[redacted]

Central Auditory Processing Evaluation

Name: [redacted]
Grade: [redacted]
School: [redacted]

Date of Birth: [redacted]
Age: [redacted]
Evaluation Dates: [redacted]

Confidential – Do Not File in Cumulative Folder

DEFINITION OF AUDITORY PROCESSING DISORDER (APD)

The American Academy of Audiology (AAA), and the American Speech and Hearing Association (ASHA) define an auditory processing disorder (APD) as a significant difficulty in the following auditory processes:

- *Sound localization and lateralization*: the ability to know where sound has occurred in space i.e., to identify the source of a sound.
- *Auditory discrimination*: The ability to discriminate one sound from another. This is a function of our temporal processing of pitch, volume and timing to create a clearly recognized speech pattern.
- *Auditory pattern recognition*: The ability to determine similarities and differences in the pattern of sounds. This involves various aspects of timing and the ability to fuse information together (auditory integration).
- *Temporal aspects of audition*: The ability to process auditory stimuli over time, to sequence sounds, ability to integrate a sequence of sounds into words, ability to perceive sound as separate i.e., to resolve acoustic signals.
- *Auditory performance with competing acoustic signals*: The ability to perceive speech or other sounds when another signal is present such as background noise or competing speech.
- *Auditory performance decrements with degraded acoustic signals*: The ability to perceive a signal in which information is missing and the ability fill in parts of speech/conversations that were missed (auditory closure).

These mechanisms and processes occur in the auditory system prior to cognitive and linguistic operations that occur in the cortex of the brain (which are higher-order processes). The transmission of auditory signals from the auditory nerve to the brain is referred to as *bottom-up* processing. *Bottom-up* processing is influenced by higher-order factors such as attention, memory, and linguistic competence. If *bottom-up* processing of auditory signals is disrupted at any point along the auditory pathway, the final auditory signal that reaches the brain can be adversely affected. Also, deficits in cognitive ability, attention, memory and language will negatively impact performance on measures of central auditory function, and must be considered in the interpretation of any auditory processing assessment. Therefore, both *bottom-up* and *top-down* factors determine an individual's ability to process auditory information.

The criterion recommended by the American Academy of Audiology (AAA) for diagnosis of a Central Auditory Processing Disorder (CAPD) is a score that is two standard deviations or more below the mean for at least one ear on at least two different behavioral auditory tests. This criterion was based on studies of sensitivity and specificity obtained using various cut-off values for auditory tests that were given to patients with conditions known to impair processing in the Central Auditory Nervous System (CANS).

BACKGROUND HISTORY

[redacted] is in the third grade at [redacted] Elementary School where he is enrolled in a general education third grade classroom with special education support services. His primary eligibility category for special education and related services is orthopedic impairment, and his secondary eligibility category is visual impairment. In 2006, [redacted] underwent a right hemispherectomy to control epileptic seizures. He has been diagnosed with cerebral palsy – left hemiplegia, and complete hemianopia (blindness on one half of the visual field). His visual loss is on the left side of each eye. Standardized testing indicated that [redacted] visual perception and visual-motor integration skills are below average when compared to children his age. Per an occupational therapy report, [redacted] demonstrates difficulties in "fine motor control, in-hand manipulation, and bilateral coordination." [redacted] receives specialized vision services, orientation and mobility services and occupational therapy. He is supported throughout the school day with paraprofessional support.

[redacted] received a Central Auditory Processing (CAP) *screening assessment* on 09-16-09 at age five years, nine months. The *screening* was completed by [redacted], Au.D., CCC-A, FAAA. The areas assessed were phonological awareness, auditory closure, auditory figure ground, and dichotic listening ability. Dichotic listening situations occur when different information is provided by more than one speaker at the same time.

[redacted] scored within the normal range when each ear was tested separately (monotic listening). His performance on the dichotic listening subtests was consistent with research findings on dichotic listening in subjects that have undergone right hemispherectomy. That is, when non-competing messages were used, as was the case with the phonemic processing, auditory closure and auditory figure-ground assessments, [redacted] was able to process the information adequately to obtain scores within the average range. However, when dichotic (competing) auditory stimuli were presented, [redacted]s left ear performed outside the normal range and much more poorly than the right ear.

[redacted]s mother, [redacted] provided medical and behavioral background information by completing a CAPD case history form. Ms. [redacted] reported that [redacted] was born at forty-two weeks gestation after a prolonged period of labor, and that he suffered a stroke in utero. There is a history of aneurysms, epilepsy, and right hemispherectomy.

Children with CAPD often have a history of ear infections. Ms. [redacted] reported that [redacted]as frequent colds with a runny nose, and has had one to two problems with his ears. He has not had pressure equalization (PE) tubes placed in his ears, and has not had any other ear surgery. He has not been seen by an Ear, Nose and Throat physician. (When [redacted]was first brought in for the CAP evaluation in January 2013, he was getting over a cold. Tympanometry indicated negative middle ear pressure in both ears, which can be a precursor to fluid collecting in the middle ears. A hearing test revealed a mild hearing loss in the left ear with normal hearing in the right ear.)

According to his mother, walking and talking were delayed. Ms. [redacted] expressed that she has always been aware that [redacted] has difficulty processing and comprehending information. When asked to select behavioral characteristics from a checklist of behaviors that [redacted] exhibits, she selected: sensitive to loud sounds; appears to be confused in noisy places; easily upset by new situations; difficulty following directions, does opposite of what is requested; short attention span; impulsive; easily distracted; forgetful; asks for repetitions; prefers to play with younger children; prefers solitary activities; seeks attention; has anxiety; does not complete assignments; and tires easily.

His mother reported that [redacted] excels at Math, although he has difficulty with math word problems, and that he has the most difficulty with Language Arts. She also reported that he has difficulty with reading comprehension, decoding, and intrinsic questions. She reported that "he gets overwhelmed in noisy situations and can only tolerate 20 – 30 minutes". She also mentioned that he will ask the same question repeatedly. He participates in a drama class and Challenger Baseball.

A [redacted] triennial psycho-educational assessment was complete in April 2012 by [redacted] School Psychologist, [redacted] Ed. S, M.A, and Resource Specialist, [redacted], M.A. The *Differential Ability Scales – 2nd Edition (DAS-II)* was administered. [redacted]s overall General Conceptual Ability (GCA) score which is derived from the Verbal, Nonverbal, and Spatial ability clusters of the *DAS-II*, fell within the below average range of cognitive ability. In the previous administration of the *DAS-II* completed in 2009, [redacted]'s overall GCA score was within the average range. His Verbal Cluster score (vocabulary development, expressive language, knowledge of verbal concepts, and general knowledge), and the Nonverbal Reasoning Cluster (inductive reasoning abilities, comprehension of simple verbal instructions, visual cues, and the use of verbal mediation strategies) scores were in the average range. Ms. [redacted] noted that in the current assessment, his performance in the Spatial cluster and specifically, the Recall of Designs subtest brought his overall GCA score into the below average range.

[redacted] scored within the average range on all subtests of the *Woodcock Johnson Tests of Achievement – Third Edition (WJ-III)* with the exception of Understanding Directions, which was in the below average range.

TEACHER REPORT

[redacted]'s third grade general education teacher, [redacted] was given a mainstream checklist that provided information pertaining to [redacted]s academic performance, classroom participation, ability to complete daily assignments, and social skills.

In the area of class participation, Ms. [redacted] reported that [redacted] often understands "whole-group" instructions, and that he "sometimes wants the teacher to slow down." She reported that he begins work appropriately after receiving instructions and will sometimes ask for instructions to be repeated. She indicated he often volunteers correct answers and/or makes appropriate comments. He will often ask for help when necessary and is often able to answer open-ended questions. Ms. [redacted] reported that [redacted] never gives a minimal response when called upon.

Regarding daily assignments, his teacher reported that he often completes seat-work with minimal instruction but needs prompting, and that his homework is often completed correctly. Depending on the task, he will look around the room for cues from classmates, and he sometimes works independently.

In the area of social skills, Ms. [redacted] reported that [redacted] often initiates one to one conversations with adults and sometimes with students. He will sometimes participate in group conversations appropriately with his peers, and will ask questions. His teacher reported, he often tells jokes or uses humor when conversing.

Ms. [redacted] indicated that [redacted]'s overall level of academic performance is in the average range, including decoding, reading comprehension, and math computation skills. Language-dependent math skills were reported to be in the below average range. It was noted that "math word problems were difficult, as for other students as well." Reading vocabulary was reported to be in the above average range. His teacher indicated that [redacted] often/sometimes understands the language of the curriculum.

CLASSROOM OBSERVATION

[redacted] was observed on November 01, 2012 at [redacted] Elementary School for approximately forty-five minutes during a science lesson. The purpose of the observation was to gain an understanding of his classroom listening skills in general and in particular when competing messages are present.

During the lesson, [redacted] was observed to answer and follow directions without looking for cues from other students. It was observed that at times he did not answer in unison with the class. After about thirty minutes into the lesson, it appeared that [redacted]'s attention began to wane. He was observed more than once to direct his visual attention to other areas of the room. After about forty minutes into the lesson, it appeared that [redacted] was no longer attending to the teacher's voice. For the last five minutes of the lesson, he turned his head to the left and focused his attention on posters and items that were on one wall of the classroom.

When a student at an adjacent table said, "We're done.' [redacted] looked at her with a smile on his face and said, "You're dumb". During a transition period with multiple conversations taking place, [redacted] promptly responded to a request made by his teacher (from about 9 feet away) to push his chair in.

Also, at times during the lesson it appeared that [redacted] needed more time to formulate what he wanted to say, and he appeared anxious about not expressing his thought quickly enough.

CENTRAL AUDITORY PROCESSING (CAP) EVALUATION

TESTS ADMINISTERED:

01-15-13
Peripheral Hearing Assessment
01-30-13
Peripheral Hearing Screening & Tympanometry
SCAN-C – Filtered Words and Competing Sentences subtests
Dichotic Digits Test (DDT)
Bamford Kowal-Bench – Speech-in-Noise (BKB-SIN) Test

02-01-13
Auditory Continuous Performance Test (ACPT)
Competing Sentences Test (CST)
Masking Level Difference (MLD) Test
Pitch Pattern Sequence Test (PPST)
Random Gap Detection Test (RGDT)

TEST BEHAVIOR:

[redacted] was accompanied to each test session by his mother, [redacted] He entered the testing situation willingly. Testing was completed in the morning, and lasted for approximately sixty minutes on each test date. [redacted] appeared relaxed and attentive throughout testing on each date, and appeared to put forth his best effort throughout. When there were indicators of fatigue, he was given a listening break. He was also able to leave the test booth to interact with his mother while the testing materials were changed and calibrated. Two to three listening breaks were provided in each test session. Instructions for each test were provided live voice before the headphones were placed, and [redacted] asked clarification questions following each explanation. Instructions were also provided on most of the recorded material used, so that [redacted] heard the instructions again before the test began. For each test, [redacted] understood the task required. Most of his responses were given promptly. Lapses in attention and restlessness were minimal. However, fatigue may have influenced his responses for the last processing test given on the second day of the assessment. All test results were obtained under supra-aural headphones at recommended test presentation levels. Overall, results are considered to be an accurate and valid representation of his auditory processing abilities.

Peripheral Hearing Acuity Assessment

[redacted] received a complete peripheral hearing acuity assessment on 01-15-13. His mother reported that [redacted] was getting over a cold. Otoscopic examination revealed a minimal amount of wax in each ear and the tympanic membranes were visualized. The assessment found a mild conductive hearing loss in his left ear from 250 - 8000 Hz, with normal hearing in his right ear. His left ear speech discrimination score in quiet was 84% correct. In his right ear, his speech discrimination score in quiet was 100% correct Tympanometry indicated negative middle ear pressure in both ears with normal compliance. In his left ear, ipsilateral acoustic reflexes were absent at 500 and 4000 Hz, and present at 1000 and 2000 Hz. Acoustic reflexes are normally present in the absence of a hearing loss, and are recorded at elevated levels commensurate with the degree of hearing loss. Otoacoustic emissions were absent in his left ear across the test frequency range of 1000 – 5000 Hz. Otoacoustic emissions are usually present in ears when there is no hearing loss present or when the hearing loss is of a mild degree. They will be absent in ears when middle ear pathology is present that obstructs recording of the emission. In his right ear, ipsilateral acoustic reflexes were present from 500 – 4000, Hz and otoacoustic emissions were present across the test frequency range (1000 – 5000 Hz.)

Due to the hearing loss in his left ear, the central auditory processing evaluation was postponed until his cold resolved.

[redacted] returned for the CAP evaluation on 01-30-13. Otoscopic examination again revealed a minimal amount of wax in each ear, and the tympanic membranes were visualized. Tympanometry yielded slightly negative middle ear pressure in each ear with normal compliance. The acoustic reflex was screened at 1000 Hz and was present in each ear. [redacted] responded to warbled pure tones presented at 15 dBHL from 250 – 8000 Hz bilaterally, indicating normal hearing in each ear. Therefore, the CAP evaluation proceeded.

TEST RESULTS:

Auditory Continuous Performance Test (ACPT)

The *ACPT* is a standardized test of auditory attention. It was designed to help identify children who have auditory attention disorders, and measures selective and sustained attention. It yields scores for inattention and impulsivity which are combined to obtain a Total Error Score (TES). The subject is asked to listen to a list of single words and indicate when the word *dog* is heard. If the subject does not respond when the word *dog* is presented, it is counted as an inattention error. If the subject responds to a word other than *dog*, it is deemed an impulsivity error.

ACPT				
9 –11 years Criterion Score	TES	Impulsivity Errors	Vigilance Decrement	9 –11 years Percentage of sample
19	17	11	3	10 %

[redacted] made made 6 inattention errors and 11 impulsivity errors for a Total Error Score (TES) of 17. A TES of less than 19 is a passing score. Therefore, on this measure [redacted] scored comparably to other children his age for auditory attention. In general, children who have an auditory processing disorder do not have difficulty with the *ACPT* task.

The *ACPT* also yields a Vigilance Decrement Score that measures the decline in attention that occurs over time. It is obtained by comparing the number of correct responses to *dog* on the first presentation, to the number of correct responses to *dog* on the last presentation. A significant vigilance decrement is considered to be characteristic of individuals with attention deficit disorders and a small vigilance decrement is typical of individuals that do not have an attention deficit. [redacted] obtained a Vigilance Decrement Score of 3 which is considered to be within the normal range. A vigilance decrement seen in 10% or more of the non ADHD sample should not be considered unusual. Children diagnosed with ADHD had much larger vigilance decrements between Presentation 1 and Presentation 6.

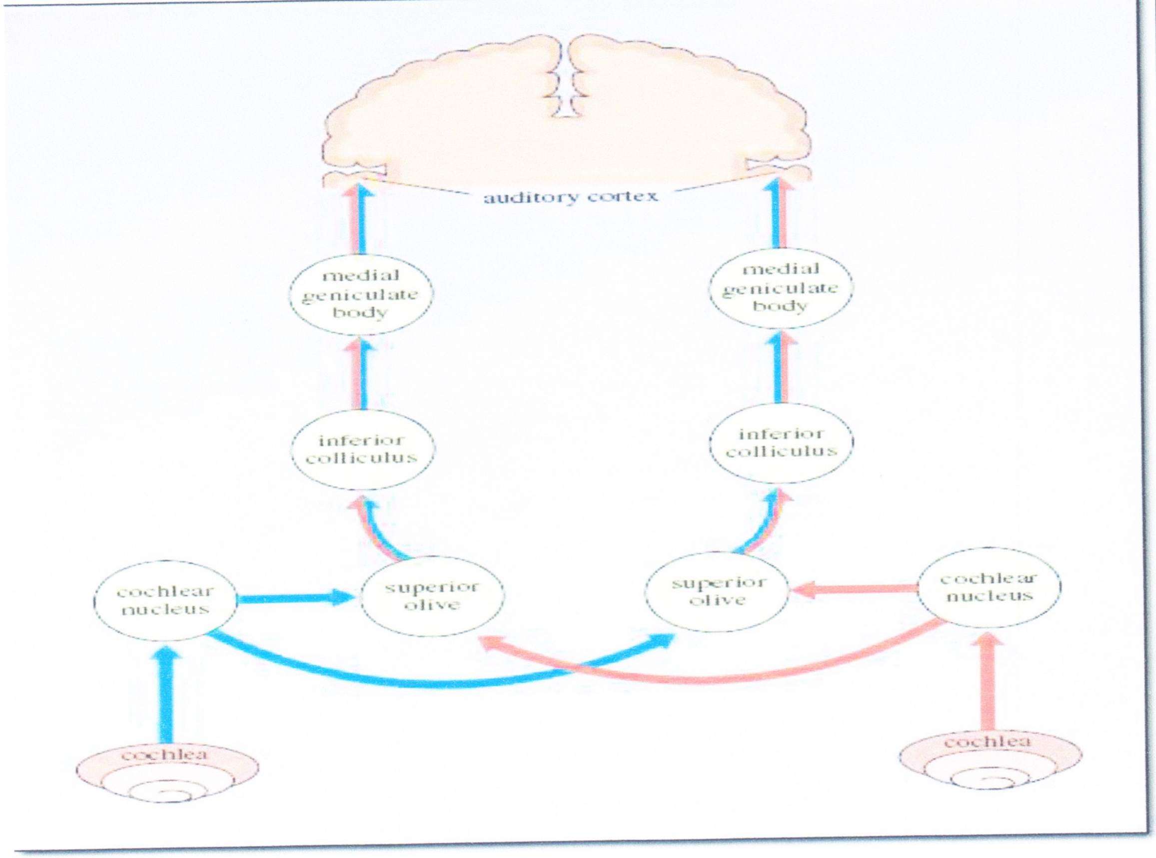
A number of the impulsivity errors that [redacted] made occurred after he made eye contact with the examiner. It seemed that he was anxious about missing a presentation. His posture and behavior suggested that he was highly anticipating the next presentation of the word *dog*, and when it seemed to him that a long length of time had passed without a presentation of *dog*, he would look at the examiner and raise his thumb. It appeared that because he hadn't heard *dog*, he assumed that he'd missed it, and he wanted to project that he was still staying with the task - so he raised his thumb. His behavior suggests that he is aware that he sometimes thinks about other things when he's supposed to be listening.

According to the authors of this assessment, children that make a large number of impulsivity errors on the *ACPT* find it difficult to stay with the task at hand, and are easily distracted by environmental stimuli.

DICHOTIC LISTENING

The term *dichotic* refers to auditory stimuli that are presented to both ears simultaneously, with the information presented to one ear being different from that presented to the other. In most individuals, language is processed in the left hemisphere of the brain.

CENTRAL AUDITORY TRANSMISSION PATHWAY



During dichotic listening, ipsilateral pathways are suppressed and are weaker; the contralateral pathway becomes the dominant pathway for transmission of the auditory signal. As a result, verbal information presented to the left ear is first transmitted to the right temporal lobe (via the stronger contralateral pathway) before crossing over to the left temporal lobe via the corpus callosum. Conversely, verbal information presented in the right ear is immediately processed in the left hemisphere of the brain (via contralateral pathways) – without passing through the corpus callosum. Information is still transmitted ipsilaterally, but it is a weaker transmission.

Dichotic listening task may require the subject to repeat everything that is heard (binaural integration), or to direct their attention to one ear and repeat what is heard in that ear only (binaural separation). In general, the more similar the stimuli, the more difficult the dichotic task will be. However, a greater amount of linguistic information also increases the difficulty of the task. A greater right-ear advantage (REA) will be observed in children when more complex, linguistic dichotic stimuli are used (sentences) than with less complex stimuli (digits). That is, the right ear will perform better than the left. As children mature, the REA will decrease, and the ears begin to perform equally by age 11 or 12.

Dichotic Digits Test (DDT)

The *Dichotic Digits Test (DDT)* is a binaural integration task. Two digits are presented to each ear simultaneously, and the listener is asked to repeat all four digits heard in any order. On the continuum of least to most difficult, the *DDT* is somewhat in the middle, since the stimuli is very similar (digits) while the linguistic load is very low. Using digits minimizes the effects of language processing deficits on performance. Test results are however affected by auditory short term memory.

The *DDT* is not highly influenced by cognition or attention because the digit response is a somewhat closed response set, and is not linguistically complex. Also, inattention would not account for the within test ear differences since right and left stimuli is presented simultaneously.

DICHOTIC DIGITS TEST		
Ear	**Percent Correct**	**% Correct for 9.0 – 9.11**
Right	52 %	> 80%
Left	29 %	> 75%

These scores indicate that [redacted] would have more difficulty than same aged peers, understanding information presented to both the right and left ears, in dichotic listening situations. For less complex linguistic stimuli he was able to take in some of the information presented to this left ear, but only about half as well as his right. This is consistent with weaker ipsilateral transmission.

His test scores are consistent with research that shows that the ear on the opposite side of the remaining hemisphere i.e., [redacted]'s right ear would have an ear advantage; and the ear on the same side of the remaining hemisphere will exhibit nearly complete suppression.

In general, children with binaural integration deficits exhibit difficulty processing auditory input in the presence of competing signals. They may have difficulty understanding speech when more than one person is talking. An example of a binaural integration task that could occur in a classroom setting, would be when a student is attempting to listen to the teacher and also listen to (rather than ignore) comments made by other students, when the teacher and the students are talking at the same time.

SCAN – C Competing Words subtest

Standard Score (SS) subtest mean is 10 with a Standard Deviation (SD) of 3.

The *Competing Words (CW)* subtest is also dichotic listening task. The stimuli are words as opposed to digits, and therefore carry a higher linguistic load making this test more difficult. A different word is presented to each ear simultaneously and the student must repeat the word heard in each ear. For the first twenty-five test items the student is asked to repeat the word heard in the right ear, and for the second twenty-five items, say the word heard in the left ear first. Like the *DDT*, this is a binaural integration task. The

CW is sensitive to the maturation of the auditory system i.e., as the child matures left-ear performance improves.

SCAN – C Competing Words subtest		
Standard Score	Percentile Rank	SD below the mean
4	2nd	2

[redacted]*'s standard score on the* CW *subtest is 2 SD below the mean again evidencing significant difficulty with binaural integration.*

[redacted]correctly repeated all of the words presented to his right ear; he was unable to repeat the words presented to his left ear.

Competing Sentences Test (CST) – (Auditec Version)

The *CST* is a dichotic listening test that measures binaural separation i.e., the ability to direct listening to a specific ear and ignore information that is simultaneously presented to the opposite ear. The listener must repeat the sentence heard in the target ear only, and ignore the competing sentence. The target sentence is presented at a quieter level than the competing sentence. On the continuum of least to most difficult, the *CST* is considered difficult since sentence stimuli are heavily linguistically loaded and the sentences are very similar.

It was a long ride by car.
I thought we would never get there.

Competing Sentences Test (CST)		
Ear	**Percent Correct**	**Normal**
Right	90%	≥ 90%
Left	0%	≥ 90%

This score meets the criteria for an auditory processing disorder for binaural separation.

[redacted]as unable to process the verbal message presented to his left ear when a different competing sentence was simultaneously presented to his right ear. His facial expression suggested that he was not even aware that a sentence was being presented to his left ear. He definitely understood the directions, because he did not repeat the sentence that was presented to the right ear. He was waiting for the sentence in the left ear to be presented. Again, the scores are consistent with anatomical and physiological findings of subjects who have undergone a hemispherectomy. In subjects with right hemispherectomy, complete suppression of information presented to the left ear in a dichotic listening situation has been found.

BINAURAL INTERACTION - Tests of binaural interaction assess the ability of the Central Auditory Nervous System (CANS) (primarily the low brainstem) to process different, but complementary, information presented to the two ears. Auditory functions that rely on binaural interaction include localization and lateralization of auditory stimuli and detection of signals in noise. The primary behavioral characteristic of this type of processing disorder is the inability to process speech in a noisy background.

Masking Level Difference (MLD) - *The MLD is the most sensitive behavioral procedure for assessing auditory brainstem integrity. It cannot however diagnose a brainstem lesion. The MLD assesses the brainstem's ability to recognize a signal embedded in background noise.*

The *Masking Level Difference (MLD)* was assessed using 500 Hz tones embedded in narrow-band noise. Interspersed within the presentations are bursts of narrow-band noise that do not contain tones. The primary behavioral characteristic is an inability to detect speech in a noisy background.

MASKING LEVEL DIFFERENCE TEST	
Masking Level Difference (MLD)	**Normal Range**
6 dB	≥ 10 dB

This score meets the criteria for an auditory processing disorder in this area.

These results would indicate that [redacted]'s ability to localize and lateralize sounds and detect a signal embedded in noise is outside the normal range.

LOW REDUNDANCY - Normal listeners are typically able to achieve closure (the ability to fill in missing parts) and make auditory discriminations even when a portion of the auditory signal is missing or distorted. Listeners with CAPD will typically perform quite well when in an ideal listening environment, but will often demonstrate significant problems when the signal is distorted. Often when a central auditory processing disorder is present, the intrinsic physiologic redundancy that is present in a normal system is reduced or absent. Since intrinsic redundancy is already reduced, reducing extrinsic redundancy (distorting the signal) can reveal a deficit in auditory closure.

The *Filtered Words* subtest of the *SCAN – C*, and the *Bamford Kowal-Bench – Speech-in-Noise (BKB-SIN) Test* both reduce the extrinsic redundancy.

SCAN – C Filtered Words subtest

Standard Score (SS) subtest mean is 10 with a Standard Deviation (SD) of 3.

The *FW* assesses auditory closure; high frequency speech sounds have either been distorted or left out of the words presented. The test is administered to each ear separately with no stimuli present in the ear not under test, thus it is not a dichotic listening situation.

SCAN – C Filtered Words subtest		
Standard Score	Percentile Rank	SD below the mean
4	2nd	2

This score meets the criteria for an auditory processing disorder in the area of auditory closure.

[redacted] correctly identified 10 of 20 words presented to his right ear and 16 of 20 words presented to his left ear. His Total Subtest score was 2 SD below the mean, indicating significantly more difficulty with auditory closure than other children his age.

Children that score 2 standard deviations below the mean may have difficulty filling in the missing pieces of words. In a classroom parts of a word may not be heard when the teacher's back is turned, when there is background noise, when speech is delivered at a rapid rate, or when the student is seated at the back of the classroom. Morning announcements made through the intercom system is another example of distorted speech that is heard in a school setting.

<u>Bamford Kowal-Bench – Speech-in-Noise (BKB-SIN) Test</u> *– The primary effect of the addition of noise is a reduction in the external redundancy of the speech signal.*

This speech-in-noise test is used to identify auditory figure-ground problems. Sentences are presented at pre-recorded Signal-to-Noise Ratios (SNRs) that decrease in 3 decibel (dB) steps from +21 dB i.e., the primary signal is 21 dB louder than the multi-talker babble, to -6 dB, the primary signal is 6 dB softer than the multi-talker babble. Two list pairs of 10 sentences each are administered to each ear separately, and the student must repeat the sentence heard. The sentences are 5 – 7 words in length.

BKB-SIN TEST				
Ear	**SNR-50**	**Ages 7 – 10 Mean SNR-50**	**SNR Loss**	**Standard Deviation below the Mean**
Right	1.5 dB	0.8 dB	0.7 dB	< 1 SD
Left	5.5 dB	0.8 dB	4.7 dB	4 SD

The right ear score is less than 1 SD below the mean, the left ear score is 4 SD below the mean. His right ear score meets the criteria for an auditory processing disorder with regard to his ability to understand speech in the presence of competing verbal messages.

The *BKB-SIN* test yields a SNR-50 score which is the signal-to-noise ratio needed to obtain 50% correct. In the right ear, [redacted] needed the signal to be 1.5 dB louder than background noise to obtain 50% correct; in the left ear he needed the signal to be 5.5 dB louder than background noise to obtain 50% correct.

The SNR Loss score, represents how much louder the signal needs to be for a subject to perform as well as same aged peers. In the right ear, he needed a 0.7 dB greater SNR than normal-hearing 7 – 10 year olds for equivalent performance on this task. In his left he needed the signal to be 4.7 dB louder than other children in his age group for equivalent performance on this task.

TEMPORAL PROCESSING - ability to process auditory stimuli over time, to sequence sounds, determine similarities and differences in the pattern of sounds. Also the ability to integrate a sequence of sounds into words, to perceive sounds as separate i.e., to resolve acoustic signals.

Pitch Pattern Sequence Test (PPST) - *The PPST is useful in the detection of disorders of the cerebral hemispheres and has been shown to be sensitive to corpus callosum dysfunction.*

The *PPST* assesses the processes of frequency discrimination, temporal ordering, and linguistic labeling which are critical to speech perception. On the first half of the test, subjects are asked to replicate a three-tone pattern by humming what they hear. For the second part of the test, subjects are asked to apply a linguistic label to the pattern heard.

Pitch Pattern Sequence Test (PPST			
Ear	**Hummed Response**	**Labeling**	**Labeling Norms Age 9-0 to 9-11**
Right	100%	100 %	63 %
Left	100%	100 %	63 %

[redacted]was able to hum the patterns with 100% accuracy, demonstrating ability to recognize auditory patterns over time. For most individuals the right hemisphere is dominant for perception of nonlinguistic stimuli, including rhythm and stress. Discrimination and ordering of tonal stimuli and the prosodic elements of speech have also been attributed to the right hemisphere.[redacted]'s ability to recognize these tonal patterns with 100% accuracy in each ear evidences that his left hemisphere has now assumed these functions. Additionally he was able to apply linguistic labels to the patterns heard with 100% accuracy which is unexpected. Normally, subjects with disruption in the interhemispheric transfer of information can hum the pattern, but have more difficulty labeling the pattern. This occurs because information would be transferred from the right hemisphere of the brain to the left hemisphere via the corpus callosum. The fact that[redacted]was able to supply these labels with 100% accuracy is further evidence that other transmission pathways have developed.

Random Gap Detection Test (RGDT) – *A temporal processing test. Gap detection tests have been shown to be sensitive to left temporal lobe dysfunction.*

Gap detection is one of the functions necessary for discrimination of subtle cues such as voicing. For example, the reason why the word *dell* sounds different from the word *tell* is that voicing begins earlier for *dell* (by about 35 milliseconds). Also, the length of the silent interval between words, and placement of the silent interval affects the meaning of a sentence. For example, *fair ground* versus *fairground - it's parked* versus *it sparked.*

In the *RGDT*, tones are presented in pairs. The silent interval between each pair is randomly increased and decreased in duration from 0 to 40 milliseconds (msec.). The listener's task is to indicate whether they hear one tone or two tones. When the interval between the tones is shorter it is harder to detect that two tones are present. The gap detection threshold is defined as the smallest interval at which the listener hears two tones rather than one tone. Gap detection thresholds below 20 msec. are considered to be in the normal range. The greater the gap detection threshold in msec. the more likely the temporal processing deficit interferes with speech perception.

During the screening/practice portion of this test, [redacted] indicated that he heard two tones for gap durations of 15 msec. or more. However during test administration he did not indicate that he detected a gap on any of the presentations i.e., for each presentation he indicated that he heard one tone. His inability to detect gaps larger than 15 msec. during the test may have been due to fatigue, as this was the last test given on the second test date. It would be necessary to administer this test again before drawing a conclusion regarding his ability to recognize and resolve acoustic signals into discrete units.

A deficit in the area would make it more difficult for a subject to understand rapid rates of speech. Rapid speech will reduce ability to separate sounds occurring successively and can result in excessive masking effects, where loud (vowel) sounds may obscure softer phonemes.

SUMMARY/CONCLUSIONS

[redacted], age nine years, two months underwent a right hemispherectomy at age two and a half. He has been diagnosed with left hemiplegia, and complete hemianopia (blindness on one half of the visual field). His visual loss is on the left side of each eye. Standardized testing indicated that [redacted]s visual perception and visual-motor integration are below average when compared to children his age. Per occupational therapy report, [redacted] demonstrates difficulties in fine motor control, in-hand manipulation, and bilateral coordination.

[redacted] peripheral hearing acuity was assessed prior to commencement of the auditory processing evaluation. He was initially found to have a mild conductive hearing loss in his left ear and normal hearing in this right ear. Tympanometric results indicated negative middle ear pressure bilaterally. His mother reported that [redacted] was getting over a cold at the time. The CAP evaluation was postponed for two weeks to allow time for the cold to resolve. When he returned in two weeks, tympanometry yielded slight negative middle ear pressure with normal compliance in each ear. His hearing was tested and found to be within the normal range from 250 – 8000 Hz in each ear.

[redacted]s overall cognitive ability as measured by the *Differential Abilities Scales – second edition (DAS-II)* General Conceptual Ability (GCA) score measured in the below average range. However his GCA score was depressed by his performance on the Recall of Designs subtest. The Verbal Ability Cluster and Non-Verbal Reasoning Cluster scores were within the average range. Also, when assessed using *DAS-II* in 2009 his GCA score was within the average range. [redacted] scored within the average range on all subtests of *The Woodcock Johnson Tests of Achievement – Third Edition (WJ-III)* with the exception of the Understanding Directions subtest, which was in the below average range.

This Central Auditory Processing (CAP) evaluation examined dichotic listening, for binaural separation and binaural integration, low redundancy monaural speech temporal processing and binaural interaction.

[redacted] scored below age level expectancy for the both the right and left ears on the binaural integration task using digits. This indicates that he has difficulty "taking in" different auditory verbal inputs that occur simultaneously (*Dichotic Digits Test and the SCAN – C Competing Words* subtest). He also demonstrated difficulty directing his attention to a specific verbal stimulus and ignoring a competing verbal stimulus at the sentence level (*Competing Sentences Test*).

Test results also indicate that he has more difficulty than his peers understanding speech in the left ear when multiple talkers are speaking (*Bamford Kowal-Bench – Speech-In-Noise*) test, and detecting speech in the presence of background noise *(Masking Level Difference)* test. The *MLD* also indirectly assesses sound localization and lateralization, and a small *MLD* suggests that he may have difficulty knowing the direction sound is coming from especially when there is lots of noise present.

Additionally test results demonstrated that when compared to other children his age, he has more difficulty understanding speech that is not clear *(SCAN-C Filtered Words)* subtest. The *FW* subtest measures auditory closure i.e., the ability to figure out what word was said, when the word was not heard clearly.

In the area of temporal processing, [redacted] was able to discriminate tonal frequencies, recognize and sequence the tones, and label the tones heard commensurate with same age peers *(Pitch Pattern Sequence Test)*. However, he did not consistently demonstrate ability to recognize the silent intervals between two tones. However, the results obtained on the *Random Gap Detection Test*, may have been due to fatigue as this was the last processing test administered. A deficit in the area would make it more difficult for a person to understand rapid rates of speech.

This evaluation found many areas of auditory processing where [redacted] is not performing commensurate with same age peers. These results indicate that listening is more difficult for [redacted] than other children his age. On a directed auditory attention task (*ACPT*), [redacted] did score comparably to same age peers in his ability to sustain attention. Although a fair amount of impulsivity was demonstrated on this assessment, it seemed to be the result of [redacted] being anxious about missing the next presentation. It has been noted, and observed by this examiner that [redacted] does demonstrate difficulty sustaining attention in class. Based on the results of the *ACPT*, it may be that he does not have an inherent attention problem, but rather his difficulty with auditory processing manifests as inattention. That is, if it is difficult to understand speech, that is not clear, difficult to understand speech that is spoken rapidly, difficult to understand speech when there are competing messages or background noise present, it will become difficult to sustain attention.

RECCOMMENDATIONS

Binaural Separation, binaural integration and ability to understand speech in the presence of background noise i.e., binaural interaction:

- Make adaptations to the listening environment that reduce/eliminate the need for the listener to focus on auditory information while ignoring competing auditory messages.
    - Try to minimize dichotic listening situations. That is instructions or information should not be given when [redacted] would need to listen to his peers and teachers at the same time, or not listen to peers and only listen to his teacher.
    - Reduce background noise or use an assistive listening device (FM) to compensate for background noise.
    - Administer tests in a quiet room without auditory distractions.
    - To better utilize hearing and visual cues, use flexible preferential seating that is away from hall or street noise, and in the absence of an FM system not more than 10 feet from the teacher.
    - A quiet study/work area, or an isolated area, such as a study carrel, for individual seatwork, testing, or tutoring would help minimize difficulties with foreground/background discrimination.

- Teach compensatory strategies for directing attention.
    - Place the body in an alert posture by straightening the spine.
    - Incline the upper body and head toward the speaker.
    - Keep eyes firmly on the speaker.
    - Avoid activities that distract attention from the speaker.

- Improve ability to localize the source of both the target and competing message.
    - Use an assistive listening device in one ear to focus attention on the primary signal. The unaided ear will still hear competing messages.

<u>Auditory Closure – Auditory Discrimination</u>

- Pre-teach new information and new vocabulary. It is easier to figure out what has been missed auditorially if the listener is already familiar with the context.
- Teach [redacted] to use information that is embedded in the message itself, or use the situational context to derive the meaning of new vocabulary words.
- Teach [redacted] to recognize intonation and stress patterns within messages that provide clues about the intended meaning, e.g., "You need to stay **here**. versus **You** need to stay here."
- Avoid using rapid rates of speech.
- Emphasize critical information by increasing the silent period before a key word is said.
- Use tape recorders so that information can be listened to again, or use books on tape.

<u>General</u>

- Focus [redacted]'s visual and auditory attention before giving directions.

- Use cueing to help him become aware of when he is not paying attention – may be a visual cue (tapping the ear or drawing attention to the eyes) or auditory cue, "ready?"
- Frequent checks for understanding.
- Mark transitions between activities. Students with auditory processing difficulties often need more time to make transitions. Therefore, it is helpful and important to mark transitions between activities by clearly identifying the new activity by naming and explaining the sequence of steps needed to accomplish the task.
- Review before transition. Clearly closing an activity by briefly summarizing what the student should have learned and/or completed before transitioning to the next activity.
- Repeat instructions rather than rephrasing, so that the same information is processed.

[redacted] M.A, FAAA
Educational Audiologist Lic. No. [redacted]