# Electrophysiological Findings Support Powerful New Therapy for Kids Struggling in School

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## Introduction

We have all witnessed the astronomical rise in the number of children with attention disorders. AD/HD is now the number one childhood disorder with the US DEA noting an 800% increase in production quotas of Ritalin from 1768 kg(1990)to 14,442 kg(1998). Concurrently, classrooms are becoming more crowded and as budgets are cut in response to the economic times, services are thinning. Struggling teachers are often seeking ways to manage the behaviors of their students, and parents report having to medicate their children at the school's request.

As Drs. Brock and Fernette Eide discuss in their book, "The Mislabeled Child", there are many reasons why children have attention issues. At our center in South Florida, a large percentage of our clients struggle with attention problems that is exacerbated by a little known, but common problem called an auditory processing disorder (APD). This disorder does not necessarily mean there is anything wrong with their hearing. Their ears may be working fine but the child may not hear clearly if the speaker is far away or if the environment is noisy. Common responses may be "what?", "huh?", or simply a blank stare which often gets misconstrued as poor attention. These children perform better with one-to-one instruction than in group settings. Auditory processing speed is slow in many cases, making it hard to follow multi-step directions. In addition, there may be difficulty understanding complex language. As a result of these processing challenges, these children may have trouble paying attention for long periods of time. They are often diagnosed with attention disorders, despite the fact that there may be no concerns regarding their ability to quiet, easy listening situations. In essence, many of them may have been misdiagnosed and consequently not rendered the appropriate treatment. Because the listening and balance systems share the same receptors (the vestibule-cochlear apparatus), a consistent co-morbid finding with APD includes deficits in coordination, handwriting, social skills, language skills, and academics (reading fluency, reading comprehension, math, etc.).

Many before us have suggested the use of sound stimulation (Tomatis) and the combination of sound stimulation and sensorimotor activities (Frick and Hacker) as effective strategies for treating processing disorders. In this paper we enhance this body of knowledge by presenting preliminary electrophysiological findings that support the combination of a specific sensorimotor approach, the H.O.P.E. Method and the iLs program together as an effective means to treating children with these types of processing disorders.

**A Combined Therapy: H.O.P.E. & iLs**

The H.O.P.E. method (Harper's Optimal Protocols for Enrichment) is a unique program that focuses on the systematic and structured application of existing, evidence-based treatment techniques. Designed by Julia Harper, MS,OTR/L, a pediatric occupational therapist, it is a treatment planning tool and a clinical decision making guide for therapists while functioning as a road map to effective therapy for parents.

Integrated Listening Systems (iLs) is a sound and movement program which includes both receptive and expressive language exercises. The sound component consists of specifically processed classical music in which frequencies are enhanced or filtered out per different therapeutic objectives. The music is housed on an iPod and transferred through headphones capable of both air and bone conduction delivery. iLs trains the auditory system to process the full range of language frequencies more effectively, and the bone conduction oscillator provides a unique stimulation to the cochlear/vestibular system.

In our center, we offer the combination of H.O.P.E. Method and the sound protocols of the iLs program in an intensive format. We begin with a thorough Neuro-Developmental Evaluation using functional neurology strategies and a Neuro-Auditory Processing Evaluation to determine where the processing breakdowns are occurring. Ultimately we investigate how well sensory information, including sound, is traveling through the Central Nervous System. When there is a breakdown of information as it travels through the CNS structures on its way up to the cortex, it is known as a processing disorder or what Dr. Martha Herbert, Assistant Professor of Neurology at Harvard Medical School and Pediatric Neurologist describes as a "Disorder of the Brain" as opposed to a "Brain Disorder".

We use the information from the evaluations to design customized, sensorimotor protocols (the H.O.P.E method) and sound protocols (iLs program), which are provided in an intensive format for three consecutive Monday to Friday sessions, for three to five hours of daily, direct, one-to-one therapy. This is sometimes supplemented by speech-language intervention and/or educational support. Each of the therapies is provided by a different specialist, expert in their particular area. The importance of the combination of therapies is that all of the professionals are providing coordinated brain-based intervention. Regardless of the discipline, the intervention is directed at a specific CNS level identified as having a processing breakdown to access the greatest change. For most of our clients, the primary area of processing breakdown appears to be at the brainstem level. As a result of these findings, in most of the cases we begin our intervention by focusing at this specific region of the CNS to access plasticity; that is the potential of the brain to change. It is the combined power of the multidisciplinary approach incorporating the skills of a variety of professionals synthesizing the H.O.P.E method and iLs programs, and focused on a specific area of the brain, that creates the changes that we are

reporting. Any of these approaches done singularly does not have the summating effect and thus does not create the specific brain changes we are witnessing.

**The Testing**

Over the past year and a half since we began combining the powerful interventions of the H.O.P.E. method and the iLs program, we have followed 29 cases. At this time we have collected a volume of anecdotal results reported by parents and teachers such as improved attention, increased academic function, including handwriting and reading skills and increased social skills.

Additionally, we can provide findings on observed functional gains as measured by physiological and behavioral measures which depend on the participation of the child and professional interpretation. These include gains in vestibular processing as measured by the Post Rotary Nystagmus Test (PrN), improved oculor-motor skills, increased cerebellum functioning, inhibition of primitive reflexes and improved gross and fine motor coordination as measured by the Berry Test of Visual Motor Coordination and the Peabody.

Our focus in this paper is to highlight the dramatic improvements we have been able to measure in auditory processing skills using an electrophysiological test called Auditory Brainstem Response (ABR). The ABR is an objective evoked potential test, similar to an EEG, which measures neural integrity through the brainstem. We believe that by targeting this area of the brain using the H.O.P.E method and iLS program, we would also improve processing at the cortical level.

**The Findings**

These are the results of a group of 29 children ranging from four to 14 years. These children were diagnosed with processing disorders that included AD/HD, learning disorder, dyslexia, language and attention disorder, autistic spectrum disorder and academic challenges. They were seen for intensive programs using a combination of the H.O.P.E. protocol and iLs. The children were pre-tested prior to the first three week intensive to establish baseline data in both the sensorimotor and auditory processing areas. All testing was repeated when the child completed the H.O.P.E. protocol and both the receptive and expressive phases of the iLs program. The course of intervention ranged from three weeks (one intensive) to two years (four to five intensives) with the average length being one year (three intensives).

In all 29 cases, pre-testing identified the brainstem as having processing breakdowns. As the portal of information from the peripheral system to the cortex, the focus of our interventions was increasing the processing of information in this area. A major factor in addressing processing through the brainstem is the activation of the vestibular system. By systematically providing an organized group of protocols as prescribed by the H.O.P.E method, we were able to

demonstrate increased vestibular processing. Pre-testing indicated that 0 of the 29 children had intact vestibular processing skills measured by the PrN and functional skills. On post-testing, all 29 were within normal limits.

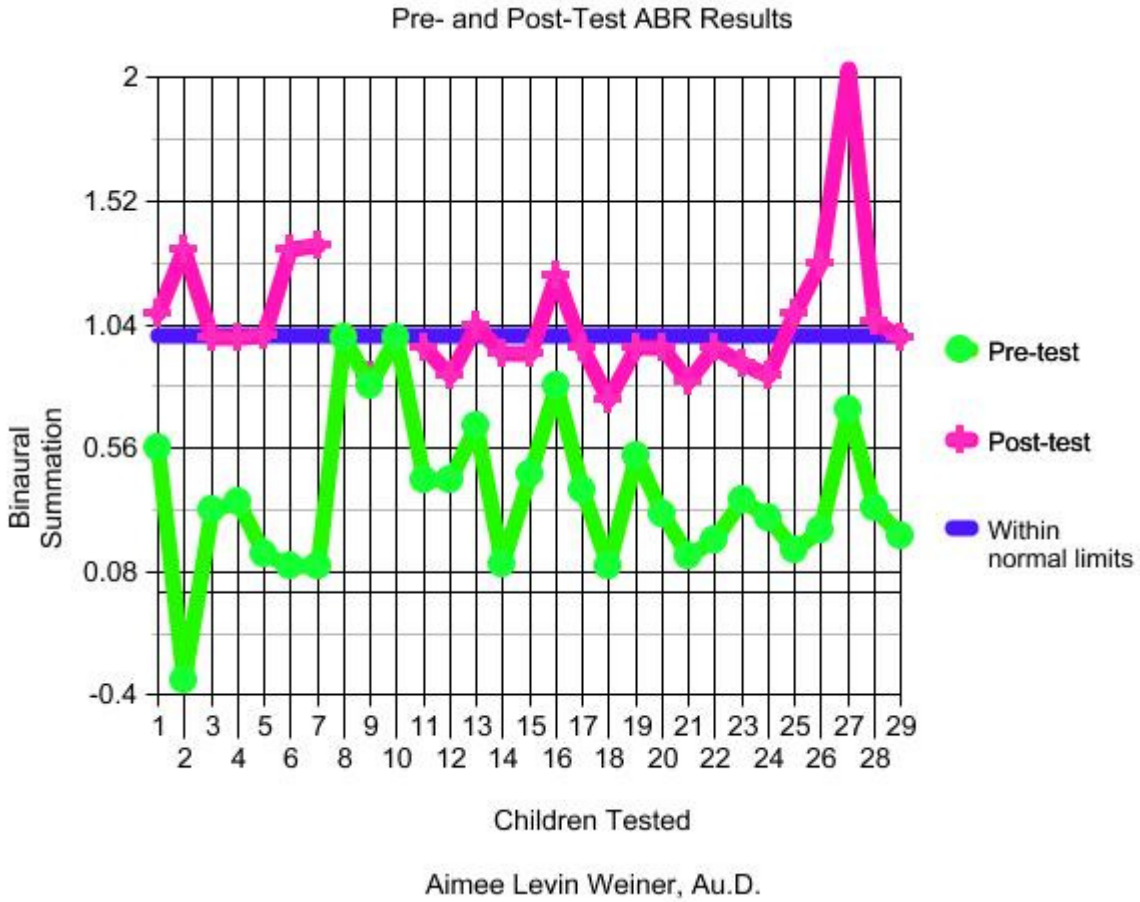
The physiological and functional connection between the vestibular and auditory systems has long been established, therefore it is plausible that the changes we facilitated in the vestibular system were expressed not only in overall improvements in the children's balance, coordination and motor skills, but also supported the improvements demonstrated in the auditory processing system as well. Intact vestibular functioning is foundational to improved processing in both the auditory and ocular systems. Pretesting showed that 28 of the 29 demonstrated ocular-motor deficits in the areas of visual pursuits, saccades and convergence/divergence skills. Post intervention, 25 of the 29 demonstrated intact ocular motor skills. This finding contributed to improvements in reading and writing skills reported by parents and teachers and was verified by increased visual motor performance on the Berry VMI. It is important to note that the strong sensorimotor emphasis of the H.O.P.E. method laid the groundwork for the auditory gains we are reporting with the addition of the iLs program.

While sensorimotor testing has long pointed to the brainstem as the main area of weakness in processing disorders, the addition of ABR testing (from the APD test battery) has provided electrophysiological proof of this theory. The brainwaves elicited on ABR provide information regarding speed of sound transmission from the ears to the low, middle, and high portions of the brainstem. In addition, by noting the size of the waveforms when listening to sound with one ear compared to the size when listening with both ears, it becomes clear whether the ears are coordinating with each other. There should be a significant benefit to listening "in stereo" as opposed to listening monaurally. Sound quality, localization ability, and auditory figure-ground discrimination are all enhanced when the ears are working in tandem. If the ears are coordinating well with each other at the brainstem level, the amplitude of the waveforms should be significantly larger when listening with both ears than when listening with each ear individually (binaural summation).

ABR results on pre-testing showed that while sound was traveling at the right speed from the ears through the brainstem, it was noted in 27 of the 29 children that there was little or no difference between the size of the waveforms when listening with either one or both ears. These findings suggested that for the majority of these children, there was poor coordination of the ears at the brainstem level, giving them no benefit from listening with both ears. Traditional, behavioral APD testing showed multiple auditory processing weaknesses at the cortical level in the areas of auditory decoding (hearing clearly in degraded listening situations), integration (inter- and intra-hemispheric transfer of auditory information), and organization (memory and sequencing).

ABR results on post-testing were startling. Where there had been only small differences in the size of the waveforms on pre-testing, there were now robust differences between the waves generated when listening with both ears compared to those generated with each ear individually. Along with this marked electrophysiological change in auditory brainstem coordination were concomitant improvements in every area of auditory processing at the cortical level. The significant improvement in binaural summation is a new finding since the addition of the iLs program to the H.O.P.E. method, and is thought to account, at least in part, for the extensive improvement noted in the auditory processing ability within the cortex on post-testing.

The following is a graph depicting the changes in binaural summation (the difference between the size of the waveforms when listening with both ears compared to the size when listening with each ear individually) from pre- to post-testing for each of the 29 children. A size difference of 1.0 uV is considered within normal limits.



## Auditory Processing Findings

Although not the focus of this paper, we are happy to report that traditional auditory processing measures showed significant improvement at the cortical level once the brainstem deficits had been addressed. As noted above, while pre-testing showed multiple areas of auditory processing weakness for each child, post-test results were uniformly improved in all areas tested. Functionally, these gains suggest that all the children are now able to hear more clearly in difficult listening situations (e.g. being far away from a speaker, listening in noise), remember and understand what they have heard in the correct order, and blend sounds with their ears in order to be better able to decipher words by phonics. Our post-intervention results also indicated that at least 27 of the 29 children will now be better equipped to process auditory information in a timely fashion, making it easier to follow multi-step directions. In fact, 22 of the 29 children had auditory processing skills that were completely within normal limits in every area on post-testing! In sum, all of the children showed markedly improved listening skills that are key components to academic success (e.g. attending, following directions, reading). Additionally, the gains made in auditory processing skills have been noted to remain stable in those children who have returned for further intensives.

## Additional Findings

Approximately a quarter of the children (seven of 29) began this therapy on medication for attentional concerns. Of these, two were on additional medications for bi-polar disorder. By the end of the program, the medications had all been discontinued with no further concerns in these areas.

Parents and teachers reported improvements in social skills, language, improved grades in reading and math, with most of the kids showing definite improvement in reading comprehension.

A welcomed side-effect of these interventions was the increased self-confidence demonstrated by the children. It is best summed up by Steven who said at the end of his intensive "…*these 3 weeks taught me I can do anything*…"

## Summary

Both the sensorimotor and the audiological findings were suggestive of central nervous system breakdowns between the brainstem and the brain. The children had peripheral sensory function that was essentially within normal limits. Combining the H.O.P.E. and iLs programs focused on improving processing proficiency through the brainstem and consequently through the brain. The significant improvements noted behaviorally at the brainstem level were validated

by the electrophysiologic changes noted on ABR testing. Where there had been only small differences in the size of the waveforms on pre-testing, there were now robust differences between the waves generated when listening with both ears compared to those generated with each ear individually. Functionally, the children showed marked improvements in the areas of motor coordination, handwriting, auditory processing, attention, social skills, language, and academics. In addition, seven of the 29 children who began therapy on attention medication were able to discontinue its use by the end of the program. The marriage of the H.O.P.E. method and the iLs program has proven to be an exciting intervention for children with sensorimotor and auditory processing deficits.