

# **Infra-Low Frequency Neurofeedback for Early Development and Childhood Emotional and Behavioral Disorders**

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## **1.0 Introduction**

This monograph covers various aspects of neurodevelopmental disorders, as well as behavioral and emotional disorders of childhood and adolescence. It presents an overview of ten years of working with this population in our clinical practice of neurofeedback. It discusses how our implementation of Infra-Low Frequency (ILF) neurofeedback training, with emphasis on interpreting presenting symptoms in terms of basic failure modes, guides the clinical decisions made throughout the process. Several illustrative case studies are presented: some with similar formal diagnoses but strikingly different clinical presentations highlight the uniqueness of each case. The case studies also illustrate how interesting and challenging this work with early childhood developmental and behavioral disorders can be for the clinician. At the same time, this work is satisfying and rewarding, when the clinician can observe the positive impact of neurofeedback on all these disorders and see also how the neurofeedback complements and potentiates other interventions and modalities used to address such issues in children and adolescents.

## **2.0 Neurodevelopmental disorders**

Neurodevelopmental disorders are a group of neurologically based conditions with onset in the developmental period that can interfere with the acquisition, retention, or application of specific skills or sets of information. They may involve dysfunction in attention, memory, perception, language, problem-solving, or social interaction. Neurodevelopmental disorders include attention-deficit/hyperactivity disorder (ADD/ADHD), autism spectrum disorders, learning disabilities as well as intellectual disabilities. Neurodevelopmental disorders frequently co-occur: for example, individuals with autism spectrum disorder often have intellectual disability (intellectual developmental disorder), and many children with ADHD also have a specific learning disorder. Looking beyond the formal diagnoses, our clinical work focuses on the wide range of developmental, behavioral and emotional symptoms for which the families of these younger clients seek neurofeedback.

In our Neurofeedback clinic children and adolescents comprise about 50% of the clientele. Most of them seek help for a variety of issues, ranging from anxiety and depression to emotional reactivity and aggressiveness, from impulsiveness to obsessive compulsive symptoms, and so much more. Neurofeedback is being used for this population when traditional medicine is either not enough to alleviate their often chronic symptoms, or disturbing, and dysfunctional behavior, or when the children's parents want to avoid the medication route all together, out of concern about adverse reactions and side effects. In broad generality, neurofeedback has proven to be an effective intervention to add to any other modality the clients are relying on to overcome their difficulties.

## **3.0 Risk factors associated with mental, behavioral, and developmental disorders (MBDDs) in children**

It has been long demonstrated that sociodemographic factors and environmental factors in early childhood have significant impact on development, mental health, and overall health throughout the lifespan. In a report

published in March 2016, the Centers of Disease Control (CDC) offers some national data identifying significant associations of early childhood mental, behavioral, and developmental disorders (MBDDs) with sociodemographic, health care, family and community factors.<sup>1</sup> The factors most strongly associated with early childhood MBDDs were fair or poor parental mental health, poverty, child care problems (for the 2-3 years age group). The analysis was based on data gathered through a parent-reported survey among parents of children between 2-8 years (National Survey of Children's Health 2011-2012<sup>2,3</sup>). While the report only included children with diagnosed disorders and was based on parents' reports that can be biased or contain errors, it revealed that 1 out of 7 U.S. children aged 2 to 8 years old had a diagnosed mental, behavioral, or developmental disorder. The report highlighted the need to direct resources toward improving healthcare and supporting families and communities in order to prevent early childhood MBDDs and promote healthy developmental among all young children.

#### **4.0 Prevalence of behavioral, emotional and developmental disorders in children**

The first comprehensive CDC mental health report from 2013 describes the number of U.S. children aged 3–17 years who have specific mental disorders, such as ADHD, disruptive behavioral disorder, oppositional defiant disorder, conduct disorder, autism spectrum disorder, mood and anxiety disorder, substance use and Tourette Syndrome.<sup>4</sup> The report used data collected from a variety of sources between the years 2005-2011, and the analysis of the data revealed the following:

Children aged 3-17 years identified as having a current diagnosis of

- Attention-deficit/hyperactivity disorder (ADHD): 6.8%
- Behavioral or conduct problems: 3.5%
- Anxiety: 3.0%
- Depression: 2.1%
- Autism spectrum disorder: 1.1%
- Tourette syndrome (among children aged 6–17 years): 0.2%

Adolescents aged 12–17 years identified as having a current diagnosis of

- Illicit drug use disorder in the past year: 4.7%
- Alcohol use disorder in the past year: 4.2%
- Cigarette dependence in the past month: 2.8%

Suicide, which can result from the interaction of mental disorders and other factors, was the second leading cause of death among adolescents aged 12–17 years in 2010. The number of children with a mental disorder increased with age, except for autism spectrum disorders which is highest among the 6-11 years age group.

The National Alliance on Mental Health (NAMI),<sup>5</sup> citing statistics provided by the National Institute of Mental Health, revealed a different, more severe situation:

20% of youth ages 13-18 years live with a mental health condition

11% of youth ages 13-18 years have a mood disorder

10% of youth ages 13-18 years have a behavior/conduct disorder

8% of youth ages 13-18 years have an anxiety disorder

Considering that the average delay between onset and intervention is 8-10 years, one can appreciate the importance of addressing emotional, behavioral or developmental concerns as early as possible. This objective is more easily met with interventions that do not hinge on a formal diagnosis because they operate out of a training model as opposed to a deficit model.

In a state by state ranking for 2017, Mental Health America states that 11% of youth (age 12-17) report suffering from at least one major depressive episode (MDE) in the past year<sup>6</sup>. Major Depression is marked by significant and pervasive feelings of sadness that are associated with suicidal thoughts and impair a young person's ability to concentrate or engage in normal activities. The data indicates a significant increase in the number of depressed youths across the country over time.

7.4% of youth (or 1.8 million youth) experienced severe depression. These youth experienced very serious interference in school, home and in relationships. 5.13% of youth in America report having a substance use or alcohol problem. The report continues with another sobering fact: 64% of youth with major depression do not receive any mental health treatment, which means that 6 out of 10 young people who suffer from depression, and who are most at risk of suicidal thoughts, difficulty in school, and difficulty in relationships with others do not get the treatment needed to support them.

With such a high number of youth suffering from various severe and debilitating symptoms, there is a great need for treatment modalities that can prevent and restore optimal function and neurofeedback plays a center role here.

## **5.0 Diagnosis-based versus symptom-guided treatment approach**

As discussed above, often MBDDs go undiagnosed until later in life. This explains why some of the youngest clients we see for neurofeedback training don't come with a formal diagnosis. They are brought to us because teachers or parents have concerns about them. But even among the ones who have been formally diagnosed, with our thorough assessment we reveal a variety of symptoms that often times challenge the boundaries of the label. That allows us to build training protocols to include all the client's needs and this integrative approach leads to a better regulated nervous system, with positive consequence across the board.

Over decade-long experience working with children on the spectrum, it has become clear that an integrative approach will always yield the best results. While Neurofeedback can make a significant difference in symptoms as it helps the brain self-regulate and function more optimally, other modalities can complement it and provide support while the brain rewires. Speech therapy, occupational therapy and music therapy as well as ABA (Applied Behavioral Analysis) or Floor Time therapy are just some of the more mainstream interventions used with this population, and it is well documented that the earlier the interventions, the better the outcomes—provided the neural substrate can support the challenge. Fortunately, ILF neurofeedback can be helpful even in the earliest stages of development, thus setting the stage for complementary modalities.

Less well-known, perhaps, but also very effective are the various biomedical interventions, along with special diets to address underlying sensitivities, allergies or inflammatory processes. Music therapy, as another way of training the brain into self-regulation, has gained a solid reputation in addressing the sensory processing and integration issues that often accompany spectrum disorders. Another aspect known to make a great difference is parenting. While support and love are important as they are for any child, setting appropriate limits is equally important, and failing to do so does more harm than good for this population, for which structure and predictability may well make the difference between chaos and a somewhat settled existence.

In our practice, we get to work a lot with clients who suffer with attachment disorders and symptoms related to it. Often children are brought to us due to escalating aggressiveness that is frequently directed towards adoptive parents. Attachment is the deep connection established between children and their primary caregivers, one that profoundly affects the child's development, their ability to express emotions and to build meaningful relationships later in life. If this core skill fails to develop early on either due to neglect or abuse, the child will never learn to feel safe and secure in their environment and won't develop trust in others. This will have a significant impact on all aspects of later development, with the child presenting with poor self-confidence and self-esteem, inability to build and maintain relationships, difficulty with emotional control and so much more. Neurofeedback training can restore that core sense of self and moderate the fear response to calm the brain and relieve the hair-trigger emergency response. That will have a profound impact on emotional regulation and control and will allow the child to develop a stronger sense of self and better relationships with others.

Anxiety is a normal physiological response to a threat in the environment. In anxiety disorders however, the response to things that one should be able to cope with easily become out-of-proportion. Despite the 17% increase in anxiety disorder diagnosis in children and adolescents reported by the 2018 Child Mind Institute<sup>7</sup> report on children's mental health, anxiety remains untreated in 80% of this population. Described as the "invisible condition", anxiety is mistaken for other conditions and its symptoms are minimized or ignored. Unfortunately, untreated anxiety leads to greater risk for depression, school failure, substance abuse and difficulty transitioning to adulthood. The average age of onset for separation anxiety is 11 years, while the average age of onset for social anxiety is around 14 years. Anxiety disorders are linked to a two-fold increase in risk of substance abuse disorder. Anxiety and depression often coexist, and in teenagers this is associated with more suicidal ideation, suicide attempts and more depressive symptoms.

Beyond the suffering of many children and adolescents we need to consider the socio-economic implications of unrecognized, undiagnosed and untreated mental health conditions in youth, knowing that 37% of students with a mental health condition age 14 and older drop out of school.<sup>5</sup> This is the highest dropout rate of any disability category. It is also noteworthy that according to the National Institute of Mental Health<sup>5</sup> 70% of youth in state and local juvenile justice systems have a mental illness.

The complexity of case presentations compels our move beyond the formal disorders in organizing the therapeutic agenda. Instead we use symptom profiles to discern underlying basic neurophysiological patterns of dysregulation. The following case studies illustrate how this works out in practice.

## **6.0 Case studies**

The case studies presented below are complex cases with a mixture of different symptoms in the realm of behavior, emotional and developmental disorders. They are, however, quite representative of what we encounter in our clinic.

When working with children who present symptoms of MBDDs, the neurofeedback process focuses on the right hemisphere to impact arousal levels. In some cases, it includes inter-hemispheric training to increase stability of function. That is not surprising given the fact that many symptoms in this realm stem from disruptions in early development which can interfere with learning how to self-regulate and self-soothe. The right brain is involved in early development of self-regulation; training this side of the brain allows for grounding and calming which results in better emotional regulation and allows meaningful attachments.

### **6.1. Case study #1**

This 6-year-old boy was brought to us for a variety of presenting symptoms. The official diagnosis given to him was Asperger's Syndrome, or high functioning autism. His developmental history revealed a difficult

pregnancy after in vitro fertilization (IVF), with the mother being placed on bed rest for most of the pregnancy. He was born prematurely at 31 weeks, weighing only 3.7 lbs, and he spent 21 days in the NICU isolated from the mother.

The first two years of life were described as difficult by his parents. Developmental delays in walking and talking as well as poor eye contact and little meaningful communication were concerns early on. When he arrived in our clinic, he presented with significant sensory processing and integration difficulties manifested as long periods of spinning and seeking pressure on his body, bumping into things or people. He had a very limited diet and avoided certain smells and textures. He wouldn't eat if different foods touched each other on the plate. Stimming behaviors were reported: he would move his toy cars back and forth, and close to his eyes for long periods of time. He was described as inflexible, having difficulties with transitions and changes in his routine. He was easily frustrated, and any emotional dysregulation increased the intensity of motor tics, like blinking, twisting fingers or toes etc. When becoming anxious he would tense up his body and would experience increased agitation and his speech would become more repetitive. With increase in agitation and anxiety he could become aggressive. He had to be pulled out of three different schools due to violent behavior towards his peers. Compulsions were another big concern: he always wanted his car toys with him and would refuse to engage in other activities if he didn't have them. Repetitive hand washing was another presenting problem. Limited social interaction and poor expressive and receptive language skills were reported as well. He exhibited a variety of fears, which seemed to change over time. He was often constipated, and parents suspected food allergies to be the reason for periodic skin rashes.

He came to us for intensive training and the training effects became obvious early on in training. Following the developmental sequence, we focused on providing physical calming and emotional regulation and control, which called for two of the primary protocols. He calmed down significantly and after only three sessions he tried a new food and became more affectionate towards his mother. One of the first symptoms to respond to the training was constipation, which resolved quickly as a result of the calming effect of the training. He was in a significantly better mood and more easy-going with transitions. By session 6 speech patterns started changing from repetitive speech unrelated to ongoing discussions to more appropriate and diversified responses. At the end of the intensive training he was overall calmer and was seeking less sensory input. He was more adventurous in trying new foods and much less compulsive. He could still get upset with changes in his routine but was bouncing back faster; fears were less of a problem and he displayed increased interest in communicating with others. He was showing more affection to parents and exhibited improved eye contact. He was more aware of others and tics were not as intense with heightened emotions. Sugar cravings and stimming behaviors had lessened as well. Parents suspected an underlying undiagnosed inflammatory disease and wanted to investigate complex biomedical testing and a diet based on the findings before continuing neurofeedback training, but it was clear after only 20 sessions that neurofeedback was a valuable tool in their toolbox.

## **6.2 Case study #2**

This 4-year-old girl, diagnosed with autism, was brought to us for training mainly to improve verbal communication. Born into a bilingual family, the child had very little language. There was poor eye contact. She would not answer when called, presented with short attention and echolalia. She was highly sensitive to sugar intake, which made her very hyperactive. At the same time and she had limited food choices, and her appetite awareness was poor. Before starting the training, she couldn't count; drawing was more like a scribble, and she threw frequent tantrums when things wouldn't go her way. Her developmental history revealed development regression following a vaccine administered at 18 months. At the time she had about 10-20 words, but she stopped talking all together after that. She also exhibited some aggressive

behaviors, hitting and screaming when not getting her way. She was not engaging with peers and didn't quite understand reciprocity when interacting with others.

After just a couple of sessions the girl started using more language and was recruiting new words. Her mother also reported that her appetite appeared to be better regulated and that she had tried a food she disliked in the past. By her sixth session the teacher reported that the child started counting and was now naming objects and organizing them by category. She soon thereafter started writing her name and continued to experiment with new foods. In later sessions it was reported that her separation anxiety had moderated, and she was able to sit on her own in sessions instead of having to sit on mother's lap. While it may seem small, this was a significant step forward towards independence. All these changes were observed within the first set of 20 sessions, when the emphasis of the training was on calming her nervous system down.

### **6.3 Case study #3**

A 6-year-old boy, adopted at 18 months, presented with frequent tantrums, fear of anything new, hypervigilant and inflexible. He was behind in reading and sometimes displayed immaturity in both behaviors and emotions. He had difficulties falling asleep and had frequent nightmares all related to his feeling unsafe. He was manipulative and defiant, would lie a lot and was insensitive to others. He was obsessed with trying to control things in his environment, and he carried a lot of anger and was subject to mood swings. Teachers were concerned about his disruptive behavior in class, his distractibility and difficulty following directions and staying on task. 20 sessions into the training he had no nightmares or difficulties to fall asleep. Teachers and parents were seeing some significant improvement in his behaviors: he was less moody and much less worried; hypervigilance had lessened, and he didn't feel the need to control everything around him as much anymore. Anger outbursts became less frequent and less intense and he experienced fewer mood swings. He was better with trying new things, not as fearful as he had been. There was some improvement in his ability to follow directions and stay on task, but it was clear that much more training was needed to consolidate these gains and further work on some of the behaviors that were about the same as before training. He was more connected and was displaying an increased ability to process things in a more mature manner.

### **6.4 Case study #4**

This 9-year-old boy had suffered hypoxia during birth. He was first in foster care and was then adopted, but his first two years of life had been rather traumatic. The parents' main concerns were his emotional reactivity and negative self-talk, the tantrums and oppositional behaviors as well as high anxiety that would make him shut down. Aggressiveness and sometimes rage were reported as well. He would get easily frustrated over homework and would start negative self-talk that would continue for a while. He had a difficult time recovering after being triggered. He suffered from constipation which often is a consequence of living in fight-or-flight mode. He had a restless sleep and sometimes would complain of headaches and stomachaches. His sustained attention was poor, and he needed constant redirecting in order to complete his work. Impulsiveness was also a reported concern. He had had several physical injuries and concussions. The first QIKtest revealed difficulties with task maintenance both when performing under low-demand or high-demand conditions and confirmed the difficulty he had in recovering after being pushed for a longer period.

Already four sessions into the training he was much less reactive and even said he was feeling happier. Constipation was improving. The teacher noticed that classwork was easier to complete and was impressed with his progress. He was overall calmer and was responding much better to being told "no", becoming less reactive and able to bounce back more easily. By session 13 he was better organized and able to plan his

day, was completing school work on his own in a timely manner, and he continued to be in a better mood. He maintained good emotional control while the family went through a crisis, which would have been unimaginable before neurofeedback. While he will need more training to consolidate and maintain these training outcomes, it is exciting to see how quickly and dramatically he responded to training. No doubt the significant changes in symptoms would be reflected in the QIKtest when it is time to re-assess.

## **6.5 Case study #5**

The parents of this shy 7-year-old boy were seeking help for his debilitating anxiety, combined with physical agitation and obsessive worries that interfered with every day life. During intake his parents described rituals and compulsions as well as emotional overwhelm when having to perform under pressure. He presented with low self-confidence and low self-esteem and had difficulties making friends. With increased anxiety sometimes he would shut down, other times he would burst into tears or start compulsively cutting paper and chewing on it. Testing was a major anxiety trigger and any unstructured assignment would also result in increased anxiety. Stomachaches and sleep walking were also part of his clinical presentation. School days were mostly bad days in his perception, as he always feared failure and inability to complete tasks in given time.

Over the course of the training spanning over several years, during which time he came to sessions on and off, he went from being a withdrawn, fearful child to being happy and more confident and having mostly great days. His emotions were in better control, while thoughts and compulsions lessened. There were no more complaints of stomach aches and the anxiety, when emerging, was more manageable. With every big transition in his life – changing school and teachers, for instance, he still experienced some anxiety and would come in for maintenance sessions as needed. He has completed over 100 sessions to date and while the core of the training was directed towards calming all the aspects of his anxiety, we also worked on focus and frustration, self-confidence and ability to socialize. He became more flexible in new situations and less fearful of what the future would bring.

## **6.6 Case study #6**

This 5-year-old girl came to us with difficulties following directions in school and at home, difficulties completing homework and disruptive behaviors in class. Some hyperactivity, emotional reactivity, tantrums and rage were reported by parents. She would talk back to teachers and was bossy in interactions with her peers. Episodes of sleep talking, and bruxism were also part of her clinical presentation. She was becoming self-conscious after realizing she was often getting in trouble at school and parents were concerned about her confidence being shattered. She presented as an energetic, happy and very talkative child that appeared hyperactive at times and seemed to lack self-control. She presented with obsessive worries about death and went through a period during which she displayed poor attachment toward her mother, being mean and distant. At times she would pick at her fingers.

She responded quickly to sessions, and the training allowed better self-regulation and more optimal brain function. After less than 20 training sessions she was no longer grinding her teeth and was less hyperactive. She was now able to follow directions better at school, and her attention and hyperactivity greatly improved, to where she is now enjoying classwork and is performing quite well. Her previous attachment issues have resolved and she no longer has tantrums or rages. She is still coming in for tune-ups every now and then, to maintain optimal function as her nervous system matures.

## **6.7 Case study #7**

This 15-year-old boy came in to seek help for his debilitating anxiety and OCD. He had a long history of difficulties controlling his emotions and taking responsibility for his actions. He described his anxiety

manifesting as tension in his body, loss of appetite and feeling that everything is wrong. He would often worry about school and homework and this would interfere with his ability to complete the tasks. He reported feeling that he won't remember things and having an urge to constantly check everything. Ruminating on negative thoughts, vocal tics and pacing were also part of the presenting symptoms. His parents described him as an angry child with difficulties in school. He had been bullied for over a year and didn't tell anyone for all that time. The symptoms worsened towards the end of that year and he developed panic attacks and fears to the point that he had to be homeschooled for a while.

**Figure 1** Initial QIKtest results for Case Study #7. Standard scores and percentiles are shown for the principal measures of the Continuous Performance Test (CPT). Entries falling below 80 in standard score (9th %ile) are shown in red; scores rising above 120 in standard score (91st %ile) are shown in green.

**Results Summary:**



Results	Data	Norm	Score	
M15.1 Total Test	Measured Value	Median of Distribution	Standard Score	Percentile
Omission Errors	10 errors	2 <sub>s</sub> errors	82	12 %
Outlier Responses	5 errors	1 <sub>s</sub> errors	89	24 %
Commission Errors	54 errors	8 <sub>s</sub> errors	55	1 <sub>o</sub> %
Response Time	319 <sub>s</sub> ms	369 ms	120	90 %
Variability	106 <sub>s</sub> ms	81 ms	87	19 %

RAW DATA	Period 1	Period 2	Period 3	Period 4	Period 5	Sect. 1	Sect. 2	Sect. 3	Total
	Sect. 1 Low Demand	Sect. 1 Low Demand	Sect. 2 High Demand	Sect. 2 High Demand	Sect. 3 Low Demand				
Omissions(#)	6	0	0	3	1	6	3	1	10
Outliers	1	0	2	1	1	1	3	1	5
Commissions(#)	4	3	10	25	12	7	35	12	54
Response time(ms)	439	419	302	269	351	428	287	351	320
Variability(ms)	141	113	106	87	86	126	99	86	107

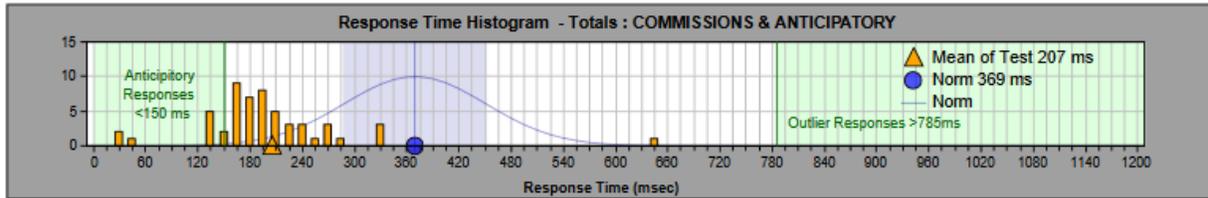
His baseline QIKtest CPT revealed a very fast response time but poor accuracy with many commission and omission errors and high variability of response times. His accuracy score was well below average. He had a hard time initiating a new task and had difficulties performing under pressure, especially when having to maintain being on task. Recovery was difficult as well, with more errors and high variability.

Results are shown in Figure 1. The high score for reaction time is suspect, given the large number of commission errors. Suspicions are confirmed by the distribution in reaction times for the commission errors, as shown in Figure 1a. Most of these errors lie at very short reaction times, which implies that they reflect pure rather than choice reaction time events. About 50 such events are registered below 300msec, most of them occurring during the high-demand periods. Here the ratio of Go to NoGo events is 7:2, which

implies that on the order of 175 hits may be questionable. When accommodation is made for the fast responses, a mean reaction time of 390msec is obtained, not far from the norm of 370msec.

**Figure 1a** Distribution in reaction times for the commission errors. Nearly all are found below 300msec, suggestive of pure reaction time events.

cRT=388.5ms Definition: Choice Reaction Time = avg(RT) without fast responses; only for tests with a high number of commission errors.



Norms: the blue line represents a normal distribution of reaction times for this age and group: compare by form and position to your data in red. The light blue area represents 68.2% (or  $\pm 1\sigma$ ) of a normal distribution.

Two other tests were administered, after 10, respectively 20 sessions, and there was a significant improvement in both, with the third one showing above average performance index and the accuracy index in the upper normal range. The overall improvements in brain performance as measured by the QIKtest are reflected in the results summary of test #2 and test #3, as seen below.

**Figure 2** Test #2: Case study #7 after 10 sessions.

**Results Summary:**



RAW DATA	Period 1	Period 2	Period 3	Period 4	Period 5	Sect. 1	Sect. 2	Sect. 3	Total
	Sect. 1	Sect. 1	Sect. 2	Sect. 2	Sect. 3				
	Low Demand	Low Demand	High Demand	High Demand	Low Demand				
Omissions(#)	0	1	0	0	0	1	0	0	1
Outliers	0	1	1	1	1	1	2	1	4
Commissions(#)	1	0	2	2	0	1	4	0	5
Response time(ms)	388	436	352	347	450	411	350	450	372
Variability(ms)	100	77	97	100	98	93	99	98	95

Symptom-wise he had improved quite a bit after the first 20 sessions, feeling more relaxed and less anxious overall, reporting good sleep and better mood with much reduced reactivity. His OCD had improved, but was still a big concern, and the reassessment revealed a need to continue training for symptoms related to that. After continuing training for another year, he was managing his stress level very well and was doing much better overall. He went back into the school system without any problems.

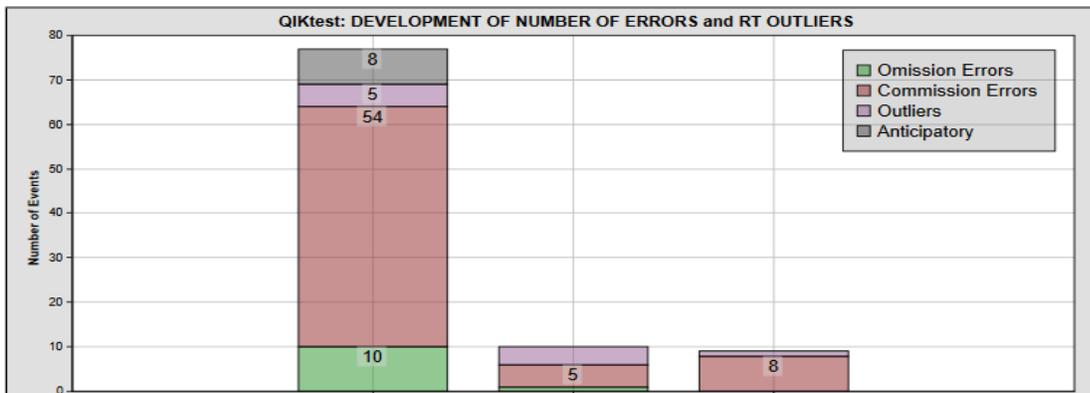
**Figure 3** Test #3: Case study #7 after 20 sessions. Over the course of 20 sessions, consistency of response improved from 19<sup>th</sup> to 99<sup>th</sup> percentile. Speed of response improved from 55<sup>th</sup> to 81<sup>st</sup> percentile in ten sessions.

**Results Summary:**



	Period 1	Period 2	Period 3	Period 4	Period 5				
RAW DATA	Sect. 1	Sect. 1	Sect. 2	Sect. 2	Sect. 3	Sect. 1	Sect. 2	Sect. 3	Total
	Low	Low	High	High	Low				
	Demand	Demand	Demand	Demand	Demand				
Omissions(#)	0	0	0	0	0	0	0	0	0
Outliers	0	0	1	0	0	0	1	0	1
Commissions(#)	0	0	1	4	3	0	5	3	8
Response time(ms)	359	384	329	306	357	372	318	357	332
Variability(ms)	29	30	59	59	58	32	60	58	47

**Figure 9.4** The improvement in number of errors and response time outliers is illustrated. Improvement is from the first percentile in accuracy score to the 70<sup>th</sup> percentile, and then to the 75<sup>th</sup>.



**6.8 Case study #8**

This teen-age girl was seeking neurofeedback for severe anxiety and depression. She had a generalized anxiety disorder (GAD) and an ADHD diagnosis. Her birth had been problematic, as she was oxygen-deprived during the process. She was diagnosed with severe separation anxiety at the very young age of two, and had struggled with anxiety her entire life. Her anxiety manifested as physical tension and racing negative thoughts. She had poor emotional control, and would experience rage and anger very frequently. The debilitating anxiety had led to depression, suicidal thoughts and one suicide attempt (by way of

ingesting anti-anxiety medication). At times she would become aggressive when fear and anxiety escalated. Sleep was disrupted, and she also had night-terrors and sleep walking episodes. Stomach pain, low appetite, headaches, bruxism, constipation and reflux were reported at the beginning of the training and she also had irregular periods and severe PMS symptoms that would mostly impact her mood. Social anxiety, some compulsions and addictive behaviors completed the clinical presentation. She appeared fragile and thin, had dark circles under her eyes and felt hopeless and fearful. She had been on several different medications, some of them resulted in worsening of some of her symptoms.

The training had a strong impact on her symptoms early on. Anxiety and sleep were the first symptoms to improve and gradually she started reporting a decrease in worries and depression and her family reported better emotional control. While coming in for sessions she started becoming more independent and more willing to take charge. She returned to school and started driving herself to appointments and to the gym. Soon her periods became regular again and she gained some weight, and her appearance changed to a healthier version of her. She was smiling more and felt calmer and more confident. 20 sessions were just the beginning in her case, but the significant and profound changes she and her family had noticed were persuasive to them that significant improvement was possible. While undergoing neurofeedback training, she was also in cognitive behavioral therapy, and the combination of the two along with her parents' strong support were probably the key to her success.

## **6.9 Case study #9**

This 10-year-old boy arrived with a dual diagnosis of ADHD and OCD. He was brought to training for impulsivity, rage and high anxiety that manifested as obsessive worries and negative thoughts about people getting hurt, especially those really close to him. He was described as a very bright and strong-willed child, one who was argumentative and very reactive, quick to anger and sometimes aggressive. Frustration would often spiral into negative self-talk and, once started, it would take a long time to calm down. He sometimes took a long time to fall asleep when worries escalated, and occasionally he had nightmares. He was addicted to electronics and would become reactive and aggressive when screen time was restricted. Always very fast paced, he was hyperactive and had little impulse control. Headaches and some sensory seeking behaviors completed the clinical presentation. He was on a stimulant and an antidepressant when we started training. These were helping but not completely controlling his symptoms. He had suffered a traumatic birth and never learned to crawl. He had always been a poor sleeper and had sensory processing and integration issues of longstanding.

In this case the multitude of physiological issues along with the varying effects of medication changes made it almost impossible to fold neurofeedback in successfully. While some symptoms improved quickly others proved to be more difficult to get to, especially because this young brain proved to be highly sensitive and easily destabilized. A complex clinical presentation like this requires more patience and a very systematic approach that might take longer to implement than in other cases. And sometimes clients simply won't want to wait for neurofeedback to reveal their true potential, either because the symptoms are too disruptive or perhaps because the medication route is faster and easier. That was the case with this boy, as the family gave up after 15 neurofeedback sessions and before we were able to fully develop and implement the treatment plan. That, too, is a reality in fee-for-service clinical practice. However, we did get a glimpse of what can be achieved in this case, and often clients find their way back to us later, when they are ready to undertake this longer and more demanding process.

## **6.10 Case study #10**

The following report represents an almost ideal case to review in that the child at issue benefited from having very competent, concerned, and caring parents who spared no resources in getting the child the help

that he needed. The parents faithfully pursued numerous therapeutic options for several years before encountering ILF training. One likely causal contributor to the problem in this case was high mercury levels in the entire family due to fish consumption in Asia, where the family resided at the time.

Difficulties were noted with the child from the time of birth in 2007. At fifteen months, there was a bad reaction to the MMR vaccine. Adrenaline and steroid injections followed. At two years, the child was diagnosed with RSV (Respiratory Syncytial Virus), for which he was hospitalized. At age 2.5, the child was still unable to chew his food or to use a straw. He also exhibited stimming behavior.

Chelation was used for the removal of mercury. The child received Vitamin B12 injections and benefited from hyperbaric oxygen therapy. There was also a trial of conventional (EEG-band, frequency-based) neurofeedback that turned out to be unproductive, according to the parents. With the biomedical methods being employed, the child began to use words, but this was clearly a matter of rote learning. There was no context and no novelty. The child did, however, develop some self-awareness. Speech therapy, which was pursued intensively, was largely unproductive. The speech therapist eventually capitulated, pronouncing in exasperation that the child was suffering from “rigidity of mind.”

The child came to ILF training directly from extensive speech therapy, at the threshold of entering school in 2013 at age six. Intensive training of twenty sessions was conducted over the course of two weeks. The child was judged incapable of taking the QIKtest. He made observable progress with every training session. After the first session, his gait changed from unstable, quick walking to more stable, calmer and slower paced gait. After the first day, the concept of “yesterday, today, and tomorrow” was finally understood. The parents had been trying to teach that for a year. The resting heart rate dropped from 125 to 85. At end of the first day, the child constructed his first novel sentence at dinnertime. The child became more aware of his surroundings, more attentive to events happening around him, and more connected with parents. He did not have to be kept on a virtual leash all the time. By the end of the twenty sessions, the child was off all his medications and supplements (which had been more than 20), continuing only with conventional vitamins, enzymes and probiotics.

The family took the Cygnet® system home to Asia with them to continue training their child. He was accepted immediately into school with no concerns upon return from Los Angeles. Alternatively, there would have been no school option for him for another year. At this point, he was unable to say whether 8 was larger or smaller than 10. He was still poor at social behavior and communication. Within weeks of returning to Asia, the diagnosis of autism spectrum disorder was replaced by “Social Communication Disorder” by the same developmental pediatrician who had originally diagnosed the autism.

By 2014, all biomedical treatments such as B-12 shots had been stopped, except for the occasional chelation. Parents concentrated on speech therapy and occupational therapy in addition to neurofeedback. The child passed his interview for acceptance into a new school. During the year, the parents returned to Los Angeles for more (brief) training of the child, and for additional speech therapy.

By 2015, chelation had been stopped as well. The parents returned to the US for more neurofeedback (for the evaluation of additional protocols) and for speech therapy. The child was now able to do the QIKtest for the first time. He scored in the normal range across the board. He had conversations with staff during sessions, was engaged and happy, calm and focused. His mother described him as affectionate for the first time, as he had started hugging her without invitation, and he was making more eye contact. He was less obsessive. His language comprehension had improved, along with fine motor skills (handwriting).

Near the end of the school year he earned a star student award (one of four meted out during the year in his class of fifteen) and was noted for “active listening” and being the “best reader in his class.” In the fall he

needed no more learning support and was at third Grade level in math. Prior concern with low muscle tone, poor coordination, and poor spatial awareness had been replaced by commendations from physical education teachers. He was becoming a role model to classmates and was chosen to sing a brief solo in the Christmas musical. The year before he had been given a non-speaking role.

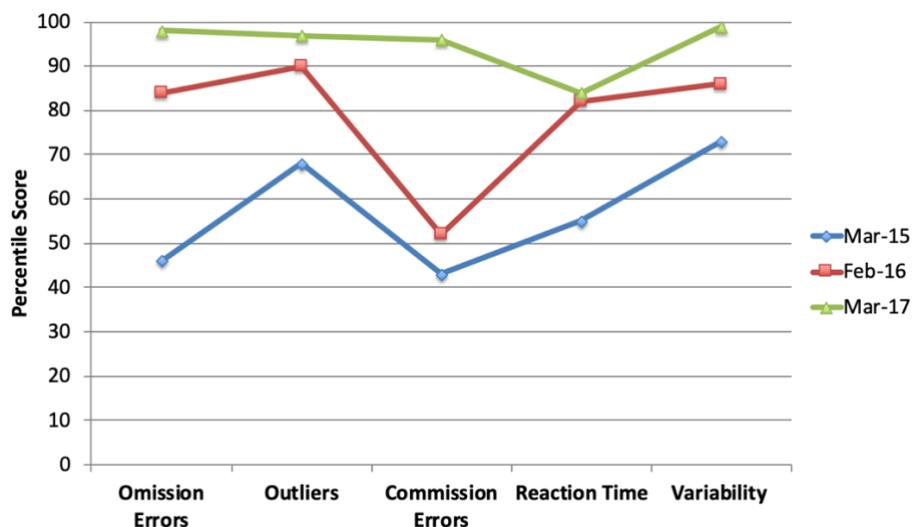
In the spring of 2016 he received another star student award in his second-grade class. His second QIKtest showed vast improvement over the first. In 2017, his QIKtest scores were superior all around. Percentile scores for all three tests are shown in Figure 5. The time series for reaction times are shown in Figure 6 for the first and last tests. It was in July of 2017 that the parents asked the child about the first airplane flight that he remembered as a coherent experience, and it was the trip home after his first ILF neurofeedback sessions at the age of six.

In 2018 the parents introduced the latest protocol development—ILF synchrony training—into the home training. The response was immediate. The attitude toward his mom became warmer. She was no longer seen primarily in her role of regimenting his life. A rash on his arm, which was being continually provoked, was observed to heal rapidly. Clearly, the youngster was experiencing a new level of calm.

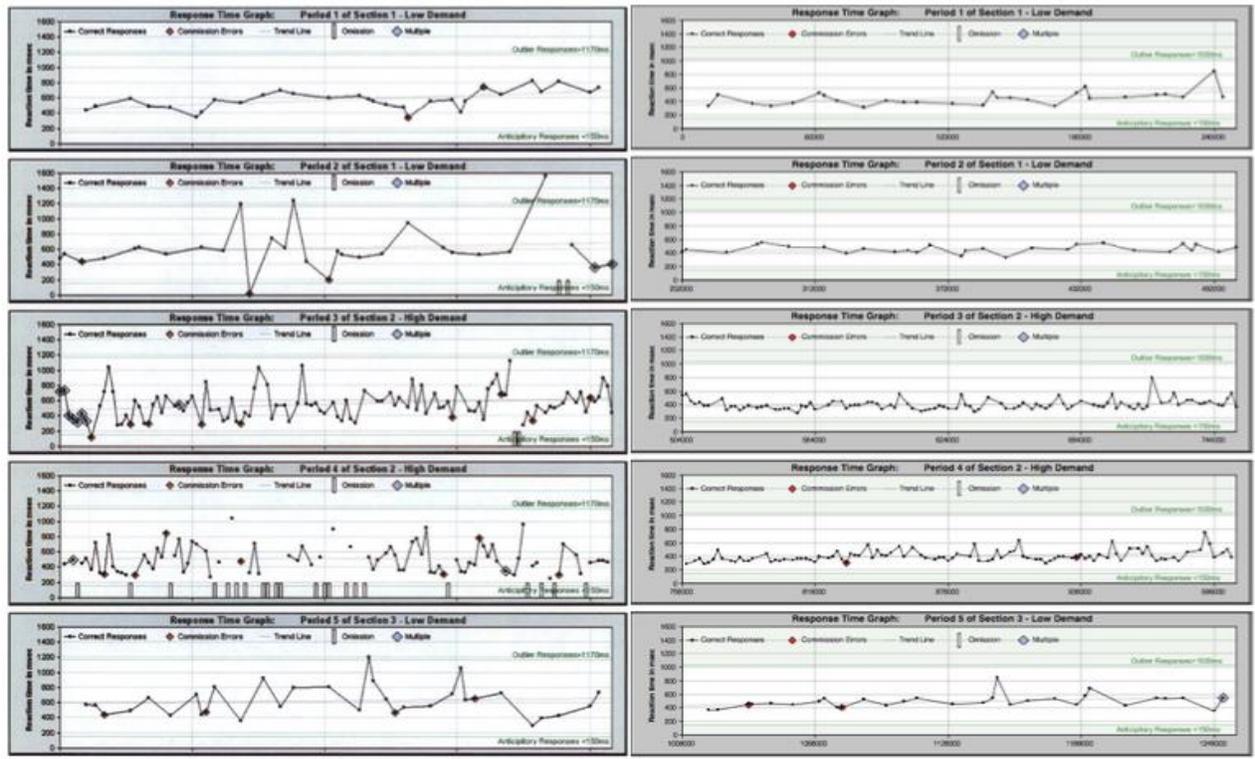
The parents’ reflection on their child’s progress is instructive. They observed him questioning things that they thought he already knew—proof that the child’s past verbal speech had been pure rote learning and did not reflect understanding. The same held for concepts. He had fooled not only his parents but the speech therapist as well. The mother wrote: “We found that he had to relearn EVERYTHING again in a neuro-typical way.” “It was only after neurofeedback that our son was ready to absorb other therapies he was receiving (e.g. speech, occupational therapy).” “Neurofeedback really gave our son a whole new level of functionality that made it easier for his therapists to teach him.” “His natural gifts are coming to be expressed.”

This case illustrates what can happen when all the necessary resources are being brought to bear on an autistic child. The linchpin of the therapy was clearly the ILF neurofeedback, and it is noteworthy that all relevant functional domains—namely all that were previously deficient—were positively affected by the training. At this point, functionality is at age level or above in all relevant respects, and a new acquaintance would not be able to discern that the child had ever been autistic.

**Figure 5** Percentile scores for 3 successive tests. This child’s scores are among the very best we’ve seen on a QIKtest. This result was obtained 3.5 years after the first test in 2013, which he was unable to take.



**Figure 6** Time series of reaction times observed in the first test (2015) and the most recent (2017)



## 7.0 Conclusions

Working with the younger population often proves to be more challenging for several reasons: very young children and non-verbal children aren't able to provide feedback to the neurofeedback clinician about training effects. This, in turn, makes it more difficult for the clinician to make appropriate changes to the training protocol to impact presenting symptoms and lengthens the time needed to train to achieve desired results. In the younger population (below 6-7 years old), and in children with debilitating symptoms (like those related to the autism spectrum), the standardized computerized tests can't be administered. While those tests don't guide the actual clinical decisions on an ongoing basis, they can provide information on strengths and weaknesses of brain performance, helping to track training outcomes.

There is another important variable: medication. When medication is part of their baseline and it is masking symptoms, it is more difficult to tell what impact the training is having on the underlying failure mode. Sometimes medication changes, and the client's response to them, can blur the gauge of clinical outcomes and make it more difficult to implement a treatment plan. Beyond that, the individual's awareness, sensitivities and vulnerabilities will all play a role in the results we will see at the reassessment milestone. With therapies and other treatment modalities coinciding with the neurofeedback training, it is often more difficult to tease out the effects of each intervention. Despite any heightened challenges, however, it has become apparent over all the years of working with children with behavioral, developmental and emotional disorders, that an integrative approach to their problems, along with support, will yield the best clinical outcomes.

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