

# Neurofeedback for Autistic Spectrum Disorder – Theory & Research

## What is Neurofeedback ?

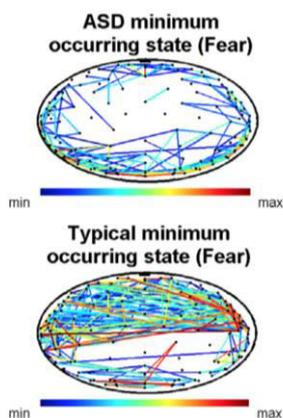
Neurofeedback is a technology that improves brain function by providing the brain with direct, real-time feedback on how well it is working. With Neurofeedback the brain's own capacity for change is used to reshape brain pathways. Although the technology behind Neurofeedback is complex, the process is simple, painless, and non-invasive. **It is just learning.** You learn to alter your brain activity the same way you learn every other skill. You learn through feedback and practice.

Many learning difficulties or disabilities are associated with brain activity that is either over-active or under-active compared to the 'norm' in particular areas. Neurofeedback can help to normalise brain activity and so improve function.

With Neurofeedback you will be guided by a form of feedback that was previously not available to the brain. During a Neurofeedback session you will get instantaneous information or feedback about changes in your brain's electrical activity. This information is for example provided in video games ('a car would go slower or faster') or videos ('the screen bigger or smaller'), that respond to the brain activity.

Through multiple sessions of this feedback the brain is literally 'trained' to work better, to the point where the brain continues to work better without the feedback.

## What is the theory behind Neurofeedback for Autistic Spectrum Disorder?



2013 paper<sup>1</sup> shows brain networks of ASD/Non-ASD with fearful face stimulus

ASD sufferers have poor integration of function, particularly the emotional core that allows us to function in socially-connected ways.

Our emotional functioning is dependent upon both the physical structure of the brain and the functional operation of the brain. Whilst we can't do anything to influence the physical structure, emotional connectivity is mostly dependent on the functional operation, which is accessible through Neurofeedback.

When the normal development/presence of emotional connection is disturbed, the experience of life can be uncertain and frightening. This uncertainty drives the nervous system to heightened states of activation, and the brain can never relax because of the lack of a sense of safety.

So the internal state is highly activated, to the point where the sufferer feels overloaded and may look 'shut down' as a defence mechanism to cope with the high activation and prevent any further stimulus that would make things worse, or adopt other repetitive coping mechanisms.

In this over-activated state other parts of brain function suffer, and the brain tries to compensate for this dysfunction by becoming even more activated.

The purpose of Neurofeedback in this model is firstly to calm the brain down, reduce the activation and sensory overload, and bring the neural network of emotional connectivity back 'on-line'. This has been described as a 'guided meditation for the autistic brain'. We are not aware of any other way to bring this calming about.

Then, with the brain in a calmer state, we find that other brain functions can be trained to function better. This might involve improving emotional relating and overall stability, helping to keep the child 'on an even keel' through daily life. Once the brain has been calmed in this way, other interventions such as sound therapy may be more effective.

## **How can Neurofeedback help Autistic Spectrum Disorder?**

Neurofeedback can change core deficits of ASD by enhancing physical and emotional calming and improving the ability to manage sensory input.

By initially calming the nervous system we can reduce the 'overload' experienced and get the brain out of the cycle of becoming ever more activated to try to compensate for the dysfunction caused by high activation.

The brain is then ready for further training, and this is typically done in an order that emulates our original developmental sequence.

So for example, training the right back side of the brain leads to bodily calming and body awareness, hyperactive behaviour can be reduced, the ability to understand their relationship to the world and therefore social awareness, can be enhanced. By training the right front side, rages, emotional outbursts and overall emotional expression – not words and grammar, but appropriate emotional communication – can be improved.

Since the right side of the brain is associated with learning new skills, if there were delays in the emergence of language this area would be trained. Speech becomes a left-side function only once it becomes routine. By training the left front side of the brain changes can be made in attention and obsessive compulsive symptoms, however, it is the right side training that has shown to be the most effective for ASD symptoms.

ASD often co-exists with ADHD, for which there is an 85% success rate with Neurofeedback. By addressing ADHD symptoms, we find that social interaction naturally improves.

### **School-based neurofeedback for ASD**

In 2005, a Special School in Queensland, Australia won the Commonwealth Award for Outstanding National Achievement in School Improvement after they introduced Neurofeedback for ASD students who required the highest level of support.

After 28 neurofeedback sessions, autistic behaviour in the classroom setting reduced by 64%. Improvements were also reported in sleep, mood, speech, academic performance, attention, memory, and social skills; as well as reductions in anger, aggression, seizures, hyperactivity, and impulsivity. The two students who had epilepsy both stopped having seizures, while two non-verbal students both began speaking a few words.

After an average 40 sessions in the first term, independent observation using the Autism Treatment Evaluation Checklist showed improvements ranging from 2% to 47%.

### **What is the evidence for Neurofeedback's efficacy for ASD ?**

There is a growing body of evidence for the efficacy of Neurofeedback for ASD. It is not as mature as that for ADHD, but ASD is a complex condition and the first case study applying Neurofeedback to ASD came in 1994, 20 years after the first application to Hyperactivity.

It should also be remembered that a less mature evidence base doesn't mean it doesn't work. Although the American Academy of Pediatrics didn't accept that Neurofeedback met their highest standards of Evidence-Based Practice for Attention and Hyperactivity before October 2012, there are thousands of ADHD children and parents who know Neurofeedback helped them before then.

Some of the peer-reviewed studies that have been published on Neurofeedback's ability to help ASD are listed overleaf.

Publication	Date	Research Reference	Summary of Research	Summary of Findings
Applied Psychophysiology and Biofeedback	2010	<a href="#">Coben, R., &amp; Myers, T. E. (2010). The relative efficacy of connectivity guided and symptom based EEG biofeedback for autistic disorders. <i>Applied psychophysiology and biofeedback</i>, 35(1), 13-23.</a>	Literature review assessed 5 separate studies which in total reported <b>180 ASD individuals receiving NF training.</b>	We view <b>neurofeedback</b> as an intervention that may prove to be efficacious in the treatment of symptoms of autism. Presently, it <b>should be viewed as possibly efficacious with potential</b> and would then be <b>in the same category as most interventions used with this challenging population.</b>
Research in Autism Spectrum Disorders	2010	<a href="#">Kouijzer, M. E., van Schie, H. T., de Moor, J. M., Gerrits, B. J., &amp; Buitelaar, J. K. (2010). Neurofeedback treatment in autism. Preliminary findings in behavioral, cognitive, and neurophysiological functioning. <i>Research in Autism Spectrum Disorders</i>, 4(3), 386-399.</a>	20 children age 8-12 diagnosed with autism were randomly assigned to a neurofeedback group and a control group. The neurofeedback group had 40 x 21min sessions of neurofeedback.	Parents of NF group reported <b>significant improvements in reciprocal social interactions and communication skills.</b> EEG analysis showed <b>60% of those receiving neurofeedback reduced Theta waves in anterior cingulate cortex (ACC)</b> known to be involved in social & executive dysfunctions in autism.
Journal of Neurotherapy	2007	<a href="#">Coben, R., &amp; Padolsky, I. (2007). Assessment-guided neurofeedback for autistic spectrum disorder. <i>Journal of Neurotherapy</i>, 11(1), 5-23.</a>	Neurofeedback was conducted in 20 sessions for 37 patients with ASD. The experimental and control groups were matched for age, gender, race, handedness, other treatments, and severity of ASD.	NF group had <b>89% success rate</b> improving ASD symptoms, <b>40% reduction in core ASD symptomology (ATEC scores), 76% reduction in hyper-connectivity.</b>
Journal of Neurotherapy	2002	<a href="#">Jarusiewicz, B. (2002). Efficacy of neurofeedback for children in the autistic spectrum: A pilot study. <i>Journal of Neurotherapy</i>, 6(4), 39-49.</a>	Twenty-four autistic children were divided into two groups, matched by sex, age, and disorder severity. One group received neurofeedback training and the second acted as a control group.	NF group had <b>ATEC score reduction of 26%</b> on average compared with 3% in control group. Parents reported improvements in all behavioral categories assessed.
Research in Autism Spectrum Disorders	2009	<a href="#">Kouijzer, M. E., de Moor, J. M., Gerrits, B. J., Congedo, M., &amp; van Schie, H. T. (2009). Neurofeedback improves executive functioning in children with autism spectrum disorders. <i>Research in Autism Spectrum Disorders</i>, 3(1), 145-162.</a>	Seven autistic children diagnosed with autism spectrum disorders (ASD) received a neurofeedback treatment that aimed to improve their level of executive control.	NF group showed <b>significant improvements in attentional control, cognitive flexibility &amp; goal setting.</b> Parents reported improvements in social interaction & communication skills.
Research in Autism Spectrum Disorders	2009	<a href="#">Kouijzer, M. E., de Moor, J. M., Gerrits, B. J., Buitelaar, J. K., &amp; van Schie, H. T. (2009). Long-term effects of neurofeedback treatment in autism. <i>Research in Autism Spectrum Disorders</i>, 3(2), 496-501.</a>	Follow-up on above study to test for lasting effects.	Follow-up on NF group in above study found <b>maintenance of improvement of executive functions and social behavior after 12 months.</b>
<i>Applied psychophysiology and biofeedback</i>	2010	<a href="#">Thompson, L., Thompson, M., &amp; Reid, A. (2010). Neurofeedback outcomes in clients with Asperger's syndrome. <i>Applied psychophysiology and biofeedback</i>, 35(1), 63-81.</a>	15 year clinical outcome study. 40–60 sessions of neurofeedback, combined with training in metacognitive strategies and, for most older adolescent and adult clients, biofeedback.	<b>Average 9 points IQ score increase. Decrease in difficulties with attention, anxiety, social functioning plus improved academic and intellectual functioning.</b>
6 <sup>th</sup> International IEEE/EMBS Conference in Neural Engineering		<a href="#"><sup>1</sup>Jamal, W., et al (2013) Using brain connectivity measure of EEG synchrostates for discriminating typical and Autism Spectrum Disorder. 6th International IEEE/EMBS Conference in Neural Engineering (pp. 1402-1405).</a>	Comparative brain connectivity network analysis of 11 ASD and 12 control group children under fear, neutral and happy face stimuli.	<b>Children with autism have a different modularity of such networks from typical children.</b> This result could pave the way to a new modality for possible identification of ASD from non-invasively recorded EEG data.