

Neurofeedback for the Autism Spectrum

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Neurofeedback is a highly promising emerging therapy for the autism spectrum. At issue here is a tool for the direct training of brain function, one that has already shown itself highly effective in addressing a wide range of "mental health" concerns. As has been the case for other therapies, its application to the autism spectrum has been complicated by the inherent complexity of the condition we confront. In the following, we recapitulate the development of neurofeedback for the autism spectrum and give some guidance to both therapists and parents with regard to the choices open to them.

Our own work with the autism spectrum using neurofeedback goes back some twenty-five years. In those early days of the field, the principal application of neurofeedback was to Attention-Deficit Hyperactivity Disorder (ADHD), but the very same procedures were clearly also helpful for a variety of other issues. So it came naturally to want to try these methods also with children on the autism spectrum. These early attempts were just as likely to make things worse as they were to make things better, so we quickly placed a virtual fence around autism and decided we did not know enough to venture there. Some years later, a few practitioners in our network reported some good results with newer techniques, so the door was once again opened to working with the autism spectrum.

Neurofeedback procedures have proliferated in kind over the years, and with a broader set of clinical tools it was also possible to match up to a broader set of clinical challenges in the autism spectrum. The point was being reached where one could reasonably expect worthwhile progress with nearly all autistic children. At the same time, scientific understanding of the issues was advancing to the point where the neurofeedback work could now be understood in terms of an accepted model. Before going into more detail on the neurofeedback approach, it is helpful to have that model in mind.

Therapies for autism can be broadly lumped into approaches that address biomedical issues that lie in the causal chain and methods that attempt to ameliorate the behavioral consequences. At first blush, neurofeedback fits into the latter category, and indeed neurofeedback practitioners tend to belong to the mental health camp. But in truth, this assignment is not a good fit at all. By addressing behavior at the level of the brain itself we are in fact opening up an entirely new terrain that does not fit comfortably either within the standard biomedical model or the standard mental health or behavioral model.

Looked at from the perspective of brain behavior, the most obvious shortcoming in autism lies at the level of integration of function. Moreover, this deficit is not uniform across functional domains but rather afflicts particularly our emotional core that allows us to function in socially-connected ways. At the level of the brain, even our emotional functioning is organized by neural networks. We already know that there are developmental flaws in the structural connectivity of these networks. Beyond that, however, there are also deficits in the functional connectivity that operates on this flawed architecture. If we just survey the structural deficits in the white matter, we find no reason to believe that emotional networks should be selectively impacted. At the level of functional connectivity, they clearly are. This is where neurofeedback comes in. In this kind of training, we work to bring the neural network of emotional connectivity back online, among other things. We must necessarily operate within the limitations of what is available in terms of structural connectivity, but the good news is that emotional connectivity in the autistic child lies largely in the functional domain and is therefore clinically accessible to us. *EEG neurofeedback* allows us to do this efficiently. There is at present essentially no other comparable means to bring this about.

In addition to adopting the “brain perspective” on autism, it is helpful also to adopt the child’s perspective for additional insights. What is the life experience of the autistic child who is not emotionally connected? We can gain insights into this by reflecting on other children who have severe attachment issues (often known by the term "Reactive Attachment Disorder"), those who may have been raised in Chinese, Russian, or Romanian orphanages without the benefit of early nurturing. Such children live in extreme states of raw fear. We derive our sense of safety in the world from our early social relationships. In the absence of these comforting social bonds, the experience of life can be uncertain, capricious, and even threatening. The lack of assuredness in navigating one’s world drives the nervous system toward heightened states of activation and arousal. The brain can never relax its vigilance because the child lacks the experience of a sense of safety. Even if the child presents as shut down, the internal state of that system is invariably one of high arousal---without apparent exception.

There is an even larger truth here. In the presence of various kinds of dysfunction, the brain will attempt to compensate by increasing activation generally. The effect may, however, be counter-productive. In any event, it imposes costs. We know very well what happens when we try to function in a highly agitated state. Brain function suffers. The larger principle at issue here is that problems in functional connectivity are not merely consequence. They are also the cause of yet further dysfunction. This is best visualized by reference once again to another affliction, namely Post-Traumatic Stress Disorder (PTSD).

In this condition, there may be nothing in the causal chain beyond the witnessing of a highly traumatizing event. Yet the lingering physiological consequences can devastate the rest of that person’s life. In this case, we have no choice but to trace all these adverse consequences back to the original event, and all we have to work with is functional connectivity (which is demonstrably altered). There had been no physical injury, after all. Everything that occurred in that trauma experience lay in the functional domain at the outset. Very clearly, then, deficits in functional connectivity are quite sufficient to wreak all kinds of havoc with our physiology, and that is what also happens in the autistic spectrum.

The significance of this observation is that by addressing functional connectivity in autism directly, we are not only helping with the consequences of other biomedical deficits, we are also remediating an important element in the causal chain of dysfunction in its own right. This helps to make the case that neurofeedback should be an early intervention in the autistic spectrum. Given what we now know, we believe that it should be the very first thing undertaken by any family whose child is suspected of starting to exhibit autistic features. Families already involved in other therapies should consider folding neurofeedback in early as a high priority. But this is getting ahead of the story. Just what goes on in neurofeedback training, and how is it done?

Given the above model, it would be simple enough (at least in principle) to just characterize the deviations in functional connectivity and target those in training. The deviations are numerous, however, and one still needs a guiding principle to determine the appropriate order in which they should be addressed. And then one runs into the usual conundrum that some approaches help and others don’t. So matters turn out not to be so simple at all. We have evolved a very different approach, one that starts with the observation already made above that the autistic child lives with an over-aroused nervous system, and that status does not do the child any favors.

In a kind of triage mentality, we find it most appropriate to move the child’s brain out of emergency mode as the first order of business. “Calm the stressed and agitated nervous system” is the operative principle. This can be done relatively straightforwardly with essentially any autistic child, irrespective of level of functionality or of age. This strategy finds additional support in our work with servicemen coming back

from Iraq and Afghanistan with PTSD and traumatic brain injury and in our work with children with severe attachment issues. All three of these classes of problems will be started with the very same neurofeedback approach because the initial objective is common to them all: it is to move the nervous system to a calmer and more controlled place. All three confirm for us that we are doing the right thing for each of them.

What actually happens in a session is as follows: The child sits in a large comfy chair in front of a large video screen. (Alternatively a young child may be held on a parent's lap or in a car seat.) Three electrodes are adroitly mounted on the child's scalp while the child is hopefully distracted by images on the screen. A skilled clinician can accomplish this task in about thirty seconds. The electrode leads are held out of the child's field of view. The images on the screen already relate to the "game" that the child will be watching for the feedback. This video game-like display encodes information derived from the child's EEG, so that the ebb and flow of game performance relates directly to a salient feature in the child's EEG. For example, the EEG variable may be reflected in the speed of a car or rocket or train. Other visual features in the image may be used as well to provide corroborative cues. Auditory feedback likewise encodes the information. And there is a tactile feedback module that also reflects the desired signal. So the child experiences immersive feedback in which the relevant information is corroborated with appeals to different sensory systems.

Functional improvements are observed almost immediately, simply by virtue of this change of state in which the nervous system functions. Of course one needs to do a number of sessions in order to get the brain to acquire new habits of functioning. All the while, additional functional improvements continue to surface while others continue to consolidate. What has been learned here is that the matrix of functional connectivity is itself a strong function of the state of arousal of the central nervous system. The greatest and swiftest payoff for our efforts therefore lies in first tending to the brain's emergency mode of function into which it has escalated.

One can often witness the effect on the child within the very first session. Understandably, the child most commonly starts out terrified of the novelty of neurofeedback and at minimum suspicious of the electrodes about to be attached to the scalp. But almost as soon as the training gets under way, one can often see a kind of tranquility settle on the child's face and a certain composure descend over his body. The child may even become completely still, and some have been observed to shift to a meditative pose---all quite uncharacteristic of the child who was brought in by the parents just hours earlier. The child's brain will have noticed that the information presented on the screen in some way actually mirrors its own activity. It cannot help but be intrigued to see its own activity mirrored back to it in this fashion, and so it becomes engaged in the process. Once the brain is thus entrained into the experience, then of course the child readily goes along for the journey. One can even think of this as guided meditation for the autistic brain. It clearly relishes the experience, and those dreaded electrodes are long forgotten by the child.

The immediate payoff for the child is that he is just more comfortable in his own skin. The secondary payoff is in terms of emotional relating. This follows from the fact that affect regulation is intimately coupled to arousal regulation. Regulating the one influences the other and vice versa. In fact, we have chosen to target our emotional circuitry as the most direct way of training arousal regulation, taking advantage of this relationship. A third critical payoff is that the brain is progressively much more stable. In general, the child will then go through life more on an even keel. More specifically, this training can be very helpful for children whose autistic presentation is further complicated by a seizure disorder. In fact, epilepsy was the first clinical indication for which efficacy of EEG feedback was proved in animal and human subject research, so the focus on seizure susceptibility is appropriate. The story is consistent

throughout: moving the child to better-regulated arousal states helps brain stability, and so does the re-normalization of connectivity relationships. Control of seizures then may open the door for enhanced cognitive function. We will have kindled a virtuous cycle in which every specific advance also promotes the overall objective of enhanced functionality.

Over time, the training process is repeated at various scalp sites in order to pursue other specific functional objectives, and in each case the training is shaped into its most productive course by the response of the child within session and across sessions. If everything goes as expected, the agenda gradually proliferates in terms of targeting and progresses on many fronts. Every feature of autistic behavioral presentation can be selectively targeted one after another. This is typically done in an order that emulates our original developmental sequence. Thus, for example, right hemisphere function is addressed before left-hemisphere function. The first placement is always on the right parietal region, which leads to profound bodily calming and to bringing the child into body consciousness and into awareness of large-scale spatial relationships, i.e. of the relationship of self to the outside world. Right pre-frontal training targets emotional connectivity directly. And inter-hemispheric placement is specifically helpful for the instabilities such as seizures. Eventually left-side training may be introduced for more specific purposes.

Right-hemisphere training is quite commonly the key to the emergence of language because the right hemisphere is in charge of acquiring new skills. Language becomes a left-hemisphere function only once it becomes routinized. Moreover, the problem may not be language ability per se at all, but rather the very concept of communication itself. Once that concept is grasped, language may suddenly burst forth in fully formed sentences.

After a sufficient number of sessions to thoroughly establish the method for a particular child, it is often advisable to let parents take over the training at home, using a rented instrument, with ongoing remote supervision from the clinician. There is no obvious endpoint to the training, as the increasingly competent brain just continues to develop new competencies. Somehow our society needs to assure that every autistic child has the opportunity to expand his mental horizons with neurofeedback.