Topics in Central Auditory Processing

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In This Issue

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"I don't know what's wrong with the car, but it won't start"

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This is one of my favorite CID Everyday Sentences because I find it so useful when thinking about treating auditory processing disorders. Imagine the car owner saying this to the mechanic only to hear in response, "Well, we could try putting on new tires and see if that will help". That owner would be looking for a new mechanic right away thinking how can you possibly suggest a "fix" for my car when you don't know what's wrong with it. Similarly, a computer owner would shy away from the so-called expert who wants only to offer an upgraded system without first running a computer diagnostic. If we insist on this level of quality assessment for our cars and computers, we must provide the same for our clients with suspected CAPDs. One cannot provide effective intervention for a deficit that has not been specifically defined.

It is well-established that those with auditory processing disorders are heterogeneous, not only with respect to the deficit's functional impact and symptomatology, but also to its underlying neurologic nature. In order to assess and treat effectively these complex problems we must understand the neurogeography that underlies each person's processing disorder, each aspect of the "process" of processing, and then implement deficit-specific management and remediation strategies.

This paper outlines a model for defining specifically central processing, and briefly describes appropriate tools for assessing these skills. It will also present considerations for therapeutic interventions, including remediation and its functional impact.

It really is a PROCESS!

Our ability to use what we hear begins at the ear and ends when we execute a response - correct or incorrect. The outer, middle, inner ears and auditory nerve are responsible for collecting and detecting incoming acoustic signals and faithfully transforming them into signals that can be recognized by the neural cells in the brainstem and cortex. Any disruption at these preliminary steps in the process results in a peripheral hearing impairment. Beginning at the cochlear nucleus through the primary auditory cortex (Heschl's gyrus), neural cells code the frequency, intensity, and timing cues of the signal through their unique electrochemical responses and through binaural interaction of cells/regions at various levels in the brainstem as well as across the corpus callosum. Having been analyzed and synthesized, the signal is transmitted to the language centers of the brain, comprised largely by Wernicke's area at which point the acoustic signal is coded according to the rules of language. In the final step of the process, the now linguistically encoded information (along with information from other systems as needed) moves to the frontal regions of the brain for organization and execution of a response. While any disruption among these steps may be defined as a central processing disorder, not all disruptions are specifically auditory in nature. Instead, one can appreciate that our ability to use what we hear includes acoustic, phonetic-linguistic, and executive-motor steps with the acoustic steps providing what we HEAR, the phonetic-linguistic steps providing what we KNOW and the executive-motor steps enabling us to DO something with the input.

Thus, the signals that we process, whether running speech or music can be conceptualized as a series of acoustic speech and non-speech patterns to which specific meaning must be attached for accurate comprehension and/or action to occur. In every day communication, the listener must navigate between/among these rapidly changing acoustic patterns – analyzing, synthesizing, manipulating, and quickly attaching meaning to them. A non-impaired listener can perceive the "ebb and flow" of these changing patterns in the speech stream and make sense of signals even when disrupted by noise or competing signals, loss of signal clarity or absence of associated cues.

Assessing processing skills

Given this model, the comprehensive assessment of auditory processing will include probes of skills associated with the peripheral auditory system, brainstem, right hemisphere, left hemisphere, corpus callosum, and frontal lobes. That is, tasks that are predominantly acoustic as well as tasks predominantly phonologic, linguistic, and/or cognitive in nature. Because of the complex nature of this process, it is not possible to develop any one test that can measure every skill discretely or, conversely, to develop a test that will only assess one skill set. As we assess, we must be mindful of the "processing load" associated with any given task. The tasks, "say the word *cat*" and "tell me something about a *cat*" are markedly different with respect to processing load. In the former, "say the word…" the processing load is predominantly auditory/acoustic with little need to interpret or react to the input. The latter request, "tell me something about…", while verbal-auditory, is heavily "loaded" for linguistic-cognitive processing as the listener must not only "hear" the target but also stop and think about what the request "means" and how best to respond. We will likely suspect an auditory-based deficit if the listener answers that "tell me" request with "you need it to play baseball", clearly having misheard "bat" for "cat". However, we cannot know- without other information- if the listener who responds "what?", stares blankly or states, "I don't like cats" has an issue that is auditory, linguistic, cognitive-behavioral, or even some combination of these. Audiologists use tests that minimize, as much as possible, the cognitive, linguistic, and/or extra-sensory load. Speech-language pathologists and other professionals use tests that use a verbal input in order to assess linguistic-cognitive skills, as discretely as possible. By amassing as much assessment data as possible about each step in the processing of spoken language, we clarify the nature of the listener's functional difficulties, thereby maximizing the effectiveness of our interventions.

As alluded to above, the significant internal redundancy within our neural network coupled with the extensive external redundancy of running speech allows the non-impaired listener to use information effectively even when disrupted or unclear. Given the neuroanatomy/neurophysiology of the system, we know that the comprehensive behavioral assessment of central auditory skills should include tests that tax auditory discrimination and resolution, binaural processing, and temporal processing. The peripheral assessment should include standard puretone and speech audiometric and immittance measures as well as in many cases otoacoustic emissions to rule out a co-existing peripheral component. Tasks taxing auditory discrimination include recognition of speech signals altered with respect to frequency or timing characteristics as well as speech masked by ipsilateral noise. Binaural processing occurs at both the brainstem and cortical levels necessitating some probe of each type. Brainstem-based binaural interaction can be assessed by manipulating interaural timing and/or intensity cues and/or those that tax binaural summation. At the cortical level, dichotic listening is the method of choice to assess binaural integration and separation skills with tests employing stimuli of varying linguistic load, e.g., dichotic digits versus dichotic sentences. In general, temporal processing includes temporal masking, temporal integration, temporal resolution, and temporal patterning with reliable clinical tools available to assess resolution and patterning skills. Although not specifically designed to assess linguistic-cognitive function, behavioral tests of central auditory function can provide insights into the integrity of these higher-order skill sets depending upon the linguistic and/or response demands of the test, e.g., repeat targets in a specified order versus free recall. These findings may inform and/or marry with finding from tests of phonologic processing, language processing, executive functioning, and/or psychoeducational function. Thus, the assessment of verbal processing abilities "takes a village" with auditory-based tasks to examine the system's ability to receive, perceive, and synthesize acoustic information, phonemic/phonologic tasks to assess recognition and manipulation of "sounds", linguistic probes of knowledge needed to decode the message, and tests of executive functioning designed to examine attention, organization, response execution, and related skills. By examining patterns of performance, both poor and not, across the entire test battery patterns emerge that clarify the true nature of the disorder and lead to effective intervention.

Intervention for auditory processing disorders

Management strategies for auditory processing disorders often include recommendations for preferential seating, repetition of information, and use of listening technology. However, even these seemingly obvious recommendations can be adjusted and refined based on the specific nature of the deficit. Not all listeners with auditory impairment need to sit in the front of the room; some need a visually distraction-free environment. Repetition of auditory signals is an excellent strategy for listeners with impaired discrimination or interhemispheric integration issues but is useless for the listener whose “auditory” impairment is inability to attach meaning to the incoming signal – a phonologic-linguistic issue. Assistive listening technology, while useful for some types of auditory processing issues, e.g., impaired discrimination, is not helpful for others, e.g., impaired integration. Moreover, one must remember that these devices are compensatory tools, designed to improve the signal quality reaching the ear, not to improve the underlying auditory skill set. While many management recommendations are beneficial to most types of processing impairment; truly effective management at home, school or in the workplace will be based on the client’s specific functional needs and the specific nature of the processing deficit.

Treating impaired auditory processing also “takes a village” and includes bottom-up training to reduce or resolve the specific neuro-sensory impairment and top-down teaching of strategies to improve use of compensatory skills and minimize functional impact. The research is compelling with respect to the effectiveness of relatively short-term auditory training, especially computer-based exercises, for improving central auditory discrimination, temporal and spatial resolution, temporal patterning and dichotic listening as well as in reducing listening effort and improving listening stamina. There is a growing body of research examining the extent to which these benefits translate directly into improved higher-order communicative and/or educational skills; although these effects are in need of additional well-designed study. As we consider inclusion of any auditory training program into a listener’s intervention plan, we must ask ourselves, “does it work? should it work? does it fit?”. That is, we examine the available research related to the program’s effectiveness as well as its neuroscientific foundations and choose programs designed to treat the specific deficit that has been diagnosed. Programs designed to train dichotic listening, for example, regardless of their level of research support, will likely not be effective for improving auditory discrimination skills. Conversely, a reported perceptual training program targeting discrimination of fine acoustic differences would not be expected to be effective for addressing an interhemispheric impairment.

Speech-language-hearing professionals have long appreciated the value of aural rehabilitation for listeners with auditory impairments. Top-down aural rehabilitation goals that should be included in a client’s intervention plan are those for improved noise tolerance, use of visual and other non-auditory cues, verbal comprehension, use of metalinguistic, metacognitive, and metamemory strategies, and self-advocacy. Improvement in these skills as well as in any related phonologic, linguistic or executive skills that may require treatment allow the listener to “work around” their auditory impairment and gain functional communicative success. Finally, as we develop “treatment” goals, let us consider the value of simple games that draw upon the very skills targeted in therapy as a means to extend therapy benefits beyond the clinic, engage the listener in the intervention process, and illustrate the notion that auditory processing IS what we do with what we hear- all the time.

References

American Speech-Language-Hearing Association. (2005). Technical report: Central auditory processing disorders. Rockville, MD: Author.

Baran, J. (2013). Metalinguistic skills, strategies, and approaches. In D. Geffner and D. Ross-Swain (Eds.) *Auditory Processing Disorders,* 2nd ed. (pp 469- 494). San Diego: Plural Publishing, Inc.

Ferre, J. (2010). Aural Rehabilitation & Central auditory processing disorders (CAPD): Outcome evidence among school-age children. *Educational Audiology Review, 27,* 8–17.

Ferre, J. (2012) .Classroom Management: Collaboration with Families, Teachers, and Other Professionals. In Chermak, G. & Musiek, F. (Eds.). Handbook of central auditory processing disorder: Comprehensive intervention Vol 2., 2nd ed. (pp. 377- 403). San Diego, CA: Plural Publishing, Inc.

Ferre, J. (2019). The ABCs of CAP: Practical Strategies for Enhancing Central Auditory Processing and Related Skills. In Geffner, D. & Ross-Swain, D. (Eds.) Auditory Processing Disorders: Assessment Management, and Treatment. San Diego, CA: Plural Publishing, Inc.

Gillam, R. B., Loeb, D. F., Hoffman, L. M., Bohman, T., Champlin, C. A., Thibodeau, L., & Friel-Patti, S. (2008). The efficacy of Fast ForWord language intervention in school-age children with language impairment: A randomized controlled trial. *Journal of Speech, Language, and Hearing Research*, *51* (1), 97-119.

McArthur, G. M., Ellis, D., Atkinson, C. M., & Coltheart, M. (2008). Auditory processing deficits in children with reading and language impairments: Can they (and should they) be treated?. *Cognition*, *107*(3), 946-977.

Moncrieff, D. W., & Wertz, D. (2008). Auditory rehabilitation for interaural asymmetry: Preliminary evidence of improved dichotic listening performance following intensive training. *International Journal of Audiology*, *47*(2), 84-97.

Ross-Swain, D. (2007). The effects of auditory stimulation on auditory processing disorder: A summary of findings. *The International Journal of Listening*, *21*(2), 140-155.

Strong, G. K., Torgerson, C. J., Torgerson, D., & Hulme, C. (2011). A systematic meta-analytic review of evidence for the effectiveness of the 'Fast ForWord' language intervention program. *Journal of Child Psychology and Psychiatry*, *52*(3), 224-235.

Weihing, J., Chermak, G. D., & Musiek, F. E. (2015). Auditory Training for Central Auditory Processing Disorder. Seminars in Hearing, 36(4),199–215. doi: 10.1055/s-0035-1564458.

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Why Test Early?

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I write this article with deep conviction that testing early is necessary and doable. I encourage all those who test children for auditory processing disorders not to wait till the age of 7 or 8. Previously when asked, why do we wait?" the answer has been "*because we do not have the instruments to test children that young."* And the myth continues. It is especially damaging when special educators, directors of Committees on Special Education (CSE), Programming and Planning Committees (PPT) and Heads of Departments of Special Education, tout that myth when the question arises. They are doing a great disservice to those children. In investigating the feasibility of testing young children, there are several behaviors that are prominent to enable us to screen those young children who are experiencing auditory processing deficits, especially between the ages of 4-7. Such behaviors become glaringly evident when a child needs repetition, re-explanation, asks "what?" or mispronounces words or is unable to associate letters with their sounds or put sounds together to form words. They have trouble listening in the presence of noise or can't follow a conversation because it goes too fast. A child's difficulty listening in noise is an indication of a pending processing disorder. Children who cannot discriminate speech in the presence of the "din" of a kindergarten classroom, are those most likely to be at risk for having a reading problem in later grades (Carr K, Nicol T, Bradlow AR et al. 2015; Kraus,N., and White-Schwach, 2015). Children who struggle to listen in noisy
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environments (the “din” of the classroom) may struggle to make meaning of the language they hear on a daily basis, which can set them at risk for literacy challenges (Kraus,N. and White-Schwach,T., 2015; Schwoch, et al., 2015). “Our view is that background noise disrupts the brain mechanisms important for language development. Indeed, these responses are reliable in infants, and we would argue that consonants in noise should be used to screen the newborn hearing brain for language impairment (pg 39).”

There are other issues to be considered such as youngsters with attention or language impairment. And a word should be said about neuroplasticity. The earlier we can identify youngsters, the better the opportunity to retrain the brain and take advantage of the neuroplastic quality of brain tissue to reorganize and remediate deficiencies. Time and age matter.

One must consider the co-morbid conditions such as language processing, reading disorders, learning disabilities and social-pragmatic deficits that often accompany the disorder in this population. A reason for such co-morbidity is that, although CAPD is a distinct diagnosis; co-morbidity occurs due to brain organization. The auditory system is extensive and overlaps other systems. This brain organization underlies co-morbidity and produces a multitude of clinical profiles. It also speaks to opportunities for multi-modality intervention programs and input from a multidisciplinary team such as a psychologist, special education teacher, pediatrician, neurologist, etc.

CAPD may contribute to, be associated with, or co-exist with difficulties in higher-order language, learning, cognitive and communication function due to shared neuroanatomical areas. However, true CAPD is *not the result of* these dysfunctions in other modalities, but rather a result of a CANS dysfunction.

In the younger child, there are early warning signs that an auditory processing disorder is present. It is often intertwined with compromised language, especially comprehension, ability to follow directions and to learn sound symbol relationships for early literacy. The young child may continue to develop adequate vocabulary and syntactic skills as noted in their kindergarten and first grade classes, but as the grades increase and the demand for higher level language skills unfold, they falter and deficits begin to surface. Their ability to understand more subtle and inferential language begins to fall behind the traditional language skills that one has in the early grades. The peer interaction of such children is often compromised by the child’s mishearing and misinterpretation. For the young child, their early roots of understanding tones of voices for sarcasm, the subtle words that convey feeling or humor are not recognized, and the subtleties of phonic sounds are not picked up, placing their ability to learn to read at risk.

Children who mishear their friends or teachers are often in conflict and ostracized from group activities, leading to loneliness, rejection and bullying. These youngsters often mishear, misinterpret what is meant, causing communication breakdowns among friends, family and teachers. Others are too embarrassed or confused to ask for clarification. Such deficits carry over into later adolescents further compromising the person’s ability to communicate and understand the message. One is often left with fewer resources to draw from for educational achievements, thus robbing them of joy and confidence.

In order to evaluate CAPD, there is a challenge in selecting tests to account for potential language deficiencies. The following is a compilation of available tests for young children to determine the wide range of weaknesses:

- Phonemic Synthesis Picture Test, ages 4-7, (Precision Acoustics), Katz, J.
- CTOPP-2 (Comprehensive Test of Phonological Processing, 4-21.11 (Pro-Ed), Wagner, R., Torgeson, J., Rashotte, C., Pearson, N.
- TAPS-4 Test of Auditory Processing Skills, ages 5-21(Academic Therapies), Martin, N., Brownell, R., Hamaguchi, P.

- Multiple Assessment of Auditory Processing (MAPA-2), ages 7-14, (Academic Therapies), Schow, R., Seikel, J., Brockett, J., and Whitaker, M.
- Listening in Spatialized Noise Test (LiSN-S) – Sentences (Version 1.0.0) Cameron, S., Dillon, H. (2006). [Computer software]. Sydney, NSW: National Acoustic Laboratories. Normative data from age 6.0 to 60 years, for both the Australian accented version and the USA accented version, are built into the software. Ideal for 6.0 to 12.0. Sold in USA by Phonak. See Cameron, S. and Dillon, H, (2007)
- SCAN-3C Test of Auditory Processing, ages 5-12.11(Pearson Publishing), Keith, R.
- Phonological Awareness and Print Scale, ages 3.6-8.11 (Western Psychological Services) Williams, K.T.
- Token Test for Children-2, ages 3.0-12.11, (Pro-Ed), McGhee, R., Ehrler, D, DiSimoni, F.
- Auditory Skills Assessment (ASA), ages 3.6-6.11 (Pearson Publishing), Geffner, D. and Goldman, R.
- Staggered Spondaic Word Test (SSW), ages 5-60, (Precision Acoustics) Katz, J.

One should not negate the impact that early Otitis Media has on the development of auditory skills in childhood. Thus, it only behooves the audiologist to be extra vigilant in assessing such children who are at higher risk. The impact of early Otitis Media on the child's hearing mechanism, early language skills and speech production include the following (Katz, Zalewski, and Brenner, 2019):

- Auditory Sensory deprivation leads to slower recovery, reversal of recovery and lack of recovery caused by synaptic depletion of the chemical mediator as a result of sound deprivation.
- ABR findings show that the presence of OME slows down auditory transmission even at the brainstem
- Children with early OME had poorer scores on articulation, vocabulary and auditory processing skills. Other studies found deficits in verbal comprehension, verbal expression and reading ability.
- The first three months of life is critical for OME and then the first 3 years of life. Conductive loss as small as 15 dBHL can cause language problems.
- Early effects of OME can continue to influence reading ability and verbal IQ through high school years. Subsequent APD problems can play a part in language learning deficits for years beyond when the disorder was diagnosed.

Further, treatment options, therapy techniques, CDs, apps and technology are available to help this population improve their processing skills, such as: Fast Forward (FFW),Scilearn.com; Central Auditory Processing CAPD Online Therapy System (CAPDOTS), a dichotic integration listening training program used to treat CAPD, specifically binaural integration deficits and separation deficits (The Listening Academy, Vancouver, Canada); Phonemic Synthesis Program; Integrated Listening Systems (ILS); HearBuilders (superduperinc.com). There are apps such as Ear Plane (Acoustic Pioneer), Hamaguchi Apps such as: *The Listening Power Preschool (HD*), (Listening for descriptions, Directions, Grammar and Meaning, Stories with Pictures and Stories without Pictures), *Listening Power, Grades K-3, (*Listening for Word Memory, Listening to Stories, Description, Grammar and Meaning*), Between the Lines 1, Fun with Directions* with 5 activities that address Listening for Descriptions, Directions, Grammar and Meaning, Picture the story, *More Fun with Directions, Picture the Sentence, Picture the Stories* without Pictures. There are other apps such as: *Auditory Processing Work-out, Auditory Processing Studio*, OticonMedical.com, Starkey Hear Coach, *Ready, Set Hear* and specific apps for phonological awareness training such as *ABC Pocket Phonics, ABC Phonic Stories, AB Listening Adventures.* Such are available for the younger child to help remediate auditory processing deficits, and the list goes on.

It is important to mention the benefits not only for management of FM systems, but for treatment and its long-term effects on the auditory mechanism (Geffner, 2019). So, in other words, we have the instruments, we have the knowledge, we have the programs for remediation and we know the benefits of neuroplasticity. So why wait?

References:
Cameron S. ,& Dillon H.,(2006). Listening in Spatialized Noise Test LISN-S .(Version 1.0.0) [Computer software].

Cameron S., Dillon H. (2007).Development of the Listening in Spatialized Noise-Sentences Test (LISN-S). *Ear Hear*; 28(2): 196-211.

Carr K., Nicol T., Bradlow A.R., and Kraus, N. (2015). Auditory-neurophysiological responses to speech during early childhood: Effects of background noise. Hearing Research, 2015 Oct 1;328:34-47.

Geffner, D. (2019). Management Strategies with FM systems and Assistive Listening Devices. In Geffner, D., and Swain, D. (Eds.), Auditory Processing Disorders: Assessment, Management and Treatment, (3rd Ed.). (Chapter 15, pp. 351-387). San Diego: Plural Publishing, Inc.

Katz, J. , Zalewski, T and Brenner, M. (2019). Otitis Media and CAPD in Auditory Processing Disorders: Assessment, Management and Treatment. In Geffner, D., and Swain, D. (Eds.), Auditory Processing Disorders: Assessment, Management and Treatment, (3rd Ed.). (Chapter 13, pp. 307-326). San Diego, CA: Plural Publishing.

Kraus,N and White-Schwoch, T. (2015) Listening in the Din: A Factor in Learning Disabilities? The Hearing Journal, September, 39-40.

White-Schwoch T, Carr K, Thompson EC, et al. (2015). Auditory processing in noise: a preschool biomarker for literacy. PLoS Biol 2015;13(7):e1002196.

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Auditory Processing Disorder and Attention

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Children with APD can also have difficulties with attention. Differentially diagnosing these problems can be challenging for audiologists who may not routinely include measures of attention in their assessment of a child's listening abilities. Stavrinos and colleagues (2018) sought to address this issue by examining whether a diagnostic protocol for APD that included measures of attention could provide useful information for APD management.

Stavrinos et al. recruited 27 children (aged 7–11 years) who had been referred for APD assessment. Each child was assessed on one occasion using the Dichotic Digits Test (DDT), Gaps-in-Noise (GiN), Frequency Pattern Test (FPT), and SCAN-3 Auditory Figure Ground (AFG); and on a second occasion using the Wechsler Non-Verbal (WNV) Scale of Ability, the Test of Everyday Attention for Children (TEACh), and the Listening in Spatialized Noise-Sentences (LiSN-S) test. Each child's parents were also asked to complete the Communication Checklist 2 (CCC-2).

Four proposed test batteries were then applied to each child's results. Test battery one classified a child as having APD if at least two AP test scores were at least 2 SDs below the mean, or the LiSN-S scores were at least 2 SDs below the mean for spatial advantage and high cue/total advantage (suggesting the presence of spatial processing disorder). Test battery two classified a child as having an attention deficit (AD) if at least two TEACh subscores were at least 2 SDs below the mean. Test battery three classified a child as having APD without AD if APD was diagnosed as per test battery one but no AD was identified as per test battery two. Finally, test battery four was a newly proposed test battery that classified a child as having an inattentive sub-type of APD (i-APD) if APD was diagnosed as per test battery one and only one TEACh sub-test score was at least 2 SDs below the mean.
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Simple correlation analyses showed divided auditory and divided auditory-visual attention strongly correlated with the DDT (r = 0.68, p < 0.05, and r = 0.76, p = 0.01, respectively). This suggested some relationship between DDT performance and divided attention.

Cochrane's Q test analysis of the proportions of diagnosis under the four test batteries showed the standard APD battery (test battery one) identified a larger proportion of participants as having APD than the attention battery (test battery two) identified as having ADs. The APD without AD test battery (test battery three) did not have a significantly different diagnosis proportion than the standard APD battery (test battery one). Finally, the newly proposed test battery identifying an inattentive subtype of APD (test battery four) identified five children who would have otherwise been considered as not having an AD.

The researchers concluded that a subgroup of the children with APD demonstrated underlying sustained and divided attention deficits. They suggested that further research should consider the possibility that attention deficits in children with APD might centre on the auditory modality, and that examination of different types of attention in this population is required.
With regards to APD and attention in the clinic, the researchers suggested it could be useful to revise APD test batteries to include tests of attention. They also suggested their newly proposed inattentive sub-type of APD be considered as potentially providing additional useful data to clinicians to ensure the careful interpretation of APD assessments.

References

Stavrinos, G., Iliadou, V.M., Edwards, L., Sirimanna, T. Bamiou, D-E. (2018). The relationship between types of attention and auditory processing skills: Reconsidering auditory processing disorder diagnosis. Frontiers in Psychology, 9, 34. doi: 10.3389/fpsyg.2018.00034.

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For Those Who Use or Don't Use the SSW

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The SSW was developed almost 60 years ago to identify and locate CNS disorders in those suspected of having central abnormalities. With the help of neurologists, neurosurgeons and anatomists it turned out to be an amazing test. When working with one neurologist, who was locating lesions of his patients for our SSW NIH study, the test was so sensitive/accurate that he told Dr. Katz that he was the smartest person he ever knew. Of course, he was wrong about that, but the test does give us so much valuable information. Later on, when APD came on the scene, we found that the loci of brain lesions explained 4 aspects of this disorder. One of the beauties of this test is that we have 20 indicators of AP dysfunction, directly or indirectly, based on the mapping of lesions in patients with brain and brainstem disorders. The SSW is a widely used central test (Emanuel et al., 2011) and a highly sensitive test compared to 7 others in a TBI study (Gallun, et al., 2012). In addition, the Buffalo Model is an accurate diagnostic procedure (Jutras et al., 2007) and the test has been in continuous use since 1962.

In the last issue we reported on a correction factor for the old spondees on the SSW that added additional errors. These appear not to be random errors, but rather ones that were too sensitive for the 1998 norms. So why not, just re-norm the test? The key-word is 'just'. We welcome anyone who would like to do that! It is an enormous task. Instead we decided 'to just' remove the 11 old spondees (in 7 different items). Oiy Vey! For one thing that would take a lot of time and effort to score when testing. But worst of all, it would unnecessarily weaken the SSW. The norms were based on 80 spondees, not 69. So if we removed them it would remove 14% of the test (that would be as though all 22 monosyllables were always correct for everyone).
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[The 69 regular spondees in the previous sample had a mean of 11.1 errors per person. So we were aiming for 80 items with 11.1 to compare with the norms. If we did not count just 2 items (#s 4 and 27) that contained 4 of the 11 old spondees, it would only take away 107 errors. That might reduce the score by too few errors compared to the 40 item norms. By a stroke of luck, if we eliminate 4 spondees it also removes the equivalent of 44 more errors (none of those spondees would have an error). By omitting 2 items, the 40 item mean came out 11.2 (instead of 11.1)!]
Even if the paragraph above was too much to digest before lunch, not only did the omission of 2 items produce the target amount of errors, it left the test and error pattern intact. Luckily one spondee was REF and one LEF and the number of errors across the 8 CN were similar to the pattern of the 69 spondees. This suggests that the 1998 norms for the Total score, 4 Conditions, Ear/Order Effects and Type-A would be consistent for our 38-item test.

The Current Study

The purpose of the current study was to determine if the previous data for 40 subjects would be consistent with the data from a new sample from 2 audiologists, one of whom did not contribute to the original study. Dr. Kaul, contributed 13 cases and Dr. Katz who provided the original data provided 10 new cases. This analysis was to see the effect on the SSW, with and without items #4 and #27. Our first question was whether the two new samples were similar. At a first look they were not similar. One of the two samples had an average of 39.2 errors based on all 40 items and the other had only 31.1. On further inspection the difference was based on one subject who was randomly chosen with 131 errors (or one quarter of all the errors for that sample). If that subject was omitted the difference was eliminated. Since we already made the figures, we decided to leave that subject in because we were just looking to see the comparison of all 40 to 38 items.

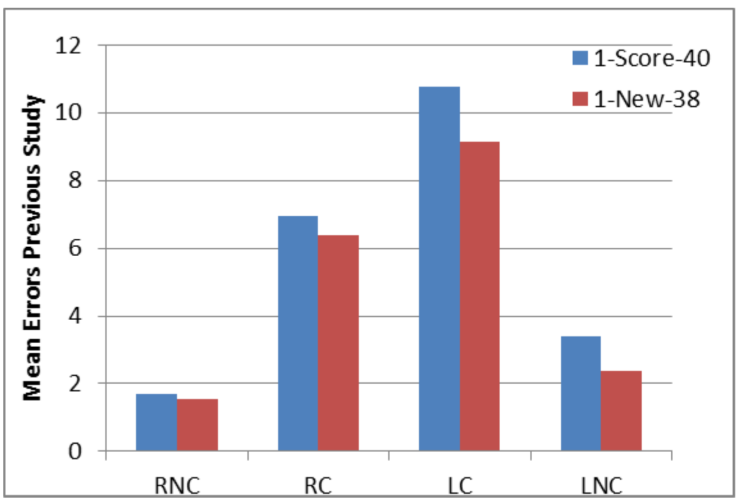

Figure 1. Score=40 items, New= 38. Shows results for the previous study (40 children with APD). The 4 Conditions show improvement, but not major changes in the mean scores. As expected this suggests that the pattern of error is the same, but the extent is modified. So this seems to have had the intended effect of minimizing the influence of old spondees while not harming the SSW's power.

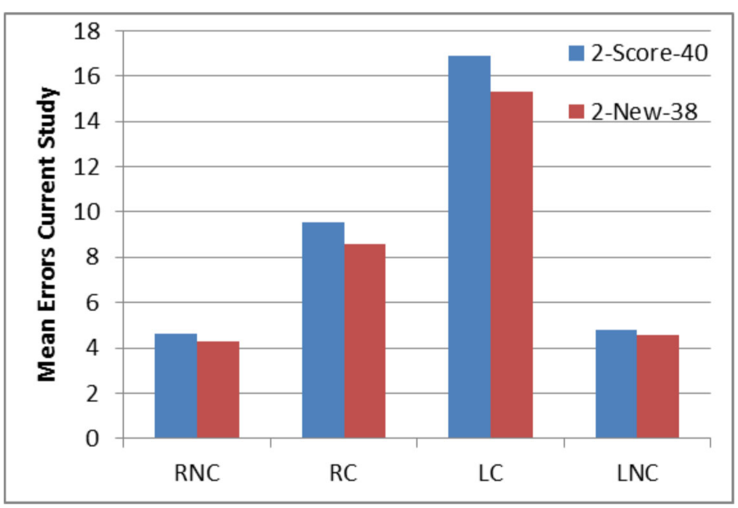

Figure 2 shows the results of the recheck study to validate the original data. This sample had 23 subjects from 2 audiologists. As expected, the means for the 4 Conditions all show improvement when the 2 'old' items were omitted. Compared to Fig. 1, there appears to be a slightly smaller difference for the left ear in this sample.

So how will this influence the diagnostic power of the SSW test?

Overall, the recheck supports the original data. We took this analysis a few steps further. Figure 3 shows the effect of the 2-item omission on the number of significant findings on the SSW? We looked at the correction influence on the 4 Conditions and Total scores, Ear and Order Effects, Type-A, SIR and Reversals (a total of 10 diagnostic indicators). Figure 3 shows the average positive scores for the 10 measures for the 23 children using either 1 or 2 SDs.

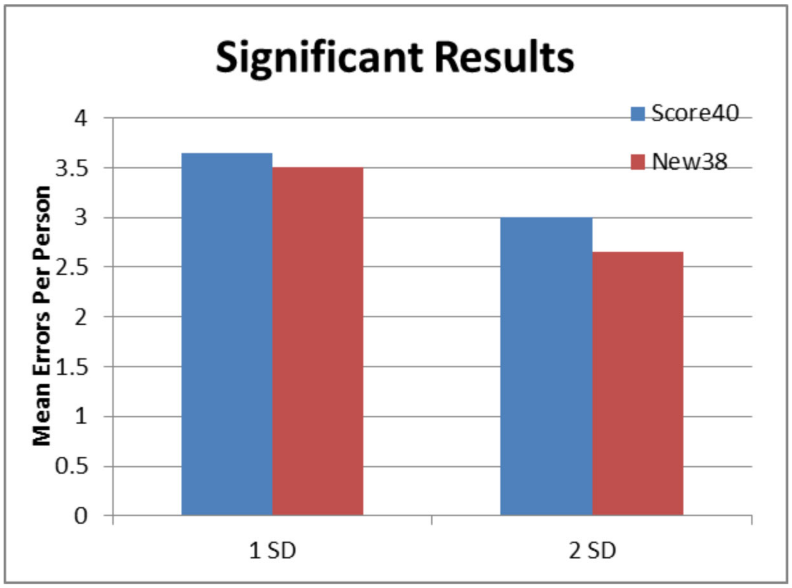

Figure 3. The mean significant findings at 1 SD for 40-items (blue) was 3.65 & for 38-items (red) 3.5 (or 4%↓). So, ignoring those 2 items reduced the number of significant SSW finds, but not enough to harm the test in most cases. At 2 SDs means went from 3.0 to 2.65 (12%↓). When we compare 1 SD for 40-Score and 2 SD for 38-New, it reduces the findings by 37%! That surely weakens SSW for mild & mild-moderate cases.

Putting It All Together

We feel that in dealing with APD, we have to get it right. Suffering with APD, especially in the critical developmental years, must be avoided. If we must err, we should err by giving a positive diagnosis (because therapy will not harm their education etc.).

Anyway, we are unlikely to make false-positive diagnoses because: 1) People are not referred to us (and pay good money) if there is no problem. 2) The problems they have resemble APD. 3) Then, indeed, these people show a significant number of positive signs of APD. 4) We also use the BMQ-R, so we can be sure our tests are on target. 5) We see consistently that in therapy their skills improve and that also shows up on the retest! And after all that, we see that they have improved on the original complaints (by parents-teachers). The more likely error we can make is to unnecessarily reduce the power of the SSW, so it does not identify the breadth of the AP problem. Furthermore, hardworking-bright children and those with previous speech, reading etc. therapies come to us much more able and sophisticated for our tests than the normative population.

Do you remember that someone wrote that if you have more than 68% positive findings you are over-diagnosing APD? Does that make any sense in a school for dyslexia, intellectually challenged etc., or those who come to us specifically for APD help? Not if you have sensitive tests. Very sadly, a lot people with APD who may need help may not get it.

With that in mind, we need to make the best clinical decisions we can to serve those we serve. Those who use the SSW, now have a decision to make. You seem to have 4 choices. Are we going to use a 1 or 2 SD criterion and then decide with or without the 2 item correction?

We hope that the information above will help you to make a fair and effective decision. It is likely that for those with pretty severe results on the SSW there will be no difference on the 4 choices. For those with moderate performance the choice is likely not too consequential (but may look a little better than they are). However, for those with mild SSW results (including those who perform better than expected than the normative group) there is a good possibility that the number of positive signs will be importantly reduced.

better than expected than the normative group) there is a good possibility that the number of positive signs will be importantly reduced.

We are not yet ready to make an ‘official’ decision regarding this SSW-old spondee question without having some months of clinical study. We plan to label the results as ‘SSW-1/40’ for 1 SD - all 40 items, ‘SSW-1/38’ and for 1 SD and 38 items etc.

The SSW test has so much information and power to offer in the evaluation of those seen for APD, with and without hearing loss as well as those who are seen because of neurological concerns at various CNS levels (with and without hearing loss). It has given us so much valid and reliable information for decades. We suspect this study will lead to further insights and enable us to use the SSW effectively until there is something better.

References

Emanuel, D.C., Ficca, K.N., and Korczak, P. (2011). Survey of the diagnosis and management of auditory processing disorder. *American Journal of Audiology,* 20, 48-60.

Gallun, J.B. Diedesch, A.C., Kubli, L.R., Walden,T.C., Folmer, R.L., Lewis, MS, McDermit, D.J., Fausti, S.A. and Leek, M.R., (2012). Performance on tests of central auditory processing by individuals exposed to high-intensity blasts. *Journal Research, Rehabilitation, Development*, 49(7) 1005-1024.

Jutras, B., Loubert, M., Dupuis, J., Marcoux, C., Dumont, V., Baril, M. (2007). Applicability of central auditory processing disorder models. American Journal Audiology, 16(2),100-106.

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