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# CLINICAL APPLICATIONS OF NEUROFEEDBACK AND THE POSSIBLE BENEFITS: REVIEW OF CURRENT EVIDENCE AND A PILOT STUDY

BY

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## Abstract

Neurofeedback has been utilised in many clinical settings as an alternative, or adjunct therapy to medication and has been a topic of controversy in its efficacy. A review was conducted to evaluate the impact of neurofeedback on multiple areas of psychiatric disorders as well as the controversial claims surrounding it. A pilot study* was then conducted to investigate possible mental health benefits of a 10-session non-linear neurofeedback programme. The study included 6 adults (3 males, 3 females) recruited from the general population who were required to complete a minimum of 10 sessions (one participant failed to meet the criteria; final N=5). The non-linear neurofeedback system used was NeurOptimal. All participants were studied in a longitudinal design over a period of 3-5 months during which they received neurofeedback training and were assessed before, midway, and after training for possible improvement in their mental health. The progress was tracked using symptom check list-90 revised form (SCL-90 R), visual analogue mood scales (VAMS), and Pittsburgh sleep quality index (PSQI). The results did not show formally significant changes ($p>0.05$) in mood, sleep, and mental health from before to after neurofeedback training but there was a general shift towards better mental health, mood, and sleep quality with certain specific domains having a larger effect size over others such as psychoticism ($\eta^2=0.5$) and calmness ($\eta^2=0.5$). In conclusion, from the review, neurofeedback has a wide array of clinical applications from existing literature with promising results despite having reoccurring methodological issues. Non-linear neurofeedback shows promise (based on the pattern of mental health benefits seen in the pilot study) that requires extensive research to establish a clearer impact but may be a potential therapeutic alternative to medication in mental disorders.

*Recruitment was limited due to the implications of COVID-19; therefore, an adjustment was made to also include a detailed review of neurofeedback.

## Introduction

Neurofeedback is electroencephalography (EEG) biofeedback, which teaches self-control of brain functions to subjects by measuring brain waves and providing a feedback signal. Since the 1960s it has evolved through different branches and has accumulated research on the effectiveness in the treatment of epilepsy, attention deficit hyperactivity disorder (ADHD), anxiety, alcoholism, post-traumatic stress disorder (PTSD), mild head injuries, along with alternative use with learning disabilities, stroke, depression, autism, insomnia, tinnitus, problems with physical balance and for the enhancement of peak performance (Hammond, 2007). EEG neurofeedback deals with brainwaves that are categorised in five classic groups known as gamma, beta, alpha, theta, and delta. Gamma brainwaves are very fast EEG activity above 30 Hz (30 cycles per second). Although further research is required on these frequencies, we know that gamma-band range has been related to cognitive functions such as intense focus, learning, and memory (Kraiser et al, 2003). Beta brainwaves are small, relatively fast brainwaves (13-30Hz), considered to reflect a state of alertness and associated with intellectual activity and outwardly focused concentration (Dustman et al, 1962; Hammond, 2011). The lower end of this frequency band (sensorimotor rhythm or SMR) is associated with relaxed attentiveness. Alpha brainwaves (8-12 Hz) are slower and larger. They are generally associated with a state of relaxation, common in practices such as meditation and has even been linked to have a gating function on sensory stimulation, inhibiting unattended information (Toscani et al, 2010). Theta (4-7 Hz) activity represents a more daydream like state of mind that is associated with mental inefficiency (Hammond, 2011). At very slow levels, theta brainwave activity is a very relaxed state, representing the twilight zone between waking and sleep. Delta brainwaves (0.5-3.5 Hz) are very slow, high amplitude (magnitude) brainwaves and are what we experience in deep, restorative sleep (Dang-Vu et al, 2005; Sekimoto et al, 2000). This is a general overview of

the state of mind and behaviour associated between the distinguished brainwave bandwidths. Human beings always have some degree of each of these various brainwave frequencies present in different parts of the brain and a balance is necessary to maintain an optimal healthy state. ADHD, head injuries, stroke, epilepsy, developmental disabilities, and chronic fatigue syndrome tend to have excessive slow waves (theta, delts and sometimes excess alpha) present (Butnik, 2005; Hammond, 2011). When these excess slow waves resonate in the frontal lobes which are involved in executive function, it becomes difficult to control attention, behaviour, and emotions. This can lead to problems with concentration, memory, impulse control, and overall exhibit diminished intellectual efficiency, deteriorating mental health in the process. Disrupted or out of synch brainwaves tends to make an individual vulnerable to mental disorders as research has found that there is differences in the EEG patterns associated with different diagnostic conditions such as ADHD, anxiety, or obsessive compulsive disorder (Hammond, 2010a).

Neurofeedback attempts to address the imbalance of brainwave activity. Usually a typical training consists of one or more electrodes placed on the scalp and one or two on the earlobes. This is connected to electronic equipment which relays information of the brain's electrical activity to provide instantaneous feedback (usually auditory or visual) about the participant's brainwave activity. No electrical current is put into the brain. The process is like exercising or doing physical therapy with the brain, enhancing cognitive flexibility and resilience. For brain-related disorders, neurofeedback offers additional opportunities for rehabilitation through reconditioning by retraining the electrical activity patterns in the brain. Even if the problem is biological in nature, neurofeedback allows for alternative treatment rather than to simply rely on medication (Duffy, 2000).

**Specialised Types of Neurofeedback**

As mentioned before, neurofeedback has evolved since the 1960s where there are specialised types of neurofeedback. The conventional form of neurofeedback utilises a linear model which works at one bandwidth at a time. Within the linear domain, there are different types of neurofeedback used for the treatment of various disorders, the most frequently used is frequency/power neurofeedback that is implemented to treat ADHD, anxiety, and insomnia. Slow cortical potential neurofeedback (SCP-NF) which is based on electrical activity usually less than 1Hz (can also range between 0.3 to 1.5hz) which can be thought of as the direct current baseline, has been used to treat ADHD, seizures, and migraines (Christiansen et al, 2014, Strehl et al, 2017). This comes from the knowledge that there is a general negative shift in direct current potentials that occurs during cognitive processing (to create hyperexcitability) and positive slow cortical potentials occur during inhibition of cortical networks. For instance, during and prior an epileptic seizure, the cortex is electro-negative which has also been seen before many migraines. After a seizure, when the cortex is fatigued, it tends to be electro-positive and slow cortical potential neurofeedback has been done to mediate the process (Strehl et al, 2006; Kotchoubey et al, 1997).

Low-energy neurofeedback system (LENS) delivers a weak electromagnetic signal to change the patient's brain waves using a local sinusoidal extremely low frequency magnetic field (LSELF-MF). The field has a strength of 10 to the power of -18 watts/cm2 which is the equivalent of $1/400^{th}$ of the input received from holding a phone. This feedback is adjusted 16 times a second to remain a certain number of cycles per second faster than the dominant frequency which has been used to treat traumatic brain injury (Hammond, 2010b), ADHD (Larsen et al, 2006), insomnia, fibromyalgia (Mueller et al, 2001), restless legs syndrome, anxiety, depression, and anger (Zandi-Mehran et al 2014, Marzbani et al, 2016; Hammond, 2010c).

Hemoencephalography (HEG) neurofeedback provides feedback on cerebral blood flow by studying vascularity, blood volume, oxygenation, metabolism, or temperature in real time, all a part of cortical hemodynamics used for cognitive enhancement (Toomim and Carmen, 1999). While the results are preliminary and still early for a complete evaluation, the technique has shown clinical promise (Dias et al, 2012). Live Z-score neurofeedback produces sound and video feedback, based on a computation assessing the different variables of brain function (e.g. power, asymmetries, phase-lag, coherence) using a normative database to produce multiple targets guiding the brain towards normalised function. This has been demonstrated to be effective in the treatment in insomnia (Hammer et al, 2011) as well as in a variety of clinical scenarios (Collura et al, 2010).

Low-resolution electromagnetic tomography (LORE-TA) has been shown to provide physiologically meaningful results. This is a kind of quantitative EEG (QEEG) analysis that provides an estimation of the location of the underlying brain regions (e.g. the anterior cingulate, insula, fusiform gyrus) of the individual's EEG activity within a frequency band. Application of this approach has shown potential in the treatment of epilepsy, the rehabilitation of traumatic brain injury (TBI), and in general, the training of any spatial specific cortical electrical activity (Pascual-Marqui et al, 1994; Congedo et al, 2004).

Functional magnetic resonance imaging (fMRI) informed neurofeedback is a type of neuroimaging that examines brain activation to evaluate brain functioning which has been utilised for neurofeedback. This enables participants to obtain voluntary control over multiple brain regions and provides the opportunity to explore the feasibility of self-regulation of functional brain networks (Johnston et al, 2010). Interesting research has implicated the anterior insula and the basal ganglia consistently activated during self-regulation in real time fMRI neurofeedback. Basal ganglia have been linked to procedural learning, visuomotor integration and other cognitive processes including motivation while the anterior insula has

been implicated in interoceptive awareness of the body and cognitive control (Emmert et al, 2016). Additional activations occurred in the dorsolateral and ventrolateral prefrontal cortex, temporo-parietal area and visual association areas including the temporo-occipital junction. Out of all the specialised types of neurofeedback, fMRI neurofeedback is probably the least practical due to the heavy expenses needed to attain and maintain such equipment.

A distinguish needs to be made between linear and non-linear neurofeedback. The conventional and the majority specialised types of neurofeedback are linear as previously mentioned. Non-linear neurofeedback also known as dynamical neurofeedback is a process for the optimization of natural central nervous system (CNS) functioning. This works at multiple bandwidths simultaneously without conscious volition (does not require the participant to be aware), thereby releasing natural capacities for efficient and effective networking in the brain, and the process is automated, negating the need of an expert practitioner to make constant changes in the system. One of these systems is known as NeurOptimal (NO) and has been used in this pilot study which is discussed in detail later.

## A Review of Linear Neurofeedback Training Protocols and Their Beneficial Effects

### Training protocols

In linear neurofeedback there are various training protocols due to the brain eliciting various brainwaves (gamma, beta, alpha, theta, delta). In alpha protocol training, research has shown improvement in cognitive processing speed and executive function (Angelakis et al, 2007). This pilot study used a double-blind controlled design to investigate whether training older individuals to increase peak alpha frequency would result in improved cognitive performance. While cognitive processing speed and executive function improved, it had no clear effect on memory. This suggest that peak alpha frequency neurofeedback is a promising technique for selected cognitive function. This is further strengthened by individuals who elicited better performance after upper alpha neurofeedback training when it came to a mental rotation task as training success was positively correlated with the improvement in cognitive performance (Hanslmayr et al, 2005). These procedures enhanced alpha brainwaves, the enhancement of which has been associated to various other outcomes such as decrease in anxiety (Hardt and Kamiya, 1978), however similar results have been found but were unrelated to either the direction or magnitude of the changes in alpha activity (Plotkin and Rice, 1981). Rather it was the expectation of the perceived success of neurofeedback training that resulted in reduction of anxiety ratings, attributing it to the placebo effect. Moreover, increase in the quality of musical performance has been associated with the enhancement of individual upper alpha but the efficiency of training depended on the baseline EEG alpha activity status, including alpha peak frequency, individual alpha bandwidth, and the amount of alpha suppression. Nevertheless, both groups of high and low activity showed improvement after training (Silvana et al, 2008). The continued claim for cognitive enhancement through alpha training was demonstrated where 11 out of 14 subjects showed significant greater performance of a mental task after 5 sessions compared to the control

group (Zoefel and Hermann, 2011). Interestingly, the outcomes of these studies have stemmed from a variety of sessions completed as it ranges from 1 session to 36 sessions. This may implicate the procedural appliance of the approach as a contributing factor towards the efficacy of neurofeedback or perhaps the participants' differences making certain individuals more susceptible to the training over others.

Beta activity is a good indicator for mental performance and inappropriate beta activity can represent mental and physical disorders like depression, ADHD, and insomnia due to beta training having an attention-enhancing and an arousal-enhancing effect (Egnar and Gruzelier, 2004). Beta training have shown encouraging potential in the treatment of ADHD by enhancing beta (15-18Hz) and sensorimotor rhythm (SMR, 12-15Hz) while inhibiting theta (4-7Hz) which demonstrated improved behavioural concomitants of ADHD (Fuchs et al, 2003). This was further strengthened with the addition of epilepsy but while showing potential in the treatment of neuropsychiatric disorders, it was concluded that further controlled studies are necessary to establish clinical efficacy and effectiveness (Heinrich et al, 2007). The enhancement of beta (12-22Hz, including SMR) with the inhibition of theta and in some cases high beta (22-30Hz) pertains to a wide variety of outcomes such as enhancement of attentional performance and improved perceptual sensitivity due to an increase in cortical arousal (Egner and Gruzelier, 2001), increased recall in semantic working memory (Vernon et al, 2003), and reduction of inattention, hyperactivity and impulsivity (Lubar et al, 1995). To have these bolstered mental traits, it is plausible to see how it can be effective when it comes to treating ADHD.

Alpha/theta training is one of the most popular neurofeedback training for stress reduction, creativity, relaxation, musical performance but also has been used for the treatment of deep levels of depression, addiction, and anxiety (Gruzelier, 2009; Raymond et al, 2005; Egner and Gruzelier, 2003). In addition, accurate alpha/theta neurofeedback effectively

facilitates the production of higher theta/alpha ratios than do noncontingent feedback relaxation (mock feedback) which filters out the possibility of the outcome resulting from the placebo effect (Egner et al, 2002). Through this protocol, reduction in anxiety has been correlated with improvement in dance artistry and technique (Gruzelier et al, 2014). It is worth noting that similar reduction in anxiety was shown in heart variability training (HRV) which is another form of biofeedback. Theta neurofeedback alone has been demonstrated to improve memory consolidation of a motor sequence in which the results were maintained for 7 days after training, longer than any of the control groups. Furthermore, in the neurofeedback group, night sleep improved motor performance beyond that of the control groups (Reiner et al, 2014).

Delta waves are associated with stages 3 and 4 of the sleep cycles, important phases in memory consolidation as well as recovery and repair. Disruption of these waves have been associated with decreased pain threshold, increased discomfort, fatigue, and the inflammatory flare response in skin (Lentz et al, 1999). Delta waves tend to have the most prevalence during sleep compared to wakefulness where it usually operates at limited capacity, an excess of which has been correlated to  mental inefficiencies mentioned previously (Hammond, 2010a) with the addition to autism (Fauzan and Amran, 2015). Down regulation of delta with the upregulation of alpha has demonstrated significant improvement in all areas evaluated in patients with down syndrome (Surmeli and Ertem, 2007). This included, effectiveness in developing speech, improving attention and concentration, improving learning, decreasing behavioural problems or impulsivity, and alleviating balance problems, providing a wide variety of benefits which could have clinical applications.

Gamma waves have the highest frequency and has been associated to intense focus, memory, and intelligence. Gamma neurofeedback has demonstrated a decrease in feature binding costs while increasing intelligence, suggesting that the control of feature binding and

intelligence share a common underlying mechanism (Keizer et al, 2010). However, the results could not be replicated when looking at the effect of beta and gamma neurofeedback on memory and intelligence in the elderly (Staufebiel et al, 2014). Cognitive performance was determined before and after the training through an IQ and memory task. Both neurofeedback protocols resulted in a significant increase of the brain activity, implying that the aging brain is still trainable. No effect was found on cognitive performance after training. It was concluded that potential methodological flaws played a contributing factor, emphasising on the improvement of feedback protocols for future studies.

## Mental Health Benefits

### Attention Deficit Hyperactivity Disorder (ADHD)

A meta-analysis on the efficacy of neurofeedback treatment in ADHD concluded that neurofeedback treatment for ADHD can be considered "efficacious and specific" with large effect sizes for inattention and impulsivity and a medium effect size for hyperactivity (Arns et al, 2009). Potential confounding factors such as small studies, lack of randomization in previous studies and lack of adequate control groups have been addressed, and the clinical effects of neurofeedback in the treatment of ADHD can be regarded as clinically meaningful. This is further demonstrated in a double-blind placebo-controlled study where children with ADHD can profit from neurofeedback, effectively improving behavioural symptoms and performing better on a continuous performance test (deBeus and Kaiser, 2011).

### Learning Disabilities

Regarding learning disabilities, Fernandez et al. (2003) demonstrated in a placebo-controlled study that neurofeedback was an effective treatment in learning disabled children. All changes observed in the experimental group of significant improvement and not observed in the control group suggests that changes were due not only to development but to

neurofeedback treatment. The improvements were sustained after a 2-year follow up in which the EEG maturation continued in children belonging to the experimental group, and was accompanied by positive behavioural changes, which were reflected in remission of learning disabilities symptoms (Becerra et al, 2006).

**Epilepsy**

Medication treatment of epilepsy is ineffective in one third of patients, and the long-term use of many antiseizure medications can have health risks as well as risk of addiction (Iasemidis, 2003). Therefore, an alternative other than in addiction to medication would be desired. In a meta-analysis of neurofeedback treating epilepsy demonstrated a 74% reduction in seizure incidences in patients who were resistant to antiseizure medication (Tan et al, 2009). In these harsh cases of medically intractable epilepsy, neurofeedback has been able to facilitate greater control of seizures in patients, often reducing the level of medication required. In another group of 25 uncontrolled epilepsy patients, 100% became seizure free following QEEG-guided neurofeedback, with 76% no longer requiring an anticonvulsant for seizure control (Walker, 2008). The same approach was used on an additional 20 patients with intractable seizures, 18 of them became seizure free with 2 remaining on a single anticonvulsant drug. In the same study, a group of mothers with epilepsy who were controlled with anticonvulsant therapy wanted to cease taking drugs to get pregnant. After QEEG-guided neurofeedback, all 9 patients were seizure free and have remained so for an average of 6 years (Walker, 2010).

**Schizophrenia**

Schizophrenia can be considered one of the most devastating mental illnesses due to its onset in early patient's life and its symptoms can be destructive to the patient, family, and friends. In a clinical series, Surmeli et al (2012) investigated the efficacy of QEEG-guided

neurofeedback in 51 participants with schizophrenia, the symptoms being assessed by the Positive and Negative Syndrome Scale (PANSS; Kay et al, 1987). Besides PANSS, 33 out 51 were also evaluated by the Minnesota Multiphasic Personality Inventory (MMPI; Hathaway and McKinley, 1951) and the Test of Variables of Attention (TOVA; Greenberg and Waldmant, 1993) at baseline and following treatment. Of the remaining 48 (3 dropped out) participants, 47 showed clinical improvement after neurofeedback training, based on the changes on the PANSS scores. The participants that took the MMPI and TOVA also showed significant improvements, overall demonstrating neurofeedback to be effective. This study provided the first evidence for positive effects of neurofeedback in schizophrenia, which was closely followed by a case study (Nan et al, 2012) and an inference of the efficacy of neurofeedback training for relieving distressing auditory verbal hallucinations in patients with schizophrenia (McCarthy-Jones, 2012). While results are promising, the research is limited to make a substantial claim on the efficacy of neurofeedback on schizophrenia but certainly enough for consideration in future research.

**Insomnia**

Insomnia is a prevalent sleep disorder worldwide, an area where neurofeedback has shown potential as a psychophysiological treatment. In a pilot study, two groups with insomnia were given two distinct z-score neurofeedback protocols. Both groups received fifteen 20-min sessions. Post-treatment all participants were normal sleepers with significant improvement in all parameters assessed which included, mental health, quality of life, and insomnia status consisting of Insomnia Severity Index, Pittsburgh Sleep Quality Inventory (PSQI), and PSQI Sleep Efficiency (Hammer et al, 2011). As this is a pilot study with 12 participants which is a small sample size, while not enough to form a solid conclusion it does open another area of clinical application. In addition, a review has highlighted that neurofeedback can impact the sleep spindle circuitry, normalising the sleep onset insomnia

and thereby affect the noradrenergic locus coeruleus, a region of the brain associated in vigilance stabilization (Arns and Kenemans, 2014). Hence, neurofeedback does contain potential contribution in the realm of sleep, reason for further research.

**Depression and Anxiety**

Depression and anxiety have been reported to have physiological predispositions such as hypometabolism in the cingulate, frontal cortex, insula, anterior temporal cortices, amygdala, basal ganglia, and thalamus for depression (Marzbani et al, 2016). Anxiety is often defined as high level muscle tension along with an imbalanced fight-or-flight response with the imbalance being explained through psychological factors (Hoehn-Saric, 1998; de Vente et al, 2014). It has been indicated that in depression most patients perceive a difference after 3 to 6 30-min neurofeedback sessions, feel a significant improvement after 10-12 sessions, and usually complete treatment within 20-22 sessions (Hammond, 2005a). In addition, this treatment is not only helpful combating depression, but it also reduces anxiety and rumination (Hammond, 2005b). However, these are only preliminary results due to the case series being uncontrolled while promising, controlled trials would be required to establish a stronger correlation on the efficacy of neurofeedback. This also applies to the preliminary reports in the treatment of OCD which suffers from the same methodological flaw even though the results showed significant improvement that were maintained in follow ups of 13 and 15 months after treatment. One patient elicited improvement not only in OCD symptoms, but also in depression, anxiety, somatic symptoms, and in becoming extroverted rather than introverted and withdrawn (Hammond, 2003).

**Controversy**

Surrounding the topic of neurofeedback there is controversy relating to the scientific rigour of studies such as being susceptible to a high proportion of false positives, including

small sample sizes, small effect sizes, exploratory analyses, flexible research designs, ideological or financial interests (Thibault et al, 2017). Furthermore, it has been scrutinised that the effects of neurofeedback can be the result of the placebo effect (Thibault et al, 2017b). This claim was derived from a well-established study by Schabus et al (2017) who reported a carefully crafted experiment probing the treatment of insomnia, by comparing the results of genuine and sham neurofeedback, the findings suggest the benefits of neurofeedback may derive largely from placebo effects. Despite the genuine feedback being of linear origin, it was still proposed to offer a potent psychosocial intervention to the point that patients may benefit more from neurofeedback placebo effects than from other available treatments (Thibault et al, 2017b).

Another evaluation looked at whether neurofeedback enhanced performance. The review pointed out the existing literature suffered from methodological issues and that claims regarding the use of neurofeedback training to enhance performance is only matched by the paucity of research showing a clear effect (Vernon, 2005). Recommendations were made for future studies to strengthen the methodology of neurofeedback such as, measuring pre and post EEG baseline to monitor changes resulting from neurofeedback training, include a non-contingent control group, and obtain clear pre and post training measures of behaviour, and to correlate changes in EEG to changes in behaviour (Vernon, 2005). Despite this, it was concluded the findings from neurofeedback studies to be intriguing and suggestive due to the reported association between specific patterns of cortical activity and particular levels of performance, making it plausible for neurofeedback to be utilised as a tool to retrain the brain in an attempt to enhance performance.

A review investigating the clinical efficacy and potential mechanisms of neurofeedback surmised that the few controlled studies that exist are insufficient to resoundingly declare therapeutic success in all conditions but ADHD. However, the data that

exist provides reason for cautious optimism as further research aimed to optimise and personalise neurofeedback, may enrich the current approaches to neurological and psychological dysfunction (Niv, 2013).

**Non-Linear Neurofeedback and Its Beneficial Effects**

Most published studies focus on linear neurofeedback which entails diagnosis and protocols such as uptraining and down-training bandwidths separately (delta, theta, alpha, beta, and gamma). Notwithstanding that the entire procedure needs to be overlooked and managed by an expert, this methodology has been used in more than 250 publications (Arns, 2012). This differs greatly when looking into non-linear neurofeedback as there is no need of diagnosis or protocols as the expertise is built into the system which becomes time saving and cost effective over its counterpart.

In recent years it has been realised that quite ordinary systems obeying simple nonlinear laws can give rise spontaneously to behaviours of considerable complexity associated with abrupt transitions, a multiplicity of states, rhythmic activity, pattern formation or a random-looking evolution which is referred to as deterministic chaos (Nicolis et al, 2009). This may prove to be an accurate model when looking at the human brain as it functions in a non-linear fashion (Walter and Adey, 1968), it even shows functions of a quantum nature when looking at principles such as non-locality (Grinberg-Zylberbaum et al, 1994). As complex as the human brain is, using a neurofeedback system that compliments its true nature may exceed the efficacy when compared to a system working in a restricted manner (linear).

Before delving into the existing literature for non-linear neurofeedback, it is important to mention that research into non-linear neurofeedback is limited as research has simply not

been done in various areas concerning mental disorders. The research that has been done is scarce but offers insight in the potential of its use.

DeLong (2003) investigated the effects of EEG neurofeedback and neuro-cognitive processing in the educational environment. This pilot study revealed a 290% increase in listening skills for the study group (n=12), as compared to the control group (n=12). In reading development, the study increased their performance by 162% over the control group, this included word identification, word attack and word comprehension. The Peabody Picture Vocabulary Test measured global achievement. This measure showed an overall global achievement increase of 341% of the study group over the control group, a substantive educational improvement in a period of only 90 days. Math scores of the study group increased by 157% compared to the control. The study group showed marked improvement in attention, slight improvement in hyperactivity, and a decline in internalising while making minor progress in their adaptive skills whereas the control group became less attentive and more hyperactive. However, it was determined that a minimum sample size of 48 would have been needed to have documented significant statistical findings in the areas of cognition, reading, and auditory processing. Despite the insufficient sample size, it was concluded that neurofeedback and neuro-cognitive coaching can result in educational gains in areas like auditory processing, global achievement, attention, problem solving, and critical thinking.

Although reports are limited by the relatively short time non-linear/dynamical neurofeedback has been available, outcome studies are promising in a variety of populations. Okunola et al (2007) has done work with dynamical neurofeedback (DN) on chronic insomnia with significant improvements in total sleep time, sleep efficiency, wake after sleep onset, and sleep onset latency. One study has demonstrated that DN has the potential for reducing the negative cognitive and emotional sequelae of cancer treatment as well as improving fatigue and sleep patterns (Alvarez et al, 2012). A clinical study investigated the

effect of DN as compared with methylphenidate in the treatment of ADHD in children. Most parameters that were assessed between the two groups there was no significant differences. Both groups benefited from the treatment. Behavioural measures were improved by both types of method, but methylphenidate was significantly more effective than DN. Response inhibition was improved only by DN. The findings concluded that EEG biofeedback (DN) can significantly improve several behavioural and cognitive functions in children with ADHD, and offer an alternative to individuals who are not responding to medication or favour a non-pharmacological treatment (Nazari et al, 2011).

According to Duffy (2000), even though improvements are needed in the methodological details, the scholarly literature does suggest that neurofeedback should play a major therapeutic role in many difficult areas. For non-linear neurofeedback to become a clinical reality, it must be demonstrated through rigorous methodological studies to be considered an effective alternative to medicinal treatment.

## Investigating Mental Health Benefits of Non-linear Neurofeedback: A Pilot Study

### Background and Rationale

Mental health is a state of emotional, psychological, and social well-being in which an individual can use their capabilities to function in everyday life. It helps determine how we handle stress, relate to others, and produce coherent cognition, making mental health vital at every stage of life. From childhood through adulthood, it is essential to maintain a healthy and optimum state. Mental health problems are one of the main causes of overall disease burden worldwide (Vos et al, 2013), with major depression being the second leading cause of disability worldwide and a major contributor to the burden of suicide and ischemic heart disease (Whiteford et al, 2013). In England, 1 in 6 adults (17%) met the criteria for a common mental disorder in 2014, and with conditions such as anxiety or depression, 39% of adults aged 16-74 were accessing mental health treatment (McManus et al, 2016).

In the UK, when a problem arises, the conventional form of treatment is prescription drugs. While certain medicine has benefitted humanity and increased its life expectancy, its sole dependence has made the malignant side effects exponentially clear (Abuse. S, 2006, McCabe et al, 2006, Savage et al, 2003). According to the Health Survey for England, about 50% of women and 43% of men in England regularly take at least one type of prescription medication (The Manor Clinic, 2019). The USA is considered the centre of prescription drug abuse and although the number of deaths related to drug poisoning reviewed from the UK is not as high as the USA, the overall trends are remarkably similar (Giraudon et al, 2013). Current UK data show an increase in all prescription opioids and prescription opioids with no illicit use according to the National Drug Treatment Monitoring System (NDTMS, 2019). These data are likely to underestimate the prevalence of addiction as not all individuals with this problem will be referred to drug treatment and recovery services (Faculty of Pain

Medicine, 2019). People develop a chemical dependency to escape from the pain or any mental issues that they are faced with which brings the question, can dynamic non-linear neurofeedback be an alternative, safer, and cost-effective solution to the problem?

**Uniqueness of NeurOptimal**

Non-linear dynamic neurofeedback NeurOptimal (NO) uses a software program that utilises 4 ways to detect the changes in cortical activity which are duration, intensity, frequency, and shifts (phase changes) all of which are measured by a mathematical algorithm known as Joint-Time Frequency Analysis (JTFA)

Throughout the sessions NO relays feedback, in 4 second intervals onto each other to see a pattern, any detected large variation throughout the session indicates a shift is coming. The interruption causes a reorienting response and then a relaxation response, these are known as Time Frequency Envelopes (TFE).

Shifts in EEG are best understood in terms of 'flutter' before a shift occurs there is an increase in activity. This is how the brain receives the crucial information about itself via the mirroring of NO by the dynamic range of variability or 'fluttering' around the different TFE. This allows for individualised optimal balancing as determined by that brain, this dynamical approach mirrors 'information' (changes in cortical activity) micro-second by micro-second and then the central nervous system (CNS) responds by learning a new pattern of cortical activity.

When the 'flutter' is detected by NO system, the brain notices and adapts or self-regulates by being in the present moment. The brain perceives the interruption (at an unconscious level) which is the feedback that triggers the brain to re-orient and self-regulate.

## Study Aims

The aim of this pilot study was to explore the mental health benefits of dynamic non-linear neurofeedback on mental health. It is hypothesised that all individuals will benefit in some manner relating to their mental health and wellbeing and any individuals, for instance with worst sleep are expected to have a larger scope of change.

# Method

## Sample and Design

From the general population, 6 participants were recruited through word of mouth (3 males and 3 females; age range: 20-43). All participants underwent a screening process to rule out marked hearing or visual impairment (blindness). All participants were studied in a longitudinal design over a period of 3-5 months during which they received neurofeedback training and were assessed before, midway, and after training for possible improvement in their mental health. Up to 20 sessions were given for participants to reach which was conducted for each participant at a time suitable to the participant. Those who miss certain weeks of training were not excluded from the study provided they complete at least 10 sessions in total during the study period.

Each participant served as their own control. As this is a pilot study with limited resources (dissertation project), no comparator group (with linear neurofeedback training or no training control) was included in the design.

Ethical approval was obtained through BREO (Brunel Research Ethics Online; reference number). All participants provided a written informed consent prior to taking part.

## Neurofeedback Equipment and Training

The equipment used consist of an ASUS laptop, USB cable, monitor, HDMI cable, zAMP, a pair of sensors (5 individual sensors), ten20 conductive neurodiagnostic electrode paste, headphones, charger, tissues, and wet wipes. The participants were in a seated position throughout the session.

The 5 sensors were colour separated into yellow, blue, and black. The blue sensors measured any outside noise known as line noise which it blocked out during the session. The yellow sensors measured the electrical current of the brain and the black sensor was used to

ground the signal. The zAMP took analogue information from the brain and turned it into digital for the computer and amplified the signal out of the brain.

Before the session started, 5 sensors were applied on the participant using the conductive electrode paste, one at the bottom right ear lobe, one at the top of the right ear, one at the top of the left ear, and two on the top of the head (C3 and C4).

The sensors were connected to the zAMP which was connected to the laptop using the USB cable. The participants were provided with headphones to put on and listen to music as the session progresses. The feedback was done through the music by a series of interruptions which the brain responds to. The HDMI cable was connected to a monitor from the laptop to provide a visual aspect of the session although it was not compulsory to watch. The standard time per session was 33 minutes.

**Assessment**

All participants were assessed at baseline on mental health using Symptom Check List-90 Revised form (SCL-90 R; Rief and Fichter, 1992) which was scored using the procedure described by Prinz et al (2013) , impulsivity (using the Barratt Impulsiveness Scale - BIS-11; Patton et al, 1995), past and current mood (using Visual Analogue Mood Scales - VAMS; Bond and Lader 1974), quality of sleep using Pittsburgh Sleep Quality Index (PSQI, Buysse et al, 1989), presence of ADHD symptoms (ADHD Self-Report Scale - ASRS-v1.1; Kessler et al, 2005), and Brief Trauma Questionnaire (BTQ, Schnurr et al, 1999).

None of these forms were used as clinical scales but they provide reliable self-reported symptoms of a range of mental disorders and mood. Throughout the training, analogue scales (for mood), PSQI (sleep) and SCL-90 R forms were used after every 5 sessions to track the individual's progress.

## General procedure

All participants were given a participant information sheet. Those willing to take part were required to give written consent. Throughout the screening and training procedure it was emphasised that they can stop their participation without having to give a reason. At the end of the study, they were fully debriefed. In addition, during the training period, the participants were given an opportunity to give details if any, that they have noticed change since they started.

## Statistical Analysis

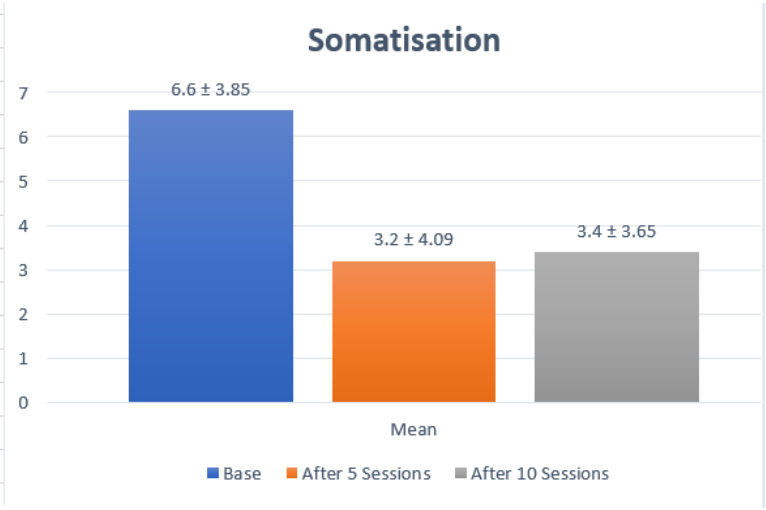
Possible changes in mental health (assessed using the SCL-90 R and PSQI), and mood were examined using repeated measures analysis of variance on mental health and mood scores obtained before, half-way and after the neurofeedback training. Improvements in mental health and mood were correlated with data on various measures used to characterise the sample to explore possible predictors of a good response to non-linear neurofeedback training.

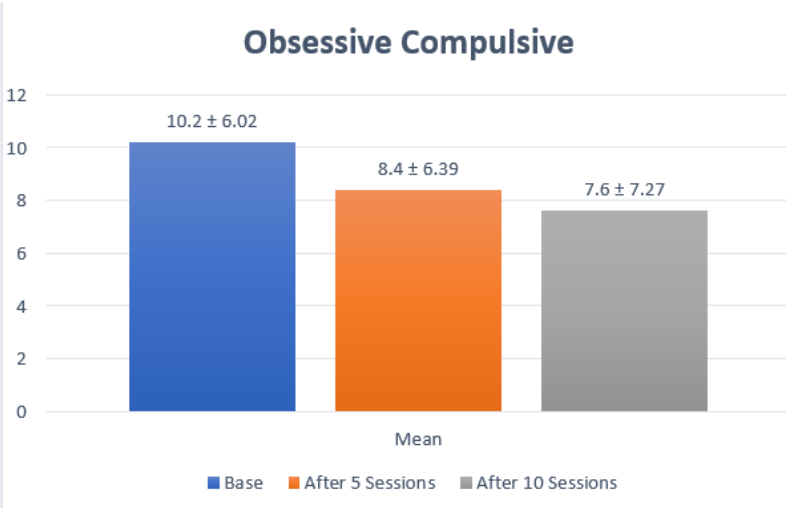
# Results

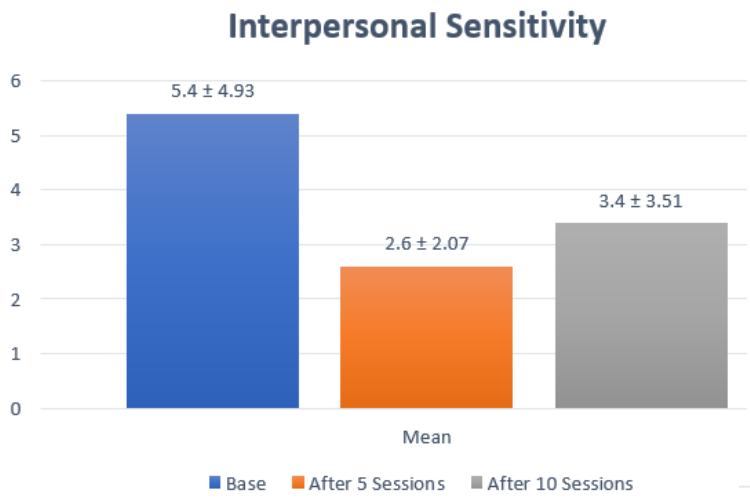
## Mental Health (SCL data)

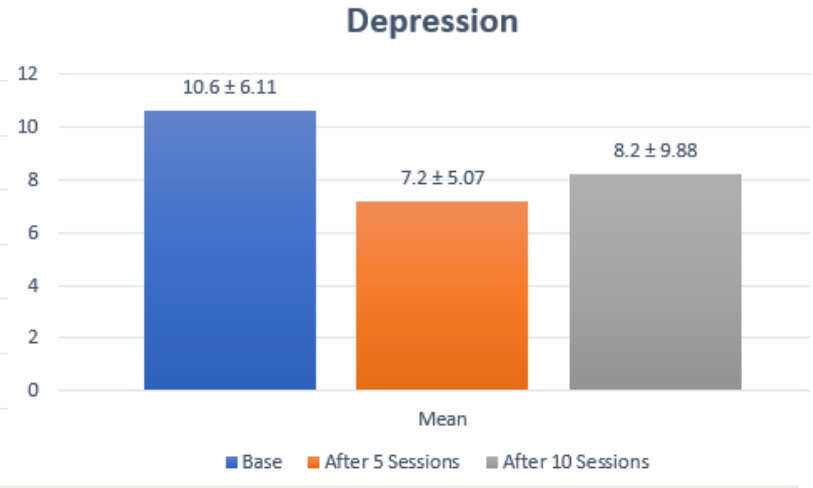
The changes in score ratings in any of the SCL-90-R symptom domains were not formally significant ($p>0.05$) but there was a positive change on some domains for certain participants as shown in Figure 6. The effect sizes* have shown varying degrees, all considered to have a large effect; somatisation ($\eta^2=0.28$), obsessive compulsive ($\eta^2=0.16$), interpersonal sensitivity ($\eta^2=0.35$), depression ($\eta^2=0.11$), anxiety ($\eta^2=0.17$), hostility ($\eta^2=0.3$), paranoid ideation ($\eta^2=0.26$), phobic anxiety ($\eta^2=0.2$), additional items such as poor appetite and poor sleep ($\eta^2=0.18$), and the biggest was found in psychoticism ($\eta^2=0.5$). Overall, numerically there was a decrease in each domain from baseline and after 10 sessions of non-linear neurofeedback. This is illustrated in *Figure 1.*

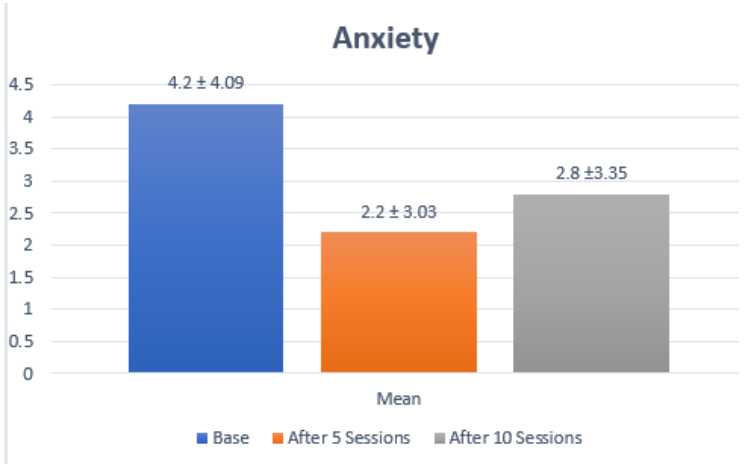
*Eta-squared ($\eta^2$) effect sizes are interpreted as follows; small (0.01), medium (0.06), and large (>0.14)

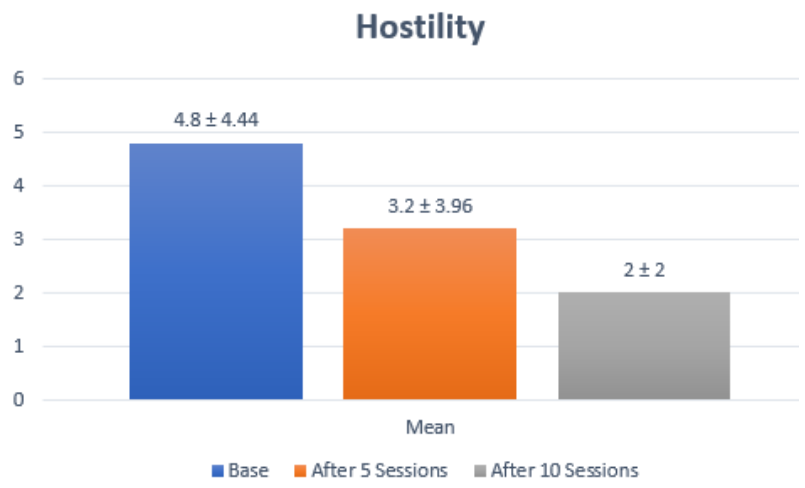

Somatisation
6.6 ± 3.85
3.2 ± 4.09
3.4 ± 3.65
Mean
Base
After 5 Sessions
After 10 Sessions


Obsessive Compulsive
10.2 ± 6.02
8.4 ± 6.39
7.6 ± 7.27
Mean
Base
After 5 Sessions
After 10 Sessions


Interpersonal Sensitivity
5.4 ± 4.93
2.6 ± 2.07
3.4 ± 3.51
Mean
Base
After 5 Sessions
After 10 Sessions


Depression
10.6 ± 6.11
7.2 ± 5.07
8.2 ± 9.88
Mean
Base
After 5 Sessions
After 10 Sessions


Anxiety
4.2 ± 4.09
2.2 ± 3.03
2.8 ±3.35
Mean
Base
After 5 Sessions
After 10 Sessions


Hostility
4.8 ± 4.44
3.2 ± 3.96
2 ± 2
Mean
Base
After 5 Sessions
After 10 Sessions

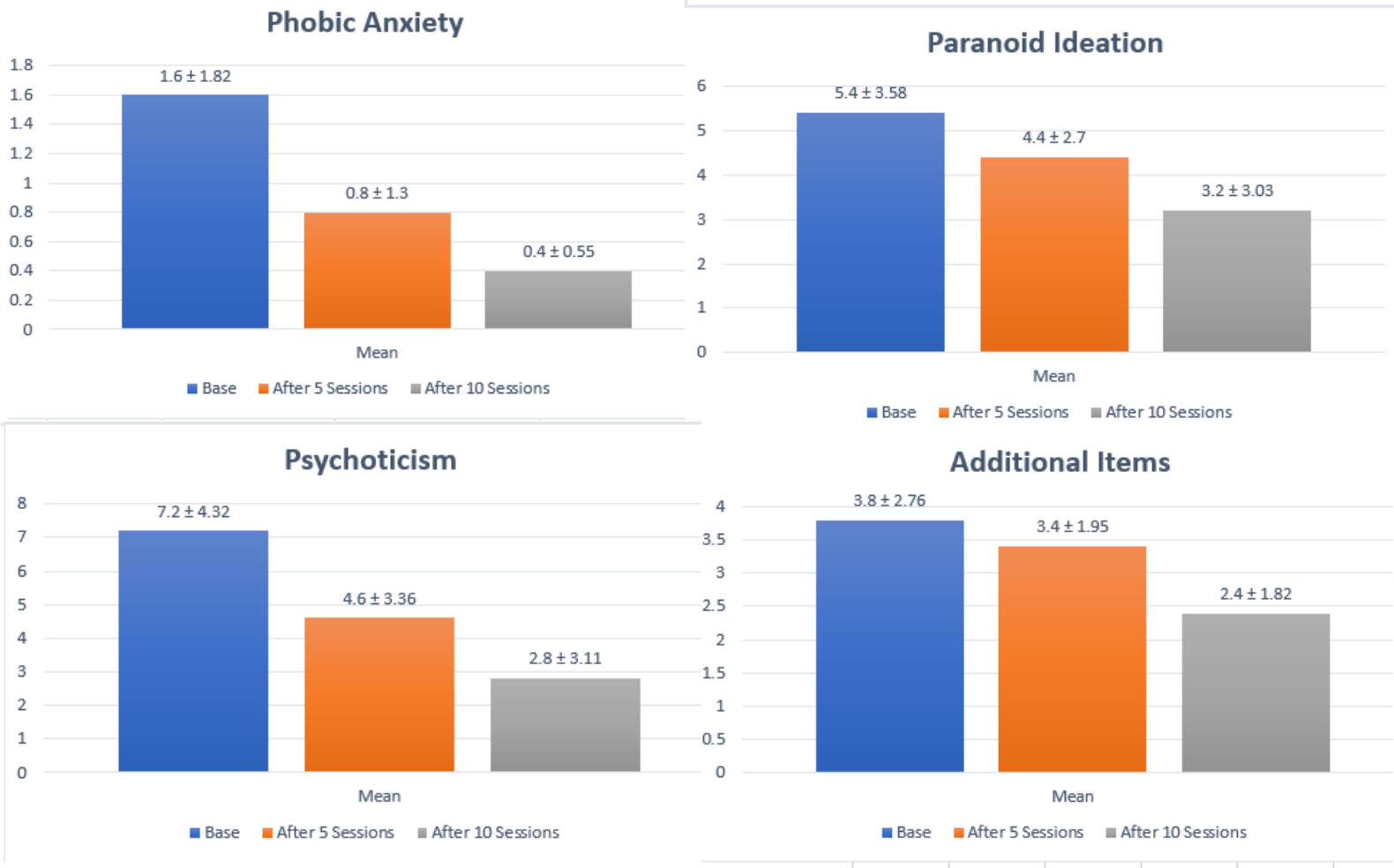



*Figure 1. Mean scores of each domain acquired from SCL 90 R forms.*

**Sleep Quality**

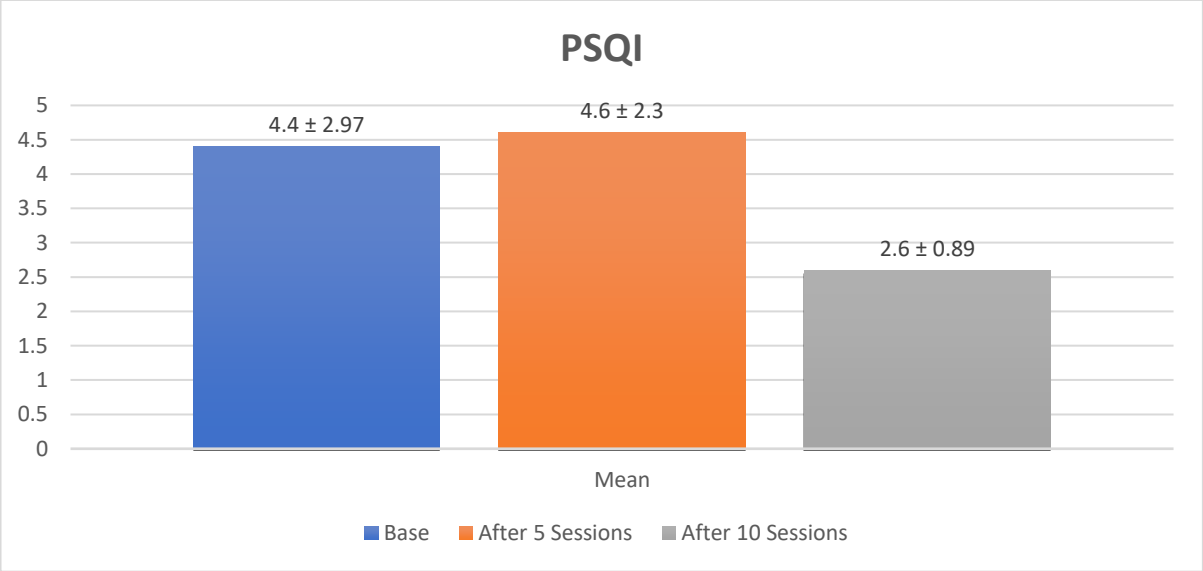



*Figure 2. PSQI mean scores.*

Overall, there was an improvement in sleep quality as there was a decrease in PSQI scores from baseline and after 10 sessions with a large effect size ($\eta^2$=0.47 $p>0.05$).

## Mood and Wellbeing


*Figure 3. Mean current mood scores for tired, depressed, anxious, stressed, in pain, and angry. Referred to as negative states.*

There was no significance in the changes for current mood scores for negative states ($p>0.05$) with small to large effect sizes; tired ($\eta^2=0.01$), depressed ($\eta^2=0.22$), anxious ($\eta^2=0.2$), stressed ($\eta^2=0.18$), in pain ($\eta^2=0$), and angry ($\eta^2=0.01$).

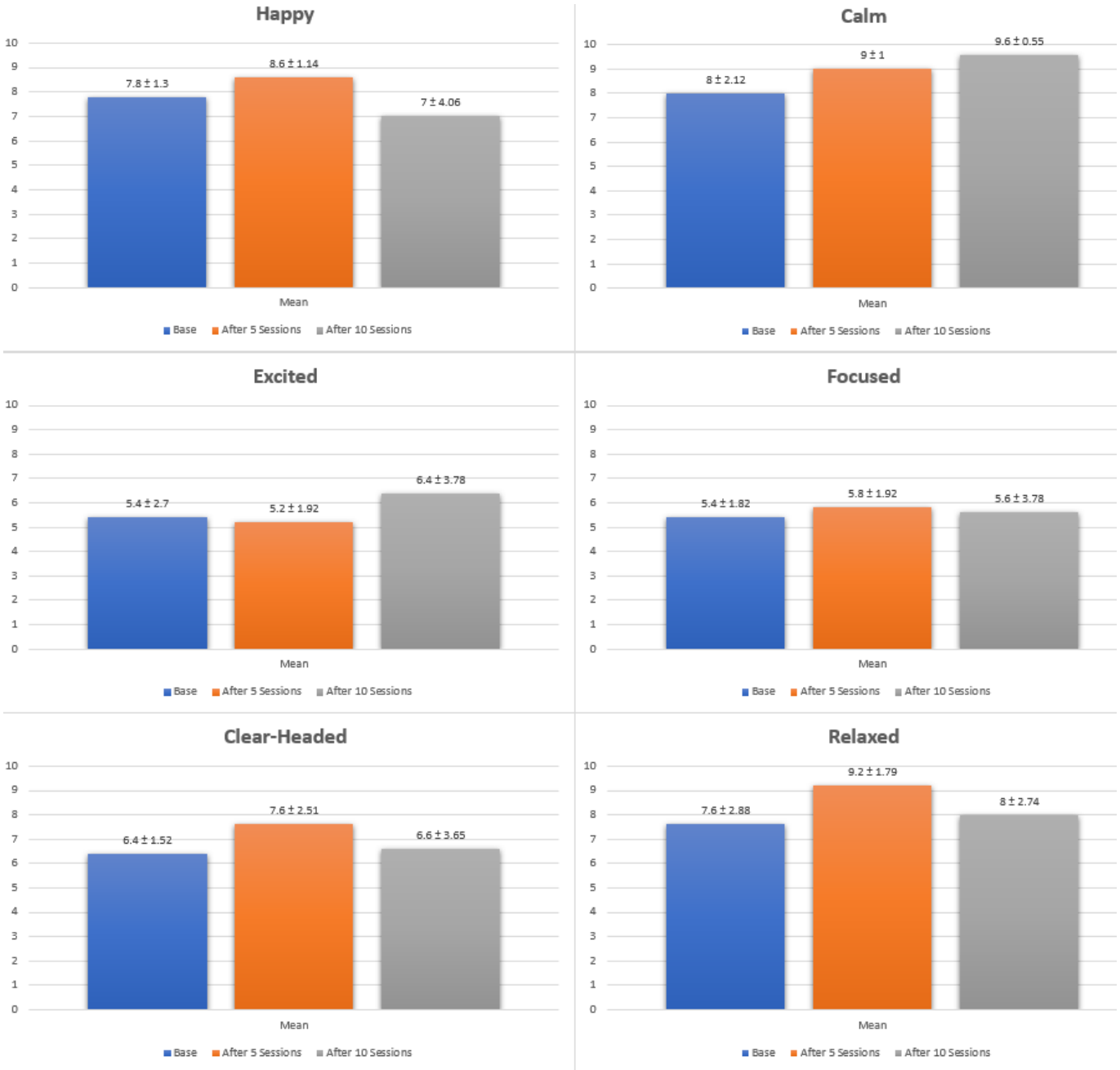



*Figure 4. Mean current mood scores for happy, calm, excited, focused, clear-headed, and relaxed. Referred to as positive states.*

There was no significance in the changes for current mood scores for positive states ($p>0.05$) but showed larger effect sizes over negative states overall; happy ($\eta^2=0.11$), calm

($\eta^2$=0.52), excited ($\eta^2$=0.11), focused ($\eta^2$=0.01), clear-headed ($\eta^2$=0.06), and relaxed ($\eta^2$=0.36).

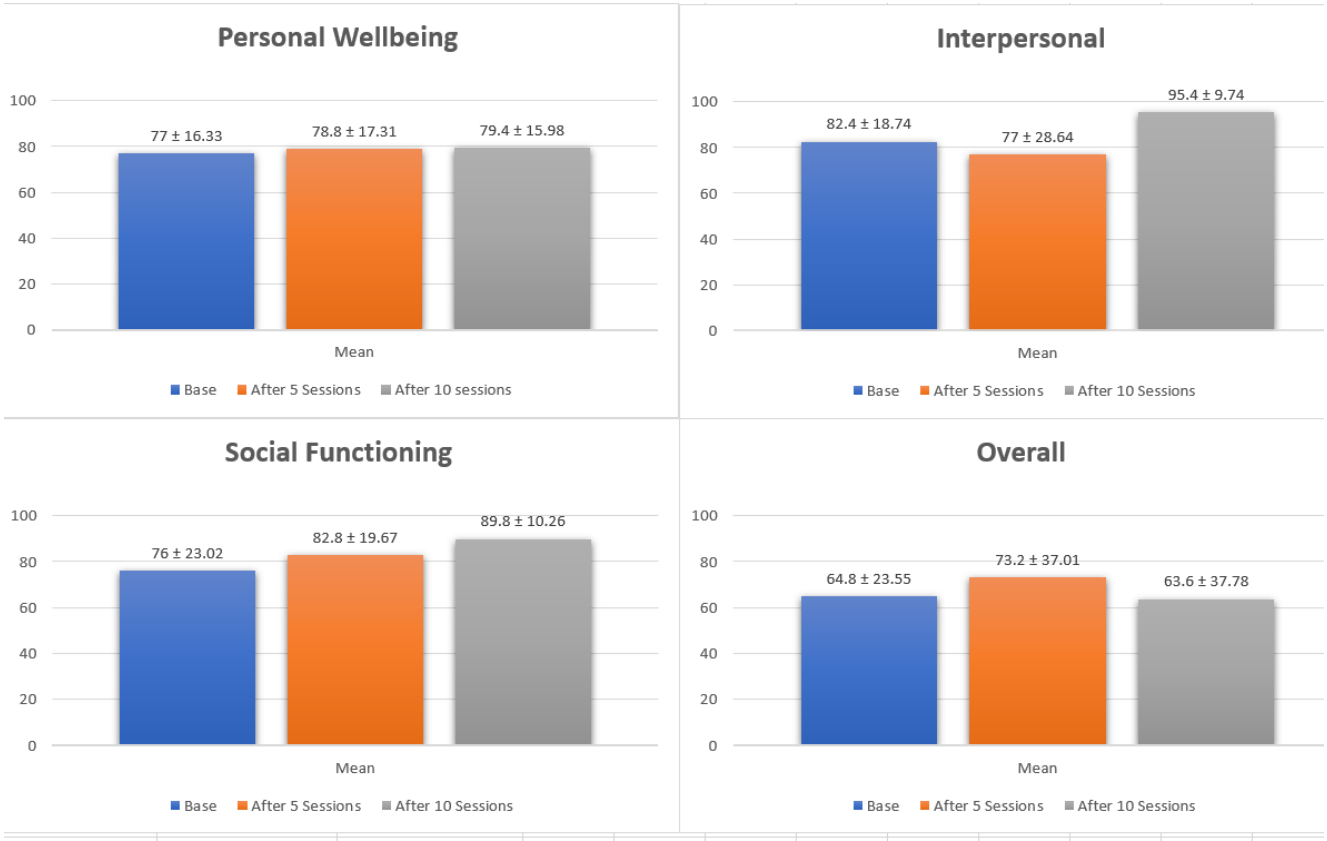
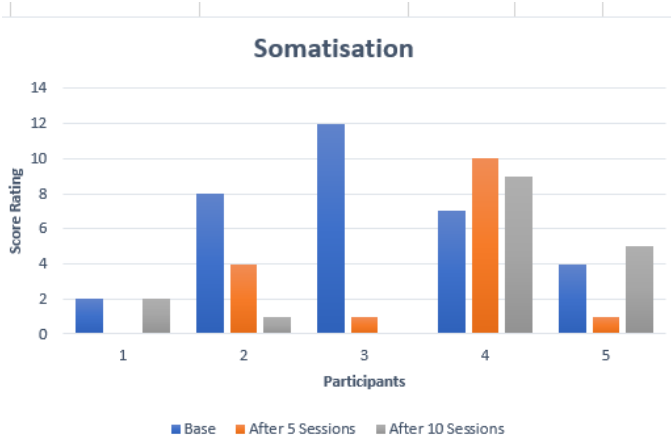


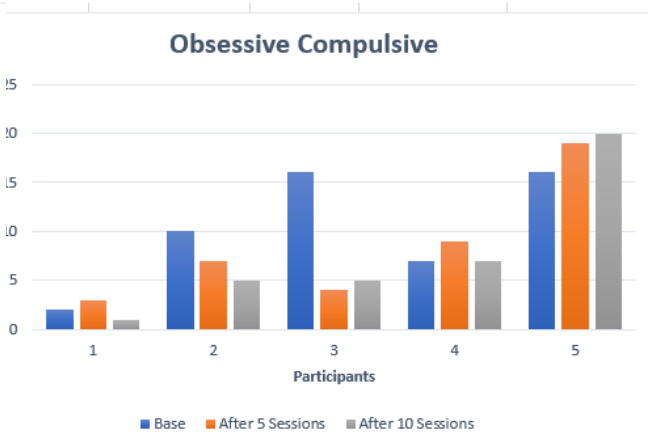

*Figure 5. Mean past mood scores for personal wellbeing, interpersonal, social functioning, and overall.*

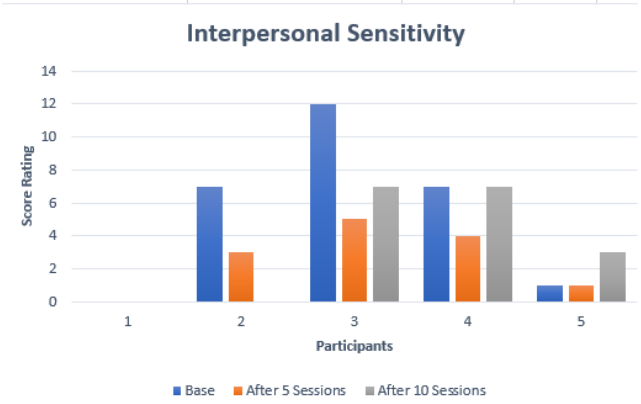
There was an increase in personal wellbeing ($\eta^2$=0.02 p>0.05), interpersonal ($\eta^2$=0.3 p>0.05), and social functioning ($\eta^2$=0.43 p>0.05) from baseline and after 10 sessions. There was a decrease in the overall rating ($\eta^2$=0.12 p>0.05) which was accompanied by the largest standard deviation in comparison to other past mood domains.

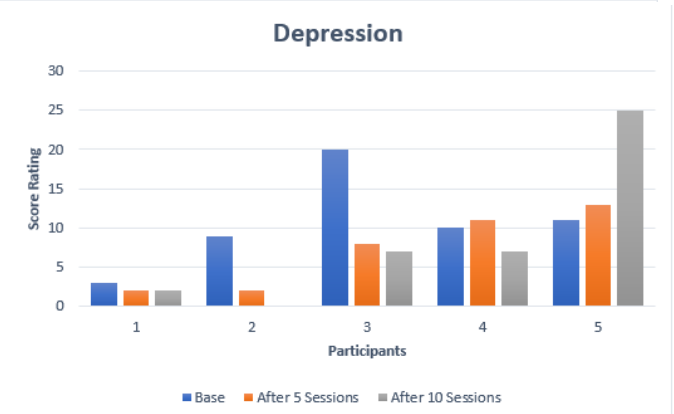
**Participant Characteristics at Pre-to-Post Neurofeedback Training Changes**

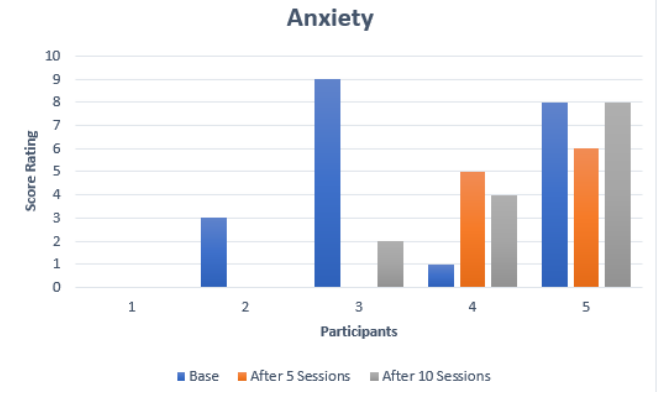
At baseline one participant (participant 2) met the criteria for symptoms consistent with ADHD (ADHD-ASRS). In BIS-11, 2 out of 5 (participant 2 and 3) scored high enough to be considered to have pathological impulsivity (Crisan et al, 2017). From the brief trauma questionnaire (BTQ), 2 individuals (participant 2 and 3) scored negative while 3 individuals (participant 1,4, and 5) scored positive for trauma. Participants 2 and 3 who scored high in impulsivity (BIS-11) and ADHD (participant 2) showed consistent improvements in mental health, sleep quality, mood and wellbeing with a large scope of change from baseline and after 10 sessions of non-linear neurofeedback compared to participants 1, 4, and 5. This is illustrated in Figures 6, 7, 9, and 10.

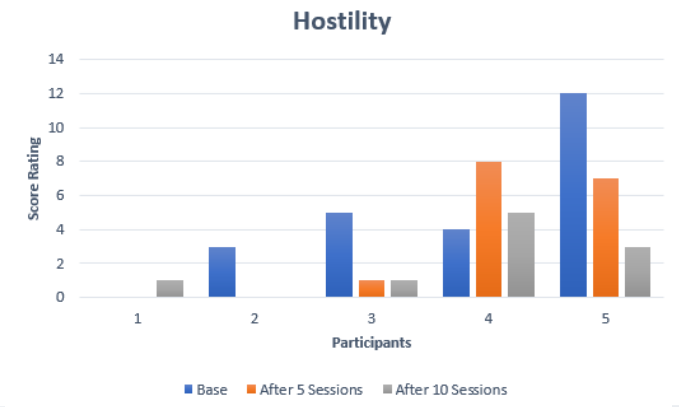

Somatisation
Score Rating
Participants
Base
After 5 Sessions
After 10 Sessions

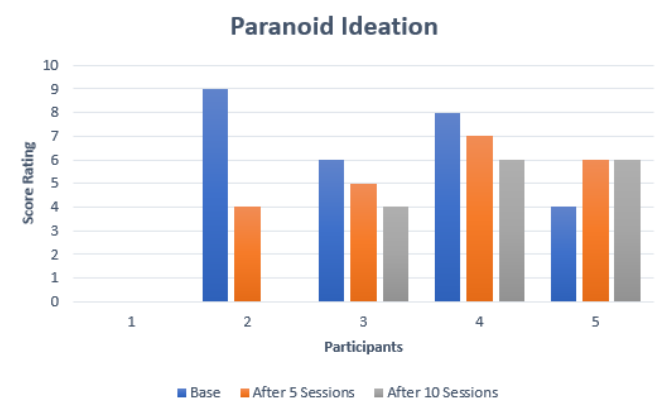

Obsessive Compulsive
Participants
Base
After 5 Sessions
After 10 Sessions

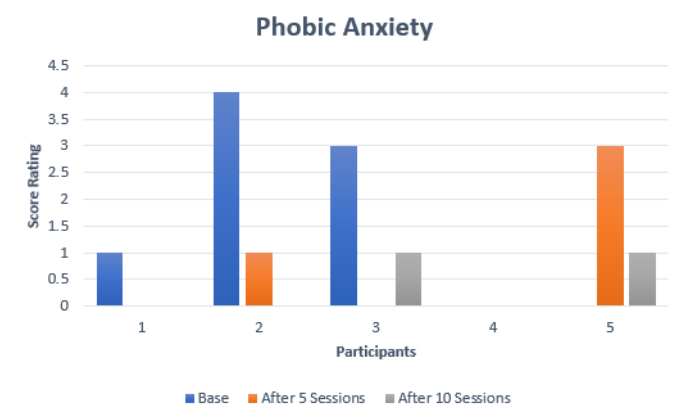

Interpersonal Sensitivity
Score Rating
Participants
Base
After 5 Sessions
After 10 Sessions


Depression
Score Rating
Participants
Base
After 5 Sessions
After 10 Sessions


Anxiety
Score Rating
Participants
Base
After 5 Sessions
After 10 Sessions


Hostility
Score Rating
Participants
Base
After 5 Sessions
After 10 Sessions


Paranoid Ideation
Score Rating
Participants
Base
After 5 Sessions
After 10 Sessions


Phobic Anxiety
Score Rating
Participants
Base
After 5 Sessions
After 10 Sessions

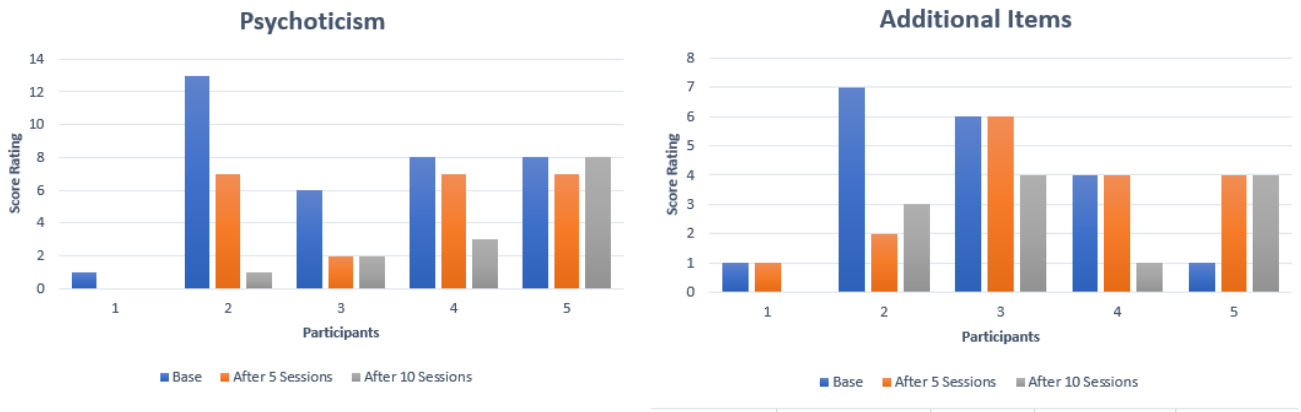



*Figure 6. Individual participant ratings in each domain acquired from the SCL 90 R forms.*

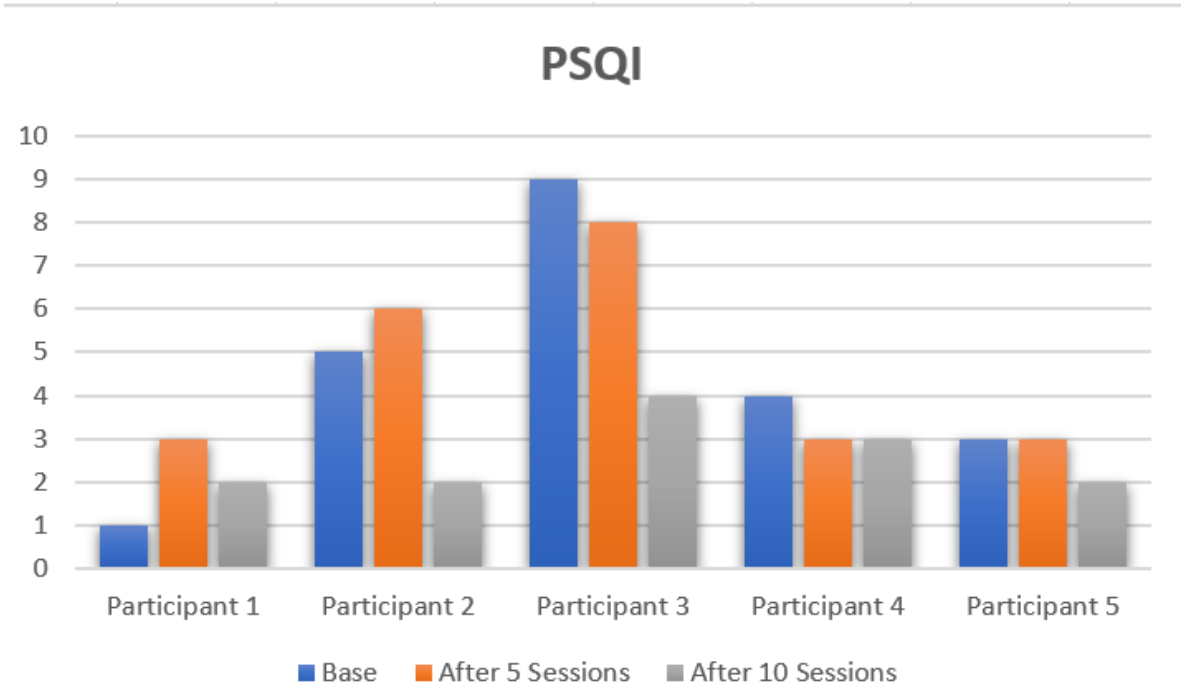



*Figure 7. Individual participant ratings for PSQI.*

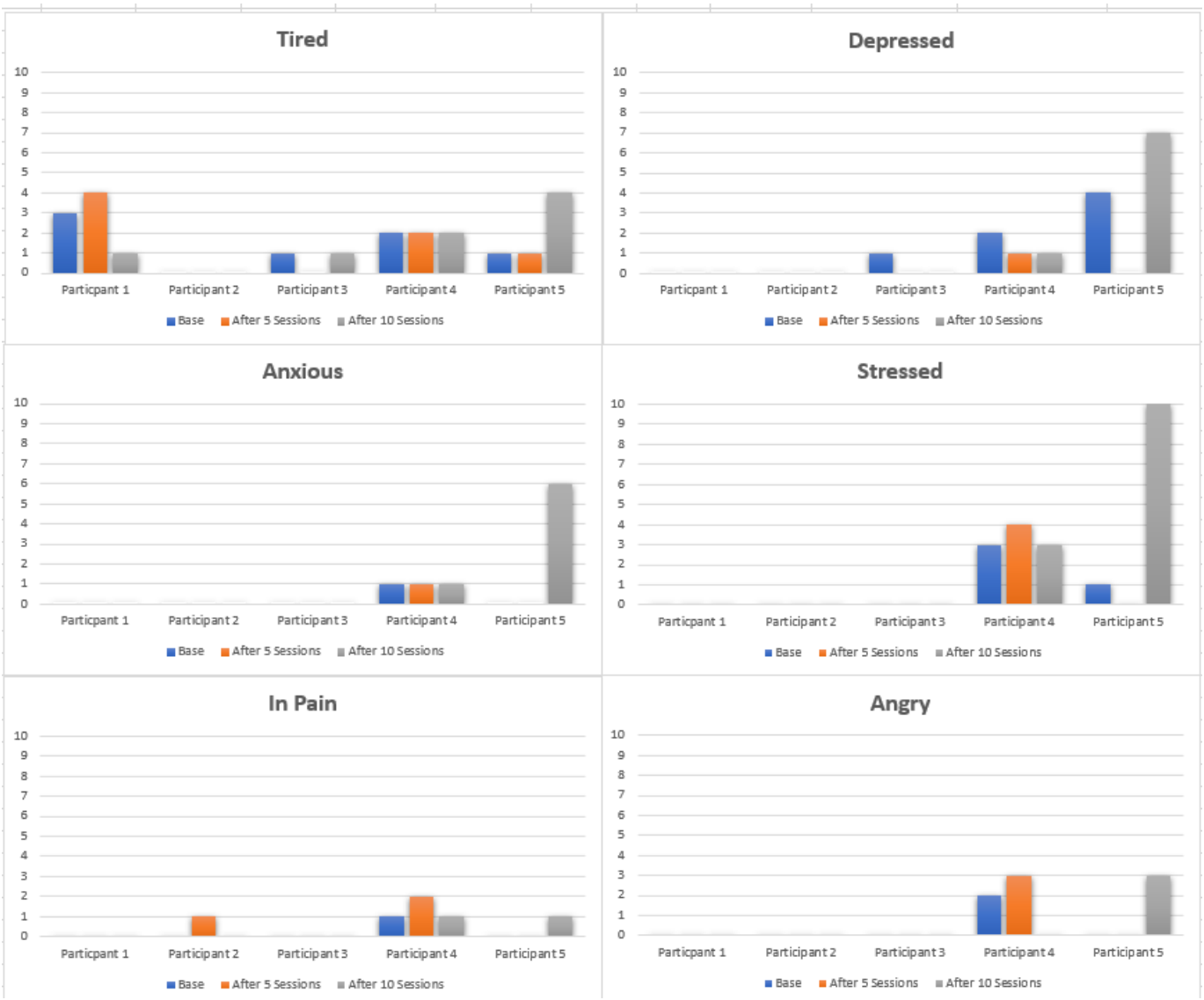



*Figure 8. Indivdual participant ratings for tired, depressed, anxious, stressed, in pain, and angry.*

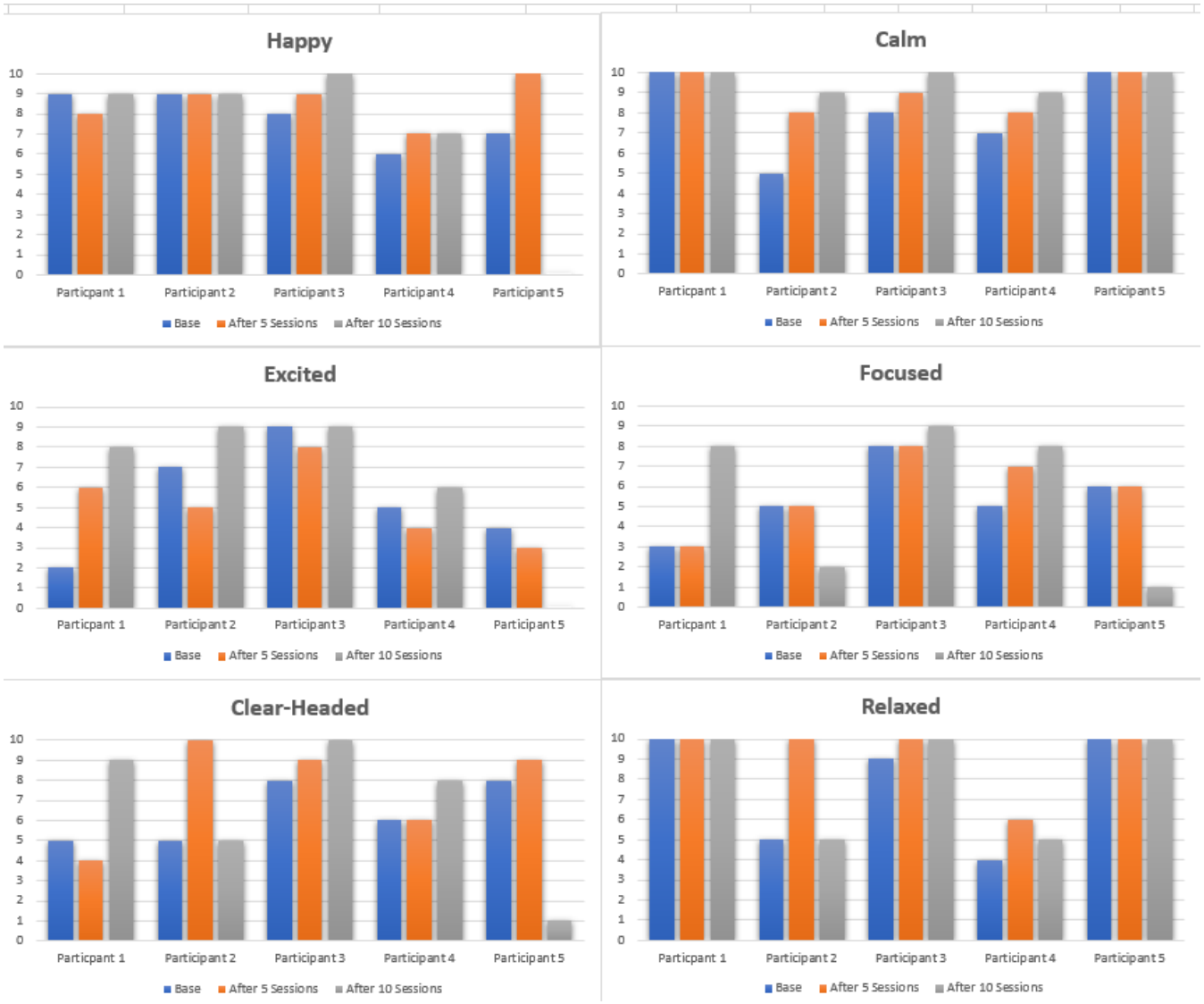



*Figure 9. Individual participant ratings for happy, calm, excited, focused, clear-headed, and relaxed.*

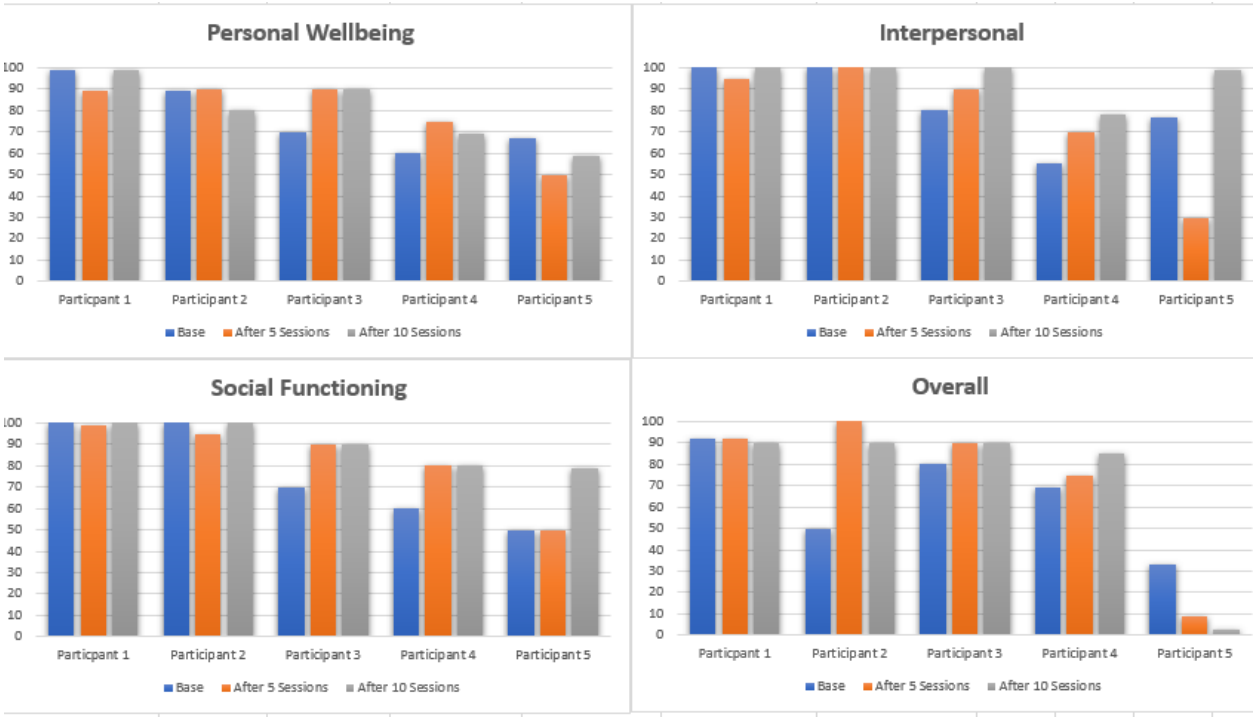



*Figure 10. Individual participant ratings for personal wellbeing, interpersonal, social functioning, and overall.*

## Discussion

The results show a general positive change in mental health (*Figure 1)* as well as improved sleep quality (*Figure 2*). Past mood scores also showed improvement in personal wellbeing, interpersonal, and social functioning except for overall rating (*Figure 5*). The lack of significance can be explained to the small sample size (n=5) with one individual reporting results that greatly deviated from the others which as a consequence given the sample size can alter the statistical analyses considerably as a whole. This is evident in the current mood scores (*Figure 8*) where high levels of depression, anxiety, and stress was reported by one participant after 10 sessions indicating that perhaps the individual was going through a personal matter that caused distress that was outside the control boundaries. However, the results do suggest that the shift after non-linear neurofeedback training is in the right direction with some mental health domains as well as mood being more susceptible than others such as psychoticism and calmness. Sleep quality improvement were reported by all participants which could also serve as a potential precursor for the improvements in mental health, acting as a potential catalyst as it is widely known that sleep plays a critical role in promoting health (Irwin, 2015).

The case notes gathered throughout the sessions where participants can report anything that they have noticed out of the ordinary that could not be tracked by the forms already used, revealed that all participants reported improvement in one form or another (Appendix A). This was done with precedence from Cochrane (2010) in her doctoral thesis of comprehensive neurofeedback training in the context of psychotherapy for transformational change. The open reports showcased how differently everyone reacted to non-linear neurofeedback which seems appropriate given that non-linear neurofeedback works throughout all the brainwaves simultaneously and subconsciously, as a result, individuals elicit different responses and this was reflected in this pilot study. Interestingly, the case notes

of this study shared a similarity from the case notes of Cochrane (2010) where the individuals, although reported different responses, the general shift of the responses was drifting towards greater mental health and stability but was expressed through different outcomes.

The minimum criteria of 10 sessions may have been premature as 3 participants manged to get up to 20 sessions with continued improvement (Appendix B) but results were analysed up to 10 due to the remaining individuals stopping at 10 sessions and one participant was excluded altogether as the minimum criteria was not met (5 sessions). This can be argued that the spikes from the individual in negative mood and depression after 10 sessions could have been mediated or stabilised if the number of sessions were extended and may show benefits that would not otherwise be present at only 10 sessions. Existing research in neurofeedback has sessions ranging from 30 to 40 (Kouijzer et al, 2009; Bakhshayesh et al, 2011; Schonenburg et al, 2017) with some reaching over 100 sessions (Cochrane, 2010) but due to a short testing period, 10 sessions was a manageably appropriate target which already showed a shift in the right direction and can be postulated to show early shifts of non-linear neurofeedback. To establish a clearer trend, additional sessions would be required.

While there was a lack of significance, the individuals who started off with higher symptom scores did exhibit a greater change in comparison to others as was predicted. This could be a result due to the initial distance from equilibrium making those individuals more susceptible to change once the imbalance is addressed. In addition, nonlinear dynamic systems tell us that change will be predictably unpredictable (Bresler and Starr, 2015) making it difficult to predict with certainty whether symptoms will respond to non-linear neurofeedback or how long the process might take. However, it can be expected for the central nervous system to function with more flexibility and resilience, which could potentially explain the drift in the right direction.

## Theoretical Interpretation

It is clear from the literature review that any mental disorder is accompanied by an imbalance in brainwave activity meaning that there is a delicate balance that is maintained for the brain to achieve an optimal state of being. Non-linear neurofeedback is built on the theory of self-organisation which means that as a complex system with many interacting elements, the brain develops its own set of preferred states, which it constructs and reconstructs. Operating in a non-linear fashion, the cortex does not rest as there is continuous change, providing constant opportunities for growth (Bresler and Starr, 2015). Time and space are fractal (Mandelbrot, 1983) which includes the idea of a detailed pattern repeating itself, this can be applied to the brainwave activity as well as neuronal activity where non-linear neurofeedback attempts to bring it into synchronous coherent function to reach equilibrium. The process, which is done subconsciously utilises the central nervous system innate intelligence allowing it to be tailored to any unique individual brain and elicit unique responses, something that cannot be attained in linear systems. Through the deterministic chaos, it is plausible that non-linear neurofeedback can improve one's cognitive coherency but can be counterintuitive if it is followed by self-sabotage behaviours and perhaps it may be better be seen as a synergistic tool to be used with volitional intent toward mental and physical health.

## Limitations

Due to this being a pilot study with limited resources and time, the sample size was small with no control group, but each participant was used as their own control as a compensatory effort. In addition, two points are worth bringing to attention during the testing. Firstly, this was conducted during the implications of COVID-19 and as a result many individuals' daily lifestyle and routine was affected such as unable to carry out their regular

habitual behaviour. This is evident in one of the participants who had a reverse sleep wake cycle given the drastic change in routine, however it was also evident that throughout the sessions the individual did regain a relatively balanced cycle. In addition, due to the implications, acquirement of further data was limited. Secondly, it was disclosed, unexpectedly, that all participants except for one were regular cannabis users. Cannabis is known for its psychoactive properties and potential inhibitions in working memory (Kanayama et al, 2004; Smith et al, 2014) and sleep (Angarita et al, 2016) to name a few. While it was not part of the exclusion criteria, the contribution of regular use of cannabis may have inhibited the efficacy of non-linear neurofeedback even though participants reported one form of improvement or another, it does bring the question whether the training may have been hindered by the use of cannabis. This would need to be considered for future research to limit potential confounding variables.

**Future Directions**

The findings from 10 sessions showing a general shift gives reason for further research but modifications should be made going forward. Firstly, a larger sample size should be considered and tracked for an extensive amount of time (30+ sessions), a longitudinal design would accommodate this. Secondly, on top of any marked visual or hearing impairment, psychoactive substances should be filtered out to limit extraneous constraints it may have while testing. Furthermore, open ended interviews with individuals may provide insight to potential benefits that non-linear neurofeedback can offer which cannot be measured on standardised forms.

**Conclusion**

Neurofeedback has a wide array of clinical applications from existing literature with promising results despite having reoccurring methodological issues. The pilot study on non-

linear neurofeedback indicated a general shift towards mental stability and health though the changes, perhaps not surprisingly given the small sample, were not statistically significant. These early findings provide a platform for extended research and gives merit for non-linear neurofeedback to serve as a potential therapeutic alternative to medication in mental disorders.

**Word Count: 8000**

## References


Alvarez, J., Meyer, F. L., Granoff, D. L., & Lundy, A. (2013). The effect of EEG biofeedback on reducing postcancer cognitive impairment. *Integrative cancer therapies*, *12*(6), 475-487.

Angarita, G. A., Emadi, N., Hodges, S., & Morgan, P. T. (2016). Sleep abnormalities associated with alcohol, cannabis, cocaine, and opiate use: a comprehensive review. *Addiction science & clinical practice*, *11*(1), 1-17.

Angelakis, E., Stathopoulou, S., Frymiare, J. L., Green, D. L., Lubar, J. F., & Kounios, J. (2007). EEG neurofeedback: a brief overview and an example of peak alpha frequency training for cognitive enhancement in the elderly. *The clinical neuropsychologist*, *21*(1), 110-129.

Arns, M., De Ridder, S., Strehl, U., Breteler, M., & Coenen, A. (2009). Efficacy of neurofeedback treatment in ADHD: the effects on inattention, impulsivity, and hyperactivity: a meta-analysis. *Clinical EEG and neuroscience*, *40*(3), 180-189.

Arns M, Drinkenburg W, Leon Kenemans J. The effects of QEEG-informed neurofeedback in ADHD: an open-label pilot study. *Appl Psychophysiol Biofeedback*. 2012;37(3):171–180. doi:10.1007/s10484-012-9191-4

Arns, M., & Kenemans, J. L. (2014). Neurofeedback in ADHD and insomnia: vigilance stabilization through sleep spindles and circadian networks. *Neuroscience & Biobehavioral Reviews*, *44*, 183-194.

Bakhshayesh, A. R., Hänsch, S., Wyschkon, A., Rezai, M. J., & Esser, G. (2011). Neurofeedback in ADHD: a single-blind randomized controlled trial. *European child & adolescent psychiatry*, *20*(9), 481.

Becerra, J., Fernandez, T., Harmony, T., Caballero, M. I., Garcia, F., Fernandez-Bouzas, A., & Prado-Alcalá, R. A. (2006). Follow-up study of learning-disabled children treated with neurofeedback or placebo. *Clinical EEG and neuroscience*, *37*(3), 198-203.

Bond A, Lader M. The use of analogue scales in rating subjective feelings. *British Journal of Medical Psychology*. 1974;47:211-218

Bresler, J., & Starr, K. E. (Eds.). (2015). *Relational psychoanalysis and psychotherapy integration: An evolving synergy*. Routledge.

Butnik, S. M. (2005). Neurofeedback in adolescents and adults with attention deficit hyperactivity disorder. *Journal of Clinical Psychology*, *61*(5), 621-625.

Buysse DJ, Reynolds CF 3rd, Monk TH, Berman SR, Kupfer DJ (1989). The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. *Psychiatry Res. 28*(2):193-213.

Christiansen, H., Reh, V., Schmidt, M. H., & Rief, W. (2014). Slow cortical potential neurofeedback and self-management training in outpatient care for children with ADHD: study protocol and first preliminary results of a randomized controlled trial. *Frontiers in human neuroscience*, *8*, 943.

Cochrane, K. (2010). *Comprehensive neurofeedback training in the context of psychotherapy for transformational change* (Doctoral dissertation, International University for Graduate Studies).

Collura, T. F., Guan, J., Tarrant, J., Bailey, J., & Starr, F. (2010). EEG biofeedback case studies using live Z-score training and a normative database. *Journal of Neurotherapy*, *14*(1), 22-46.

Congedo, M., Lubar, J. F., & Joffe, D. (2004). Low-resolution electromagnetic tomography neurofeedback. *IEEE Transactions on Neural Systems and Rehabilitation Engineering*, *12*(4), 387-397.

Crisan, G., Manea, M. M., Miron, A., Mitrofan, A., Savu, V. B., Scarisoreanu, G., & Dumitru, V. M. (2017). Is impulsivity the only trait that matters in addictive behaviour?. *European Neuropsychopharmacology*, *27*, S1082-S1083.

Dang-Vu, T. T., Desseilles, M., Laureys, S., Degueldre, C., Perrin, F., Phillips, C., & Peigneux, P. (2005). Cerebral correlates of delta waves during non-REM sleep revisited. *Neuroimage*, *28*(1), 14-21.

deBeus, R. J., & Kaiser, D. A. (2011). Neurofeedback with children with attention deficit hyperactivity disorder: A randomized double-blind placebo-controlled study. In *Neurofeedback and neuromodulation techniques and applications* (pp. 127-152). Academic Press.

DeLong, L. D. (2003). The effects of EEG neurofeedback and neuro-cognitive processing in the educational environment of an arts-based private elementary/middle school.

de Vente, W., Majdandžić, M., & Bögels, S. (2014). The pathophysiology of social anxiety.

Dias, Á. M., Van Deusen, A. M., Oda, E., & Bonfim, M. R. (2012). Clinical Efficacy of a New Automated Hemoencefalographic Neurofeedback Protocol. *The Spanish journal of psychology*, *15*(3), 930-941.

Duffy, F. H. (2000). Editorial: The state of EEG biofeedback therapy (EEG operant conditioning) in 2000: An editor's opinion. Clinical Electroencephalography, 31(1), v–viii

Dustman, R. E., Boswell, R. S., & Porter, P. B. (1962). Beta brain waves as an index of alertness. *Science*, *137*(3529), 533-534.

Egner, T., & Gruzelier, J. H. (2003). Ecological validity of neurofeedback: modulation of slow wave EEG enhances musical performance. *Neuroreport*, *14*(9), 1221-1224.

Egner, T., & Gruzelier, J. H. (2004). EEG biofeedback of low beta band components: frequency-specific effects on variables of attention and event-related brain potentials. *Clinical neurophysiology*, *115*(1), 131-139.

Egner, T., & Gruzelier, J. H. (2001). Learned self-regulation of EEG frequency components affects attention and event-related brain potentials in humans. *Neuroreport*, *12*(18), 4155-4159.

Egner, T., Strawson, E., & Gruzelier, J. H. (2002). EEG signature and phenomenology of alpha/theta neurofeedback training versus mock feedback. *Applied psychophysiology and biofeedback*, *27*(4), 261.

Emmert, K., Kopel, R., Sulzer, J., Brühl, A. B., & Berman, B. D. (2016). Meta-analysis of real-time fMRI neurofeedback studies using individual participant data: How is brain regulation mediated?. *NeuroImage*, *124*, 806-812.

Fauzan, N., & Amran, N. H. (2015). Brain waves and connectivity of autism spectrum disorders. *Procedia-Social and Behavioral Sciences*, *171*, 882-890.

Fernandez, T., Herrera, W., Harmony, T. A., Diaz-Comas, L., Santiago, E., Sanchez, L., ... & Barraza, C. (2003). EEG and behavioral changes following neurofeedback treatment in learning disabled children. *Clinical Electroencephalography*, *34*(3), 145-152.

Fuchs, T., Birbaumer, N., Lutzenberger, W., Gruzelier, J. H., & Kaiser, J. (2003). Neurofeedback treatment for attention-deficit/hyperactivity disorder in children: a comparison with methylphenidate. *Applied psychophysiology and biofeedback*, *28*(1), 1-12.

Giraudon, I., Lowitz, K., Dargan, P. I., Wood, D. M., & Dart, R. C. (2013). Prescription opioid abuse in the UK. *British journal of clinical pharmacology*, *76*(5), 823–824. doi:10.1111/bcp.12133

Greenberg, L. M., & Waldmant, I. D. (1993). Developmental normative data on the Test of Variables of Attention (TOVA™). *Journal of Child Psychology and Psychiatry*, *34*(6), 1019-1030.

Grinberg-Zylberbaum, J., Delaflor, M., Attie, L., & Goswami, A. (1994). The Einstein-Podolsky-Rosen Paradox in the Brain: The Transferred Potential. *Physics Essays*, *7*(4), 422-428.

Gruzelier, J. (2009). A theory of alpha/theta neurofeedback, creative performance enhancement, long distance functional connectivity and psychological integration. *Cognitive processing*, *10*(1), 101-109.

Gruzelier, J. H., Thompson, T., Redding, E., Brandt, R., & Steffert, T. (2014). Application of alpha/theta neurofeedback and heart rate variability training to young contemporary dancers: State anxiety and creativity. *International Journal of Psychophysiology*, *93*(1), 105-111.

Hathaway, S. R., & McKinley, J. C. (1951). Minnesota Multiphasic Personality Inventory; Manual, revised.

Hammer, B. U., Colbert, A. P., Brown, K. A., & Ilioi, E. C. (2011). Neurofeedback for insomnia: A pilot study of Z-score SMR and individualized protocols. *Applied psychophysiology and biofeedback*, *36*(4), 251-264.

Hammond, D. C. (2005a). Neurofeedback treatment of depression and anxiety. *Journal of Adult Development*, *12*(2-3), 131-137.

Hammond, D. C. (2005b). Neurofeedback with anxiety and affective disorders. *Child and Adolescent Psychiatric Clinics*, *14*(1), 105-123.

Hammond, D. C. (2010c). Lens neurofeedback treatment of anger: Preliminary reports. *Journal of Neurotherapy*, *14*(2), 162-169.

Hammond, D. C. (2010b). QEEG evaluation of the LENS treatment of TBI. *Journal of Neurotherapy*, *14*(2), 170-177.

Hammond, D. C. (2003). QEEG-guided neurofeedback in the treatment of obsessive compulsive disorder. *Journal of Neurotherapy*, *7*(2), 25-52.

Hammond, D. C. (2010a). The need for individualization in neurofeedback: heterogeneity in QEEG patterns associated with diagnoses and symptoms. *Applied Psychophysiology and Biofeedback*, *35*(1), 31.

Hammond, D. C. (2007). What is neurofeedback?. *Journal of neurotherapy*, *10*(4), 25-36.

Hammond, D. C. (2011). What is Neurofeedback: An Update. *Journal of Neurotherapy*, *15*, 305-336.

Hanslmayr, S., Sauseng, P., Doppelmayr, M., Schabus, M., & Klimesch, W. (2005). Increasing individual upper alpha power by neurofeedback improves cognitive performance in human subjects. *Applied psychophysiology and biofeedback*, *30*(1), 1-10.

Hardt, J. V., & Kamiya, J. (1978). Anxiety change through electroencephalographic alpha feedback seen only in high anxiety subjects. *Science*, *201*(4350), 79-81.

Heinrich, H., Gevensleben, H., & Strehl, U. (2007). Annotation: Neurofeedback–train your brain to train behaviour. *Journal of Child Psychology and Psychiatry*, *48*(1), 3-16.

Hoehn-Saric, R. (1998). Psychic and somatic anxiety: worries, somatic symptoms and physiological changes. *Acta Psychiatrica Scandinavica*, *98*, 32-38.

Iasemidis, L. D. (2003). Epileptic seizure prediction and control. *IEEE Transactions on Biomedical Engineering*, *50*(5), 549-558.

Irwin, M. R. (2015). Why sleep is important for health: a psychoneuroimmunology perspective. *Annual review of psychology*, *66*.

Johnston, S. J., Boehm, S. G., Healy, D., Goebel, R., & Linden, D. E. (2010). Neurofeedback: a promising tool for the self-regulation of emotion networks. *Neuroimage*, *49*(1), 1066-1072.

Kaiser, J., & Lutzenberger, W. (2003). Induced gamma-band activity and human brain function. *The Neuroscientist*, *9*(6), 475-484.

Kanayama, G., Rogowska, J., Pope, H. G., Gruber, S. A., & Yurgelun-Todd, D. A. (2004). Spatial working memory in heavy cannabis users: a functional magnetic resonance imaging study. *Psychopharmacology*, *176*(3-4), 239-247.

Kay, S. R., Fiszbein, A., & Opler, L. A. (1987). The positive and negative syndrome scale (PANSS) for schizophrenia. *Schizophrenia bulletin*, *13*(2), 261-276.

Keizer, A. W., Verschoor, M., Verment, R. S., & Hommel, B. (2010). The effect of gamma enhancing neurofeedback on the control of feature bindings and intelligence measures. *International Journal of Psychophysiology*, *75*(1), 25-32.

Kessler, R. C., Adler, L., Ames, M., Demler, O., Faraone, S., Hiripi, E. V. A. & Ustun, T. B. (2005). The World Health Organization Adult ADHD Self-Report Scale (ASRS): a short screening scale for use in the general population. *Psychological medicine, 35*(02), 245-256.

Kotchoubey, B., Blankenhorn, V., Fröscher, W., Strehl, U., & Birbaumer, N. (1997). Stability of cortical self-regulation in epilepsy patients. *Neuroreport*, *8*(8), 1867-1870.

Kouijzer, M. E., de Moor, J. M., Gerrits, B. J., Buitelaar, J. K., & van Schie, H. T. (2009). Long-term effects of neurofeedback treatment in autism. *Research in Autism Spectrum Disorders*, *3*(2), 496-501.

Larsen, S., Harrington, K., & Hicks, S. (2006). The LENS (low energy neurofeedback system): A clinical outcomes study on one hundred patients at Stone Mountain Center, New York. *Journal of Neurotherapy*, *10*(2-3), 69-78.

Lentz, M. J., Landis, C. A., Rothermel, J. L., & Shaver, J. L. (1999). Effects of selective slow wave sleep disruption on musculoskeletal pain and fatigue in middle aged women. *The Journal of rheumatology*, *26*(7), 1586-1592.

Lubar, J. F., Swartwood, M. O., Swartwood, J. N., & O'Donnell, P. H. (1995). Evaluation of the effectiveness of EEG neurofeedback training for ADHD in a clinical setting as measured by changes in TOVA scores, behavioral ratings, and WISC-R performance. *Biofeedback and Self-regulation*, *20*(1), 83-99.

Mandelbrot, B. B. (1983). The fractal geometry of nature/Revised and enlarged edition. *whf*.

Marzbani, H., Marateb, H. R., & Mansourian, M. (2016). Neurofeedback: a comprehensive review on system design, methodology and clinical applications. *Basic and clinical neuroscience*, *7*(2), 143.

McCabe, S. E., Teter, C. J., & Boyd, C. J. (2006). Medical use, illicit use, and diversion of abusable prescription drugs. *Journal of American college health*, *54*(5), 269-278.

McCarthy-Jones, S. (2012). Taking back the brain: could neurofeedback training be effective for relieving distressing auditory verbal hallucinations in patients with schizophrenia?. *Schizophrenia Bulletin*, *38*(4), 678-682.

McManus, S., Hassiotis, A., Jenkins, R., Dennis, M., Aznar, C., Appleby, L., & Brugha, T. (2014). Suicidal thoughts, suicide attempts and self-harm. *Mental Health and Wellbeing in England: Adult Psychiatric Morbidity Survey 2014*.

Mueller, H. H., Donaldson, C. S., Nelson, D. V., & Layman, M. (2001). Treatment of fibromyalgia incorporating EEG-driven stimulation: a clinical outcomes study. *Journal of Clinical Psychology*, *57*(7), 933-952.

Nan, W., Chang, L., Rodrigues, J. P., Wan, F., Mak, P. U., Mak, P. I., & Rosa, A. (2012, July). Neurofeedback for the treatment of schizophrenia: case study. In *2012 IEEE International Conference on Virtual Environments Human-Computer Interfaces and Measurement Systems (VECIMS) Proceedings* (pp. 78-81). IEEE.

National Drug Treatment Monitoring System (NDTMS) | The Royal College of Anaesthetists. (2019). https://www.rcoa.ac.uk/faculty-of-pain-medicine/opioids-aware/clinical-use-of-opioids/ndtms

Nazari, M. A., Querne, L., De Broca, A., & Berquin, P. (2011). Effectiveness of EEG biofeedback as compared with methylphenidate in the treatment of Attention-

Deficit/Hyperactivity Disorder: A clinical outcome study. *Neuroscience & Medicine*, *2*(2), 78-86.

Nicolis, G., Prigogine, I., & Glansdorff, P. (2009). On the Mechanism of Instabilities in Nonlinear Systems. *Advances in chemical physics*, *64*, 1.

Niv, S. (2013). Clinical efficacy and potential mechanisms of neurofeedback. *Personality and Individual Differences*, *54*(6), 676-686.

Okunola, O., O'Malley, E., & O'Malley, M. (2007). Effectiveness of neurofeedback training in chronic insomnia. *Sleep*, *30*, A265.

Pascual-Marqui, R. D., Michel, C. M., & Lehmann, D. (1994). Low resolution electromagnetic tomography: a new method for localizing electrical activity in the brain. *International Journal of psychophysiology*, *18*(1), 49-65.

Patton JH, Stanford MS, and Barratt ES (1995) Journal of Clinical Psychology, 51, 768-774.

Plotkin, W. B., & Rice, K. M. (1981). Biofeedback as a placebo: Anxiety reduction facilitated by training in either suppression or enhancement of alpha brainwaves. *Journal of consulting and Clinical Psychology*, *49*(4), 590.

Prescription Drugs Abuse Causes & Effects | The Manor Clinic| Hampshire, U.K. (2019). from https://www.themanorclinic.com/prescription-drugs/symptoms-signs/

Prinz, U., Nutzinger, D. O., Schulz, H., Petermann, F., Braukhaus, C., & Andreas, S. (2013). Comparative psychometric analyses of the SCL-90-R and its short versions in patients with affective disorders. *BMC psychiatry*, *13*(1), 104.

Raymond, J., Varney, C., Parkinson, L. A., & Gruzelier, J. H. (2005). The effects of alpha/theta neurofeedback on personality and mood. *Cognitive brain research*, *23*(2-3), 287-292.

Results from the 2005 national survey on drug use and health: national findings. *http://www. oas. samhsa. gov/nsduh/2k5nsduh/2k5Results. pdf*.

Rief W, Fichter M (1992). The Symptom Check List SCL-90-R and its ability to discriminate between dysthymia, anxiety disorders, and anorexia nervosa. *Psychopathology 25*( 3): 128–38

Reiner, M., Rozengurt, R., & Barnea, A. (2014). Better than sleep: theta neurofeedback training accelerates memory consolidation. *Biological psychology*, *95*, 45-53.

Savage, S. R., Joranson, D. E., Covington, E. C., Schnoll, S. H., Heit, H. A., & Gilson, A. M. (2003). Definitions related to the medical use of opioids: evolution towards universal agreement. *Journal of pain and symptom management*, *26*(1), 655-667.

Schabus, M., Griessenberger, H., Gnjezda, M. T., Heib, D. P., Wislowska, M., & Hoedlmoser, K. (2017). Better than sham? A double-blind placebo-controlled neurofeedback study in primary insomnia. *Brain*, *140*(4), 1041-1052.

Schnurr, P., Vielhauer, M., Weathers, F., & Findler, M. (1999). The Brief Trauma Questionnaire (BTQ)

Schönenberg, M., Wiedemann, E., Schneidt, A., Scheeff, J., Logemann, A., Keune, P. M., & Hautzinger, M. (2017). Neurofeedback, sham neurofeedback, and cognitive-behavioural group therapy in adults with attention-deficit hyperactivity disorder: a triple-blind, randomised, controlled trial. *The Lancet Psychiatry*, *4*(9), 673-684.

Sekimoto, M., Kato, M., Kajimura, N., Watanabe, T., Takahashi, K., & Okuma, T. (2000). Asymmetric interhemispheric delta waves during all-night sleep in humans. *Clinical neurophysiology*, *111*(5), 924-928.

Silvana, M. S., Nada, P. J., & Dejan, G. (2008). Simultaneous EEG and EMG biofeedback for peak performance in musicians. *Prilozi*, *29*(1), 239-52.

Smith, M. J., Cobia, D. J., Wang, L., Alpert, K. I., Cronenwett, W. J., Goldman, M. B., & Csernansky, J. G. (2014). Cannabis-related working memory deficits and associated subcortical morphological differences in healthy individuals and schizophrenia subjects. *Schizophrenia bulletin*, *40*(2), 287-299.

Strehl, U., Aggensteiner, P., Wachtlin, D., Brandeis, D., Albrecht, B., Arana, M., & Freitag, C. M. (2017). Neurofeedback of slow cortical potentials in children with attention-deficit/hyperactivity disorder: a multicenter randomized trial controlling for unspecific effects. *Frontiers in human neuroscience*, *11*, 135.

Strehl, U., Leins, U., Goth, G., Klinger, C., Hinterberger, T., & Birbaumer, N. (2006). Self-regulation of slow cortical potentials: a new treatment for children with attention-deficit/hyperactivity disorder. *Pediatrics*, *118*(5), e1530-e1540.

Sürmeli, T., & Ertem, A. (2007). EEG neurofeedback treatment of patients with Down Syndrome. *Journal of Neurotherapy, 11*(1), 63-68.

Surmeli, T., Ertem, A., Eralp, E., & Kos, I. H. (2012). Schizophrenia and the efficacy of qEEG-guided neurofeedback treatment: a clinical case series. *Clinical EEG and Neuroscience*, *43*(2), 133-144.

Tan, G., Thornby, J., Hammond, D. C., Strehl, U., Canady, B., Arnemann, K., & Kaiser, D. A. (2009). Meta-analysis of EEG biofeedback in treating epilepsy. *Clinical EEG and neuroscience*, *40*(3), 173-179.

Thibault, R. T., Lifshitz, M., & Raz, A. (2017b). Neurofeedback or neuroplacebo?. *Brain*, *140*(4), 862-864.

Thibault, R. T., Lifshitz, M., & Raz, A. (2017). The climate of neurofeedback: scientific rigour and the perils of ideology. *Brain*, *141*(2), e11-e11.

Thibault, R. T., & Raz, A. (2017). The psychology of neurofeedback: Clinical intervention even if applied placebo. *American Psychologist*, *72*(7), 679.

Toomim, H., & Carmen, J. (1999). Hemoencephalography (HEG). *Biofeedback*, *27*(4), 10-14.

Toscani, M., Marzi, T., Righi, S., Viggiano, M. P., & Baldassi, S. (2010). Alpha waves: a neural signature of visual suppression. *Experimental brain research*, *207*(3-4), 213-219.

Vernon, D. J. (2005). Can neurofeedback training enhance performance? An evaluation of the evidence with implications for future research. *Applied psychophysiology and biofeedback*, *30*(4), 347.

Vernon, D., Egner, T., Cooper, N., Compton, T., Neilands, C., Sheri, A., & Gruzelier, J. (2003). The effect of training distinct neurofeedback protocols on aspects of cognitive performance. *International journal of psychophysiology*, *47*(1), 75-85.

Vos, T., Barber, R. M., Bell, B., Bertozzi-Villa, A., Biryukov, S., Bolliger, I., & Duan, L. (2015). Global, regional, and national incidence, prevalence, and years lived with disability for 301 acute and chronic diseases and injuries in 188 countries, 1990–2013: a

systematic analysis for the Global Burden of Disease Study 2013. *The Lancet*, *386*(9995), 743-800.

Walker, J. E. (2008). Power spectral frequency and coherence abnormalities in patients with intractable epilepsy and their usefulness in long-term remediation of seizures using neurofeedback. *Clinical EEG and neuroscience*, *39*(4), 203-205.

Walker, J. E. (2010). Using QEEG-guided neurofeedback for epilepsy versus standardized protocols: enhanced effectiveness?. *Applied psychophysiology and biofeedback*, *35*(1), 29.

Walter, D. O., & Adey, W. R. (1968). Is the brain linear. *IFAC Proceedings Volumes*, *2*(4), 11-22.

Whiteford, H. A., Degenhardt, L., Rehm, J., Baxter, A. J., Ferrari, A. J., Erskine, H. E., & Burstein, R. (2013). Global burden of disease attributable to mental and substance use disorders: findings from the Global Burden of Disease Study 2010. *The Lancet*, *382*(9904), 1575-1586.

Zandi Mehran, Y., Firoozabadi, M., & Rostami, R. (2015). Improvement of neurofeedback therapy for improved attention through facilitation of brain activity using local sinusoidal extremely low frequency magnetic field exposure. *Clinical EEG and neuroscience*, *46*(2), 100-112.

Zoefel, B., Huster, R. J., & Herrmann, C. S. (2011). Neurofeedback training of the upper alpha frequency band in EEG improves cognitive performance. *Neuroimage*, *54*(2), 1427-1431.

## Appendix A – Case Notes

**Participant 1 (Male, 24 years old) – 20 sessions**

(#) – number of sessions

(3) – reported feeling of suspended consciousness

(5) – inclined to go to sleep earlier

(7) – more vivid dreams, better recall

(8) – weird dreams

(13) – had a hangover from the night before, felt considerably better after session

**Participant 2 (female, 20 years old) – 20 sessions**

(#) – number of sessions

(3) – falls asleep quicker, has less bad dreams than usual

(12) – decreased smoking, went from a pack a day to 4-5 cigarettes

(14) – changes in dreams, less nightmares

(15) – frequent dreams, no nightmares

(17) – goes sleep at 10am, unusual from normal routine. Feels tired in the morning, wakes up 4am for work

(18) – mood swings

**Participant 3 (female, 43 years old) – 20 sessions)**

(#) – number of sessions

(3) – sleep worsened, could not fall asleep, waking up in the middle of the night

(5) – sleep fairly bad, possible stress from friend passing away

(8) – feels more clear-headed, not as tired

(14) – more calm

**Participant 4 (male, 24 years old) – 10 sessions**

(#) – number of sessions

(4) – feels refreshed, sleeping earlier and waking up earlier

(7) – felt a burst of energy after session

(8) – feels calmer overall

(9) – feels more consistent with day to day activities

**Participant 5 (male, 23 years old) – 10 sessions**

(#) – number of sessions

(3) – sleeping earlier and waking up earlier

(6) – has less aggressive thoughts than usual

(7) – not as phased by aggressive thoughts

**Participant 6 (female, 22 years old) – 5 sessions**

(#) – number of sessions

(1) - reported a mini-anxiety attack, prone to anxiety attacks recently

(2) – have not had any anxiety attacks since

(3) – reported being calmer. Mentioned hand tremors that have been recurring for a year. Possible stress/anxiety

## Appendix B – Raw Data

**Table 1: SCL-90 R Scores for Participant 1**

| Domain | Baseline | After 5 | After 10 | After 15 | After 20 |
|---|---|---|---|---|---|
| Somatisation | 2 | 0 | 2 | 2 | 0 |
| Obsessive Compulsive | 2 | 3 | 1 | 0 | 0 |
| Interpersonal Sensitivity | 0 | 0 | 0 | 0 | 0 |
| Depression | 3 | 2 | 2 | 0 | 3 |
| Anxiety | 0 | 0 | 0 | 0 | 0 |
| Hostility | 0 | 0 | 1 | 0 | 1 |
| Phobic Anxiety | 1 | 0 | 0 | 0 | 0 |
| Paranoid Ideation | 0 | 0 | 0 | 0 | 0 |
| Psychoticism | 1 | 0 | 0 | 0 | 0 |
| Additional Items | 1 | 1 | 0 | 0 | 0 |

**Table 2: SCL-90 R Scores for Participant 2**

| Domain | Baseline | After 5 | After 10 | After 15 | After 20 |
|---|---|---|---|---|---|
| Somatisation | 8 | 4 | 1 | 2 | 2 |
| Obsessive Compulsive | 10 | 7 | 5 | 3 | 5 |
| Interpersonal Sensitivity | 7 | 3 | 0 | 0 | 0 |
| Depression | 9 | 2 | 0 | 0 | 0 |
| Anxiety | 3 | 0 | 0 | 0 | 0 |
| Hostility | 3 | 0 | 0 | 0 | 0 |
| Phobic Anxiety | 4 | 1 | 0 | 0 | 0 |
| Paranoid Ideation | 9 | 4 | 0 | 0 | 0 |
| Psychoticism | 13 | 7 | 1 | 0 | 1 |
| Additional Items | 7 | 2 | 3 | 2 | 4 |

**Table 3: SCL-90 R Scores for Participant 3**

| Domain | Baseline | After 5 | After 10 | After 15 | After 20 |
|---|---|---|---|---|---|
| Somatisation | 12 | 1 | 0 | 0 | 0 |
| Obsessive Compulsive | 16 | 4 | 5 | 4 | 4 |
| Interpersonal Sensitivity | 12 | 5 | 7 | 5 | 1 |
| Depression | 20 | 8 | 7 | 4 | 1 |
| Anxiety | 9 | 0 | 2 | 0 | 1 |
| Hostility | 5 | 1 | 1 | 1 | 1 |
| Phobic Anxiety | 3 | 0 | 1 | 1 | 0 |
| Paranoid Ideation | 6 | 5 | 4 | 4 | 1 |
| Psychoticism | 6 | 2 | 2 | 2 | 1 |
| Additional Items | 6 | 6 | 4 | 1 | 1 |

**Table 4: SCL-90 R Scores for Participant 4**

| Domain | Baseline | After 5 | After 10 | After 15 | After 20 |
|---|---|---|---|---|---|
| Somatisation | 7 | 10 | 9 | - | - |
| Obsessive Compulsive | 7 | 9 | 7 | - | - |
| Interpersonal Sensitivity | 7 | 4 | 7 | - | - |
| Depression | 10 | 11 | 7 | - | - |
| Anxiety | 1 | 5 | 4 | - | - |
| Hostility | 4 | 8 | 5 | - | - |
| Phobic Anxiety | 0 | 0 | 0 | - | - |
| Paranoid Ideation | 8 | 7 | 6 | - | - |
| Psychoticism | 8 | 7 | 3 | - | - |
| Additional Items | 4 | 4 | 1 | - | - |

**Table 5: SCL-90 R Scores for Participant 5**

| Domain | Baseline | After 5 | After 10 | After 15 | After 20 |
|---|---|---|---|---|---|
| Somatisation | 4 | 1 | 5 | - | - |
| Obsessive Compulsive | 16 | 19 | 20 | - | - |
| Interpersonal Sensitivity | 1 | 1 | 3 | - | - |
| Depression | 11 | 13 | 25 | - | - |
| Anxiety | 8 | 6 | 8 | - | - |
| Hostility | 12 | 7 | 3 | - | - |
| Phobic Anxiety | 0 | 3 | 1 | - | - |
| Paranoid Ideation | 4 | 6 | 6 | - | - |
| Psychoticism | 8 | 7 | 8 | - | - |
| Additional Items | 1 | 4 | 4 | - | - |

**Table 6: SCL-90 R Scores for Participant 6**

| Domain | Baseline | After 5 | After 10 | After 15 | After 20 |
|---|---|---|---|---|---|
| Somatisation | 26 | - | - | - | - |
| Obsessive Compulsive | 23 | - | - | - | - |
| Interpersonal Sensitivity | 10 | - | - | - | - |
| Depression | 31 | - | - | - | - |
| Anxiety | 28 | - | - | - | - |
| Hostility | 14 | - | - | - | - |
| Phobic Anxiety | 4 | - | - | - | - |
| Paranoid Ideation | 5 | - | - | - | - |
| Psychoticism | 11 | - | - | - | - |
| Additional Items | 13 | - | - | - | - |

**Table 7: Current Mood Scores for Participant 1**

| Mood | Baseline | After 5 | After 10 | After 15 | After 20 |
|---|---|---|---|---|---|
| Tired | 3 | 4 | 1 | 4 | 0 |
| Depressed | 0 | 0 | 0 | 0 | 0 |
| Anxious | 0 | 0 | 0 | 0 | 0 |
| Stressed | 0 | 0 | 0 | 0 | 0 |
| In Pain | 0 | 0 | 0 | 1 | 0 |
| Angry | 0 | 0 | 0 | 0 | 0 |
| Happy | 9 | 8 | 9 | 9 | 8 |
| Calm | 10 | 10 | 10 | 10 | 10 |
| Excited | 2 | 6 | 8 | 6 | 0 |
| Focused | 3 | 3 | 8 | 6 | 1 |
| Clear-headed | 5 | 4 | 9 | 9 | 10 |
| Relaxed | 10 | 10 | 10 | 10 | 10 |

**Table 8: Past Mood Scores for Participant 1**

| Domain | Baseline | After 5 | After 10 | After 15 | After 20 |
|---|---|---|---|---|---|
| Personal Wellbeing | 99 | 89 | 99 | 93 | 95 |
| Interpersonal | 100 | 95 | 100 | 100 | 95 |
| Social Functioning | 100 | 99 | 100 | 100 | 100 |
| Overall | 92 | 92 | 90 | 99 | 95 |

**Table 9: Current Mood Scores for Participant 2**

| Mood | Baseline | After 5 | After 10 | After 15 | After 20 |
|---|---|---|---|---|---|
| Tired | 0 | 0 | 0 | 1 | 5 |
| Depressed | 0 | 0 | 0 | 0 | 0 |
| Anxious | 0 | 0 | 0 | 0 | 0 |
| Stressed | 0 | 0 | 0 | 0 | 0 |
| In Pain | 0 | 1 | 0 | 1 | 5 |
| Angry | 0 | 0 | 0 | 0 | 0 |
| Happy | 9 | 9 | 9 | 5 | 5 |
| Calm | 5 | 8 | 9 | 10 | 5 |
| Excited | 7 | 5 | 9 | 2 | 5 |
| Focused | 5 | 5 | 2 | 4 | 1 |
| Clear-headed | 5 | 10 | 5 | 3 | 10 |
| Relaxed | 5 | 10 | 5 | 8 | 10 |

**Table 10: Past Mood Scores for Participant 2**

| Domain | Baseline | After 5 | After 10 | After 15 | After 20 |
|---|---|---|---|---|---|
| Personal Wellbeing | 89 | 90 | 80 | 90 | 90 |
| Interpersonal | 100 | 100 | 100 | 95 | 95 |
| Social Functioning | 100 | 95 | 100 | 90 | 95 |
| Overall | 50 | 100 | 90 | 90 | 80 |

**Table 11: Current Mood Scores for Participant 3**

| Mood | Baseline | After 5 | After 10 | After 15 | After 20 |
|---|---|---|---|---|---|
| Tired | 1 | 0 | 1 | 1 | 1 |
| Depressed | 1 | 0 | 0 | 9 | 0 |
| Anxious | 0 | 0 | 0 | 0 | 0 |
| Stressed | 0 | 0 | 0 | 0 | 0 |
| In Pain | 0 | 0 | 0 | 0 | 0 |
| Angry | 0 | 0 | 0 | 0 | 0 |
| Happy | 8 | 9 | 10 | 10 | 9 |
| Calm | 8 | 9 | 10 | 10 | 10 |
| Excited | 9 | 8 | 9 | 10 | 9 |
| Focused | 8 | 8 | 9 | 10 | 9 |
| Clear-headed | 8 | 9 | 10 | 10 | 9 |
| Relaxed | 9 | 10 | 10 | 10 | 10 |

**Table 12: Past Mood Scores for Participant 3**

| Domain | Baseline | After 5 | After 10 | After 15 | After 20 |
|---|---|---|---|---|---|
| Personal Wellbeing | 70 | 90 | 90 | 90 | 90 |
| Interpersonal | 80 | 90 | 100 | 100 | 100 |
| Social Functioning | 70 | 90 | 90 | 95 | 90 |
| Overall | 80 | 90 | 90 | 90 | 90 |

**Table 13: Current Mood Scores for Participant 4**

| Mood | Baseline | After 5 | After 10 | After 15 | After 20 |
|---|---|---|---|---|---|
| Tired | 2 | 2 | 2 | - | - |
| Depressed | 2 | 1 | 1 | - | - |
| Anxious | 1 | 1 | 1 | - | - |
| Stressed | 3 | 4 | 3 | - | - |
| In Pain | 1 | 2 | 1 | - | - |
| Angry | 2 | 3 | 0 | - | - |
| Happy | 6 | 7 | 7 | - | - |
| Calm | 7 | 8 | 9 | - | - |
| Excited | 5 | 4 | 6 | - | - |
| Focused | 5 | 7 | 8 | - | - |
| Clear-headed | 6 | 6 | 8 | - | - |
| Relaxed | 4 | 6 | 5 | - | - |

**Table 14: Past Mood Scores for Participant 4**

| Domain | Baseline | After 5 | After 10 | After 15 | After 20 |
|---|---|---|---|---|---|
| Personal Wellbeing | 60 | 75 | 69 | - | - |
| Interpersonal | 55 | 70 | 78 | - | - |
| Social Functioning | 60 | 80 | 80 | - | - |
| Overall | 69 | 75 | 85 | - | - |

**Table 15: Current Mood Scores for Participant 5**

| Mood | Baseline | After 5 | After 10 | After 15 | After 20 |
|---|---|---|---|---|---|
| Tired | 1 | 1 | 4 | - | - |
| Depressed | 4 | 0 | 7 | - | - |
| Anxious | 0 | 0 | 6 | - | - |
| Stressed | 1 | 0 | 10 | - | - |
| In Pain | 0 | 0 | 1 | - | - |
| Angry | 0 | 0 | 3 | - | - |
| Happy | 7 | 10 | 0 | - | - |
| Calm | 10 | 10 | 10 | - | - |
| Excited | 4 | 3 | 0 | - | - |
| Focused | 6 | 6 | 1 | - | - |
| Clear-headed | 8 | 9 | 1 | - | - |
| Relaxed | 10 | 10 | 10 | - | - |

**Table 16: Past Mood Scores for Participant 5**

| Domain | Baseline | After 5 | After 10 | After 15 | After 20 |
|---|---|---|---|---|---|
| Personal Wellbeing | 67 | 50 | 59 | - | - |
| Interpersonal | 77 | 30 | 99 | - | - |
| Social Functioning | 50 | 50 | 79 | - | - |
| Overall | 33 | 9 | 3 | - | - |

**Table 17: Current Mood Scores for Participant 6**

| Mood | Baseline | After 5 | After 10 | After 15 | After 20 |
|---|---|---|---|---|---|
| Tired | 6 | - | - | - | - |
| Depressed | 7 | - | - | - | - |
| Anxious | 7 | - | - | - | - |
| Stressed | 7 | - | - | - | - |
| In Pain | 3 | - | - | - | - |
| Angry | 3 | - | - | - | - |
| Happy | 2 | - | - | - | - |
| Calm | 5 | - | - | - | - |
| Excited | 1 | - | - | - | - |
| Focused | 6 | - | - | - | - |
| Clear-headed | 3 | - | - | - | - |
| Relaxed | 5 | - | - | - | - |

**Table 18: Past Mood Scores for Participant 6**

| Domain | Baseline | After 5 | After 10 | After 15 | After 20 |
|---|---|---|---|---|---|
| Personal Wellbeing | 40 | - | - | - | - |
| Interpersonal | 45 | - | - | - | - |
| Social Functioning | 50 | - | - | - | - |
| Overall | 30 | - | - | - | - |

**Table 19: PSQI Scores**

| Participant | Baseline | After 5 | After 10 | After 15 | After 20 |
|---|---|---|---|---|---|
| 1 | 1 | 3 | 2 | 1 | 2 |
| 2 | 5 | 6 | 2 | 3 | 3 |
| 3 | 9 | 8 | 4 | 2 | 1 |
| 4 | 4 | 3 | 3 | - | - |
| 4 | 3 | 3 | 2 | - | - |
| 6 | 9 | - | - | - | - |

**Table 20: ADHD – ASRS Scores**

| Participant | Baseline |
|---|---|
| 1 | 2 |
| 2 | 6 |
| 3 | 2 |
| 4 | 3 |
| 5 | 2 |
| 6 | 4 |

**Table 21: BIS-11 Scores for First-Order Factors**

| Participant | Attention | Motor | Self-Control | Cognitive Complexity | Perseverance | Cognitive Instability | Total |
|---|---|---|---|---|---|---|---|
| 1 | 9 | 11 | 11 | 9 | 8 | 7 | 55 |
| 2 | 11 | 20 | 18 | 13 | 5 | 6 | 73 |
| 3 | 12 | 20 | 14 | 12 | 8 | 7 | 73 |
| 4 | 8 | 14 | 12 | 10 | 8 | 5 | 57 |
| 5 | 7 | 10 | 12 | 8 | 8 | 10 | 55 |
| 6 | 13 | 17 | 19 | 14 | 7 | 7 | 77 |

**Table 22: BIS-11 Scores for Second-Order Factors**

| Participant | Attentional | Motor | Non-Planning |
|---|---|---|---|
| 1 | 16 | 19 | 20 |
| 2 | 17 | 25 | 31 |
| 3 | 19 | 28 | 26 |
| 4 | 13 | 22 | 22 |
| 5 | 17 | 18 | 20 |
| 6 | 20 | 24 | 33 |

**Table 23: Results for Trauma from BTQ**

| Participant | Baseline |
|---|---|
| 1 | Positive |
| 2 | Negative |
| 3 | Negative |
| 4 | Positive |
| 5 | Positive |
| 6 | Negative |

# Appendix C – Ethics Letter of Approval

College of Health and Life Sciences Research Ethics Committee (DLS)
Brunel University London
Kingston Lane
Uxbridge
UB8 3PH
United Kingdom

www.brunel.ac.uk

23 March 2020

**LETTER OF APPROVAL**

APPROVAL HAS BEEN GRANTED FOR THIS STUDY TO BE CARRIED OUT BETWEEN 23/03/2020AND 14/09/2020

Applicant (s): Mr Povilas Rusevicius

Project Title: Effects of Non-Linear Neurofeedback Training on Mental Health

Reference: 22546-MHR-Mar/2020- 24859-1

Dear Mr Povilas Rusevicius

The Research Ethics Committee has considered the above application recently submitted by you.

The Chair, acting under delegated authority has agreed that there is no objection on ethical grounds to the proposed study. Approval is given on the understanding that the conditions of approval set out below are followed:

- Methods - COVID-19 UPDATE - In light of the current situation, your approval is granted subject to you changing any face-to-face interviews to Skype/Phone or other formats where direct interaction is not necessary. The safety of all of our staff and students is our main priority.
- Recruitment Poster is good but needs either the college logo at the top or the name of the college when your details (not much!) are given.
- Advert - Please add to the advert that the study is part of your MSc at Brunel University London and that it has been approved by the College of Health and Life Sciences Research Ethics Committee and add both the date of approval or start date and the expiry date (your end date) of your study.
- D23- PIS - it would be preferable to have contact with yourself via your Brunel email rather than publish your personal mobile telephone number.
- D31 - Say that once you have graduated, control of the data will pass to the project supervisor (if this is the case), otherwise how will it be kept for 10 years?
- J1 – Your start date is in the past, obviously you cannot have started yet, until you receive this approval but if you need to amend the end date as a result of the delayed start then you will need to submit an amendment for approval. Obviously if you have already started please contact me immediately.
- **Please ensure that you monitor and adhere to all up-to-date Government health advice for the duration of your project.**
- The agreed protocol must be followed. Any changes to the protocol will require prior approval from the Committee by way of an application for an amendment.

Please note that:

- Research Participant Information Sheets and (where relevant) flyers, posters, and consent forms should include a clear statement that research ethics approval has been obtained from the relevant Research Ethics Committee.
- The Research Participant Information Sheets should include a clear statement that queries should be directed, in the first instance, to the Supervisor (where relevant), or the researcher. Complaints, on the other hand, should be directed, in the first instance, to the Chair of the relevant Research Ethics Committee.
- The Research Ethics Committee reserves the right to sample and review documentation, including raw data, relevant to the study.
- You may not undertake any research activity if you are not a registered student of Brunel University or if you cease to become registered, including abeyance or temporary withdrawal. As a deregistered student you would not be insured to undertake research activity. Research activity includes the recruitment of participants, undertaking consent procedures and collection of data. Breach of this requirement constitutes research misconduct and is a disciplinary offence.

## Appendix D – Participant Information Sheet

**College of Health and Life Sciences**

**Department of Life Sciences**

APPROVAL HAS BEEN GRANTED FOR THIS STUDY TO BE CARRIED OUT BETWEEN 23/03/2020 AND 14/09/2020

**PARTICIPANT INFORMATION SHEET**

**Study title**

Effect of Brain Training on Well-Being and Mental Health

**Invitation Paragraph**

You are being asked to take part in a research study. Before you decide, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask me if there is anything that is not clear or if you would like more information. Take time to decide whether you wish to take part. Thank you for reading this.

**What is the purpose of the study?**

The aim of the study is to examine the effect of brain training, called neurofeedback, on your wellbeing and mental health. Neurofeedback is a kind of brain training that is designed to help people take control of their brain activity. It works by monitoring brainwave activity in real time and producing audio and/or visual feedback to create a desired mental state. Over time, this training produces changes in the brain and other benefits, for example, people may become better at managing stress. This study will use an optimised version of neurofeedback training that analyses and targets many types of brain waves at the same time.

**Why have I been invited to participate?**

You have been invited to participate as you are over the age of 18 and do not possess a marked hearing or visual impairment (blindness). Alongside yourself, there will be an additional 10 to 14 participants taking part in this study.

**Do I have to take part?**

No, you have no obligation to be a part of the study. If you initially want to take part in the study but later decide to withdraw, you can do so at any time without having to give a reason. To withdraw, you can contact either the investigator (Povilas Rusevicius) or his supervisor (Prof. Veena Kumari). Once you have read this participant information sheet, you are free to ask any questions about the study. If you decide to volunteer, you will be provided with a consent form for your participation. You are free to withdraw your data, without giving a reason, until the point of submission (15th September 2020).

**What will happen to me if I take part?**

- Before training, your mental health and how you cope with stress will be assessed using several brief self-report questionnaires taking in total about 30 minutes.
- Neurofeedback training will be conducted over a period of 3-4 months. In those months a minimum of 10 sessions is required.
    - This can be done of your choosing, how frequently you are willing to do the sessions (e.g. 1 session per week would require a minimum of 10 weeks).
    - Within the time period you will be given an option to continue training after reaching 10 sessions.
- For the training session, you will be asked to sit or lie down.
    - 5 sensors will be applied using conductive paste.
        - Right ear lobe
        - Top right ear
        - Top left ear
        - Top of the head (2 sensors)
    - Headphones will be placed, and music will be played.
        - The volume will be adjusted to your preference.
    - A monitor will display visuals during the session (not compulsory to watch).
    - The session will last for 33 minutes.
    - You may stay awake, meditate, or fall asleep (all is acceptable).
- You will be given an opportunity to report any noticeable changes in your life whether it is general or specific.
- You will be asked to two of the self-report measures again every 5 sessions to see if there is any change in your mental health and mood.
- Assessment and neurofeedback sessions would be conducted in a Psychology laboratory (Marie Jahoda Building) at Brunel University London.

At the end of the study, you will be given a £10 amazon voucher as a thank you token for taking part.

**Are there any lifestyle restrictions?**

You will be required to avoid any binaural beats (videos or anything with a set frequency audio output meant to train the brain) during the research period as it can be counter-productive to the training sessions.

**What are the possible disadvantages and risks of taking part?**

You may find some of the questions personal. You are free not to answer these questions. After the training session, there may be residue of paste in the hair and/or ears. This is easily removed with tissue or water and does not pose any health issues. Wet wipes will be applied after every session to remove the paste.

**What are the possible benefits of taking part?**

The emergence of possible benefits:

- Better focus and attention.
- Better memory.
- Better sleep quality.
- Ability to cope with stress better.
- Less stress in general.

**What if something goes wrong?**

The research is relatively safe and pose no serious issues but by the unlikely event you are harmed by taking part in this research project, there are no special compensation arrangements. If you are harmed due to someone's negligence, then you may have grounds for a legal action, but you may have to pay for it.

**Will my taking part in this study be kept confidential?**

All information which is collected about you during the research will be kept strictly confidential. Any information about you which leaves the University will have all your identifying information removed. With your permission, anonymised data will be stored and may be used in future research – you can indicate whether you give permission for this by way of the Consent Form.

If during the research evidence of harm or misconduct come to light, then it may be necessary to break confidentiality. We will tell you at the time if we think we need to do this, and let you know what will happen next.

**Will I be recorded, and how will the recording be used?**

No audio or visual recording will be made as part of this study.

**What will happen to the results of the research study?**

The research data will be coded (for anonymity) and analysed by the researcher before being reported. The results will be used primarily for a dissertation project and may be later reported at a conference or in a scientific journal. The anonymised research data may also be shared with other researchers for further analysis, but at no point will any uniquely identifiable data be shared. If you take part in this research, you can obtain a copy of the publication by contacting the researcher.

**Who is organising and funding the research?**

The research is being organised by Povilas Rusevicius in conjunction with Brunel University London.

**What are the indemnity arrangements?**

Brunel University London provides appropriate insurance cover for research which has received ethical approval.

**Who has reviewed the study?**

This study has been reviewed by the College of Health and Life Sciences Research Ethics Committee.

**Research Integrity**

*Brunel University London is committed to compliance with the Universities UK Research Integrity Concordat. You are entitled to expect the highest level of integrity from the researchers during this research*

**Contact for further information and complaints**

**For general information**

Researcher name: Povilas Rusevicius

Email: 1412922@brunel.ac.uk

Supervisor name: Professor Veena Kumari

Email: veena.kumari@brunel.ac.uk

**For complaints and questions about the conduct of the Research**

Professor Christina Victor, Chair College of Health and Life Sciences Research Ethics Committee Christina.victor@brunel.ac.uk

**THANK YOU FOR YOUR INTEREST**

## Appendix E – Consent Form

**CONSENT FORM**

College of Health and Life Sciences

Department of Clinical Sciences /Life Sciences

**EFFECT OF BRAIN TRAINING ON WELLBEING AND MENTAL HEALTH**

PRINCIPAL INVESTIGATOR: POVILAS RUSEVICIUS

APPROVAL HAS BEEN GRANTED FOR THIS STUDY TO BE CARRIED OUT BETWEEN 23/03/2020 AND 14/09/2020

| **The participant (or their legal representative) should complete the whole of this sheet.** | | |
|---|---|---|
| | YES | NO |
| Have you read the Participant Information Sheet? | | |
| Have you had an opportunity to ask questions and discuss this study? | | |
| Have you received satisfactory answers to all your questions? | | |
| Do you understand that you will not be referred to by name in any report concerning this study? | | |
| Do you understand that: | | |
| • You are free to withdraw from this study at any time | | |
| • You don't have to give any reason for withdrawing | | |
| • Choosing not to participate or withdrawing will not affect your rights? | | |
| • You can withdraw your data any time up to 15/09/2020 | | |
| The procedures regarding confidentiality have been explained to me | | |
| I agree that my anonymised data can be stored and shared with other researchers for use in future projects. | | |
| I agree to take part in this study. | | |

| |
|---|
| Signature of research participant: |
| Print name: |
| Date: |

## Appendix F – Debrief Form

College of Health and Life Sciences
Department of Life Sciences

**EFFECT OF BRAIN TRAINING ON WELLBEING AND MENTAL HEALTH**

PRINCIPAL INVESTIGATOR: POVILAS RUSEVICIUS

APPROVAL HAS BEEN GRANTED FOR THIS STUDY TO BE CARRIED OUT BETWEEN 23/03/2020 AND 14/09/2020

**Debrief form**

We would like to take this opportunity to say **Thank You** for taking part in this study.

Please be assured, all data collected will be treated in the strictest confidence. You are free to withdraw your data from the research at any time before 15th September 2020 by contacting 1412922@brunel.ac.uk or veena.kumari@brunel.ac.uk

The completed research will help to gain an understanding of brain training on different areas of mental health. You were chosen to take part in the study because of your age and willingness to take part.

If you were unduly or unexpectedly affected by taking part in the study, please feel free to feed it back to the researcher. If you feel unable for whatever reason what-so-ever to talk with the researcher then please either contact their supervisor veena.kumari@brunel.ac.uk or one of the Division of Psychology Research ethics coordinators led by Achim.Schuetzwohl@brunel.ac.uk or 01895 266367.

**Appendix G – Recruitment Poster**

# BRAIN TRAINING AND MENTAL HEALTH

## PARTICIPANTS NEEDED!!!

**REQUISITES**

- Over 18 years old
- Do not have a marked hearing or visual (blindness) impairment

**HOW LONG WILL IT TAKE?**

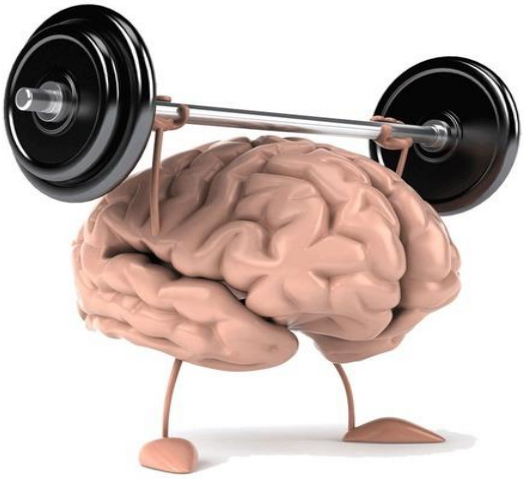
- A minimum of 10 sessions is needed over a period of 5 months
- Each session takes 33 minutes

**WHAT DO YOU NEED TO DO?**

- Lie/Sit back and listen to music

**MORE INFORMATION**

- If interested to take part or would like to know more, contact principal investigator Povilas Rusevicius on 1412922@brunel.ac.uk
- The study is part of MSc Cognitive and Clinical Neuroscience at Brunel University London
- Approved by the College of Health and Life Sciences Research Ethics Committee from 23/03/20 to 14/09/20



# Appendix H – Brief Trauma Questionnaire

## Brief Trauma Questionnaire

The BTQ is a brief self- report questionnaire that is derived from the Brief Trauma Interview (Schnurr et al., 1995). (Information about the reliability and validity of the BTI is provided in Schnurr et al., 2002). The BTQ was originally designed to assess traumatic exposure according to *DSM-IV* but specifically asked only about Criterion A.1 (life threat/serious injury) because of the difficulty of accurately assessing A.2 (subjective response) in a brief self- report format. Criterion A.2 has been eliminated from the PTSD diagnostic criteria in DSM- 5, so the BTQ provides a complete assessment of Criterion A.

The questionnaire may be used to determine whether an individual has had an event that meets the A Criterion, or to determine the different types of Criterion A events an individual has experienced. In either case, exposure to an event should be scored as positive if a respondent says yes to either:

- life threat or serious injury for events 1- 3 and 5- 7;
- life threat for event 4;
- serious injury for event 8, or;
- "Has this ever happened to you?" for events 9 and 10.

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Information about the BTQ appears in the following articles:


Koenen, K.C., De Vivo, I., Rich- Edwards, J., Smoller, J.W., Wright, R.J., & Purcell, S.M. (2009). Protocol for investigating genetic determinants of posttraumatic stress disorder in women from the Nurses' Health Study II. *BMC Psychiatry, 9* (article 29).

Kubzansky, L. D., Bordelois, P., Jun, H. J., Roberts, A. L., Cerda, M., Bluestong, N., & Koenen, K. C. (2014). The weight of traumatic stress: A prospective study of posttraumatic stress disorder symptoms and weight status in women. *JAMA Psychiatry, 71*, 44-51.

Lancaster, S.L., Melka, S.E., & Rodriguez, B.F. (2009). A factor analytic comparison of five models of PTSD symptoms. *Journal of Anxiety Disorders, 23*, 269- 274.

Morgan, C.A., III, Doran, A.P., Steffians, G., Hazlett, G.,& Southwick, S. (2006). Stress- induced deficits in working memory and visuo- constructive abilites in special operations soldiers. *Biological Psychiatry, 60*, 722- 729.

Morgan, C.A., III, Hazlett, G., Wang, S., Richardson, E.G., Jr., Schnurr, P.P., & Southwick, S.M. (2001). Symptoms of dissociation in humans experiencing acute, uncontrollable stress: A prospective investigation. *American Journal of Psychiatry, 158*, 1239- 1247.

Morgan, C.A., III, Rasmusson, A.M., Winters, B., Hauger, R.L., Morgan, J., Hazlett, G., & Southwick, S.M. (2006). Trauma exposure rather than posttraumatic stress disorder is associated with reduced baseline plasma neuropeptide- Y levels. *Biological Psychiatry, 54*, 1087- 1091.

Schnurr, P.P., Spiro, A. III, Vielhauer, M.J., Findler, M.N., & Hamblen, J.L. (2002). Trauma in the lives of older men: Findings from the Normative Aging Study. *Journal of Clinical Geropsychology, 8*, 175- 187.

Whealin, J.M., Batzer, W.B., Morgan, C.A. III, Schnurr, P.P.,& Friedman, M.J. (2007). Cohesion, burnout, and past trauma in Tri- Service medical and support personnel. *Military Medicine, 172*, 266- 272.


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## Brief Trauma Questionnaire

**The following questions ask about events that may be extraordinarily stressful or disturbing for almost everyone.** Please circle "Yes" or "No" to report what has happened to you.

**If you answer "Yes" for an event**, please answer any additional questions that are listed on the right side of the page to report: (1) whether you thought your life was in danger or you might be seriously injured; and (2) whether you were seriously injured.

**If you answer "No" for an event**, go on to the next event.

| Event | Has this ever happened to you? | If the event happened, did you think your life was in danger or you might be seriously injured? | If the event happened, were you seriously injured? |
|---|---|---|---|
| 1. Have you ever served in a war zone, or have you ever served in a noncombat job that exposed you to war-related casualties (for example, as a medic or on graves registration duty?) | No Yes | No Yes | No Yes |
| 2. Have you ever been in a serious car accident, or a serious accident at work or somewhere else? | No Yes | No Yes | No Yes |
| 3. Have you ever been in a major natural or technological disaster, such as a fire, tornado, hurricane, flood, earthquake, or chemical spill? | No Yes | No Yes | No Yes |
| 4. Have you ever had a life-threatening illness such as cancer, a heart attack, leukemia, AIDS, multiple sclerosis, etc.? | No Yes | No Yes | N/A |
| 5. Before age 18, were you ever physically punished or beaten by a parent, caretaker, or teacher so that: you were very frightened; or you thought you would be injured; or you received bruises, cuts, welts, lumps or other injuries? | No Yes | No Yes | No Yes |
| 6. Not including any punishments or beatings you already reported in Question 5, have you ever been attacked, beaten, or mugged by anyone, including friends, family members or strangers? | No Yes | No Yes | No Yes |
| 7. Has anyone ever made or pressured you into having some type of unwanted sexual contact?<br>Note: By sexual contact we mean any contact between someone else and your private parts or between you and some else's private parts | No Yes | No Yes | No Yes |
| 8. Have you ever been in any other situation in which you were seriously injured, or have you ever been in any other situation in which you feared you might be seriously injured or killed? | No Yes | N/A | No Yes |
| 9. Has a close family member or friend died violently, for example, in a serious car crash, mugging, or attack? | No Yes | N/A | No Yes |
| 10. Have you ever witnessed a situation in which someone was seriously injured or killed, or have you ever witnessed a situation in which you feared someone would be seriously injured or killed?<br>Note: Do not answer "yes" for any event you already reported in Questions 1-9 | No Yes | N/A | N/A |

# Appendix I – Adult ADHD Self-Report Scale

## Adult ADHD Self-Report Scale (ASRS-v1.1) Symptom Checklist Instructions

*The questions on the back page are designed to stimulate dialogue between you and your patients and to help confirm if they may be suffering from the symptoms of attention-deficit/hyperactivity disorder (ADHD).*

Description: The Symptom Checklist is an instrument consisting of the eighteen DSM-IV-TR criteria. Six of the eighteen questions were found to be the most predictive of symptoms consistent with ADHD. These six questions are the basis for the ASRS v1.1 Screener and are also Part A of the Symptom Checklist. Part B of the Symptom Checklist contains the remaining twelve questions.

**Instructions:**

**Symptoms**

1. Ask the patient to complete both Part A and Part B of the Symptom Checklist by marking an X in the box that most closely represents the frequency of occurrence of each of the symptoms.

2. Score Part A. If four or more marks appear in the darkly shaded boxes within Part A then the patient has symptoms highly consistent with ADHD in adults and further investigation is warranted.

3. The frequency scores on Part B provide additional cues and can serve as further probes into the patient's symptoms. Pay particular attention to marks appearing in the dark shaded boxes. The frequency-based response is more sensitive with certain questions. No total score or diagnostic likelihood is utilized for the twelve questions. It has been found that the six questions in Part A are the most predictive of the disorder and are best for use as a screening instrument.

**Impairments**

1. Review the entire Symptom Checklist with your patients and evaluate the level of impairment associated with the symptom.

2. Consider work/school, social and family settings.

3. Symptom frequency is often associated with symptom severity, therefore the Symptom Checklist may also aid in the assessment of impairments. If your patients have frequent symptoms, you may want to ask them to describe how these problems have affected the ability to work, take care of things at home, or get along with other people such as their spouse/significant other.

**History**

1. Assess the presence of these symptoms or similar symptoms in childhood. Adults who have ADHD need not have been formally diagnosed in childhood. In evaluating a patient's history, look for evidence of early-appearing and long-standing problems with attention or self-control. Some significant symptoms should have been present in childhood, but full symptomology is not necessary.

# Adult ADHD Self-Report Scale (ASRS-v1.1) Symptom Checklist

| Patient Name | | Today's Date | | | | | |
|---|---|---|---|---|---|---|---|
| Please answer the questions below, rating yourself on each of the criteria shown using the scale on the right side of the page. As you answer each question, place an X in the box that best describes how you have felt and conducted yourself over the past 6 months. Please give this completed checklist to your healthcare professional to discuss during today's appointment. | | | Never | Rarely | Sometimes | Often | Very Often |
| 1. How often do you have trouble wrapping up the final details of a project, once the challenging parts have been done? | | | | | | | |
| 2. How often do you have difficulty getting things in order when you have to do a task that requires organization? | | | | | | | |
| 3. How often do you have problems remembering appointments or obligations? | | | | | | | |
| 4. When you have a task that requires a lot of thought, how often do you avoid or delay getting started? | | | | | | | |
| 5. How often do you fidget or squirm with your hands or feet when you have to sit down for a long time? | | | | | | | |
| 6. How often do you feel overly active and compelled to do things, like you were driven by a motor? | | | | | | | |
| | | | | | | | Part A |
| 7. How often do you make careless mistakes when you have to work on a boring or difficult project? | | | | | | | |
| 8. How often do you have difficulty keeping your attention when you are doing boring or repetitive work? | | | | | | | |
| 9. How often do you have difficulty concentrating on what people say to you, even when they are speaking to you directly? | | | | | | | |
| 10. How often do you misplace or have difficulty finding things at home or at work? | | | | | | | |
| 11. How often are you distracted by activity or noise around you? | | | | | | | |
| 12. How often do you leave your seat in meetings or other situations in which you are expected to remain seated? | | | | | | | |
| 13. How often do you feel restless or fidgety? | | | | | | | |
| 14. How often do you have difficulty unwinding and relaxing when you have time to yourself? | | | | | | | |
| 15. How often do you find yourself talking too much when you are in social situations? | | | | | | | |
| 16. When you're in a conversation, how often do you find yourself finishing the sentences of the people you are talking to, before they can finish them themselves? | | | | | | | |
| 17. How often do you have difficulty waiting your turn in situations when turn taking is required? | | | | | | | |
| 18. How often do you interrupt others when they are busy? | | | | | | | |
| | | | | | | | Part B |

## The Value of Screening for Adults With ADHD

Research suggests that the symptoms of ADHD can persist into adulthood, having a significant impact on the relationships, careers, and even the personal safety of your patients who may suffer from it.[1-4] Because this disorder is often misunderstood, many people who have it do not receive appropriate treatment and, as a result, may never reach their full potential. Part of the problem is that it can be difficult to diagnose, particularly in adults.

The Adult ADHD Self-Report Scale (ASRS-v1.1) Symptom Checklist was developed in conjunction with the World Health Organization (WHO), and the Workgroup on Adult ADHD that included the following team of psychiatrists and researchers:


- **Lenard Adler, MD**
  Associate Professor of Psychiatry and Neurology
  New York University Medical School

- **Ronald C. Kessler, PhD**
  Professor, Department of Health Care Policy
  Harvard Medical School

- **Thomas Spencer, MD**
  Associate Professor of Psychiatry
  Harvard Medical School


As a healthcare professional, you can use the ASRS v1.1 as a tool to help screen for ADHD in adult patients. Insights gained through this screening may suggest the need for a more in-depth clinician interview. The questions in the ASRS v1.1 are consistent with DSM-IV criteria and address the manifestations of ADHD symptoms in adults. Content of the questionnaire also reflects the importance that DSM-IV places on symptoms, impairments, and history for a correct diagnosis.[4]

The checklist takes about 5 minutes to complete and can provide information that is critical to supplement the diagnostic process.


References:

1. Schweitzer JB, et al. Med Clin North Am. 2001;85(3):10-11, 757-777.
2. Barkley RA. Attention Deficit Hyperactivity Disorder: A Handbook for Diagnosis and Treatment. 2nd ed. 1998.
3. Biederman J, et al. Am J Psychiatry.1993;150:1792-1798.
4. American Psychiatric Association: Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision. Washington, DC, American Psychiatric Association. 2000: 85-93.

## Appendix J – Barratt Impulsiveness Scale

Participant Number: BIS-11

DIRECTIONS: People differ in the ways they act and think in different situations. This is a test to measure some of the ways in which you act and think. Read each statement and put an X on the appropriate circle on the right side of this page. Do not spend too much time on any statement. Answer quickly and honestly.

| | 1 Rarely/Never | 2 Occasionally | 3 Often | 4 Almost Always/Always |
|---|---|---|---|---|
| 1 | I plan tasks carefully. | | | 1 2 3 4 |
| 2 | I do things without thinking. | | | 1 2 3 4 |
| 3 | I make-up my mind quickly. | | | 1 2 3 4 |
| 4 | I am happy-go-lucky. | | | 1 2 3 4 |
| 5 | I don't "pay attention." | | | 1 2 3 4 |
| 6 | I have "racing" thoughts. | | | 1 2 3 4 |
| 7 | I plan trips well ahead of time. | | | 1 2 3 4 |
| 8 | I am self controlled. | | | 1 2 3 4 |
| 9 | I concentrate easily. | | | 1 2 3 4 |
| 10 | I save regularly. | | | 1 2 3 4 |
| 11 | I "squirm" at plays or lectures. | | | 1 2 3 4 |
| 12 | I am a careful thinker. | | | 1 2 3 4 |
| 13 | I plan for job security. | | | 1 2 3 4 |
| 14 | I say things without thinking. | | | 1 2 3 4 |
| 15 | I like to think about complex problems. | | | 1 2 3 4 |
| 16 | I change jobs. | | | 1 2 3 4 |
| 17 | I act "on impulse." | | | 1 2 3 4 |
| 18 | I get easily bored when solving thought problems. | | | 1 2 3 4 |
| 19 | I act on the spur of the moment. | | | 1 2 3 4 |
| 20 | I am a steady thinker. | | | 1 2 3 4 |
| 21 | I change residences. | | | 1 2 3 4 |
| 22 | I buy things on impulse. | | | 1 2 3 4 |
| 23 | I can only think about one thing at a time. | | | 1 2 3 4 |
| 24 | I change hobbies. | | | 1 2 3 4 |
| 25 | I spend or charge more than I earn. | | | 1 2 3 4 |
| 26 | I often have extraneous thoughts when thinking. | | | 1 2 3 4 |
| 27 | I am more interested in the present than the future. | | | 1 2 3 4 |
| 28 | I am restless at the theater or lectures. | | | 1 2 3 4 |
| 29 | I like puzzles. | | | 1 2 3 4 |
| 30 | I am future oriented. | | | 1 2 3 4 |

## Appendix K – Pittsburgh Sleep Quality Index

Name:_____ Date: _____

### Pittsburgh Sleep Quality Index (PSQI)

Instructions: The following questions relate to your usual sleep habits during the past month only. Your answers should indicate the most accurate reply for the majority of days and nights in the past month. **Please answer all questions.**

1. During the past month, what time have you usually gone to bed at night? _____
2. During the past month, how long (in minutes) has it usually taken you to fall asleep each night? _____
3. During the past month, what time have you usually gotten up in the morning? _____
4. During the past month, how many hours of actual sleep did you get at night? (This may be different than the number of hours you spent in bed.) _____

| 5. During the past month, how often have you had trouble sleeping because you… | Not during the past month | Less than once a week | Once or twice a week | Three or more times a week |
|---|---|---|---|---|
| a. Cannot get to sleep within 30 minutes | | | | |
| b. Wake up in the middle of the night or early morning | | | | |
| c. Have to get up to use the bathroom | | | | |
| d. Cannot breathe comfortably | | | | |
| e. Cough or snore loudly | | | | |
| f. Feel too cold | | | | |
| g. Feel too hot | | | | |
| h. Have bad dreams | | | | |
| i. Have pain | | | | |
| j. Other reason(s), please describe: | | | | |
| 6. During the past month, how often have you taken medicine to help you sleep (prescribed or "over the counter")? | | | | |
| 7. During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity? | | | | |
| | No problem at all | Only a very slight problem | Somewhat of a problem | A very big problem |
| 8. During the past month, how much of a problem has it been for you to keep up enough enthusiasm to get things done? | | | | |
| | Very good | Fairly good | Fairly bad | Very bad |
| 9. During the past month, how would you rate your sleep quality overall? | | | | |

| | No bed partner or room mate | Partner/room mate in other room | Partner in same room but not same bed | Partner in same bed |
|---|---|---|---|---|
| 10. Do you have a bed partner or room mate? | | | | |
| | Not during the past month | Less than once a week | Once or twice a week | Three or more times a week |
| If you have a room mate or bed partner, ask him/her how often in the past month you have had: | | | | |
| a. Loud snoring | | | | |
| b. Long pauses between breaths while asleep | | | | |
| c. Legs twitching or jerking while you sleep | | | | |
| d. Episodes of disorientation or confusion during sleep | | | | |
| e. Other restlessness while you sleep, please describe: | | | | |

# Scoring the PSQI

The order of the PSQI items has been modified from the original order in order to fit the first 9 items (which are the only items that contribute to the total score) on a single page. Item 10, which is the second page of the scale, does not contribute to the PSQI score.

In scoring the PSQI, seven component scores are derived, each scored 0 (no difficulty) to 3 (severe difficulty). The component scores are summed to produce a global score (range 0 to 21). Higher scores indicate worse sleep quality.

**Component 1: Subjective sleep quality—question 9**

| Response to Q9 | Component 1 score |
|---|---|
| Very good | 0 |
| Fairly good | 1 |
| Fairly bad | 2 |
| Very bad | 3 |

Component 1 score:_____

**Component 2: Sleep latency—questions 2 and 5a**

| Response to Q2 | Component 2/Q2 subscore |
|---|---|
| ≤ 15 minutes | 0 |
| 16-30 minutes | 1 |
| 31-60 minutes | 2 |
| > 60 minutes | 3 |

| Response to Q5a | Component 2/Q5a subscore |
|---|---|
| Not during past month | 0 |
| Less than once a week | 1 |
| Once or twice a week | 2 |
| Three or more times a week | 3 |

| Sum of Q2 and Q5a subscores | Component 2 score |
|---|---|
| 0 | 0 |
| 1-2 | 1 |
| 3-4 | 2 |
| 5-6 | 3 |

Component 2 score:_____

**Component 3: Sleep duration—question 4**

| Response to Q4 | Component 3 score |
|---|---|
| > 7 hours | 0 |
| 6-7 hours | 1 |
| 5-6 hours | 2 |
| < 5 hours | 3 |

Component 3 score:_____

**Component 4: Sleep efficiency—questions 1, 3, and 4**

Sleep efficiency = (# hours slept/# hours in bed) X 100%

# hours slept—question 4

# hours in bed—calculated from responses to questions 1 and 3

| Sleep efficiency | Component 4 score |
|---|---|
| > 85% | 0 |
| 75-84% | 1 |
| 65-74% | 2 |
| < 65% | 3 |

Component 4 score:_____

**Component 5: Sleep disturbance—questions 5b-5j**

Questions 5b to 5j should be scored as follows:

| | |
|---|---|
| Not during past month | 0 |
| Less than once a week | 1 |
| Once or twice a week | 2 |
| Three or more times a week | 3 |

| Sum of 5b to 5j scores | Component 5 score |
|---|---|
| 0 | 0 |
| 1-9 | 1 |
| 10-18 | 2 |
| 19-27 | 3 |

Component 5 score:_____

**Component 6: Use of sleep medication—question 6**

| Response to Q6 | Component 6 score |
|---|---|
| Not during past month | 0 |
| Less than once a week | 1 |
| Once or twice a week | 2 |
| Three or more times a week | 3 |

Component 6 score:_____

**Component 7: Daytime dysfunction—questions 7 and 8**

| Response to Q7 | Component 7/Q7 subscore |
|---|---|
| Not during past month | 0 |
| Less than once a week | 1 |
| Once or twice a week | 2 |
| Three or more times a week | 3 |

| Response to Q8 | Component 7/Q8 subscore |
|---|---|
| No problem at all | 0 |
| Only a very slight problem | 1 |
| Somewhat of a problem | 2 |
| A very big problem | 3 |

| Sum of Q7 and Q8 subscores | Component 7 score |
|---|---|
| 0 | 0 |
| 1-2 | 1 |
| 3-4 | 2 |
| 5-6 | 3 |

Component 7 score:_____

**Global PSQI Score:** Sum of seven component scores:_____



Citation: Buysse, DJ, Reynolds CF, Monk TH, Berman SR, Kupfer DJ: The Pittsburgh Sleep Quality Index (PSQI): A new instrument for psychiatric research and practice. Psychiatry Research 28:193-213, 1989

## Appendix L – Symptom Checklist 90-R

*Study* _____ *ID* _____

*Date* __ __ / __ __ / __ __ __ __

### Symptom Checklist 90-R

Below is a list of problems and complaints that people sometimes have. Please read each one carefully and **enter the number** that best describes how much you were bothered by that problem during the past week.

**Please enter only ONE.**

**FOR THE *PAST WEEK*, HOW MUCH WERE YOU BOTHERED BY:**

| | Not At All | A Little Bit | Moderately | Quite A Bit | Extremely |
|---|---|---|---|---|---|
| 1. Headaches | 0 | 1 | 2 | 3 | 4 |
| 2. Nervousness or shakiness inside | 0 | 1 | 2 | 3 | 4 |
| 3. Unwanted thoughts, words, or ideas that won't leave your mind | 0 | 1 | 2 | 3 | 4 |
| 4. Faintness or dizziness | 0 | 1 | 2 | 3 | 4 |
| 5. Loss of sexual interest or pleasure | 0 | 1 | 2 | 3 | 4 |
| 6. Feeling critical of others | 0 | 1 | 2 | 3 | 4 |
| 7. The idea that someone else can control your thoughts | 0 | 1 | 2 | 3 | 4 |
| 8. Feeling others are to blame for most of your troubles | 0 | 1 | 2 | 3 | 4 |
| 9. Trouble remembering things | 0 | 1 | 2 | 3 | 4 |
| 10. Worried about sloppiness or carelessness | 0 | 1 | 2 | 3 | 4 |
| 11. Feeling easily annoyed or irritated | 0 | 1 | 2 | 3 | 4 |
| 12. Pains in heart or chest | 0 | 1 | 2 | 3 | 4 |
| 13. Feeling afraid in open spaces or on the streets | 0 | 1 | 2 | 3 | 4 |
| 14. Feeling low in energy or slowed down | 0 | 1 | 2 | 3 | 4 |
| 15. Thoughts of ending your life | 0 | 1 | 2 | 3 | 4 |
| 16. Hearing words that others do not hear | 0 | 1 | 2 | 3 | 4 |
| 17. Trembling | 0 | 1 | 2 | 3 | 4 |
| 18. Feeling that most people cannot be trusted | 0 | 1 | 2 | 3 | 4 |
| 19. Poor appetite | 0 | 1 | 2 | 3 | 4 |
| 20. Crying easily | 0 | 1 | 2 | 3 | 4 |



*SCL DMU v1 03/28/2003*

*Study* _____ *ID* _____

*Date* __ __ / __ __ / __ __ __ __

**FOR THE *PAST WEEK*, HOW MUCH WERE YOU BOTHERED BY:**

| | Not At All | A Little Bit | Moderately | Quite A Bit | Extremely |
|---|---|---|---|---|---|
| 21. Feeling shy or uneasy with the opposite sex | 0 | 1 | 2 | 3 | 4 |
| 22. Feeling of being trapped or caught | 0 | 1 | 2 | 3 | 4 |
| 23. Suddenly scared for no reason | 0 | 1 | 2 | 3 | 4 |
| 24. Temper outbursts that you could not control | 0 | 1 | 2 | 3 | 4 |
| 25. Feeling afraid to go out of your house alone | 0 | 1 | 2 | 3 | 4 |
| 26. Blaming yourself for things | 0 | 1 | 2 | 3 | 4 |
| 27. Pains in lower back | 0 | 1 | 2 | 3 | 4 |
| 28. Feeling blocked in getting things done | 0 | 1 | 2 | 3 | 4 |
| 29. Feeling lonely | 0 | 1 | 2 | 3 | 4 |
| 30. Feeling blue | 0 | 1 | 2 | 3 | 4 |
| 31. Worrying too much about things | 0 | 1 | 2 | 3 | 4 |
| 32. Feeling no interest in things | 0 | 1 | 2 | 3 | 4 |
| 33. Feeling fearful | 0 | 1 | 2 | 3 | 4 |
| 34. Your feelings being easily hurt | 0 | 1 | 2 | 3 | 4 |
| 35. Other people being aware of your private thoughts | 0 | 1 | 2 | 3 | 4 |
| 36. Feeling others do not understand you or are unsympathetic | 0 | 1 | 2 | 3 | 4 |
| 37. Feeling that people are unfriendly or dislike you | 0 | 1 | 2 | 3 | 4 |
| 38. Having to do things very slowly to insure correctness | 0 | 1 | 2 | 3 | 4 |
| 39. Heart pounding or racing | 0 | 1 | 2 | 3 | 4 |
| 40. Nausea or upset stomach | 0 | 1 | 2 | 3 | 4 |
| 41. Feeling inferior to others | 0 | 1 | 2 | 3 | 4 |
| 42. Soreness of your muscles | 0 | 1 | 2 | 3 | 4 |
| 43. Feeling that you are watched or talked about by others | 0 | 1 | 2 | 3 | 4 |
| 44. Trouble falling asleep | 0 | 1 | 2 | 3 | 4 |

*Study* _____ *ID* _____

*Date* __ __ / __ __ / __ __ __ __

**FOR THE *PAST WEEK*, HOW MUCH WERE YOU BOTHERED BY:**

| | Not At All | A Little Bit | Moderately | Quite A Bit | Extremely |
|---|---|---|---|---|---|
| 45. Having to check and double-check what you do | 0 | 1 | 2 | 3 | 4 |
| 46. Difficulty making decisions | 0 | 1 | 2 | 3 | 4 |
| 47. Feeling afraid to travel on buses, subways, or trains | 0 | 1 | 2 | 3 | 4 |
| 48. Trouble getting your breath | 0 | 1 | 2 | 3 | 4 |
| 49. Hot or cold spells | 0 | 1 | 2 | 3 | 4 |
| 50. Having to avoid certain things, places, or activities because they frighten you | 0 | 1 | 2 | 3 | 4 |
| 51. Your mind going blank | 0 | 1 | 2 | 3 | 4 |
| 52. Numbness or tingling in parts of your body | 0 | 1 | 2 | 3 | 4 |
| 53. A lump in your throat | 0 | 1 | 2 | 3 | 4 |
| 54. Feeling hopeless about the future | 0 | 1 | 2 | 3 | 4 |
| 55. Trouble concentrating | 0 | 1 | 2 | 3 | 4 |
| 56. Feeling weak in parts of your body | 0 | 1 | 2 | 3 | 4 |
| 57. Feeling tense or keyed up | 0 | 1 | 2 | 3 | 4 |
| 58. Heavy feelings in your arms or legs | 0 | 1 | 2 | 3 | 4 |
| 59. Thoughts of death or dying | 0 | 1 | 2 | 3 | 4 |
| 60. Overeating | 0 | 1 | 2 | 3 | 4 |
| 61. Feeling uneasy when people are watching or talking about you | 0 | 1 | 2 | 3 | 4 |
| 62. Having thoughts that are not your own | 0 | 1 | 2 | 3 | 4 |
| 63. Having urges to beat, injure, or harm someone | 0 | 1 | 2 | 3 | 4 |
| 64. Awakening in the early morning | 0 | 1 | 2 | 3 | 4 |
| 65. Having to repeat the same actions such as touching, counting, washing | 0 | 1 | 2 | 3 | 4 |
| 66. Sleep that is restless or disturbed | 0 | 1 | 2 | 3 | 4 |
| 67. Having urges to break or smash things | 0 | 1 | 2 | 3 | 4 |
| 68. Having ideas or beliefs that others do not share | 0 | 1 | 2 | 3 | 4 |

*Study* _____ *ID* _____

*Date* __ __ / __ __ / __ __ __ __

**FOR THE *PAST WEEK*, HOW MUCH WERE YOU BOTHERED BY:**

| | Not At All | A Little Bit | Moderately | Quite A Bit | Extremely |
|---|---|---|---|---|---|
| 69. Feeling very self-conscious with others | 0 | 1 | 2 | 3 | 4 |
| 70. Feeling uneasy in crowds, such as shopping or at a movie | 0 | 1 | 2 | 3 | 4 |
| 71. Feeling everything is an effort | 0 | 1 | 2 | 3 | 4 |
| 72. Spells of terror or panic | 0 | 1 | 2 | 3 | 4 |
| 73. Feeling uncomfortable about eating or drinking in public | 0 | 1 | 2 | 3 | 4 |
| 74. Getting into frequent arguments | 0 | 1 | 2 | 3 | 4 |
| 75. Feeling nervous when you are left alone | 0 | 1 | 2 | 3 | 4 |
| 76. Others not giving you proper credit for your achievements | 0 | 1 | 2 | 3 | 4 |
| 77. Feeling lonely even when you are with people | 0 | 1 | 2 | 3 | 4 |
| 78. Feeling so restless you couldn't sit still | 0 | 1 | 2 | 3 | 4 |
| 79. Feelings of worthlessness | 0 | 1 | 2 | 3 | 4 |
| 80. Feeling that familiar things are strange or unreal | 0 | 1 | 2 | 3 | 4 |
| 81. Shouting or throwing things | 0 | 1 | 2 | 3 | 4 |
| 82. Feeling afraid you will faint in public | 0 | 1 | 2 | 3 | 4 |
| 83. Feeling that people will take advantage of you if you let them | 0 | 1 | 2 | 3 | 4 |
| 84. Having thoughts about sex that bother you a lot | 0 | 1 | 2 | 3 | 4 |
| 85. The idea that you should be punished for your sins | 0 | 1 | 2 | 3 | 4 |
| 86. Feeling pushed to get things done | 0 | 1 | 2 | 3 | 4 |
| 87. The idea that something serious is wrong with your body | 0 | 1 | 2 | 3 | 4 |
| 88. Never feeling close to another person | 0 | 1 | 2 | 3 | 4 |
| 89. Feelings of guilt | 0 | 1 | 2 | 3 | 4 |
| 90. The idea that something is wrong with your mind | 0 | 1 | 2 | 3 | 4 |

## Appendix M – Visual Analogue Mood Scales

### Current Mood

**How do you feel right now? (circle your answer)**

0= not at all ----------10= Extremely

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Tired** | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| **Depressed** | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| **Anxious** | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| **Stressed** | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| **In Pain** | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| **Angry** | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

**How do you feel right now? (circle your answer)**

0= not at all ----------10= Extremely

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Happy** | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| **Calm** | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| **Excited** | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| **Focused** | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| **Clear-headed** | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| **Relaxed** | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

**Past Mood Rating Scales**

Looking back over the last week, I feel I am (0-100)

content with myself.

Not at all (0) [ ] (100) Extremely

happy with my family and close relationships.

Not at all (0) [ ] (100) Extremely

doing well in my social interactions.

Not at all (0) [ ] (100) Extremely

satisfied with how things are overall in my life.

Not at all (0) [ ] (100) Extremely

**Scoring:**

| | |
|---|---|
| Personal wellbeing: | Score range: 0-100 |
| Interpersonal: | Score range: 0-100 |
| Social functioning: | Score range: 0-100 |
| Overall: | Score range: 0-100 |