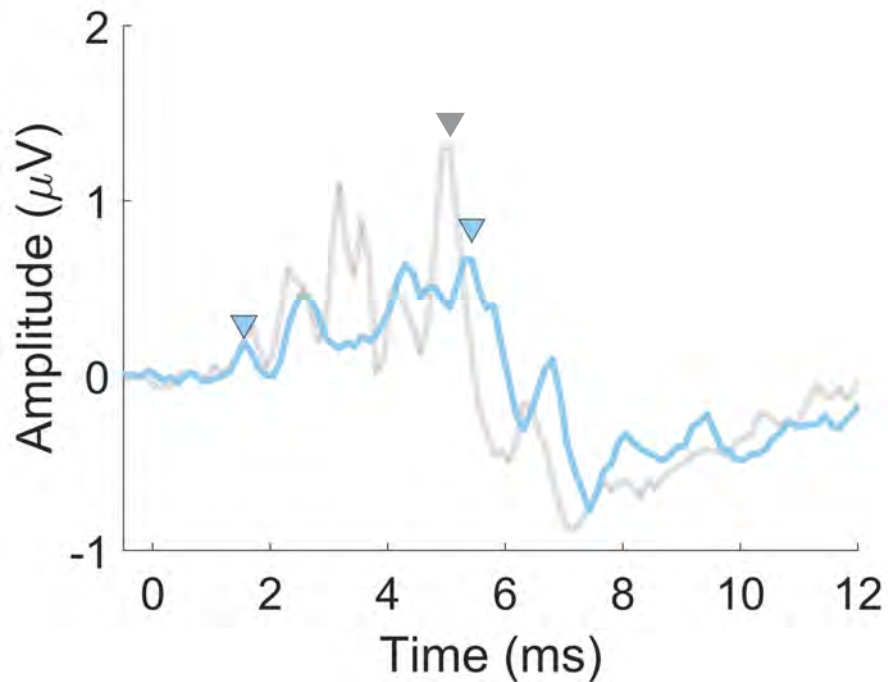
— CA

— NH

Results: Differences in Envelope Following Response (EFR)



Results: Differences in ABR to High Level Click



Normal can be highly
variable!

Classifying

Not normal...but
what kind of
abnormal?

ABR 8k Threshold

Predicted \ Actual	TTS	CA	NH
NH	5	6	18
CA	0	3	3
TTS	3	0	0

EFR Magnitude

Predicted \ Actual	TTS	CA	NH
NH	5	5	18
CA	3	4	3
TTS	0	0	0

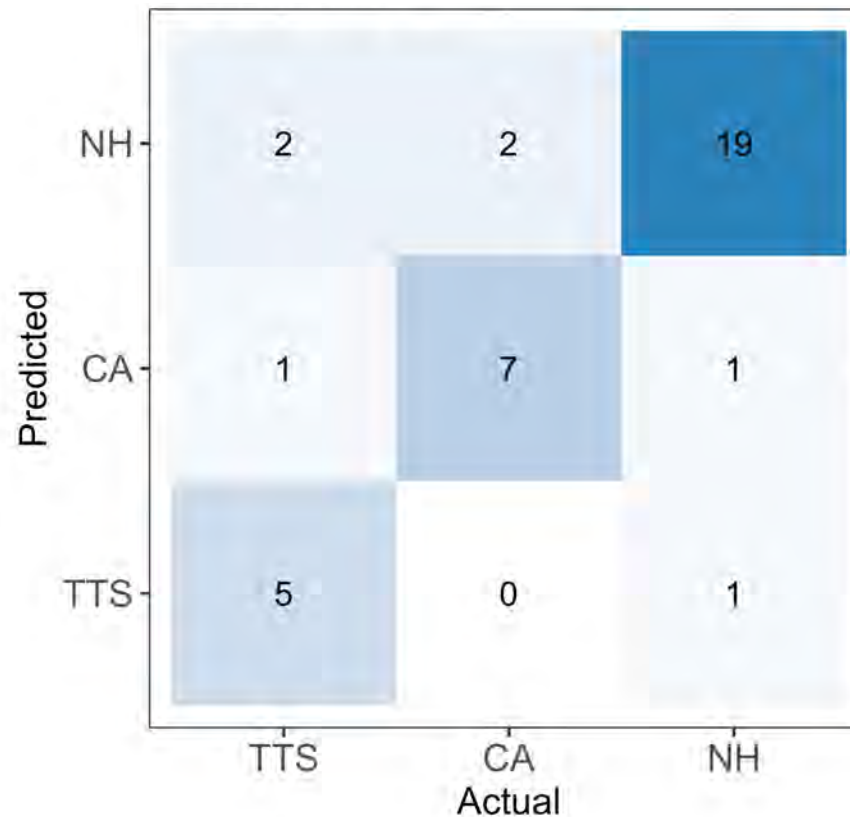
Wave 5 Amplitude

Predicted \ Actual	TTS	CA	NH
NH	4	5	18
CA	4	4	3
TTS	0	0	0

Best accuracy (ABR):
 $24/38 = 63\%$

A multi-metric approach performs better!

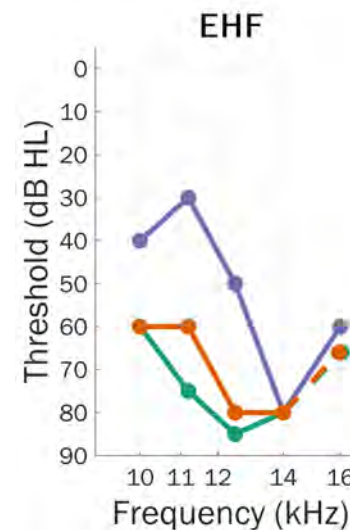
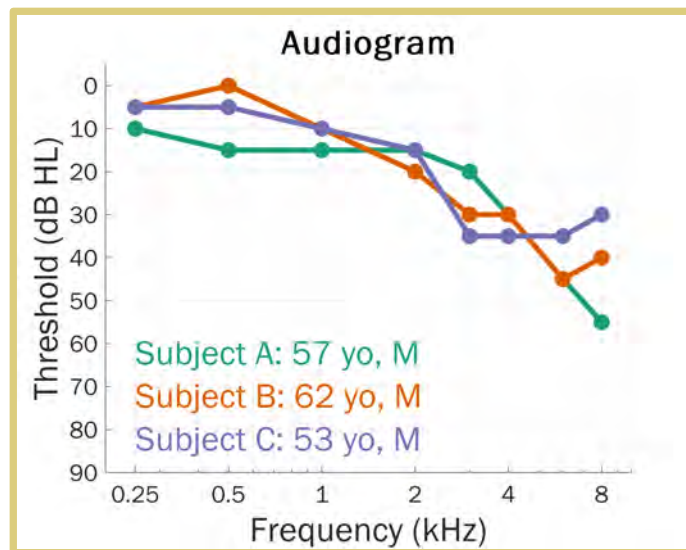
ABR + EFR Phase Locking + Wave 5



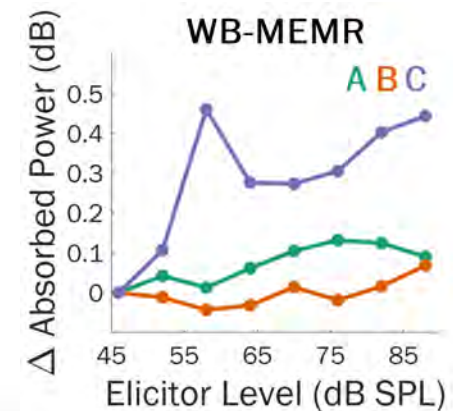
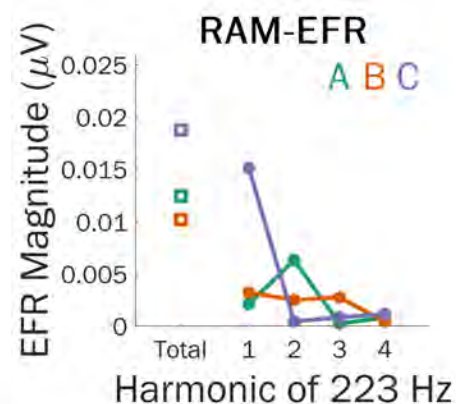
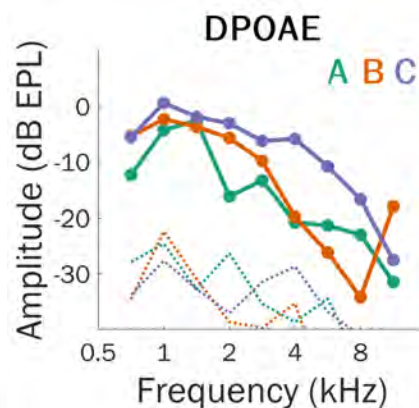
Accuracy:
 $31/38 = 82\%$



3. Precision Diagnostics for Humans



No Problems
Lots of Difficulty

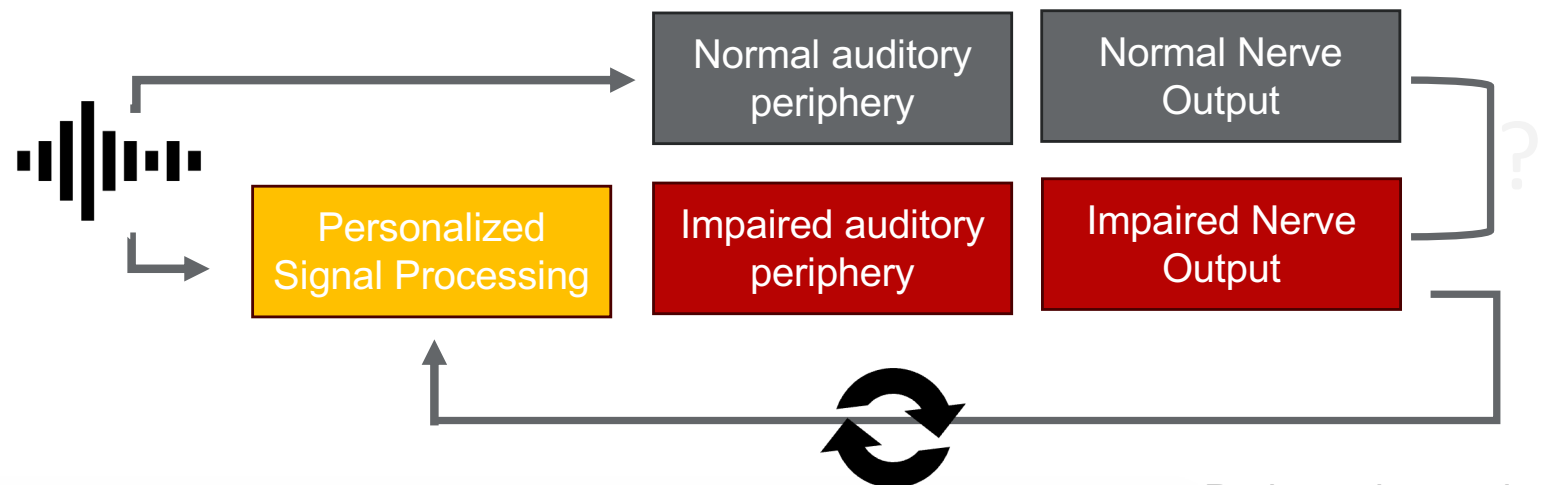


Future: Barriers to Overcome

- **Managing test time**
 - What can we replace?
 - Speech-in-noise over WRS Fitzgerald et al., 2024
 - Other situations may have more time
 - Clinical trials, research settings
- **Equipment**
 - Some only available in research settings currently
- **Diagnostics go hand-in-hand with treatments**
 - Adoption may be greater when it changes clinical decision making / treatment plans
- **Need for Big Data**

Future: Novel Treatments

- Gene therapy
- Pharmaceuticals
- Hair cell regeneration
- Next-Generation Hearing Aids



Summary

- Sensorineural hearing loss is COMPLEX
 - Variable combinations of pathology and variable outcomes
- Concepts from precision medicine can be used as a framework for understanding and addressing Complex SNHL
- A multi-metric approach will be critical to precision diagnostics
- Improvements in diagnostics open the door to new treatment strategies

Acknowledgements



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University of Pittsburgh

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Thank You!

Samantha Hauser, AuD, CCC-A



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