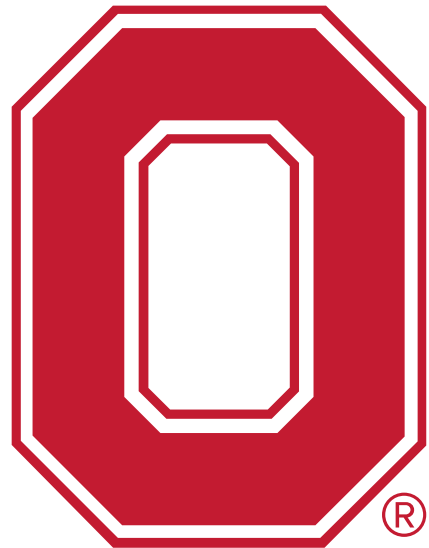


MANAGEMENT OF CHILDREN AND ADULTS WITH FUNCTIONAL HEARING DEFICITS AND NORMAL PERIPHERAL HEARING ACUITY



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Theme for this presentation

- **Tests (audiograms) don't talk, people do**
- Reframing what constitutes “normal”
- What happens when test results do not correlate to patient report?
- How do we learn to listen “between the lines”, trust our patient, trust our gut, trust our clinical judgment?
- Patients report being told they have “perfect hearing” despite the concerns they express, “the audiogram says that you have normal (or perfect) hearing”

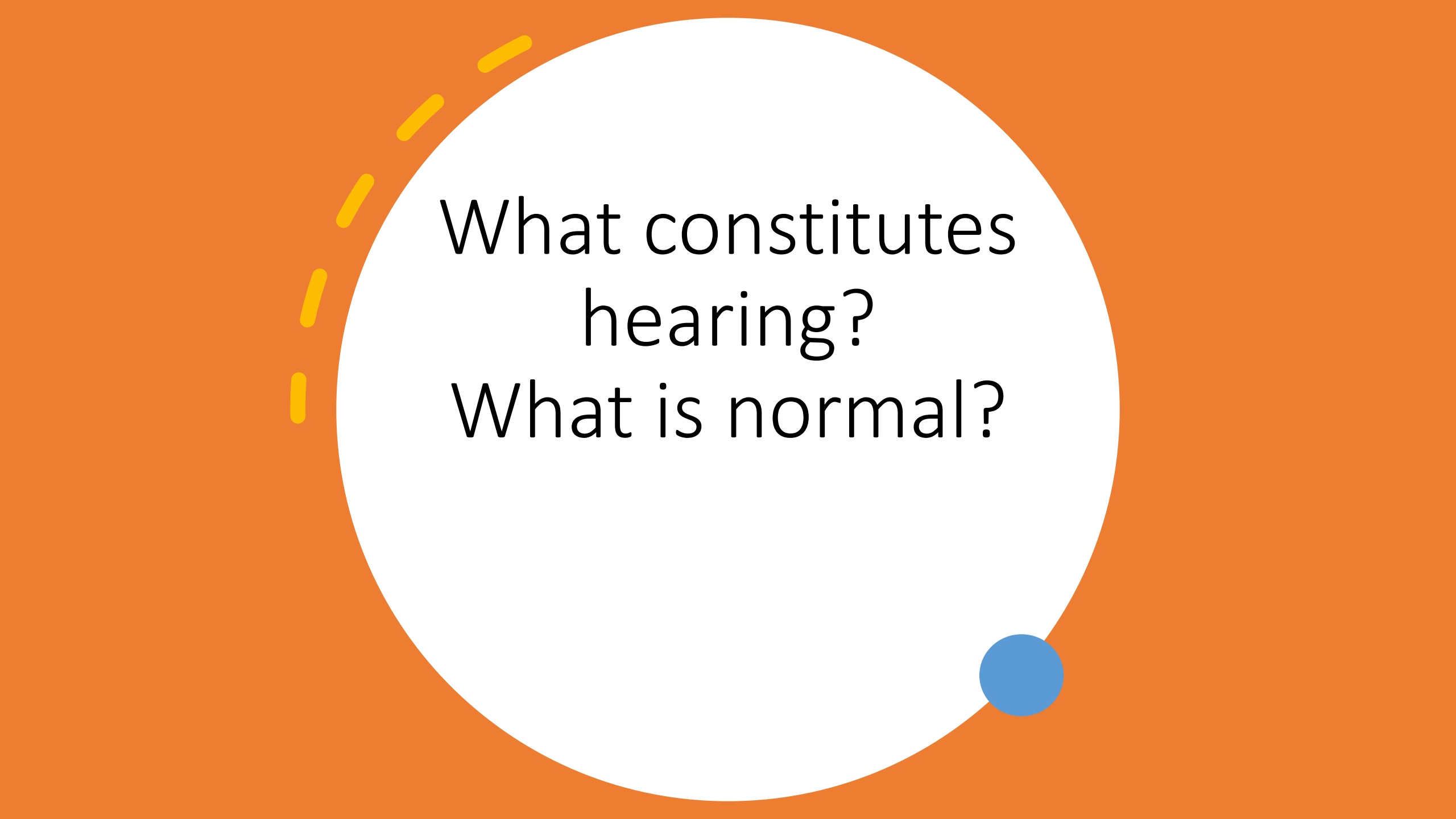
The audiology paradox (Whitelaw and Roup, in Press)

- The audiometric results reveal normal pure-tone thresholds, and the audiologist may have a paradox in discussing the findings with the patient. Does the audiologist share the results and let the patient know that they are “normal” and “everything is fine”, or does the audiologist consider the patient’s reported hearing difficulty beyond the results obtained in this evaluation?
- What is the efficiency and effectiveness by which listeners can use auditory information?
 - Fatigue and effort

Survey of audiologists

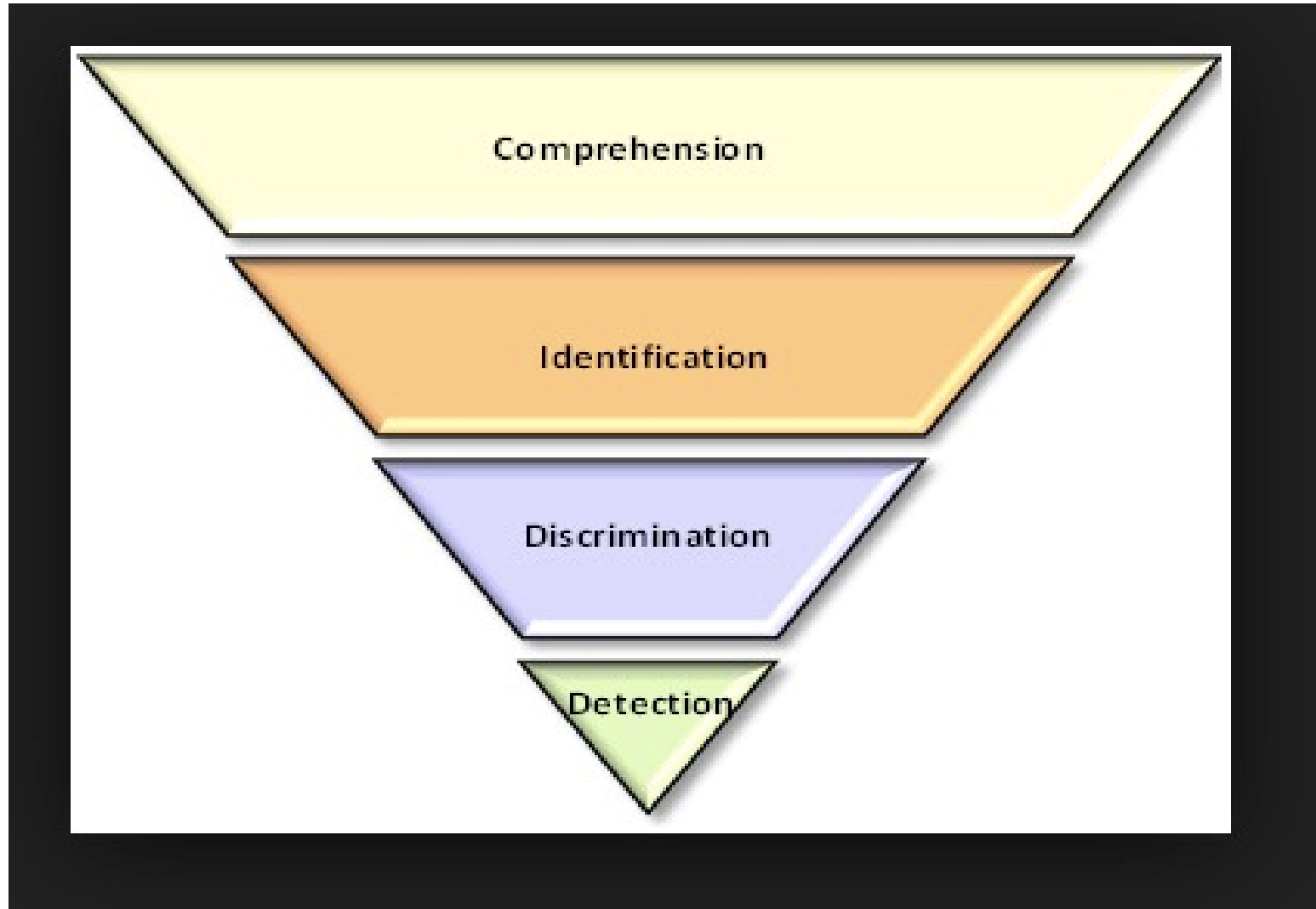
- Audiologists responded to the question “How often do you encounter patients who have communication difficulties despite having normal or near normal pure tone thresholds?”
- 0.5% reported never, 30.7% reported <1 per month, 45.4% reported 1-3 per month, and 23.4 % reported >4 per month.
- In contrast to this finding, most audiologists described their awareness of APD in as “low” and indicated that they received limited training in working with this population.
- In a survey of patients who reported hearing difficulty:
 - 54% reported challenges in being referred for a diagnostic evaluation, 61% reported obstacles in getting support for their listening difficulties, and 63% reported a general lack of awareness of APD





What constitutes
hearing?
What is normal?

Erber's Hierarchy (1992)



- Functional hearing loss, in the context of this presentation, may also be referred to as:
 - HD (hearing difficulty), Suprathreshold auditory disorders (SAD), subclinical hearing loss, hidden hearing loss
 - How does this relate to other types of auditory disorders? Auditory processing disorders, tinnitus
- The definitions of hearing loss are changing
 - World Health Organization challenges us to see hearing as “functional” communication
- The role of audiology: hearing is much broader than the “audiogram”
 - It is **an** important measure, it is NOT **the** important measure

These patients have “suprathreshold” complaints and concerns


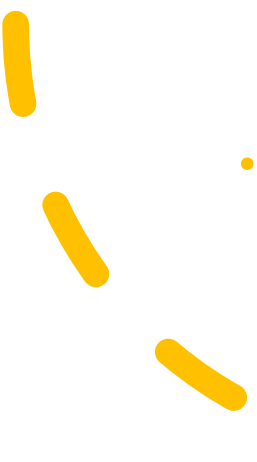
- People with “normal hearing” on an audiogram and standard audiologic testing performed in quiet but report considerable difficulty listening in less than optimal listening environments
- Estimated to be 26 million Americans (Beck and Danhauer, 2019).
- They report experiencing more difficulty “in the real world” than would be anticipated based on standard audiometric results
 - Suggested to be between 15-30% of younger adults (e.g. less than 40 years of age) (Pang et al, 2019)
- **SSQ12: Speech, Spatial and Qualities of Hearing (strong predictor)** (Kamerer et al, 2022)

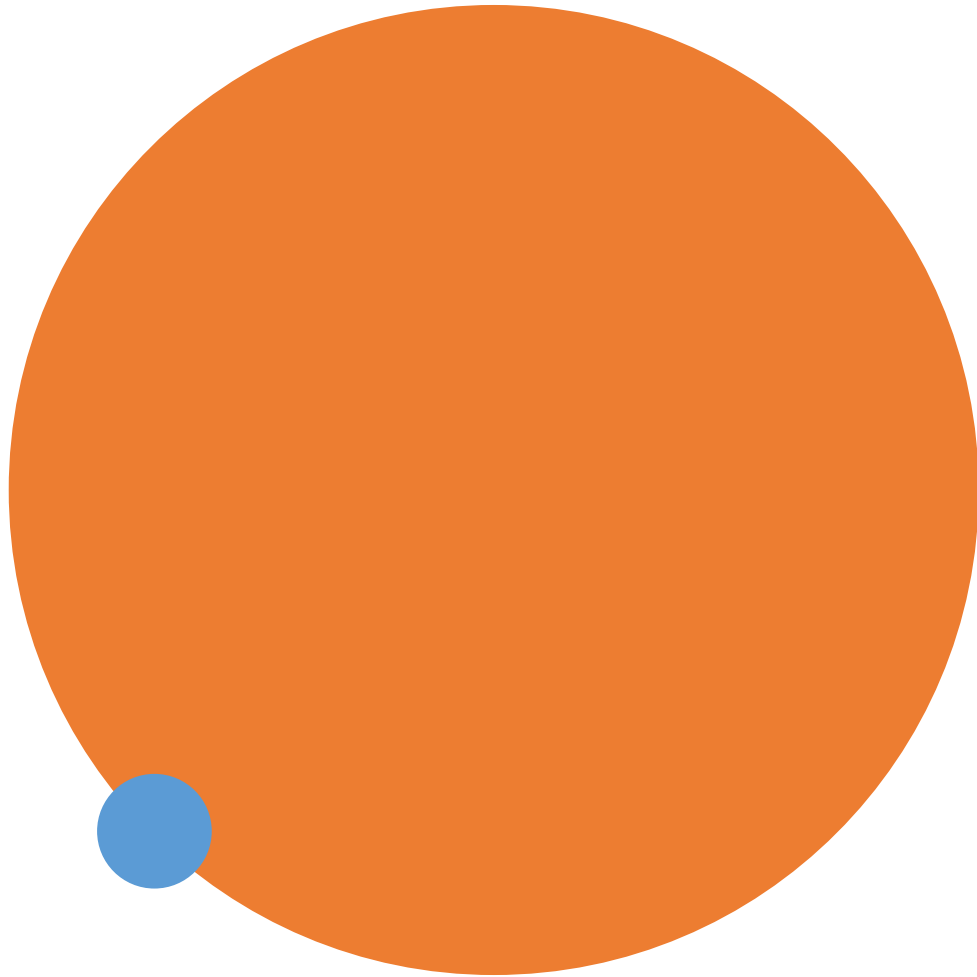
Some additional information on functional hearing loss or hearing difficulty (HD)(Whitelaw & Roup)

- Higher prevalence has been reported in specific populations such as Veterans (Gallun et al., 2012; Saunders et al., 2015), people who have experienced concussion or mild traumatic brain injury (Bergemalm & Lyxell, 2005; Gallun et al., 2012), and older adults (Pichora-Fuller & Souza, 2003; Hannula et al., 2011; Rodriguez et al., 1990), a population often overlooked.
- These prevalence data may be an underestimate of the true scope of this population based on a number of factors, including lack of a clear diagnostic criteria, patients who are not referred for audiologic evaluation, and those who “give up” on the process.
- This insight into the prevalence data provides a critical opportunity for audiologists to practice at the top of their scope of practice to offer both diagnostic and treatment services to adults with HD

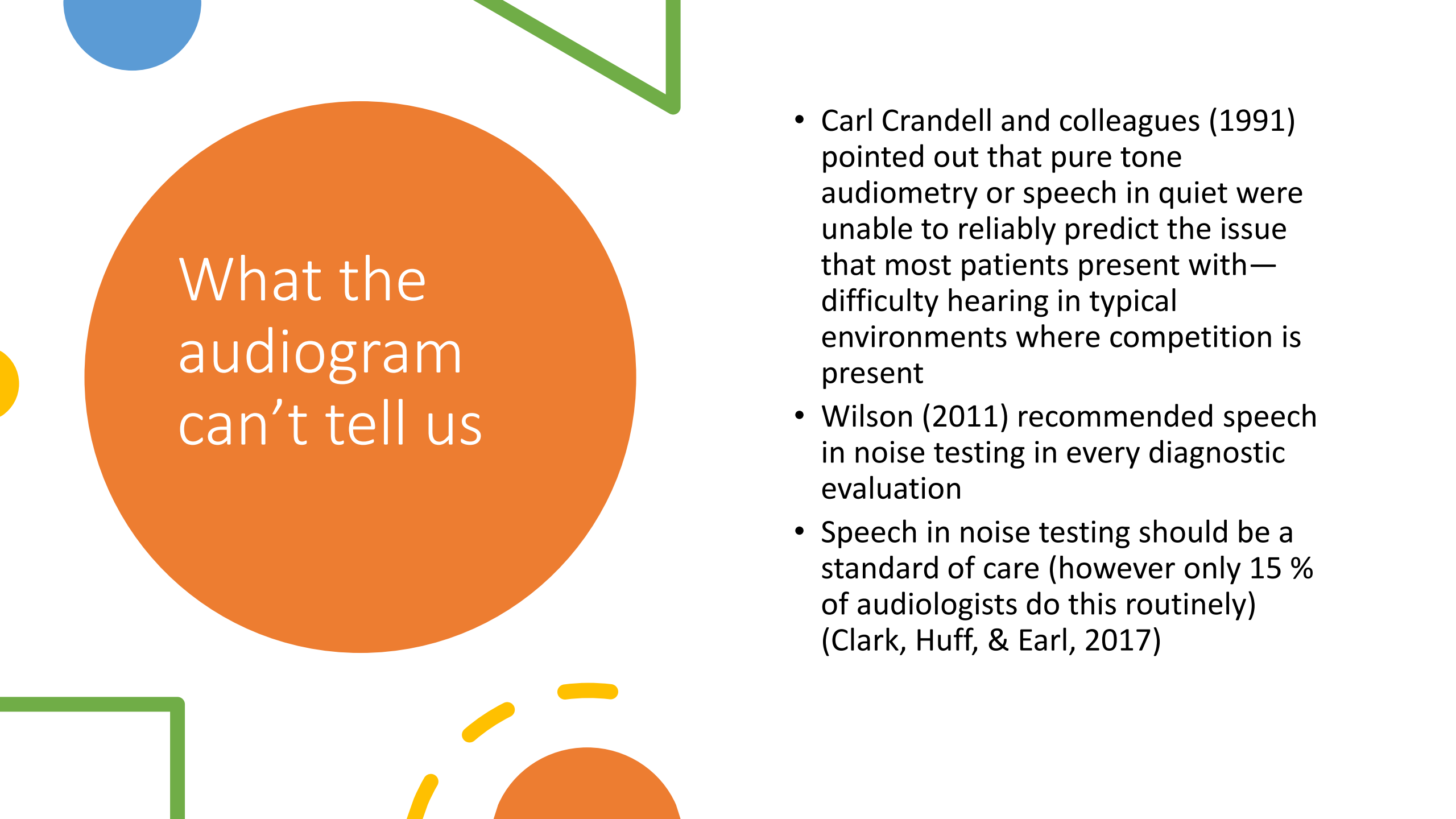
Current research: What we think the audiogram can tell us but it doesn't

- **Sanchez et al (2016)**
 - **Cochlear synaptic loss that can lead to neural changes in the auditory pathway**
 - **One of our “sites of lesion”**
 - **May have a normal audiogram; can actually have about 50% of outer hair cells die and still have “normal hearing” on an audiogram**
 - **Back to the example: People with sensorineural hearing loss have difficulty listening in background noise but it is not restricted to those individuals (and this population may have “loss” that doesn’t show up on the audiogram)**
 - **May also have tinnitus (ringing in the ear) or sound tolerance issues and these may be an early indicators of vulnerability to hidden synaptic injury**
 - **Learning more about this as a science and profession**

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- **Broadening considerations of an audiogram**
 - **Reconsidering “grades” of hearing loss based on the Global Expert Group on Hearing Loss (Olusanya, Davis, & Hoffman, 2019): 20 dB or better is normal**
 - **Historically, people with hearing between 15-25 dB HL reported difficulty listening in noise**
 - **Normal hearing at 25 dB or less is an arbitrary measure; the definition of “normal” hearing and recommendations for hearing aid candidacy are not evidence-based (Golub, et al, 2020)**
- 



- **Broadening considerations on an audiogram**
 - **Golub and colleagues (2020) introduced the term of “subclinical hearing loss” (15-25 dB HL)**
 - **Higher incidence of cognitive issues and depressive symptoms reported in this population than for those who demonstrated “normal” hearing (e.g. 15 dB HL or better)**



What the audiogram can't tell us

- Carl Crandell and colleagues (1991) pointed out that pure tone audiometry or speech in quiet were unable to reliably predict the issue that most patients present with— difficulty hearing in typical environments where competition is present
- Wilson (2011) recommended speech in noise testing in every diagnostic evaluation
- Speech in noise testing should be a standard of care (however only 15 % of audiologists do this routinely) (Clark, Huff, & Earl, 2017)

Lessons from psychoacoustics

- Bardi, Siegel, & Wright (2011)
 - Impaired frequency resolution is a factor in functional hearing loss
 - How precise listening is in those “bins” or “channels”
 - Impacted by sensorineural hearing loss—the “bins” become wider and let in more “noise”
 - In this study, subjects with normal audiograms who had no difficulty listening in noise were compared to subjects with normal audiograms who reported difficulty in noise on frequency resolution skills
 - The “impaired” group had significantly wider filters when compared to those with normal hearing and no hearing complaints, specifically in the higher frequencies; no distinguishable differences in absolute thresholds
 - Authors suggest that this population have hearing deficits that are not identified by “standard” audiometry
 - May support the use of hearing technology, for the same reasons that we aid those with sensorineural hearing loss (it’s more than a loss of volume)

What is an impaired auditory system?

- An audiologist can characterize an impaired auditory system as one that:

- 1) Cannot detect sound at levels we have determined to be “normal”
- 2) Has one or more “site of lesion” that interfere with auditory function
- 3) Does not have the entire speech spectrum available for processing
- 4) Has difficulty functioning in a noisy environment

(Carney, 1999)

Carney, A.E. (1999) Auditory system development and dysfunction: What Do we really know about childhood hearing loss. Trends in Amplification, 4(2), 32-38.

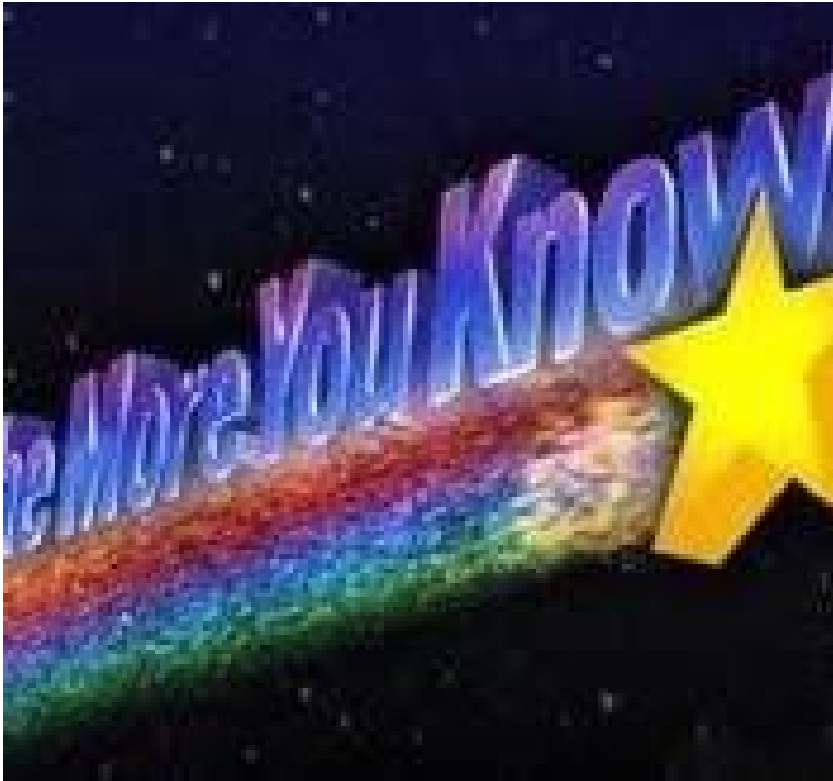
- We know more about hearing so that information needs to be incorporated into the practice of audiology
 - Tests are not infallible
 - Some things are difficult to test for or we don't have a "test" yet (or one that is clinically efficient)
 - Example is processing by the efferent auditory system



The take
home
message on
this

- A "normal audiogram" does not equate to normal hearing
- Patients, both adults and children, can have complaints regarding hearing and listening, particularly in less than optimal situations
 - Audibility
- How does this differ from other auditory disorders?
- Does the etiology matter? Can argue this both ways?

Listening is complex!



- Requires attention, cognition, executive functioning, working memory, etc.
- Engages the afferent (ear to brain) and efferent (brain to ear) systems of the auditory system
 - Some more contemporary perspectives also look at the role of hair cells, the limbic system, along with other parts of the puzzle
 - The more you know...
- Realizing that hearing and listening happen in the ear **and** the brain

Newer considerations



Listener effort: NASA TLX

How clinically testable?

See Pichora-Fuller and colleagues The Framework for Effortful Listening (FUEL)

- Applies to everything and everyone: Cognitive effort
- <https://pubmed.ncbi.nlm.nih.gov/27355771/>



Listener fatigue

Long recognized as a factor

Vanderbilt Fatigue Scale for Children

Vanderbilt Fatigue Scale for Adults

<https://podcasts.apple.com/us/podcast/dr-hilary-davis-listening-related-fatigue/id1530082864?i=1000600320780>

Authentic Assessment/Patient review of outcomes (PRO)

- Questionnaires: Adult focused
 - Adult Auditory Processing Scale (AAPS) (Roup)
 - Auditory Processing Questionnaire (APQ)
 - Speech, Spatial, and Qualities of Hearing Scale (SSQ)
 - UCHAPI (Keith, 2019)
 - tKeith, R.W., Tektas M, Ramsay K, Delaney S. Development and standardization of the University of Cincinnati Auditory Processing Inventory (UCAPI)[†]. *Int J Audiol.* 2019;58(6):373-378. doi:10.1080/14992027.2019.1585973

Authentic Assessment: Pediatric focused

- Questionnaires
 - Children's Auditory Processing Scale (ChAPS)
 - Screening Inventory for Targeting Educational Risk (SIFTER—School Aged and Secondary)
 - Evaluation of Children's Listening and Processing Skills [ECLiPS] (David Moore and colleagues)
- Ida Institute Tools—My World (<https://idainstitute.com/>)



Assessment considerations

Including

Including extended high frequency (EHF) information in clinical testing

- Significant evidence to support the correlation between EHF loss and difficulty listening in background noise
- Extended high frequency should be considered as routine part of assessment (Colak et al, 2024)

Listening

Listening in noise: Select what you are comfortable with and use this

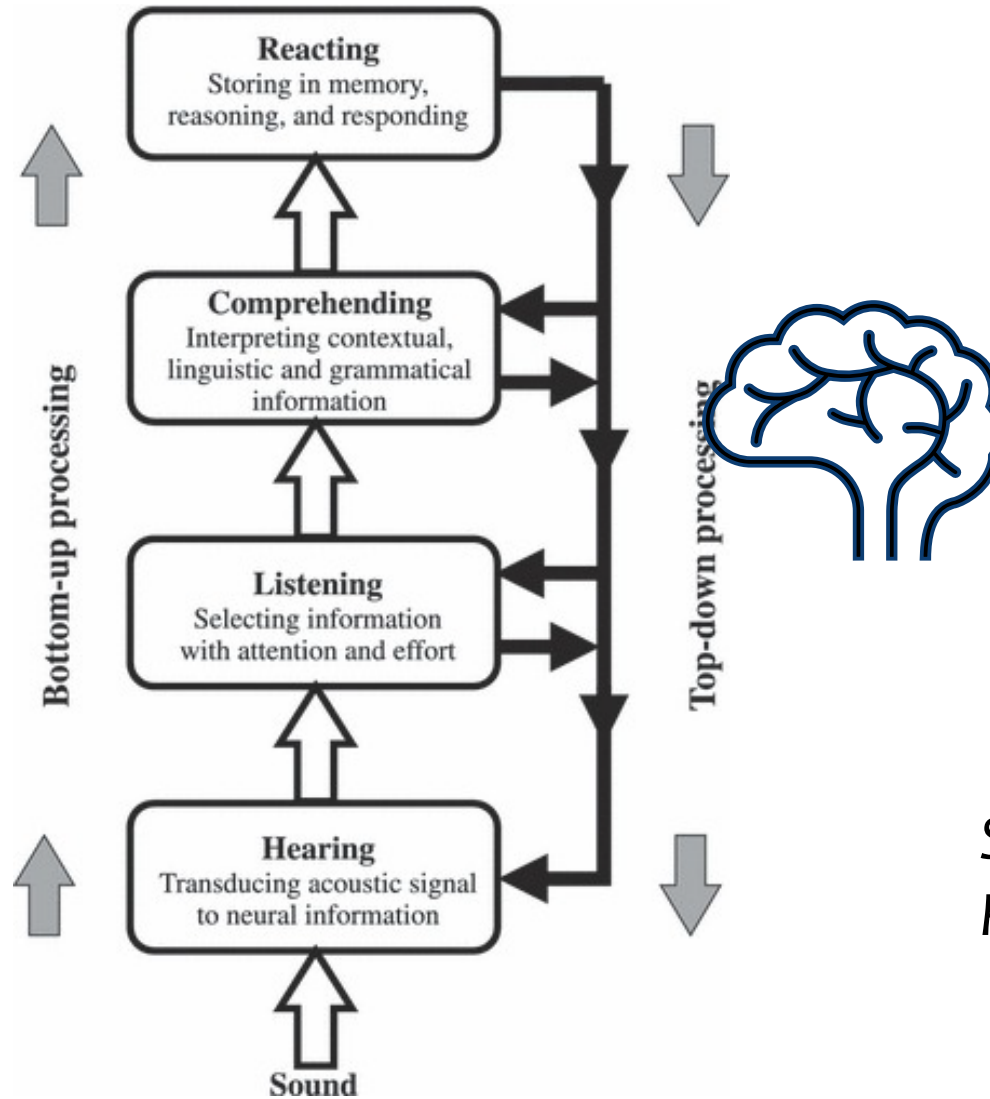
- Tutorial for audiologists regarding speech in noise testing: <https://www.thieme-connect.com/products/ejournals/html/10.1055/s-0043-1770155>

The bigger picture

- “Problems related to hearing and hearing loss are also problems that involve cognition, information processing, and brain function reflecting the response of the entire information processing system, not just the output of the auditory system disembodied from the rest of the system.” (Herbert & Pisoni, 2023)
- Ears are connected to people: important consideration in treating APD issues

What to do with these patients?
Management and treatment

Management



*Stenfelt &
Ronnberg (2009)*



Technology

Technology Options

DM /FM System

- Greatest improvement in SNR
- Convenience of use in everyday life
- Most adults discontinue use despite reporting significant benefit
- Can you “retrain the brain” in such a consistent environment?

Hearing Aids

- Enhance soft components of speech
- Improve SNR
- Directionality
- Improve comfort and reduce auditory distractions

LiD (Listening difficulties) in children with normal hearing

- Shiels, Lucy; Tomlin, Dani; Rance, Gary. The Assistive Benefits of Remote Microphone Technology for Normal Hearing Children With Listening Difficulties. *Ear and Hearing* 44(5):p 1049-1060, September/October 2023. | DOI: 10.1097/AUD.0000000000001351
- Positive impact on audibility and attention in school aged children

Fitting of amplification

- The concept of “mild gain” or “low gain” hearing aids
 - Drop the term “mild gain”: Focus on appropriately fit with verification and validation
- Not a new concept
 - Winchester (1975) raised this idea in the Maico Audiological Library Series
 - However, the control over technology today has opened this door
- An estimated million people with functional hearing loss using hearing aids?(Demeester)

Fitting of amplification

- Evidence from studies in this population
 - Reduced listening effort (Ohlenforst et al, 2018)
 - Improvement of speech in noise and signal to noise ratio (average of 6 dB) (Beck & LeGoff, 2018)
 - Improvement of listening in quiet and noise for the majority of subjects fit (Roup, Post, & Lewis, 2018)
 - Better word recall in noise, reduced fatigue/listening effort, and improved SNR (Beck, Ng, & Jensen, 2019)
 - Perception of soft sounds
 - Restoring some frequency selectivity? (Bardi et al, 2011)
 - Overall benefit: Mealings, Kiri^{1,2,6}; Valderrama, Joaquin T.^{1-4,6}; Mejia, Jorge^{2,5}; Yeend, Ingrid^{1,2}; Beach, Elizabeth F.²; Edwards, Brent^{1,2}. Hearing Aids Reduce Self-Perceived Difficulties in Noise for Listeners With Normal Audiograms. *Ear and Hearing* 45(1):p 151-163, January/February 2024. | DOI: 10.1097/AUD.0000000000001412

Fitting of amplification

- Current technology: Sophisticated
 - Directional technology
 - Beam-forming directionality
 - Multi-speaker-access-technology (MSAT)
 - Beck and Danhauer (2019)
 - Low Gain Hearing Aids (Roup, Whitelaw, & Baxter, 2018)
 - Enhance soft consonants of speech
 - Improve SNR with use of multiband directional microphones
 - Background noise algorithms may improve comfort and reduce distractions

Fitting Recommendations (Roup, Whitelaw, & Baxter, 2022)

- Open as possible? Differing approaches. Can greater occlusion result in better access to advanced features of the hearing aid?
- 5-15 dB gain for soft and conversational speech
- Little to no gain for loud sounds
- MPO not to exceed patient's LDL
- Verification using real ear unaided and aided responses for soft and moderate sounds and MPO
- Use of directional microphones and noise reduction technology



Aural rehabilitation

AUDITORY TRAINING


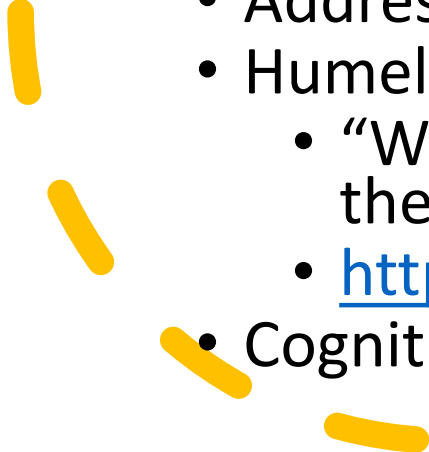
- BUFFALO MODEL AUDITORY TRAINING (BMAT)
 - The pilot case study
- AUDITORY VERBAL Therapy (AVT)
- AMPTIFY (<https://amptify.com/>)
- LISTENING AND COMMUNICATION ENHANCEMENT (LACE)
(<https://laceauditorytraining.com/>)
- WORD SUCCESS
(<https://apps.apple.com/us/app/wordsuccess/id1497217347>)
- ANGEL SOUND
(http://angelsound.tigerspeech.com/angelsound_download.html)

AUDITORY TRAINING

- Acoustic Pioneer
 - Zoo Caper Sky Scraper (dichotic listening)
 - Insane Airplane (temporal processing)
 - Elephant Memory
- CAPDOTS
 - <https://capdots.com/>



ACCOMMODATIONS

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- Technology:
 - Speech to text conversion
 - Livescribe pen
 - Captioning (such as Otter-AI that is available on zoom)
 - Counseling re: Self-advocacy
 - Accommodations through human resources
 - Vocational rehabilitation support
 - Management of co-morbid conditions
 - SLP support for top-down benefit
 - COUNSELING
 - Addressing anxiety/depression/quality of life
 - Humelan counseling
 - “We help people with hearing loss find the best solutions and live their best lives”
 - <https://www.humelan.com>
 - Cognitive behavioral therapy
- 

Summary

This patient population exists and needs us

We have the knowledge, skills, and tools to help and support them

- If we don't see these patients, they won't just "go away"
- May be misdiagnosed
- May impact the quality of their lives

Accepting that these patients may have abnormal auditory function that is not reflected in an audiogram

Consider other things, such as language processing, cognition, attention, etc.