



Neuro Presents

BRAIN-COMPUTER INTERFACE (BCI) BASED TRAINING GAME "COGO" FOR CHILDREN WITH ATTENTION DEFICIT

2022/2023 White Paper

Complementing Conventional Approaches for Treating
Attention Problems and Challenges

EXECUTIVE SUMMARY

Attention Deficit Hyperactivity Disorder (ADHD) is a neurodevelopmental disorder that affects approximately 5.29% of children globally [1]. There is no cure for ADHD but with prescribed coping strategies, children with ADHD can manage their day-to-day without complications.

Typical treatments would usually be pharmaceutical intervention along with behaviour therapy where clinicians will work with the parent(s) to achieve specific behavioural outcomes. In some cases, counselling and other education services are included in their therapy mix as well.

Prescription medication can help children with ADHD pay attention and regulate their emotions and behaviour. However, it can potentially come with side effects such as trouble sleeping at night or even weight loss. It is also vital that their medicine dosage be carefully calibrated for maximum efficacy and minimal disruption to their day-to-day activities. As every child is unique, doctors might not get it right the first time and require multiple appointments to fine-tune it. The efficacy of the medication is positive but gradually becomes less effective as the child's tolerance level toward medication increases.

Behaviour therapy is also considered an effective treatment for ADHD. While it does not change the symptoms of ADHD, behaviour therapy will be able to help children manage their symptoms better. Depending on the severity of their symptoms, some children will require medication on top of behaviour therapy while others will suffice with behaviour therapy alone to keep their symptoms under control.

Numerous clinical trials have found the effectiveness of supplementing current treatment plans for symptoms of ADHD with neurofeedback from Brain-Computer Interface (BCI) based games. It is non-invasive, non-pharmaceutical, and conveniently digital hence implementation can be done at ease without restrictions on time and monetary resources.

CURRENT TREATMENTS

MEDICATIONS

Medication for ADHD aims to increase dopamine and norepinephrine levels between the brain's synapses resulting in reduced hyperactivity, distractibility and/or impulsivity. It is typically prescribed for months to years depending on the child. The bills can add up and get expensive without coverage from health insurance coverage. Additionally, medications can come with side effects ranging from reduced appetite, headaches, sleep problems, reduced creativity, blunting of emotions, and suicide ideation [6].



CURRENT TREATMENTS

BEHAVIOUR THERAPY

Behavioural treatment can help in areas such as impulsivity control and improving executive function skills.

Parents will be required to participate as both parent and child will learn positive strategies to respond to behaviours such as ignoring instructions and throwing tantrums. Methods include using positive reinforcements such as praise and practising consistent consequences to encourage positive behaviour. Children will

also learn strategies to improve their planning, stay organised, and manage their time. These skills will help them be on top of their schoolwork and manage their responsibilities at home. Tools used could include planners and reward charts.

Behavioural therapy will be taxing for both parent and child in the long run as it requires consistent consultation with clinicians, and the costs will add up.



INATTENTIVENESS & ATTENTION PROBLEMS

With children known to have notoriously short attention spans, ADHD may not necessarily be the perpetual cause. Mental conditions have correlations and shared symptoms hence a clinician's diagnosis will provide clarity since there could be other possible causes of attention problems linked to anxiety, depression, autism, learning disabilities, trauma, and more [7].

Studies have found that the ADHD prevalence rate is highest in preschool children (aged 6 years) and seen in more males than females (aged 6 – 18 years) [3, 4].

Traditionally considered a childhood disorder, ADHD has since been acknowledged to persist into adulthood [2]. A worldwide meta-regression analysis of 11 studies of adults with ADHD found that although the ratio of males to females with ADHD decreased with age, a gender ratio of 1 to 1.6 (females to males) was still present in adults aged 19 years [4].

Interestingly, studies have pointed out that girls with ADHD are twice as likely as boys to be predominantly inattentive and experience more emotional struggles from internalising symptoms and inattention [5].

Inattentiveness and attention problems render children with self-esteem strife as they face difficulties in a classroom setting. Academic tasks requiring concentration such as learning a new concept or quizzes can set the child in a constant struggle to pay attention. When

these concerning signs are left untreated or unmanaged, it affects the children's self-esteem and their general well-being.

The good news is, attention is a cognitive skill that can be trained and enhanced using evidence-based mental stimulations.



THE EFFICACY OF DIGITAL THERAPEUTICS



Neuro's approach uses non-invasive Brain-Computer Interface (BCI) games, designed to fit in a clinical or home setting, for clinicians or parents to monitor the children's engagement and progress.

With a decade worth of clinical research and trials, Neuro's digital therapeutics programme - Cogo - is undeniably successful in improving children's attention span.

Cogo is a patented and scientifically validated attention training programme based on Brain Computing Interface (BCI) technology. It was developed by A*STAR's Institute for Infocomm Research (I²R), the Institute of Mental Health (IMH), and Duke-NUS Medical School in Singapore.

It is easily administered with fun, and interactive gameplay to help children

improve their inhibition along with sustained and selective attention over 24 sessions. In the latest clinical trial involving 172 children with ADHD, researchers found that children who received 8 weeks of intervention with Cogo had significant improvements in their inattentive symptoms than those who did not receive any intervention [8]. Additionally, 3 months upon completion of Cogo, brain scans (fMRI) were conducted on these children and it showed an increased activation in the prefrontal region of the brain which is associated to attention.

Cogo is a mobile application compatible with smartphones and tablets. This software solution only functions effectively when paired with a portable, wireless, non-invasive electroencephalography (EEG) device, SenzeBand 2, for capturing brain signals. This wearable hardware consists of 5 forehead sensors and 2 temporal lobe sensors.

During the first session, a clinician will be present to guide the child through a calibration activity to create a Personalised Attention Model unique to each child. This attention model will process a threshold level for each child to meet so that their avatar in the game can move. Consequently, for each session, Cogo's adaptive system will be able to assess the child's attention level and respond accordingly by increasing or lowering the child's threshold level in real-time.

THE EFFICACY OF DIGITAL THERAPEUTICS

Cogo consists of 3 levels - basic, intermediate, and advanced. The basic level consists of maintaining sustained attention. Once the child's threshold level is met, the avatar will be able to walk, run and sprint accordingly. The objective of the immediate level is to collect as many fruits as possible from a given list while still maintaining attention. The advanced level will have users collecting fruits as well, but sequentially as provided by the system. Any wrong or missed fruits collected will result in a penalty on their game scores. For a child to successfully pass onto the next level, he/she must complete these missions as indicated on-screen.

This real-time visual feedback of the running virtual character motivates the child in learning how to focus, which ultimately improves their quality of attention.



THE CLINICAL JOURNEY

2010

The Pilot Study

Investigated 10 unmedicated ADHD children, treated with 20 sessions over 10 weeks across 2 groups: intervention versus control.

The intervention group showed greater improvement in attentive scores on the ADHD Rating Scale (ADHD RS) as reported by parents and teachers, compared to the control group without intervention.



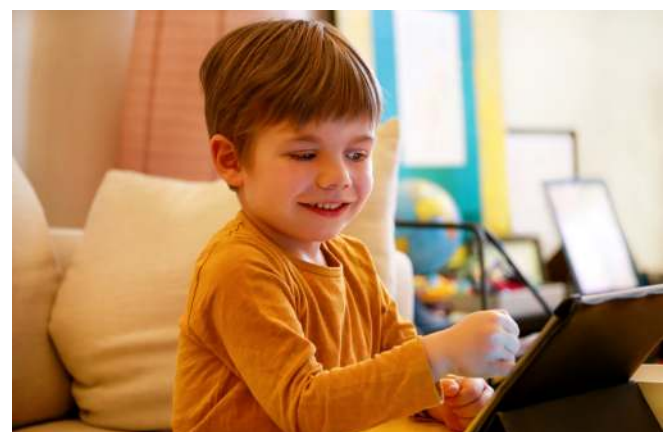
2012

The Phase 1 Study

Investigated a more intensive BCI-based attention training game system on 20 unmedicated ADHD children.

The system was calibrated for each user individually with a treatment regime of an 8-week training comprising 24 sessions followed by 3 once monthly booster training sessions.

At week 8, the mean improvement was 26% and 30% for inattention and hyperactive-impulsive symptoms respectively with a large effect size for inattentive symptoms at 0.78 on week 8 to the control group without intervention.



THE CLINICAL JOURNEY

2018

2019

Phase 2: Brain Imaging Study

66 boys with ADHD went through the BCI-based game intervention for 24 sessions over 8 weeks. Assessments and brain scans (fMRI) were obtained at baseline and after 8 weeks.

The intervention group showed reorganised brain network activity – increased closeness in the prefrontal region of the brain that is associated with attention (i.e., less inattentive symptoms).

Phase 3: RCT

Randomised controlled trial (RCT) was conducted for 172 children aged 6 to 12 attending an outpatient child psychiatry clinic diagnosed with ADHD and not receiving concurrent pharmacotherapy or behavioural intervention.

It showed children who received 8 weeks of intervention had significant improvements in their inattentive symptoms than those who did not receive any intervention when rated by blinded clinicians.



NEEURO SOLUTIONS



After 10 years of research, clinical trials and development, the available evidence on BCI brain training with children with ADHD showed that those received 8 weeks of intervention had significant improvements in their inattentive symptoms compared to those that did not.

Cogo's indisputable efficacy is evidence-backed for improving inattentiveness and other attention challenges. It is also complementary to mainstay treatment plans and conveniently doable in any conducive environment, at a clinic, hospital, or home.

Today, Neero has adopted the BCI technology used in Cogo and made it available for children to seniors seeking brain training to improve their cognitive functions through its solutions, Memorie and NeeroFIT.

As Cogo is tailored for children diagnosed with inattentiveness, Memorie is a collective of 18

engaging brain-stimulating games that stands to assist children to improve on their 5 cognitive skills in attention, memory, decision-making, spatial awareness and cognitive flexibility.

Powered by Memorie, NeeroFIT for Children is a brain fitness course that has a special emphasis placed on attention and memory, as these are the cognitive functions that serve as the building blocks for children to excel in areas of learning, especially for the subjects of Mathematics, Science and Languages while providing real-time feedback on attention levels.

All of Neero's solutions are designed to be paired with the Neero SenzeBand or SenzeBand 2, to ensure an accurate way to track one's progress with a 'Brain' score, in addition to Game scores. It is a metric that measures one's brain activity while training, and will also be provided at the end of each game level.

ABOUT NEEURO

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Neeuro is a global company that specialises in utilising Brain-Computer Interface technology to maximise the potential of users' neurological agility and fitness. Since its inception in 2013, Neeuro's extensive portfolio and an array of digital therapeutic and brain fitness solutions are backed by clinically validated research by A*STAR, an institution widely known as being at the forefront of Singapore's research endeavours.

Its core technology, NeeuroOS, is a platform that empowers healthcare professionals, researchers, and third-party developers with an Artificial Intelligence (AI) driven ability to analyse the brain signals of users, measuring mental states including but not limited to attention, relaxation, mental workload, and fatigue. Neeuro's holistic offerings numerous potential avenues to explore complementary mental health options for children with ADHD, patients with stroke, cognitive rehabilitation, and many other neurological challenges.

DISCLAIMER

All information provided in this white paper is for informational purposes only. This white paper is not meant to be used, nor should it be used, to diagnose or treat any medical condition.

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