

© QEEGs and Neurofeedback for Children on the Autism Spectrum with Special Emphasis on the Sensory System by Dr. James Neubrander

Disclaimer: The following document will approach the sensory issues seen in children on the autism spectrum primarily from the perspective of EEG and QEEG data. In no way is this article meant to imply that the sensory issues each of us face is strictly an electrical phenomenon and not one without tremendous biomedical contributions. For those of you who know me, though I have an interest in electrophysiology and its manifestations in children on the spectrum, biomedical principles have always been, and will continue to be my primary focus. I have not crossed over to the “Dark Side”!

EEGs, QEEGs and Autism

It is well known that the majority of children on the autism spectrum have some degree of sensory system involvement with troublesome symptoms, two very common ones being hyperactivity and stimming. It is not uncommon for children to exhibit increased sensory symptoms when they are experiencing the negative effects of various comorbid illnesses. It is also not uncommon for them to show significant sensory symptoms when they begin many of the more efficacious treatments that have been demonstrated to work for children on the autism spectrum. Though many theories exist as to why sensory symptoms are so prominent in these children, no one knows for sure. After observing thousands of children at my clinic and talking to their parents about their child’s *total set* of symptoms, I would like to *introduce a hypothesis* that may begin to explain many of the things parents and clinicians observe in their homes and offices, especially as they relate to sensory issues. My hypothesis is a result of data compiled from 272 QEEGs performed in my office on children with autism and the work Thatcher published from data he obtained from 54 of my autistic patients. (Thatcher RW, North DM, Neubrander JA, Biver CJ, Cutler SL, De Fina PA. Autism and EEG phase reset: deficient GABA-mediated inhibition in thalamo-cortical circuits. *Developmental Neuropsychology*, 34(6), 780-800, 2009). Thatcher’s article demonstrated that such children had *abnormal Phase Reset* wherein *Phase Shift was shortened* and *Phase Lock was lengthened*. Phase Shift and Phase Lock occurred in all frequency bands but Phase Shift was the greatest in alpha-1 (8-10 Hz) and Phase Lock was greatest in alpha-2 (10-12 Hz). Phase Lock for short distance electrodes showed the greatest amounts of slowing at the front and back of the brain. My QEEG data demonstrate the majority of children on the autism spectrum produced what I have named the “X Pattern” seen in the Phase Lag section of the NeuroGuide QEEG database report. Though a delay in electrical signaling known as Phase Lag was commonly seen in brain maps of children on the spectrum at any frequency that ranged from 0-40 Hz (delta, theta, alpha, beta), the X pattern was primarily observed in the alpha frequency range, that being 8-12 Hz.

Phase Reset is composed of two parts – Phase Shift and Phase Lock. Phase Shift is the time required for the brain to recruit the set of neurons that it will need to perform a specific neuronal task. Phase Lock is the time required for the neurons that were recruited to subsequently complete their designated neuronal task before being freed up to start working on the next task with a new set of neuron recruits. Simply stated, *Phase Shift is the hiring phase* or the amount of time that is needed to find the number of neurons that will be required to get the job done. *Phase Lock is the working phase* or the amount of time needed for the neurons to work to get the job done correctly before moving on to start the next

job. As demonstrated from Thatcher's EEG analysis, a normal brain has adequate time to recruit the number of neurons necessary to perform the designated task at hand. However, the brains of children with autism have significantly less time to recruit the number of neurons that will be necessary to perform the specific neuronal task at hand, and the recruited the neurons will take much longer to complete the task, something that often not finished. Due to this Phase Lock phenomenon, children with autism were found to need approximately *150% more time* to process electrical signals involved in the *central region* of their brains, approximately *185% more time* to process electrical signals involved in the *frontal region* of their brains, and approximately *275% more time* to process electrical signals involved the *occipital region* of their brain which was an incredible slowing in the area *adjacent to the parietal sensory processing center* of their brains! Thatcher's conclusion stated that the findings were consistent with a GABA neurotransmitter deficiency resulting in reduced numbers and/or reduced strength of thalamo-cortical connections in patients on the autism spectrum.

What I described above about *Phase Reset: Phase Shift and Phase Lock* is published and not theoretical. However, that is not the case with *the X pattern*. Until further studies have been conducted, *the X pattern* must be considered a hypothetical discussion. I introduce it so we might consider one more reason why most children on the autism spectrum exhibit at least some degree of sensory system involvement. As stated above, much of the sensory overload is believed to be due to various biomedical etiologies, most of which at this time are also are hypothetical explanations for the observed phenomena we see in these children. The information that follows is an attempt to tie together biochemical and biological factors with those that are electrical in nature. For this article I will focus on the electrical perspective as I intermingle known facts, e.g. the Brodmann areas and PZ, with theoretical discussions, metaphors and analogies, so the reader may more easily grasp the concepts.

I define the X pattern as the visual representation of electrical signals originating from multiple sites in the brain that then converge upon the *central parietal region*. This region is Brodmann area "PZ" with "P" meaning parietal and "Z" meaning central. *PZ involves the precuneus & cuneus which are involved in organization, sensory integration, synthesis, & manipulation of auditory, visual, and kinesthetic input. Deeper portions are involved in memory and quick decisions in crisis situations.* Directly adjacent to PZ are the occipital poles which are associated with multiple visual associations. *The parietal lobes involve sensation and the integration of sensory input, primarily with the visual system.* The first function integrates sensory information to form a single perception (cognition). *This is particularly important for interpretation of sensory information and the formation of the idea of a complex meaningful motor response to the stimuli whereas the frontal lobes are important for the execution of the act.* Deficits in the posterior (tertiary) parietal lobe can produce significant disturbances in the integration and analysis of sensory processing. *In addition, sudden overloading by excess stimuli can either lead to hyperactivity and stimming or total freezing and shut down.* The X pattern is seen in the Phase Lag portion of the commonly used NeuroGuide QEEG database report. Though Phase Lag is a poorly understood phenomenon among the QEEG and neurofeedback community, simply stated it is the speed and efficiency with which an electrical signal gets from Point A to Point B. What I believe the X pattern demonstrates is that electrical signals from all regions of the brain are directed to PZ to be processed and once there, their ability to be processed in a timely manner is significantly delayed. Depending

upon how much information is being sent to PZ at any one time will determine the number of symptoms and degree of severity for any of the host of behavioral manifestations that may be experienced by the child.

For children on the spectrum that we treat, *two sensory overload processes* are occurring simultaneously: 1) sensory overload from the healing process that the child is receiving from various treatments; 2) sensory overload from the disease process or processes that are operative in the child.

During the healing process that occurs from the treatments being used, Phase Shift begins to normalize. As it normalizes, the amount of time there is to recruit more neurons is increased. The process of beginning to normalize Phase Shift seems to occur quite rapidly for many treatments in which treatments are “added”, things like methyl-B₁₂, hyperbaric oxygen therapy, folic acid or methylfolate, certain GI medications, steroids, etc. As more neurons are recruited, more electrical signaling will subsequently be sent to PZ to be processed. From the clinical perspective, improvements in Phase Shift are relatively rapid and seem to occur early in the healing process. By contrast, improvements in Phase Lock remain static and unchanged or are delayed and come late in the healing process. What parents and teachers experience from this increased Phase Shift and static or delayed Phase Lock are more sensory symptoms, not fewer. This is disturbing to parents who often feel that their child has regressed when in fact the child is improving from both an electrical and biomedical perspective. Unpublished studies I did at my clinic in 2008 and 2009 for methyl-B₁₂ and hyperbaric oxygen therapy demonstrated statistically significant electrical improvement in the children’s brain map patterns. Therefore it is important for parents to understand that in order for the healing process to proceed at a quick enough pace to ‘beat the clock’ before time runs out on the child’s road to recovery, increases in sensory symptoms are often the natural evolutionary outcome of healing process treatments.

During the disease process both Phase Shift and Phase Lock remain static. During a disease state PZ is bombarded with an increased number of electrical signals that need to be processed. This incredible increase in electrical signaling is secondary to one or more of the comorbid conditions that exist for children on the autism spectrum. Some of the more common conditions that increase sensory input to PZ include pain for any reason, inflammatory conditions, infections and infestations, immune and autoimmune dysregulation, cytokine release, biochemical imbalances or toxicities, allergies, or physical and emotional distress, etc. Anything one does to decrease these conditions secondarily decreases the electrical signaling to PZ to be processed, thus diminishing sensory symptoms. Common examples include, but are not limited to diets, supplements, various types of GI treatments, immune and autoimmune system treatments, elimination of infections and infestations, treating allergies, detoxification techniques, stress reducing modalities, medications, etc.

Therefore, the number of sensory symptoms and their degree of severity at any moment in time is the summation of the electrical signals that must be processed at PZ. PZ can be ‘heated up or cooled down’. Increased electrical traffic to PZ is the result of comorbid disease processes and treatments that increase Phase Shift—‘heating up PZ’. Decreased electrical traffic to PZ is the result of decreasing or eliminating disease process incitants —‘cooling down PZ’. At any given moment on any given day, multiple factors are involved in creating this delicate balance. Rapid sensory symptom improvement is best achieved by

those treatments that 'cool down PZ'. However, to effectively treat many of the child's non-sensory symptoms, treatments that 'heat up PZ' by increasing Phase Shift and neuronal recruitment must be used. The difficulty for parents is how to reach the perfect balance for their child, for family 'sanity', so teachers can be effective in their classrooms and so therapists can have effective sessions. Parents must determine whether the side effects are of the 'nuisance variety' whereby the undesirable increases in sensory symptoms are not intolerable and are overshadowed by enough improvements in other areas to make the bothersome and inconvenient side effects worth the effort to persist with the treatment.

Autism and Neurofeedback

In my clinic I have found neurofeedback to be a valuable adjunctive therapy. For persons that do not have autism, a fairly standard set of sessions is recommended to treat certain disorders, e.g. 40 to 60 sessions is not uncommon for ADD/ADHD. However, for the majority of children with autism this is not the case and there is no clear endpoint for the number of sessions that they need. The reason I say this is because we are not dealing with a 'relatively' normal brain as we have in ADD. Instead we are dealing with a brain that has many abnormalities. Though there are increasing numbers of publications documenting these abnormalities, there is no consensus as to what an autistic brain looks like on an EEG or QEEG. However, most do agree we are not dealing with "autism" but with "the autisms" and that autistic brains have multiple abnormalities. There is mounting evidence that autism is the culmination of interactions between genetics, epigenetics, and the environment.

As a clinician it is my duty to *treat my patients now* while research attempts to find the answers at some point in the future. Though I primarily concentrate on biomedical treatments for children on the spectrum, I have come to appreciate the power that QEEG-directed neurofeedback can have on the majority of these children if done long enough. To me, for children with autism, neurofeedback is just one more treatment that can add additional pieces to their total set of symptoms and recovery process.

As a physician I must treat all the body systems of my patients. I must prioritize which treatments I feel are most important for the patient to try. At the same time I must always keep the family's financial situation in mind when balancing my options. Because I have seen the power of neurofeedback in my practice I can confidently say that it works to some degree for a significant percentage of children even though they are "not perfect candidates" according to my neurofeedback colleagues and our professional societies. Therefore QEEG-directed neurofeedback is high on my list but only if families understand that the process is one that is a slow for children with autism, that it may take several "wasted sessions" before the child even begins to understand what is expected, and that there is not the usual "target number" of 40 or 60 sessions. Parents are taught that for autism, this is a treatment option, just like other therapies that continue indefinitely. The answer to these questions is obvious: "When should my child stop speech and language therapy?" "When should my child stop going to school?" Therefore, for a child with autism, the same question can be asked, "When should my child stop neurofeedback?" The question has no definite answer because no one can predict what the child's potential may be. One thing is emerging from recent research, that being that the brains of children with autism may have more, not less, neuroplasticity which is the ability to heal and repair. Therefore, for parents who can afford to do neurofeedback, this is always an option high on my list.

The following are key points I like my parents to understand when considering neurofeedback training for their child.

1. Training children with autism requires patience, flexibility and creativity.
2. It often takes many sessions for the child to understand what's expected of him or her in a session. Once learned, there will still be days that the child will fail for reasons beyond his or her control, e.g. biomedical issues like dietary infractions, gastrointestinal flare ups from many things like yeast, dysbiotic bacteria, Clostridia, exposure to strep, allergy season, etc.
3. If parents do not understand that their child will show periods with more negative results than positive ones, they will get frustrated and want to quit. This is the natural reaction from parents if they do not understand that neurofeedback is a "training and learning process" no different than what happens in school. Just as a parent would not have their child quit school when they are having some bad days, so parents should not stop neurofeedback for the same reason.
4. Therefore it is important that parents don't write off their child's capabilities after observing several 'failed' sessions. Most children will be able to participate in the neurofeedback process successfully over time, though individual sessions are not always ideal.
5. Though we should always look for ways to accommodate a child's unique pattern of learning so that neurofeedback sessions may be better, it is important for both parents and neurofeedback technicians to trust the prescribed QEEG-directed neurofeedback protocols and not be too quick to think they are not working and therefore want to change them.
6. The parents can be the greatest boon for the session or the biggest detractor. Therefore, depending on a child's behaviors, the family dynamics, and the history from previous sessions, a skilled neurofeedback technician will need to involve some parents and need to ask others to leave the room.
7. Sometimes negative reactions are from what I call "positive-negatives". As children become more aware of what is expected of them by others or themselves and they cannot do it, negative behavioral reactions are not uncommon. Because they do not want to be embarrassed or fail, they may lash out in anger or have a tantrum.
8. Positive-negative reactions from increased awareness often lead to anxiety. Consciously or subconsciously the child now feels the pressure he is putting on himself or that he feels others are putting on him to accomplish a certain task. When not able to do it quickly or effectively, anxiety is one of the most common natural responses.
9. Another example of a positive-negative reaction from increased awareness is totally the opposite. With greater awareness the child may more clearly realize his past shortcomings and now quit more quickly or quit entirely because he doesn't want to "see himself" failing again, already convinced in his mind that he cannot do it good enough!

For any parent that can afford to get a QEEG, even if neurofeedback is not a treatment option, valuable information can be obtained that can be used in other ways. For those that can afford neurofeedback as one of their many treatment choices, it has the potential to add significant benefit to some and moderate benefit to most if used consistently and long-term as one more therapy on their treatment platter.