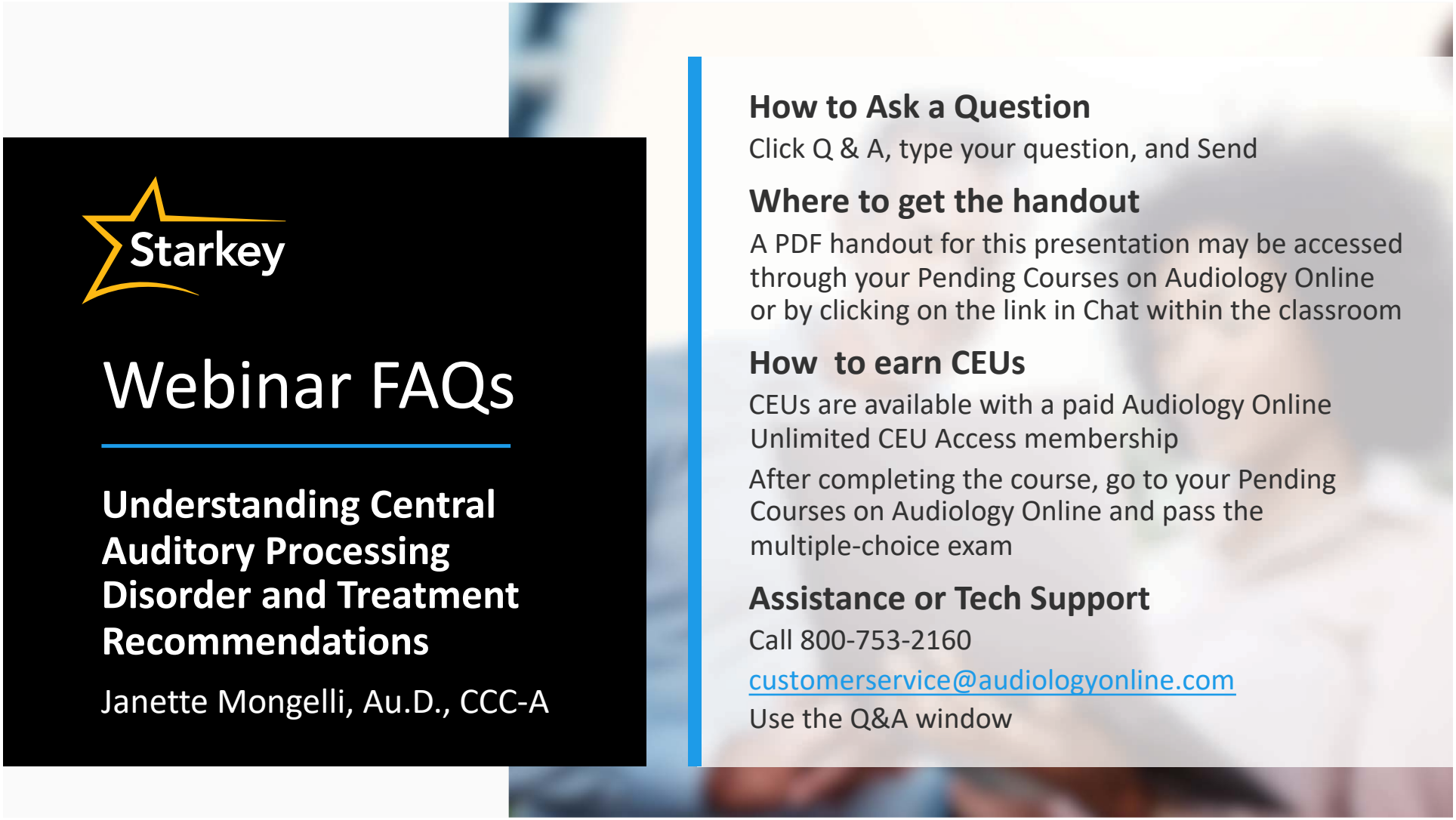

Webinar FAQs

Understanding Central Auditory Processing Disorder and Treatment Recommendations

Janette Mongelli, Au.D., CCC-A

How to Ask a Question

Click Q & A, type your question, and Send

Where to get the handout

A PDF handout for this presentation may be accessed through your Pending Courses on Audiology Online or by clicking on the link in Chat within the classroom

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Risks and Benefits

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

The interventions discussed in this course may be limited in generalizability, requiring practitioners to consider specific individual and population factors

The course may not cover all possible risk factors, diagnostic methods, or treatment options, and complex cases may require additional considerations

Healthcare providers should apply cultural competence and sensitivity to ensure effective and respectful care based on their patients' diverse needs

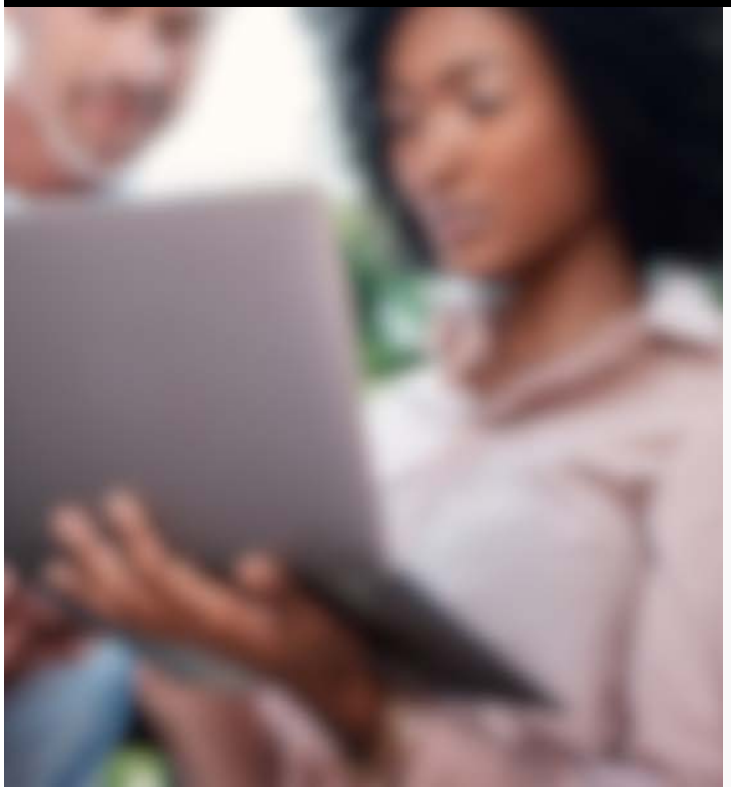
Providers should always evaluate the limitations of diagnostic and screening tools, considering their potential for false results as well as any ethical implications

It is the responsibility of course participants to critically evaluate the evidence from multiple sources to guide professional practice

Learning Outcomes

1. Define central auditory processing disorder
2. List the deficits associated with central auditory processing disorder
3. Describe recommended treatments for patients with central auditory processing disorder

Reminders



Evidence-Based

All CE courses on audiologyonline.com must be evidence-based. In evidence-based continuing education sessions, the presenter provides:

- **The best available, current, scientific evidence** to support a particular practice or guideline which can include exploratory or pilot study data and the related evidence
- **Information about his/her clinical expertise, expert opinion, and experience in this topic area**
- **Information related to client/patient/caregiver values**
- **An indication of the level of evidence** (e.g., systematic review, randomized control trial, cohort study, expert opinion, etc.) for each piece of evidence presented, ensuring clarity on the strength and reliability of the supporting data

History of CAPD

Research began in 1954 with neurological patients, who presented with difficulty understanding auditory stimuli in the presence of normal hearing

In the 1980s, doctors began research on hemispheric specialization in split-brain patients – those who had undergone surgical severing of the corpus callosum

In the 1990s, early screening measures emerged, including the Buffalo Model and the CHAPPS questionnaire

In the 2000s, Bellis & Chermak's work established key dichotic and temporal battery tests widely used in clinical diagnosis

In the 2010s through the present, systematic reviews of the literature have been completed to assess diagnostic variance and efficacy of interventions

Central Auditory Processing Disorder (CAPD)

The American Speech Language Hearing Association (ASHA) defines **central auditory processing disorder (CAPD)** as “deficits in the neural processing of auditory information in the CANS (not due to higher order language or cognitive factors) demonstrated by poor performance in one or more of the following skills:

- Sound localization and lateralization
- Auditory discrimination
- Auditory pattern recognition
- Temporal aspects of audition
- Auditory performance in competing acoustic signals
- Auditory performance with degraded acoustic signals”

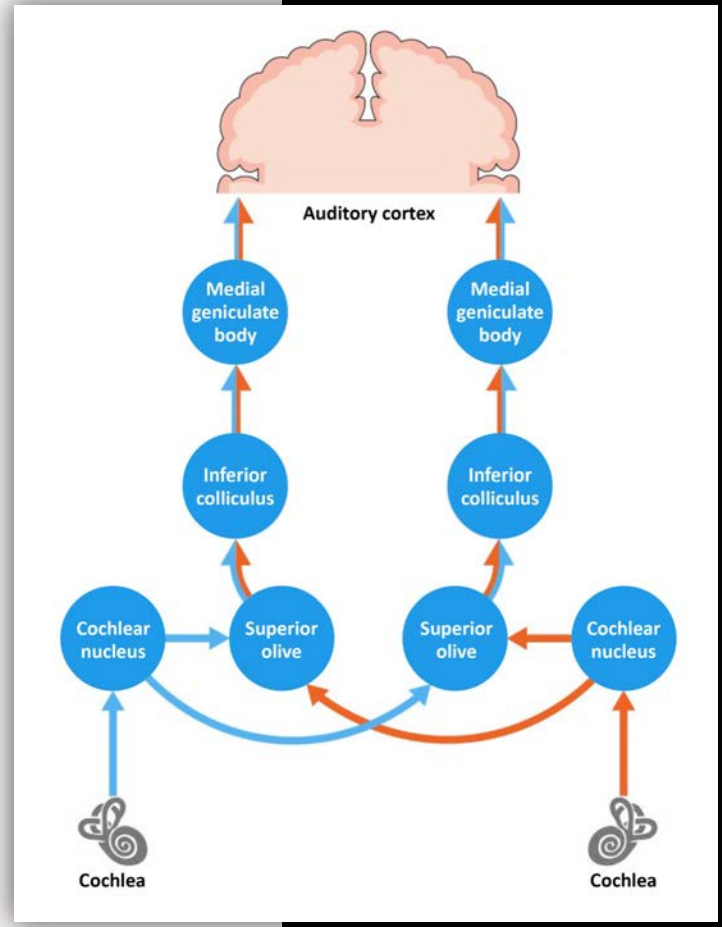
Central Auditory Processing Disorder (CAPD)

The American Academy of Audiology further outlines the following possible features of CAPD:

- Poor perception of speech and non-speech sounds
- Origins in impaired neural function
- Impacts on everyday life via reduced ability to listen and respond appropriately
- Doesn’t result from failure to understand instructions
- Often co-occurs with other neurodevelopmental disorders

Central Auditory Nervous System (CANS) Anatomy

1. Cochlear nerve (CN VIII)
2. Cochlear nucleus (superior medulla)
3. **Superior olivary complex**
4. Inferior colliculus
5. Medial geniculate body
6. Finally, projected to auditory cortex



Prevalence and Etiology of CAPD

Prevalence of CAPD

CAPD affects between **3-5%** of children in the United States

Roughly **5%** of children referred for audiologic evaluation are diagnosed with CAPD

The National Institutes for Health estimates the **prevalence of CAPD among children with diagnosed learning disabilities is 43%**

Prevalence of CAPD

The National Institutes for Health estimates that **0.5-1% of adults with normal hearing** have CAPD

In adults referred to audiology for concerns despite normal hearing, **about 0.9% are identified with CAPD**

Etiology of CAPD

Neurological Conditions: Congenital or Acquired

Lesions or tumors of the CANS

Neurodegenerative disorders
(e.g. multiple sclerosis)

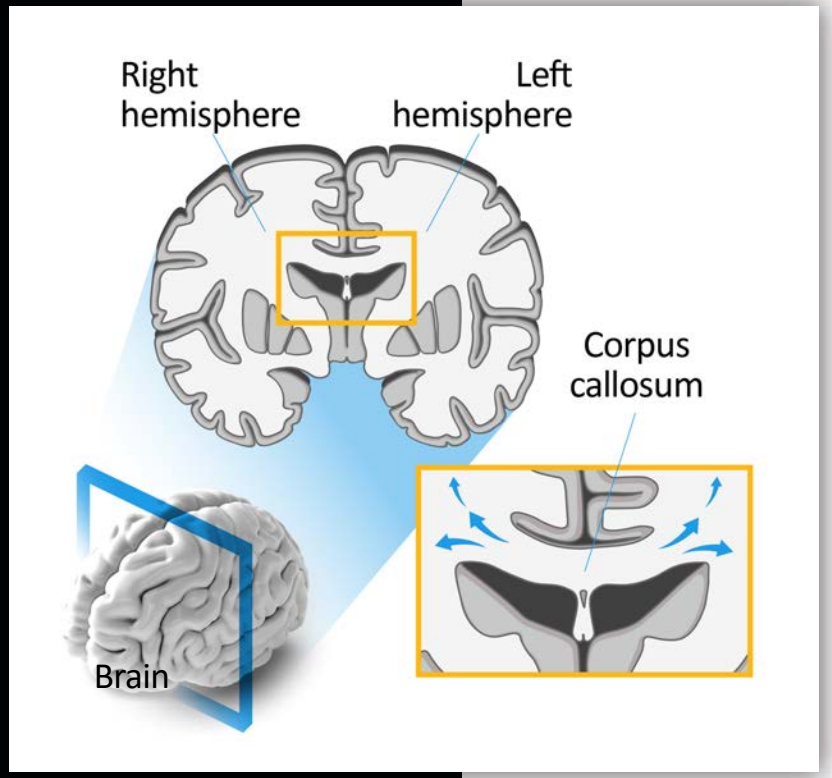
Cerebrovascular disease (including strokes, aneurysms, vascular malformations, etc.)

Traumatic brain injury

Prenatal/neonatal risk factors

Degeneration of CANS (age-related)

Imaging after stroke of left MCA



Etiology of CAPD

Delayed CNS Maturation and/or Developmental Disorders

The human auditory system is fully developed at birth, however…

Myelination of the higher auditory pathways (including the corpus callosum) is still occurring until 12 years old

As a result, any condition restricting auditory input (e.g. chronic ear infections) can affect development disproportionately

Comorbidity of CAPD

CAPD may also share features with:

Autism

Attention deficit hyperactivity disorder

Learning disabilities (including dyslexia)

Language delays and/or disorders

Sensory processing disorder

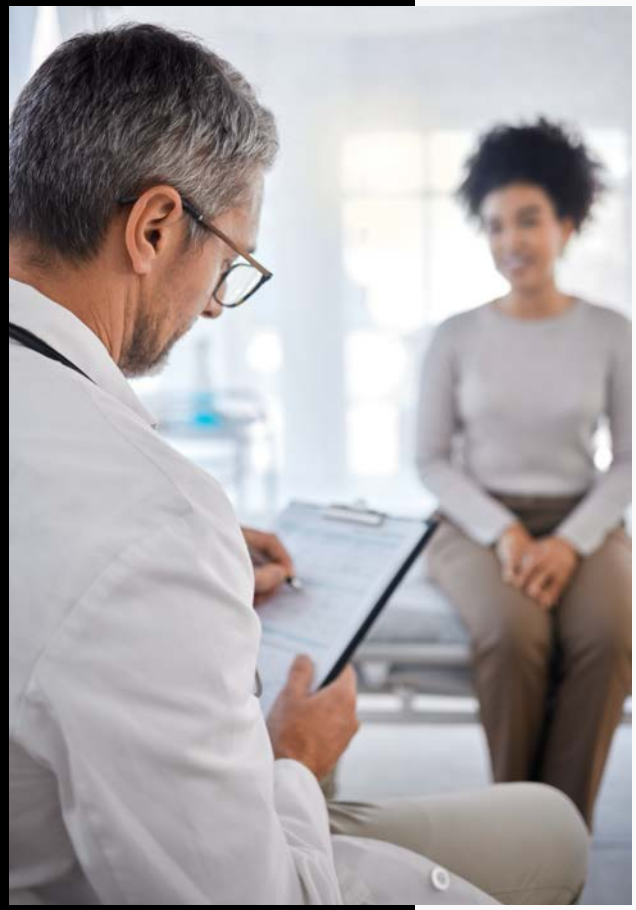
Evaluation of CAPD

Comprehensive Case History

Observational Tools

Diagnostic Criteria

Diagnostic Evaluation



Comprehensive Case History

Patient's personal and family medical history, including known or potential genetic abnormalities

Prenatal, perinatal, postnatal history and development

General health status including any significant medical conditions or psychological factors

Communication, listening, and auditory skills and behaviors

Social development, linguistic and cultural background

Any prior therapies and/or current treatments

Any etiological basis for auditory deficits – trauma, TBI, lesions, degenerative disorders, metabolic dysfunction, etc.

Behavioral characteristics

Common Behavioral Reports/Symptoms

Difficulty understanding speech in noise

Problems localizing sound sources

Difficulty hearing on the phone

Inconsistent responses to requests for information

Difficulty following rapid speech

Frequent requests for repetition and/or rephrasing

Difficulty following directions

Difficulty or inability to detect tone of voice

Difficulty learning a foreign language

Difficulty maintaining attention

A tendency to be easily distracted

Poor singing or musical ability

Academic difficulties, including reading, spelling and/or learning problems

Observational Tools

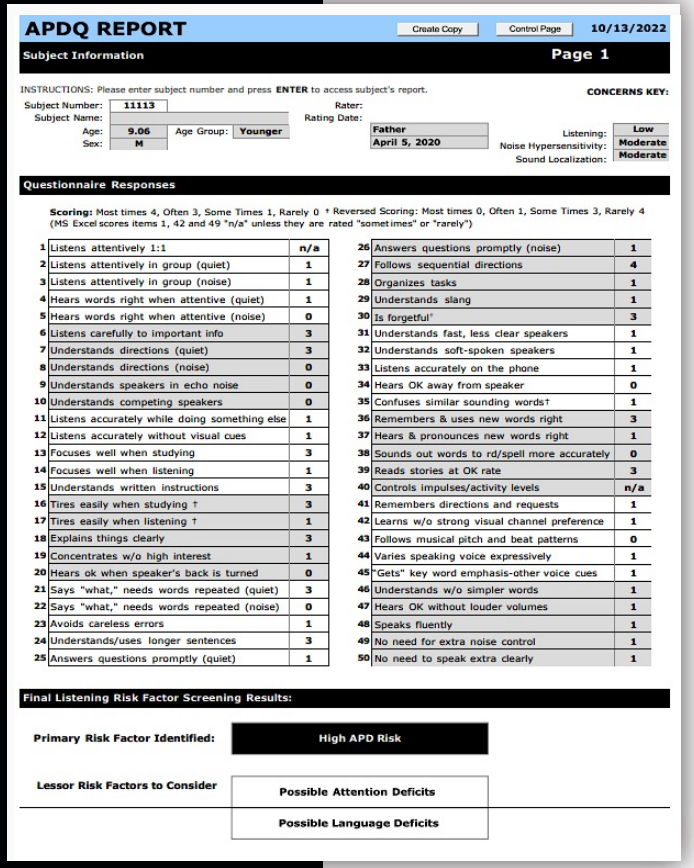
Auditory Processing Domains Questionnaire (APDQ)

Checklist of Auditory Perceptual Subskills

Children's Auditory Performance Scale (CHAPS)

Children's Home Inventory of Listening Difficulties (CHILD)

Listening Inventory for Education-Revised Student Appraisal of Listening Difficulty (LIFE-R SALD)



APDQ REPORT Create Copy | Control Page | 10/13/2022

Subject Information Page 1

INSTRUCTIONS: Please enter subject number and press **ENTER** to access subject's report.

CONCERNS KEY:

Subject Number:	11113		Rater:		
Subject Name:			Rating Date:	Father	
Age:	9.06	Age Group: Younger		April 5, 2020	
Sex:	M				

Listening:	Low
Noise Hypersensitivity:	Moderate
Sound Localization:	Moderate

Questionnaire Responses

Scoring: Most times 4, Often 3, Some Times 1, Rarely 0 † Reversed Scoring: Most times 0, Often 1, Some Times 3, Rarely 4 (MS Excel scores items 1, 42 and 49 "n/a" unless they are rated "sometimes" or "rarely")

1	Listens attentively 1:1	n/a	26	Answers questions promptly (noise)	1
2	Listens attentively in group (quiet)	1	27	Follows sequential directions	4
3	Listens attentively in group (noise)	1	28	Organizes tasks	1
4	Hears words right when attentive (quiet)	1	29	Understands slang	1
5	Hears words right when attentive (noise)	0	30	Is forgetful†	3
6	Listens carefully to important info	3	31	Understands fast, less clear speakers	1
7	Understands directions (quiet)	3	32	Understands soft-spoken speakers	1
8	Understands directions (noise)	0	33	Listens accurately on the phone	1
9	Understands speakers in echo noise	0	34	Hears OK away from speaker	0
10	Understands competing speakers	0	35	Confuses similar sounding words†	1
11	Listens accurately while doing something else	1	36	Remembers & uses new words right	3
12	Listens accurately without visual cues	1	37	Hears & pronounces new words right	1
13	Focuses well when studying	3	38	Sounds out words to rd/spell more accurately	0
14	Focuses well when listening	1	39	Reads stories at OK rate	3
15	Understands written instructions	3	40	Controls impulses/activity levels	n/a
16	Tires easily when studying †	3	41	Remembers directions and requests	1
17	Tires easily when listening †	1	42	Learns w/o strong visual channel preference	1
18	Explains things clearly	3	43	Follows musical pitch and beat patterns	0
19	Concentrates w/o high interest	1	44	Varies speaking voice expressively	1
20	Hears ok when speaker's back is turned	0	45	"Gets" key word emphasis-other voice cues	1
21	Says "what," needs words repeated (quiet)	3	46	Understands w/o simpler words	1
22	Says "what," needs words repeated (noise)	0	47	Hears OK without louder volumes	1
23	Avoids careless errors	1	48	Speaks fluently	1
24	Understands/uses longer sentences	3	49	No need for extra noise control	1
25	Answers questions promptly (quiet)	1	50	No need to speak extra clearly	1

Final Listening Risk Factor Screening Results:

Primary Risk Factor Identified:	**High APD Risk**
Lessor Risk Factors to Consider	**Possible Attention Deficits**
	Possible Language Deficits

Diagnostic Criteria

ASHA

Deficit cannot be due to higher order language, cognitive, or other factors

Requires performance deficits of:

> 2 SDs below mean on >2 tests

> 3 SDs below mean on 1 test

> 2 SDs below mean on one test when finding is accompanied by significant functional difficulty in auditory behaviors

AAA

Score > 2 SDs below the mean in > 1 ear on 2 different behavioral central auditory tests

Screening Tests

Hearing in Noise Test (HINT) and Hearing in Noise Test – Children (HINT-C)

Assess sentence recognition in background noise

Use an adaptive (bracketing) technique to determine subject's reception threshold for sentences in noise

SCAN-3:C and SCAN-3:A

Tonal gap detection test

Auditory figure ground

Competing words task

Filtered words

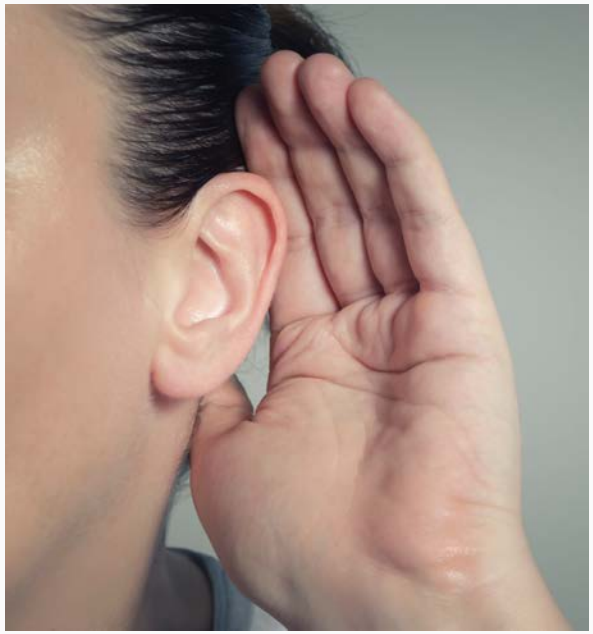
Time compressed sentences

Jerger and Musiek (2000) recommended direct screening test procedure should include dichotic digits task and gap detection test

Choosing Tests for Your Battery

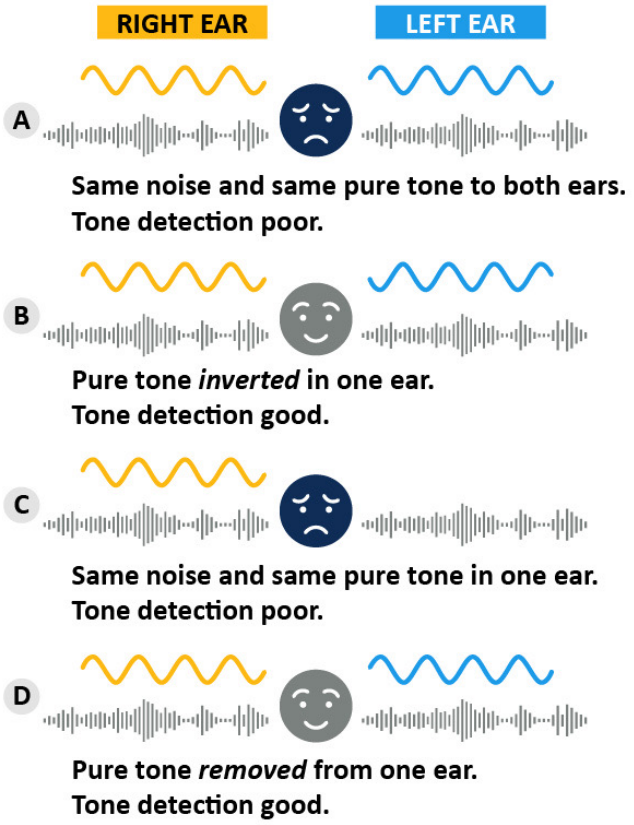
1. What specific auditory processes are being assessed by the test?
2. What other nonauditory influences might there by on performance?
3. Are test materials appropriate for age and cognitive abilities of person being tested?
4. Is normative data available? Are the norms valid?
5. Comorbid conditions' effect on results?

Four Test Types



1. Binaural Interaction tests
2. Dichotic Listening tests
3. Monaural Low Redundancy tests
4. Temporal Patterning and Processing tests

Binaural Interaction Tests



These tests require the efficient integration of acoustic information from both ears to mediate synthesis

Sensitive to brainstem pathology

Examples:

Masking Level Difference (MLD)

Synthetic Sentence Identification (SSI)

Dichotic Listening

Different speech stimuli are presented to two ears simultaneously

Sensitive to lesions of auditory cortex and interhemispheric pathways

Examples:

Dichotic Digits

Dichotic Word Listening Test

Competing Sentences

Staggered Spondaic Word Test

Monaural Low Redundancy Tests

Speech stimuli have been degraded

The ***"redundancy"*** has been reduced

Changes to the frequency, timing, and intensity of the original signal

Presented to one ear at a time

Force the brain to work harder at decoding the message

Examples:

Filtered Speech

Time Compressed Sentences

Speech in Noise tests

Sensitive to cortical lesions (typically contralateral deficits, unless the lesion in the left hemisphere is extensive)

Temporal Patterning & Processing

Four subcomponents:

Ordering

Discrimination

Integration

Masking

Examples:

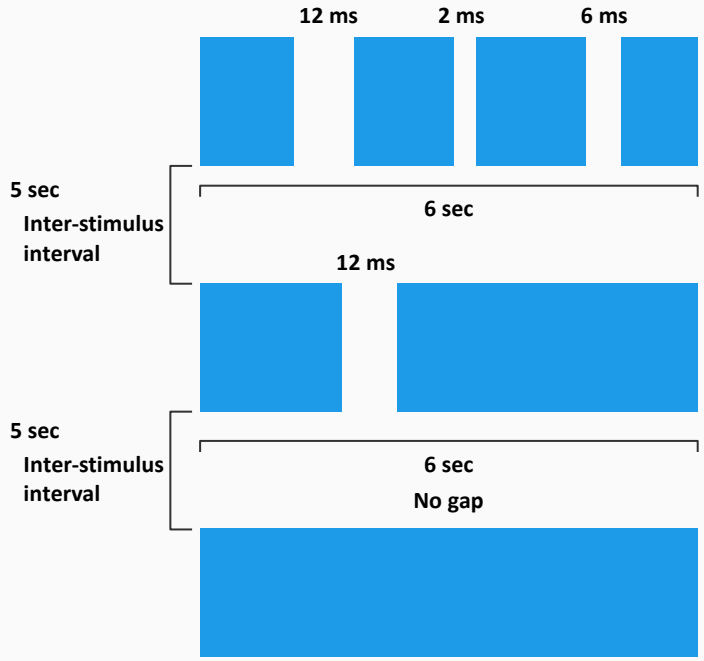
Gaps In Noise (GIN)

Random Gap Detection Test

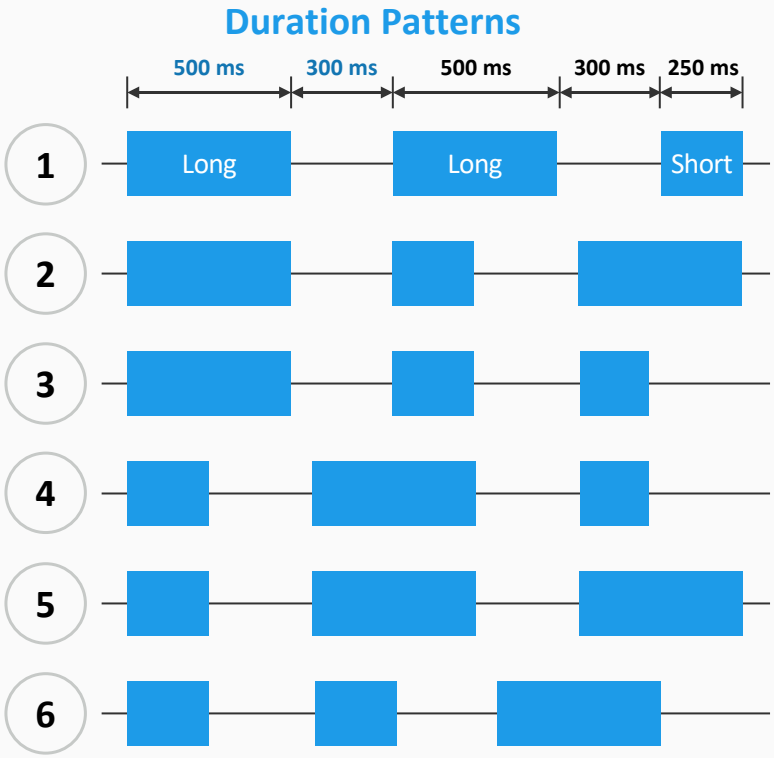
Duration Pattern Sequence

Pitch Pattern Sequence/ Frequency Pattern Sequence

Samples from Gaps In Noise test



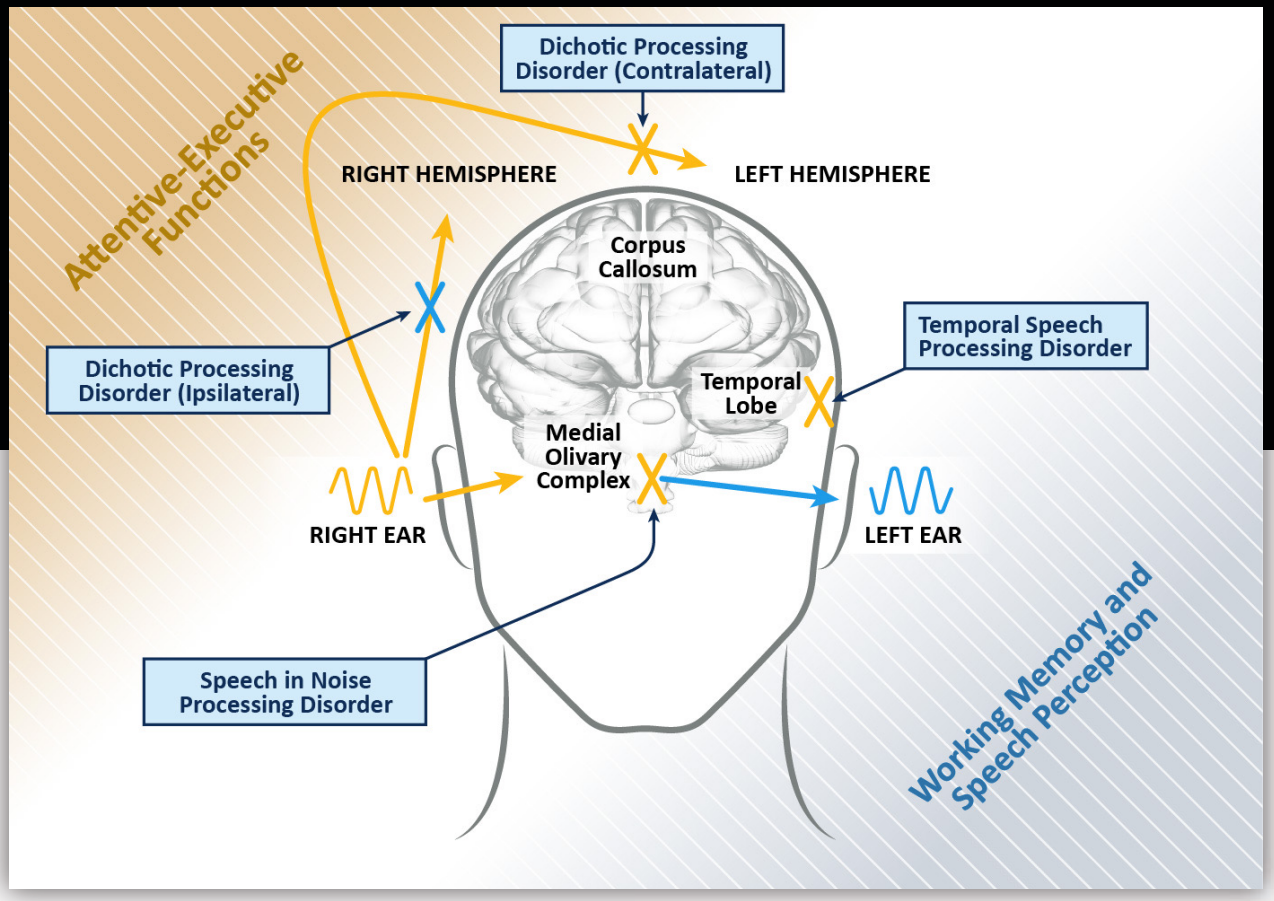
Temporal Patterning & Processing



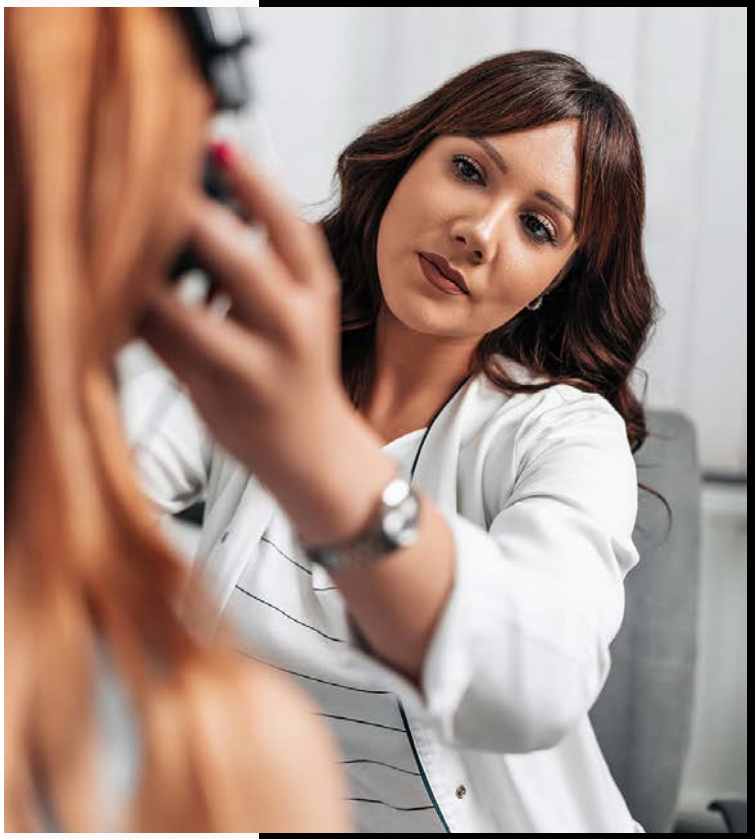
Temporal patterning tends to be sensitive to lesions in the right hemisphere

If a verbal response is required (e.g. “long, long, short”) the test is sensitive to lesions in the left hemisphere

A hummed response can also be accepted, which further assesses function of the left hemisphere


Attentive-Executive Functions
Dichotic Processing Disorder (Contralateral)
RIGHT HEMISPHERE
LEFT HEMISPHERE
Corpus Callosum
Dichotic Processing Disorder (Ipsilateral)
Temporal Speech Processing Disorder
Temporal Lobe
Medial Olivary Complex
RIGHT EAR
LEFT EAR
Speech in Noise Processing Disorder
Working Memory and Speech Perception

Test	Adults	Children	HL okay?	Sensitive to:
Dichotic Tests				
Dichotic Digits (Musiek)	Yes, ages 12 and older	Yes, ages 7-12	Yes, 50 dB WRT SRT	Lesions of auditory cortex and interhemispheric fibers, auditory brainstem lesions; contralateral ear effects; binaural deficits if left side of brain is compromised
Dichotic Words Listening Test (DWLT)	Yes	Yes, ages 7 and older		
Competing Sentences	Yes, ages 10 and older; normal = 90-100% for both ears; score dominant ear only	Yes, ages 5-10, score dominant ear only	Yes, primary ear 35 dB WRT SRT; competing ear 59 dB WRT SRT	
Temporal Processing/Patterning				
Gaps in Noise (GIN)	Yes, ages 12 and older	Yes, ages 8-11	Yes, 35-50 dB WRT SRT	Tests temporal resolution – important for speech perception. Sensitive to right hemisphere lesions, as right hemisphere is responsible for pattern recognition If verbal response is required, test is sensitive to lesions in left hemisphere.
Random Gap Detection Test (RDGT)	No	Yes, ages 5-11	No, no norms	
Duration Pattern Sequence (DPS)	Yes; 70% correct is the norm	No	Yes, needs to be audible	
Pitch Pattern Sequence (PPS) – Child	No	Yes, 6-9 years old		
Frequency Pattern Sequence (FPS) – Musiek	Yes, 12 years old and up; 75% and up is norm	10-11 yo, 72% correct is norm	Yes, 50 dB WRT SRT	
Monaural Low Redundancy				
Time Compressed Sentence Test (TCST)	No	Yes, ages 6-11	No, no norms	Insight into functional deficits; tests auditory closure, moderately sensitive to cortical lesions
NU-6 Low Pass Filtered Speech 1kHz –	No	Yes, ages 7-12	Yes, needs to be audible	
Low Pass Filtered Speech 750 Hz	Yes	No	Yes, needs to be audible	
Binaural Interaction				
Masking Level Difference (MLD)	Yes	Yes	Yes, 70 dB WRT hearing threshold level (HTL)	Efficient integration of auditory information from both ears to mediate synthesis



Intervention and Treatment

Auditory Training

Amplification & Accessories

Compensatory Strategies & Support

Auditory Training

Structured, repetitive listening exercises to improve:

Sound discrimination

Auditory memory

Temporal processing

Sound localization

Auditory closure

Auditory Training

Bottom-up Training

Focus on perceptual auditory skills

- Phoneme discrimination tasks
- Temporal gap detection
- Dichotic listening

Top-down Training

Emphasis on cognitive-linguistic skills

- Following multistep oral directions
- Auditory memory games
- Speech in noise practice

Training Programs and Techniques

Speech in Noise difficulties are common with CAPD

Treatment goals include:

Auditory attention

Spatial separation

Temporal resolution

Listening endurance

LiSN & Learn

Ages 6+ (children, adolescents)

Adaptive software trains listener in localization & attention to speech in spatially separated noise

Improves spatial processing and real-world listening

Clinician-licensed software

LiSN & Learn interface for Goal Game

Listening and Communication Enhancement (LACE) and Lace AI Pro

Designed for teens & adults

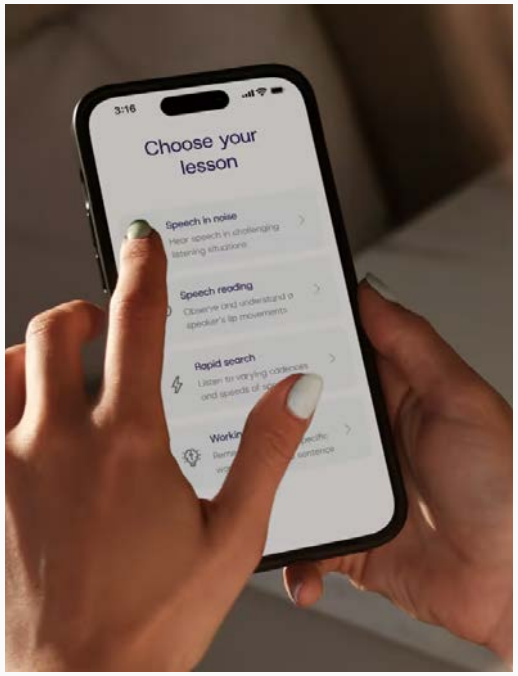
Trains user to understand degraded & rapid speech in noise

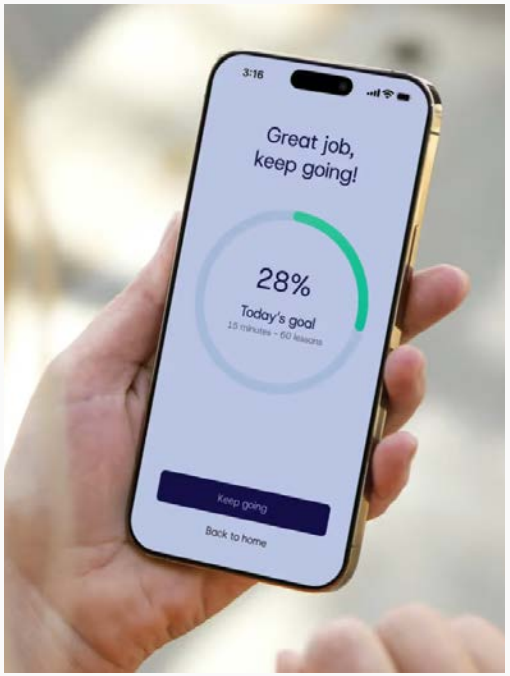
Also exercises working memory

Uses video and interactive modules

Shown to improve SiN performance and listening confidence

Computer/app based





Images courtesy of Lace Auditory Training

Buffalo Model

Designed to address specific auditory profiles

Decoding

Improves ability to quickly interpret sounds

Tolerance-Fading Memory

Enhances focus in noisy environments

Integration

Connects auditory information with other sensory input for improved comprehension

Organization

Helps with sequencing and structuring auditory information effectively

AI-generated Image courtesy of Nadia Abbott

Additional Training Ideas

Listen to an audiobook in low-level background noise

App-based training:

- SoundStorm
- HearBuilder Auditory Memory
- Train Your Ears EQ Edition

Compensatory Strategies & Support

Classroom Accommodations

Preferential seating

Visual aids and/or outlines of materials

Written instructions to support verbal directions

Built-in quiet time or listening breaks

Amplification & Accessories

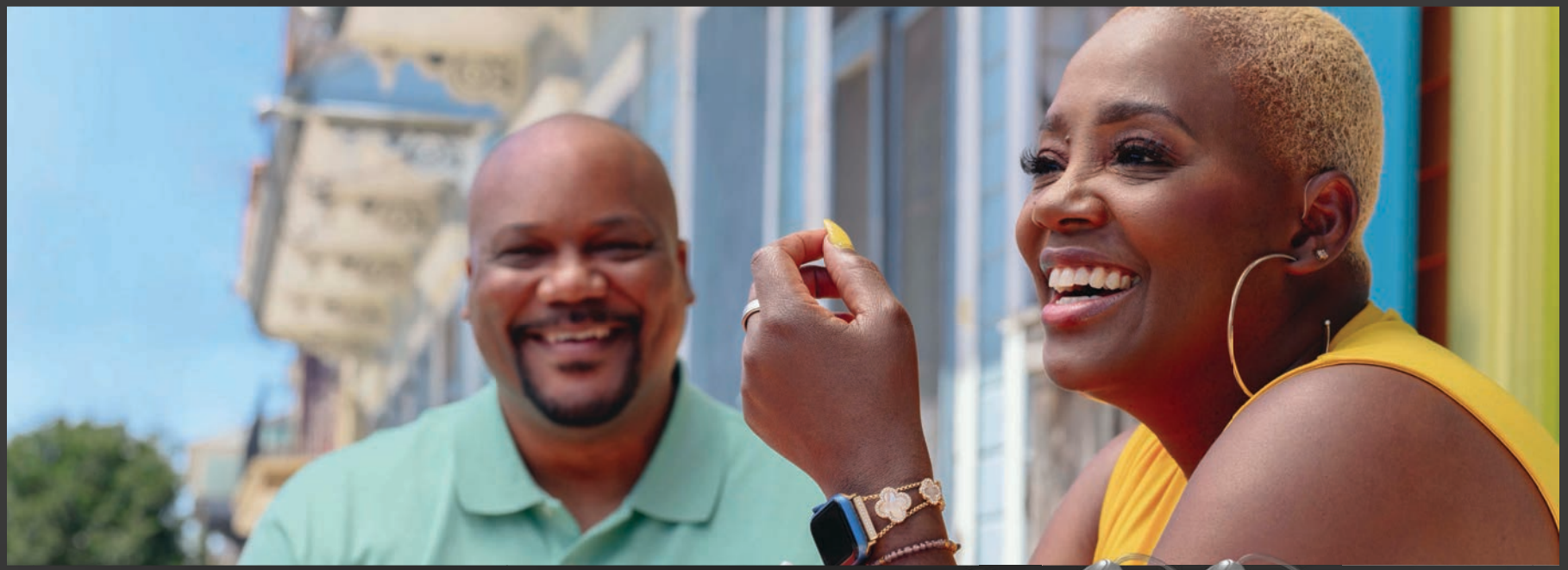
Amplification and use of ALDs can improve auditory access and reduce listening fatigue

Recommendation:

Binaural amplification, fit with mild gain

Use features that enhance speech cues

Remote microphone and/or FM systems also recommended



EDGE AI

CIC ITC/HS R ITE R mRIC R RIC RT RIC 312

Tech tiers
24 | 20 | 16

100x
MORE DNN PROCESSING
THAN GENESIS AI

30%
MORE ACCURATE
AT IDENTIFYING SPEECH

6dB
ADDITIONAL REDUCTION
IN LOW-LEVEL NOISE

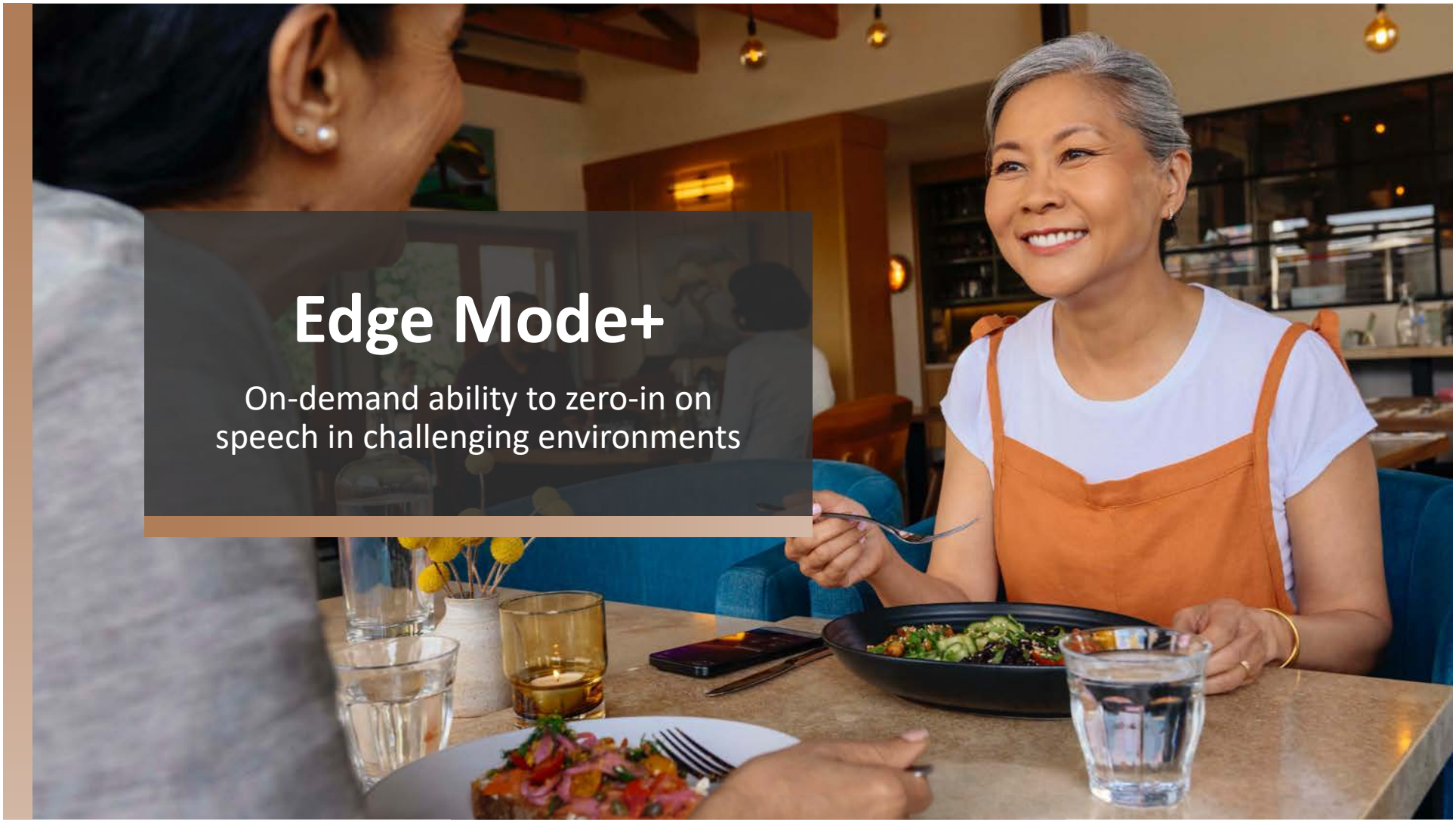
Neuro Sound Technology 2.0

It's science that speaks volumes

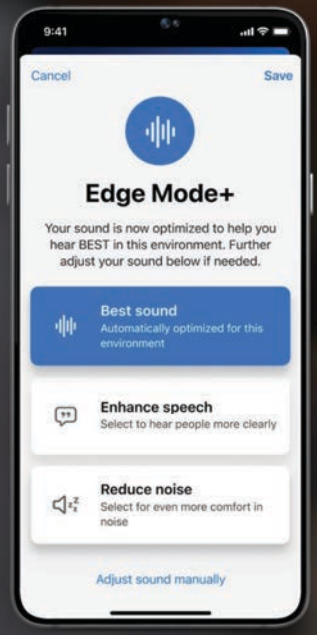
DNN Improves the Hearing Aid

Better in:

- Adapting to any acoustic environment
- Performing classification
- End-to-end optimization
- Enabling personalized solutions
- Non-stationary environments
- Fusing sensors

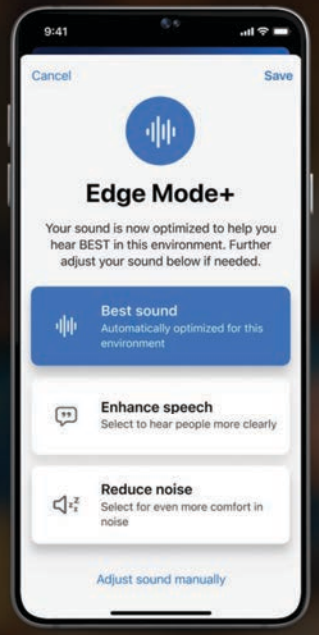

Edge Mode+
On-demand ability to zero-in on
speech in challenging environments

Edge Mode+ Tech Tier Differences



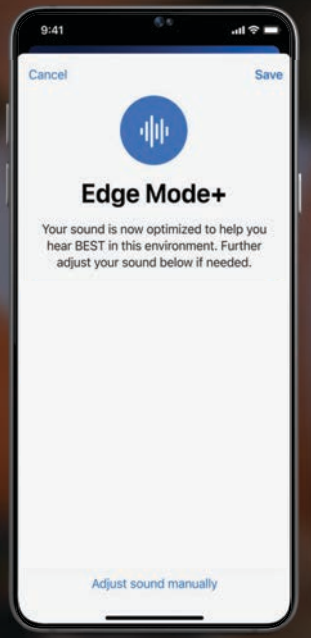
Edge AI 24

Automatic Edge Mode+ with additional patient-driven controls



Edge AI 20

Edge Mode+ with additional patient-driven controls



Edge AI 16

Edge Mode+

No further adjustments available

StarLink Edge Accessories

ALL NEW

StarLink Edge
Table Microphone

ALL NEW

StarLink Edge
Remote Microphone


ALL
NEW
StarLink Edge
Table Microphone
Our rechargeable table microphone features eight built-in microphones and multiple listening modes, automatically focusing on speech signals of interest in multi-speaker environments for clear, effortless listening

StarLink Edge

Table Microphone

Key Features

Battery charge time
2 hours

Streaming time up to
10 hours

Operating range *(15 meters)*
up to 50 feet*

*Presumes line of sight and no interference

Listening Modes

The StarLink Edge Table Mic has multiple listening modes including Automatic, Manual, Surround, and Remote Mic

For best listening:

- Place as close as possible to the conversation partner(s)
- Place with the power and volume control buttons facing the hearing aid user

ALL NEW

StarLink Edge

Remote Microphone

Our sleek, rechargeable remote microphone enables effortless binaural streaming, enhances one-on-one conversations in noise, and doubles as a convenient remote control

StarLink Edge

Remote Microphone

Key Features

Battery charge time

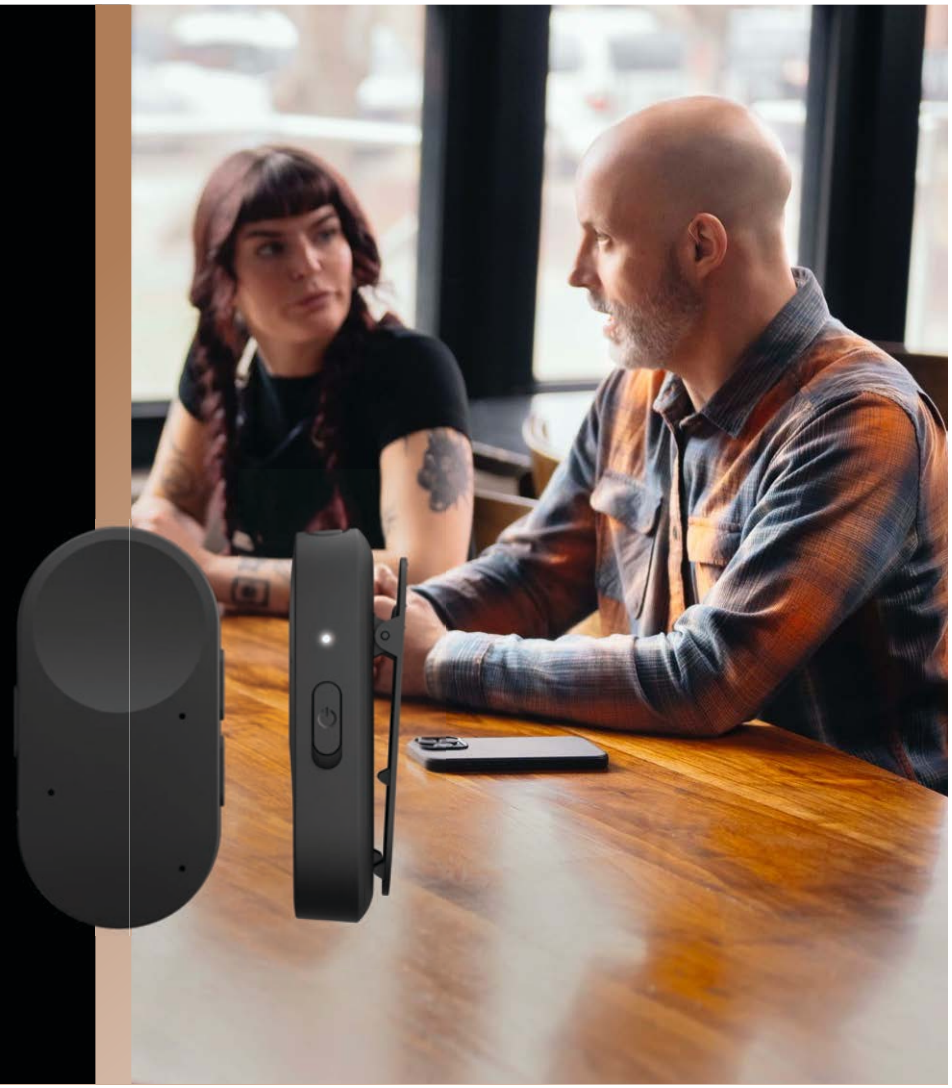
3 hours

Streaming time up to

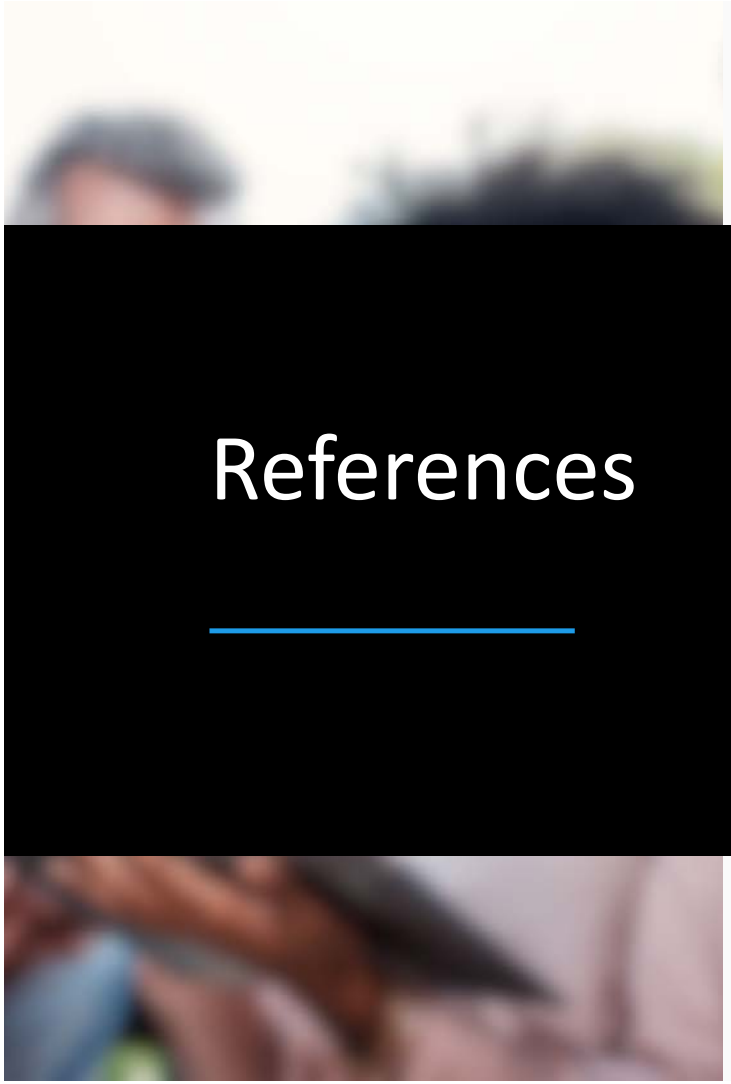
10 hours

Operating range

up to 50 feet



Every patient can benefit from Edge AI



References

Alanazi, A. A. (2023). Understanding auditory processing disorder: A narrative review. *Saudi Journal of Medicine & Medical Sciences*, *11*(4), 275-282.

Agrawal, D., Dritsakis, G., Mahon, M., Mountjoy, A., & Bamiou, D. E. (2021). Experiences of patients with auditory processing disorder in getting support in health, education, and work settings: Findings from an online survey. *Frontiers in neurology*, *12*, 607907.

American Speech-Language-Hearing Association. (n.d.). Central auditory processing disorder [Practice portal]. https://www.asha.org/practice-portal/clinical-topics/central-auditory-processing-disorder/

Musiek, F. (2016). *Introduction to temporal processing, its applications to CAPD, and other aspects of neuroaudiology. Audiology Online, Article 20238*.

Musiek, F. E., & Chermak, G. D. (2015). Psychophysical and behavioral peripheral and central auditory tests. *Handbook of clinical neurology*, *129*, 313-332.

O'Hara, Brian. (2024). APDQ USER MANUAL I FOR THE ONLINE APDQ QUESTIONNAIRE -2023 APDQ Overview. 10.13140/RG.2.2.15722.90569.

Ocklenburg, S., & Güntürkün, O. (2018). Language and the left hemisphere. *The lateralized brain*, *87*, 121.

Pickles, J. O. (2015). Auditory pathways: Anatomy and physiology. *Handbook of clinical neurology*, *129*, 3-25.

Sardone, R., Battista, P., Panza, F., Lozupone, M., Griseta, C., Castellana, F., ... & Quaranta, N. (2019). The age-related central auditory processing disorder: Silent impairment of the cognitive ear. *Frontiers in neuroscience*, *13*, 619.