1-2024

Evaluation and Treatment of Central Auditory Processing and Sound Tolerance Disorders

Aaliyah Gladney
Illinois State University, agladne@ilstu.edu

Antony Joseph
Illinois State University, arjosep@ilstu.edu

Aaliyah Gladney, B.S.

For Fulfillment of Doctor of Audiology Degree

Illinois State University, Normal, Illinois

Evaluation and Treatment of Central Auditory Processing and Sound Tolerance Disorders

January 2024

Approved by: Antony Joseph, MA, AuD, PhD, ABAC, CCC-A, CPS/A, F-NAP, Advisor

Table of contents

Abstract 1

Introduction: Central auditory processing disorder (CAPD) affects how a listener understands speech even though their peripheral auditory system is intact. **Case Presentation:** An adult female was seen for a CAPD evaluation after experiencing recent listening difficulties following an automobile accident while 20 weeks pregnant. Results from a comprehensive audiological evaluation revealed audiometrically normal hearing in both ears. Results from the CAPD evaluation suggested a prosodic deficit. **Discussion:** Although results from testing were consistent with a prosodic deficit, the patient's case history, original complaints, and recommendations were more consistent with an integration deficit. **Conclusion:** This case demonstrates that clinicians should thoroughly examine a patient's clinical history. For this case, recommendations aligned with an integration deficit, as opposed to a prosodic processing disorder.

Keywords: adult, central auditory processing disorder, Bellis/Ferre model, prosodic and integration deficit

The Presentation of Central Auditory Processing Disorders in Adults

Introduction

The prevalence of central auditory processing disorder (CAPD) in adults is not known precisely. Bellis and Anzalone (2008) estimated that around 76% of adults have CAPD. For each individual, disorders of the central auditory processing system can present differently in the clinic. In addition, there are several ways for CAPD to be described. Rosen (2005) explained that CAPD is a hearing disorder that originates within the brain, which explains why a person's pure-tone thresholds are typically within normal limits. Central auditory processing disorder is characterized by poor speech recognition, difficulty with speech discrimination and separation, difficulty localizing, and problems with nonspeech grouping sounds. With CAPD, the deficits and difficulties cannot be attributed to attention or other cognitive disorders.

Keith (1999) provided a few examples of complaints a patient may report. These include difficulty localizing sound although they have normal audiometric responses, inability to understand speech in the presence of background noise, problems following rapid speech, and trouble with auditory memory tasks. While taking case history, the patient's struggles will help guide the audiologist with the selection of assessments for a test battery. The selected battery of tests for CAPD is flexible so the same assessments will not always be used for every patient. A CAPD test battery should include tests that fall under the following categories: temporal processing, localization and lateralization, monaural low redundancy, dichotic speech, and binaural interaction. Performing assessments within these categories will assign the patient to a CAPD subtype if a diagnosis is made and will ultimately help to determine a treatment plan.

Case Presentation

An adult female patient was seen for a CAPD assessment. She reported difficulty with hearing in the presence of background noise, remembering names, learning new things, and explained that her television "sounded muffled." She described what she was experiencing as a "problem from her brain". She explained that her problems began after she was involved in a motor vehicle accident (MVA). At the time of the MVA, she was 20 weeks pregnant, and the safety of her baby was the main priority. After the MVA, she was examined by her primary care physician (PCP) and discussed her concerns. Magnetic resonance imaging (MRI) and computerized tomography (CT) were administered and were unremarkable. She reported that her condition was classified as "emotional problems" and warranted only a brief period of monitoring.

An audiologic evaluation was administered that revealed normal hearing sensitivity in both ears (**Figure 1**) with normal middle ear function. The following deficits were suggested by the CAPD assessment (**Table 1**): binaural integration which was seen in the left ear for dichotic digits, binaural separation which was seen in the right and left ear for competing sentences, temporal processing which was seen in the gaps-in-noise assessment, and temporal patterning in both the verbal and hummed labeling which was seen in the pitch pattern sequence test. During counseling, her test findings were briefly summarized, and she was informed that the CAPD team would examine her data more closely and would produce a detailed list of recommendations.

Discussion

An early-middle-aged woman was seen for a CAPD assessment. Using the Bellis/Ferre model of categorizing a CAPD, these deficits were characteristic of a prosodic deficit. With a

prosodic deficit, and person is expected to demonstrate good word-attack skills but have difficulty with sight words due to poor gestalt patterning abilities. Individuals who demonstrate this profile can comprehend the gist of a message, yet cannot discern context such as sarcasm and irony. People with prosodic deficits may show a lack of affect or be classified as monotonic readers (Bellis, n.d.).

Even though test results pointed to a prosodic deficit, the patient's case history, counseling, and recommended management strategies were not in alignment. Although CAPD was suspected, her weaknesses were more reflective of an integration deficit which occurs when the two hemispheres of the brain are not properly communicating. Integration complaints that relate to this case included challenges with reading comprehension, difficulty with multi-tasking, problems with spelling and written language, difficulty with speech in noise, and a need for more task-processing time. The challenges and management strategies of an integration deficit were better suited for this patient. As discussed in Bellis and Anzalone (2008), a management plan should not solely be based on the results of the assessments, but also on the individual's functional performance and behavioral complaints.

Conclusion

Although a CAPD diagnosis is largely based on a patient's performance on specific tests, examiners must be mindful that not all patients conform to the Bellis/Ferre sub-profiles. The case history and list of complaints for this case did not align with poor performance on temporal patterning, but her data revealed weaknesses in auditory processing. A CAPD diagnosis should be made by looking at a patient holistically, not only by objective test results. In this case, if the diagnosis had solely been based on her test results, the recommended management strategies

would have been inadequate for helping to strengthen her auditory processing skills. Therefore, clinicians should inform a patient when a deeper interpretation of the test data is required before providing recommendations. Most importantly, this might allow clinicians to develop an individualized treatment plan, rather than a generalized one.

Abstract 2

Introduction: A sound tolerance disorder is when individuals have adverse (either physical or emotional) responses to everyday sounds. A sound tolerance disorder is a broad term that encompasses tinnitus, hyperacusis, misophonia, and phonophobia. **Case Presentation:** A young adult female was seen for a sound tolerance evaluation. Results from an audiological evaluation revealed normal hearing thresholds and results from a sound tolerance evaluation indicated that a majority of responses to uncomfortable listening levels were in the normal range, which is consistent with hyperacusis. **Discussion:** Due to reduced uncomfortable listening levels, the patient was diagnosed with hyperacusis and misophonia, and extensive counseling was conducted. The counselor explained what hyperacusis was and presented the various treatment options available to the patient, including sound therapy and cognitive behavioral therapy. **Conclusion:** This case demonstrates that there may be multiple options available to aid in successful treatment for the patient, while some options may require collaboration with mental health professionals.

Keywords: young adult, hyperacusis, sound tolerance disorder, and cognitive behavioral therapy

The Presentation of Sound Tolerance Disorders in Young Adults

Introduction

A sound tolerance disorder is a broad way to describe a negative reaction or response to environmental sounds. More specific terms that designate sound tolerance disorders are hyperacusis, misophonia, noise sensitivity, and phonophobia. Hyperacusis is a physical response, usually pain or discomfort, once a sound reaches a certain loudness that would typically not be described as painful to others. Whereas hyperacusis elicits a physical response, when an individual has misophonia, their response to sound, regardless of its intensity, is emotional. Noise sensitivity is described as the state, both psychological and physiological, of the individual that results in a more intense reaction to sounds. Finally, phonophobia is the fear of certain sounds and does not typically fall into the traditional scope of an audiologist. (Henry et al, 2022). The prevalence of adults with sound tolerance disorders has not been ascertained; however, the American Speech-Language-Hearing Association (n.d.) reported a rate of 8.6 to 11.5% for adults. Paulin et al. (2016) indicated that social isolation and the use of earplugs are two methods patients use to cope with hyperacusis, which was evident in the patient described below.

Case Presentation

An adult female patient was seen for a sound tolerance evaluation, which was recommended after an evaluation by a clinical psychologist and pediatric neuropsychologist. She reported that several sounds were too loud for her and were very upsetting and overwhelming. The specific sounds that she reported as bothersome were: speech over a speakerphone and conference calls in which she described the speech as distorted, background noise and multiple

simultaneous talkers, and, specifically, her father speaking on the telephone, given the intensity of his voice. She reported struggling with the ability to ignore background noise and, as a result, she used noise-canceling headphones or earplugs during all waking hours. Due to her reactions to these sounds, the patient explained that she was frequently alone but found enjoyment in listening to music. She reported having depression and attention-deficit hyperactivity disorder (ADHD) and was receiving treatment for these conditions.

A Khalfa Hyperacusis Questionnaire and the Generalized Anxiety Disorder Screener (GAD-7) were administered. The hyperacusis questionnaire score was consistent with a severe loudness sensitivity handicap and her results on the GAD-7 suggested a probable anxiety disorder (**Table 2**). The patient expressed that she suffered from anxiety but that her vigilance and coping strategies for her ADHD manifest as anxiety. An audiological evaluation was administered that revealed normal hearing sensitivity in both ears (**Figure 2**). Uncomfortable loudness levels (UCLs) elicited using warble tones, speech, and multi-talker babble were obtained, and her responses were recorded at reduced intensity levels (**Table 2**), which is a marker for hyperacusis. The patient was counseled on the test results, her diagnosis of hyperacusis, and plans for coordinated care.

Discussion

A young adult female was seen for a sound tolerance evaluation. An assessment that was comprised of questionnaires and audiometric testing suggested a diagnosis of hyperacusis. When diagnosing hyperacusis or any other sound tolerance disorder, it is imperative to critically analyze a patient's UCLs. According to Henry et al. (2022), a normal listener can tolerate sounds upwards to 100 dBHL, at times, louder. However, when a person has a reduced tolerance to

sounds, they may only tolerate approximately 60-70 dBHL, or, in the case of our patient, lower than 60 dBHL (**Table 2**). As a result of the test outcomes, our patient was diagnosed with hyperacusis and misophonia, and time was spent counseling her on various treatment options.

Our primary recommendation was psychotherapy with cognitive behavioral therapy (CBT). Cognitive behavioral therapy aims to assist patients in exploring and uncovering the underlying factors that are causing an adverse psychological reaction to sound (Spankovich & Hall, 2014). The strategies obtained from CBT can help to reduce the negative feelings and emotions patients have attached to sound. The audiologist and psychotherapist should work collaboratively to improve the patient's quality of life. Other treatment options available include but are not limited to, the use of custom-molded or off-the-shelf musician's earplugs, tinnitus retraining therapy, and sound therapy (Henry et al., 2022). A blend of CBT, musician's earplugs, and sound therapy has been frequently recommended for patients with hyperacusis.

Conclusion

Testing, counseling, and treatment for any sound tolerance disorder involves more than standard audiological testing. With the testing, clinicians should incorporate questionnaires that target tinnitus and hyperacusis, and screeners for mental health conditions (e.g., anxiety and depression). These results may be used alongside the audiological data to inform a counseling technique and treatment regimen. Whenever possible, audiologists should collaborate with mental health professionals to help address the complex feelings and emotions that patients with sound tolerance disorders will likely experience, which inherently exacerbate their reactions to everyday sounds.

References

American Speech-Language-Hearing Association. (n.d.). *Tinnitus and hyperacusis* [Practice portal]. https://www.asha.org/Practice-Portal/Clinical-Topics/Tinnitus-and-Hyperacusis/

Bellis, T.J. (2002). Subprofiles of central auditory processing disorder. http://drkevintblake.com/wp-content/uploads/2014/04/Bellis-subprofiles.pdf

Bellis, T.J. & Anzalone, A.M. (2008). Intervention approaches for individuals with (central) auditory processing disorder. *Contemporary Issues in Communication Science and Disorders, 35*, 143-253.

Henry, J.A., Theodoroff, S.M., Edmonds, C., Martinez, I., Myers, P.J., Zaugg, T.L., Goodworth, M. (2022). Sound tolerance conditions (Hyperacusis, misophonia, noise sensitivity, and phonophobia): Definitions and clinical management. *American Journal of Audiology, 31*, 513-527.

Keith, R.W. (1999). Treatment for central auditory processing disorders: Clinical issues in central auditory processing disorders. *Language, Speech, and Hearing Services in Schools, 30,* 339-344.

Paulin, J., Andersson, L., & Nordin, S. (2016). Characteristics of hyperacusis in the general population. *Noise & Health, 18(*83), 178-184.

Rosen, S. (2005). "A riddle wrapped in a mystery inside an enigma": Defining central auditory processing disorder. *American Journal of Audiology, 14*, 139-142. https://doi.org/10.1044/1059-0889(2005/015)

Spankovich, C. & Hall, J.W. (2014). The misunderstood misophonia. *Audiology Today, 26*(4), 15-23.

Figure 1 (Case 1)

Figure 1. Pure-tone air- conduction thresholds for the left and right ear from 250 to 8,000 Hz.

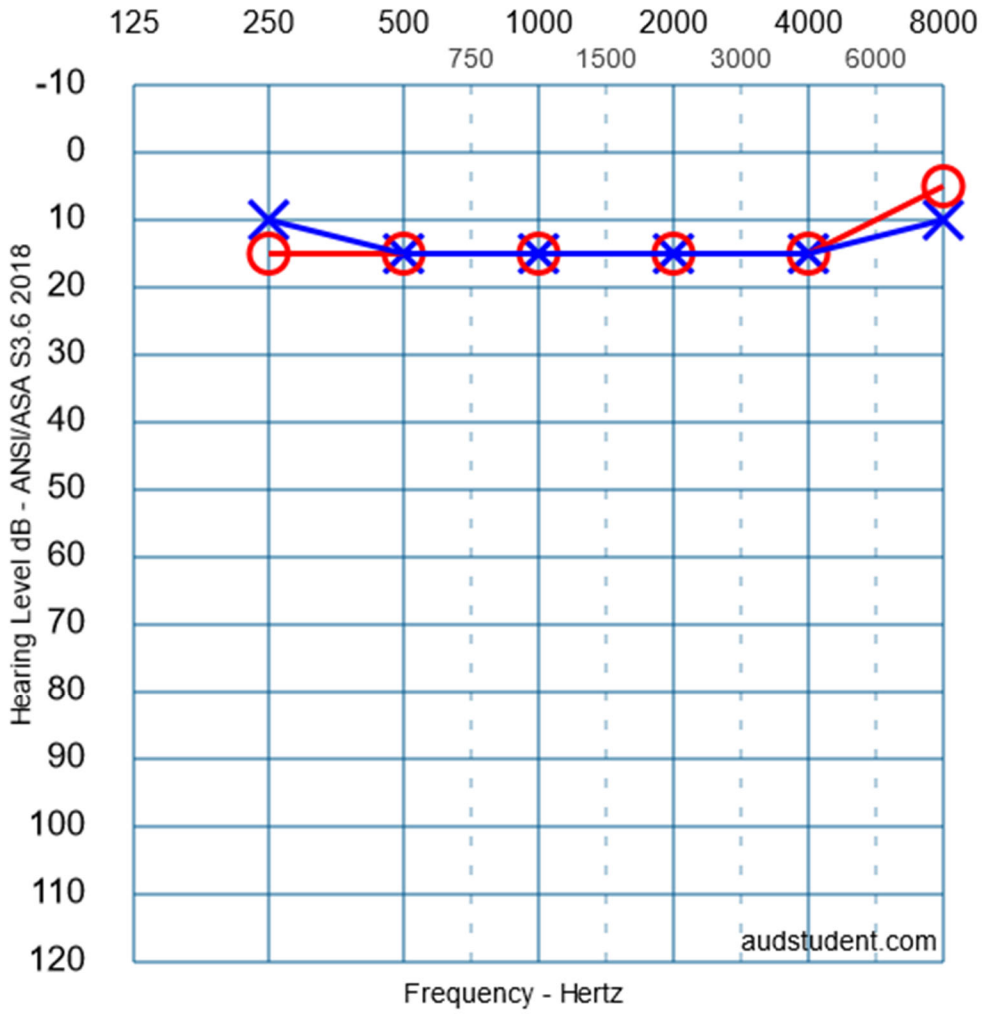

Table 1 (Case 1)

Table 1. Central auditory processing test-battery results.

Competing Sentences Test

Ear	Normal Limits	Patient's Score	
Right	90%	80%	ONL
Left	90%	72.5%	ONL

Dichotic Digits

Ear	Normal Limits	Patient's Score	
Right	90%	97.5%	WNL
Left	90%	80%	ONL

NU-6 Low Pass Filtered Speech

Ear	Normal Limits	Patient's Score	
Right	78%	80%	WNL
Left	78%	84%	WNL

Spondee Binaural Fusion

Ear	Normal Limits	Patient's Score	
Right	90%	80%	ONL
Left	90%	95%	WNL

Pitch Pattern Sequence (PPS)

Ear	Normal Limits	Verbal Response		Hummed Response	
Binaural	80%	63.3%	ONL	60%	ONL

Gaps in Noise (GIN)

Ear	Normal Limits	Patient's Score	
Left	54%	48.3%	ONL
Gap Threshold	≥ 8 ms	8 ms	WNL

Staggered Spondaic Words (SSW)

Test Condition	Normal Limits for Age	Patients Score	
Right Non-Competing	1	1	WNL
Right Competing	2	1	WNL
Left Competing	4	3	WNL
Left Non-Competing	1	2	ONL
Total Errors	6	7	ONL
Ear Effect	1	3	ONL
Order Effect	-3 + 2	1	WNL
Reversals	-2 + 3	0	WNL
Type A Pattern	3	0	WNL

SCAN-3 A Ear Advantage (+ or – value) Summary

Test	RE Score	+	LE Score	=	EA	Typical	Cumulative Prevalence
AFG 0	14	+	11	=	25	N	15%

SCAN-3: A Supplementary Score Summary

Tes	Raw Score	Scaled Score	Scaled Score Points +/-	Confidence Interval (%): 95	Percentile Rank	
AFG 0	25	8	3	5 to 11	25	WNL

Abbreviations: WNL = Within Normal Limits; ONL = Outside Normal Limits; NU-6 = Northwestern University Auditory Test No. 6; AFG 0 = Auditory Figure Ground +0

Figure 2 (Case 2)

Figure 2. Pure-tone air- conduction thresholds for the left and right ear from 250 to 8,000 Hz. Note: Air-conduction thresholds for 10,000 and 12,500 Hz were 5 and 10 dBHL for the left ear and 10 and 0 dBHL for the right ear, respectively (not shown in Figure).

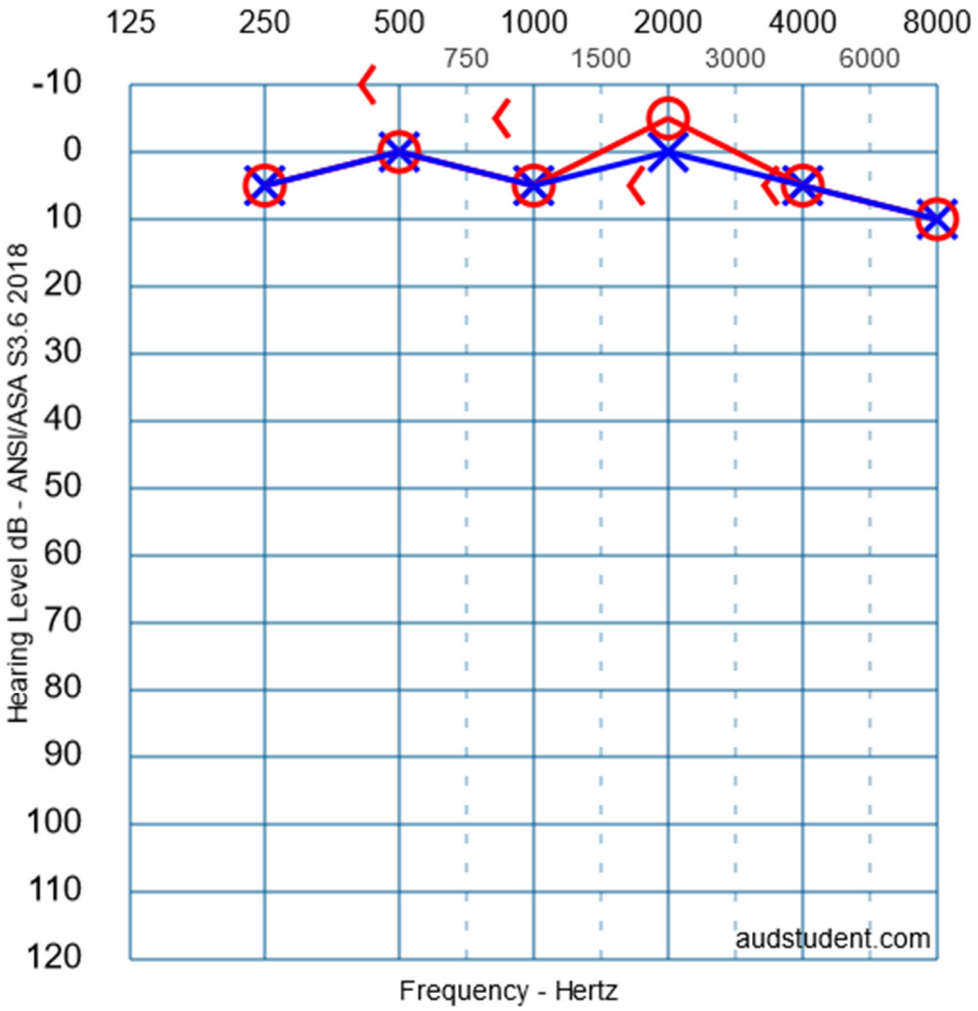

Table 2 (Case 2)

Table 2. Additional assessments were performed during the evaluation. The pre-appointment assessments were available for the clinician to review before the appointment.

Pre-appointment Assessment	Patient's Score	Interpretation
Khalfa Hyperacusis Questionnaire	94	Severe loudness sensitivity
Generalized Anxiety Disorder Screener (GAD-7)	11	Probable anxiety disorder

Additional audiometric results:								
	Uncomfortable Loudness Levels (UCLs)							
	250	500	100	2000	4000	8000	10000	12500
Left	60	35	15	25	10	15	5	15
Right	65	45	20	20	15	15	15	5

	Speech UCL	Multi-talker babble UCL
Left	30	25
Right	30	30