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Contents

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Welcome to *NeuroRegulation* Volume 2, Number 4. In this issue we received two thought-provoking special features. First, Dr. Sarah Prinsloo and Dr. Randall Lyle discuss the Microbiome, Gut-Brain-Axis, and implications for brain health. As neuroscience research advances, the need to revisit topics becomes increasingly needed. I recall in early psychopharmacology classes we were taught that up to 80 to 95 percent of serotonin was produced in the gut, while the remainder was produced in the brain, namely in the raphe nucleus located in the brain stem (Cooper, Bloom, & Roth, 1991). Over the course of years a specific function for serotonin has been elusive, yet further exploration of this gut-brain relationship may provide a more clear delineation of serotonin's role in normal human functions, as well as mental illness. Dr. Erik Peper provides an interesting examination of the association between herbicide use and increases in allergies and autism spectrum disorders (ASD). Consideration of the environment and potential exposure to toxins is very important to narrowing the possible influences of ASD. There is little doubt among clinicians and researchers that the global increase in ASD diagnoses is staggering and an area for much-needed research. Dr. Robert Coben, Kate Wright, Dr. Scott Decker, and Tina Morgan present data examining the impact of coherence neurofeedback training in learning disabilities (LD). The authors provide an examination of current methods for treating LD and demonstrate the effects of neurofeedback in a controlled fashion. We thank all authors for submitting their work to *NeuroRegulation*.

This issue also contains the abstracts from the 23rd annual conference of the International Society for Neurofeedback and Research (ISNR). The selected abstracts are from keynote and invited speakers, student award presentations, plenary sessions, and poster presentations. We would like to thank all authors for submitting their work to the conference.

Finally, as we progress to the new year, *NeuroRegulation* will be designing special editions for 2016. We will decide on topics over the holidays and begin contacting experts in each of the areas to be covered. Make *NeuroRegulation* your next publication choice!

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NeuroRegulation

The Microbiome, Gut-Brain-Axis, and Implications for Brain Health

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Abstract

As Antonio Damasio highlighted back in 1994, Descartes' division of mind and body slowed the full realization of the connectedness of the brain and the body by centuries. The simple fact that homeostasis in the brain is fully interconnected with the body has eluded researchers and clinicians even after the connection was well established. Recent studies reporting the central role in dysfunction of mental systems as a result of inflammation in the gut and the autonomic nervous system (ANS) was yet one more reminder that the entire system is connected and interdependent. Central to this discovery and its application to mental function has been the growing field of study of the microbiome. This article is an attempt to situate those who are active in the variety of ways and means of treating the brain in the essential role that is likely being played by a vast community of bacteria living in the bowels of the human being and influencing all of the higher and most "sophisticated" aspects of human interchange and thought. It is the authors' hope that this brief introduction will remind and inform researchers and clinicians that the organism is more interconnected and more complex than we have tended to think and that disorders of the mind are likely also often disorders of the gut.

Keywords: microbiome; gut-brain-axis; brain health

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The Microbiome

The microbiome can be thought of as the genome of a community of bacteria living mainly in the lower intestine, which has been shown to be associated with a range of concerns including disease susceptibility, immune response, and mental health. More than 1,000 species have been identified in the microbiome, each colony being specific to its host (Collins, Surette, & Bercik, 2012). Factors associated with the type and multitude of bacteria in the gut are a vaginal birth, diet, genetics, environment, and of course antibiotic use.

To understand the importance of the microbiome, one must first understand that the microbiome is thought to communicate directly with the brain through the so-called gut-brain axis. Specifically, bidirectional signaling between the gastrointestinal tract and the brain is thought to be mandatory for homeostasis and integrates neural, hormonal, and immunological signaling (Collins et al., 2012; Cryan & O'Mahony, 2011). Evidence now suggests that gastrointestinal bacteria have implications for brain function and even behavior (Cryan & O'Mahony, 2011).

Gut microbiota have been shown to have a significant relationship with perception of stress and the ability to handle stressors, although most studies of intestinal microbia and brain function have been carried out in mice. For a thorough review, please see Cryan and O'Mahony (2011). Not only does the link between brain and gut become apparent in disease states in this literature, additionally the pathway for treatment of disease has been posited as solely through the alteration of the microbiome. Highlights from Cryan and O'Mahony's review include such tidbits as that when intestinal microbia are replaced with intake of probiotics, improvement is seen in diseases such as irritable bowel syndrome and chronic fatigue, and specifically by way of reduction of anxiety and stress response, improvement in mood and a reduction in serum cortisol levels (Logan & Katzman, 2005; Messaoudi et al., 2011; Rao et al., 2009). Probiotic agents such as *Bifidobacterium infantis* have antidepressant properties in a forced swim test, a test commonly used to evaluate the antidepressant properties of pharmacological agents (Desbonnet, Garrett, Clarke, Bienenstock, & Dinan, 2008).

Microbes found in the intestine can alter genetic messages via messenger ribonucleic acid (mRNA), whose principal role is to carry instructions for controlling the synthesis of proteins. mRNA can actively modify central nervous system receptors, including GABAa and GABAb (gamma-aminobutyric acid), resulting in hyperpolarization of neurons and inhibition of neurotransmission. In one particularly interesting study, *Lactobacillus reuteri*, known to modulate the immune system through the alteration of mRNA expression of both GABAa and GABAb receptors, was associated with decreased anxiety and the reduction of the increase of corticosterone in mice under stress conditions (Bravo et al., 2010).

Autonomic nervous system (ANS) activity from the gut is connected to limbic areas of the brain, specifically the amygdala, hippocampus, and the limbic cortex (Collins et al., 2012). A component of the ANS, the sympathetic system, is thought to exhibit an inhibitory influence on the intestine by decreasing motility and secretion by the release of neurotransmitters such as noradrenaline (Collins et al., 2012). Other activity within the hypothalamic-pituitary-adrenal (HPA) axis, which is responsible for stress responses such as the release of corticosterone and adrenalin, is also modulated by the gut-brain axis, and potentially by the vagus nerve (Collins et al., 2012). For example, Sudo et al. (2004) found germ-free rodents were more susceptible to stress, and more specifically that stress affects their gut bacteria, and bacteria consequently affected how stress was handled. They report a decrease in brain-derived neurotrophic factor (BDNF) in the germ-free rodents, which is involved in neuronal growth in male animals in the cortex and hippocampus.

Stress early in life results in HPA-axis changes centrally, and can have adverse effects in gut microbia (Desbonnet et al., 2008). This important finding leaves room for exploration of the potential antidepressant effects of probiotics and specifically the attenuation of pro-inflammatory immune responses, the elevation of a serotonergic precursor (tryptophan) by probiotic treatment (Collins et al., 2012). For example, probiotic treatment resulted in a reversal of abnormal immune response, behavioral deficits, and restoration of norepinephrine concentrations in the brainstem (Desbonnet et al., 2010).

Human Research

Microbiome research in human subjects is limited; however, in one study looking at the effects of bacteria on stress, *Lactobacillus helveticus* and *Bifidobacterium longum* were associated with decreased cortisol (a stress hormone; Bravo et al., 2010). A proposed mechanism of the influence of stress on the microbiome, and consequently the gut-brain axis, is that stress has been shown to influence the integrity of the gut epithelium and to alter gut motility, secretions, and mucin production, thereby altering the habitat of resident bacteria and promoting changes in microbial composition or activity (Collins & Bercik, 2009).

The microbiome has been found to be associated with depression, adiposity, immune dysregulation, and eating disorders. Several authors cite the prevalence of psychiatric conditions that often have an associated gastrointestinal condition, such as irritable bowel diseases like Crohn's and ulcerative colitis, which can also be correlated with a disturbance in the microbiome (Cámara, Ziegler, Begré, Schoepfer, & von Känel, 2009; Collins et al., 2012; Mawdsley & Rampton, 2005, 2006; Wu, 2012). For example, in order to study associations between eating disorders and the microbiome, inpatients diagnosed with anorexia were compared with healthy controls (Kleiman et al., 2015). Stool samples were collected and participants completed self-report measures. Bacterial composition was characterized by gene sequencing and results showed that levels of depression, anxiety, and eating disorder psychopathology were associated with composition and diversity of microbes.

Researchers are now exploring enhanced cognitive effects, reduction of stress and emotional response, and associations with psychological diagnoses and the microbiome. In a study by Tillisch et al. (2013) healthy women were given a nonfermented milk product or no intervention (control group). The women underwent fMRI before and after the intervention to examine resting state activity and responses to an emotional faces attention task. Consumption of a probiotic-enhanced fermented milk product altered brain connectivity in areas responsible for processing emotion and sensation.

There is also research interest in substances that may harm the microbiome, disturb intrinsic balance in the gut-brain axis, and decrease diversity of bacteria. In a recent study, participants were randomly assigned to receive one of four types of antibiotics or placebo (Zaura et al., 2015). Researchers collected fecal samples prior to participants taking antibiotics, immediately after the course of antibiotics, and followed them for 12 months after finishing the antibiotics. Results showed that antibiotics were found to enrich genes associated with antibiotic resistance and to affect microbial diversity for months after the course. Especially concerning was the decline in health-associated species that produces a substance known for inhibition of inflammation, cancer formation, and stress in the gut.

Conclusion

So far, most studies are correlational, making it impossible to draw conclusions about cause and effect. However, from the research-to-date the take home message is to take care of your intestinal microbes—which are likely associated with your overall health, resistance and recovery from disease, cognitive function, and regulation of stress and emotional responses. There are many other examples of this bidirectional communication, certainly enough to make an argument that our gut bacteria should be kept as healthy and as diverse as possible. Out of the approximately 10^{14} microbes estimated to inhabit our intestines at any given time, it is not hard to believe that we co-exist with creatures that have profound implications for our species.

Author Note

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Food for Thought: Are Herbicides a Factor for the Increase in Allergies and Autism?

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Abstract

Over the last 30 years autism, allergies, Type 2 diabetes, and autoimmune disorders have significantly increased. A possible contributing risk fact is the ingestion of residual herbicides and pesticides in foods in our diet. Presently, more than 95% of all grain, corn, and soy are genetically modified to be tolerant to Monsanto-produced herbicide Roundup® (glyphosate). Almost all human and animal food now contains low levels of glyphosate and its inert but poisonous additional ingredients. The increased glyphosate use over the last 25 years correlates nearly perfectly with the increased incidence of autism, diabetes, and celiac disease. Glyphosate selectively disrupts gut bacteria balance, acts as an endocrine disrupter, and is toxic to human beings. To optimize health and neural development, adopt a precautionary principle and avoid eating glyphosate and other types of herbicide- and pesticide-contaminated foods.

Keywords: diet; glyphosate autism; diabetes; allergies

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A couple of customers reported that they could eat our baguette even though they were gluten intolerant.
—Clerk at bakery that sells organic baguettes

When I was a little boy, allergies almost never occurred. I remember only one boy in our class of 38 who had asthma and allergies.
—71-year-old male

Fruit flies fed on organic raisins, bananas, soy, and potatoes lived significantly longer, had much higher fertility, and survived longer after starvation than those fed non-organic foods (Chhabra, Kolli, & Bauer, 2013).

After a year of practicing stress management and changing to a totally organic food diet, to my own surprise my nut allergy totally disappeared.
—25-year-old woman who reversed cervical dysplasia and rid herself of HPV (Peper, 2015).

Many people report being allergic to gluten, nuts, cat hair, etc., or have hay fever or some form of autoimmune disorder. In our 2014 survey, 36% of 264 students at an urban university (average age 24.5 years) reported having allergies (Peper & Del Dosso, 2015). Over the last 40 years more and more people are reporting allergies. Allergies are often dismissed because they are not serious—just uncomfortable and may limit what you eat or where you visit (e.g., “I can’t eat a morning bun” or “I can’t visit my aunt because she has a cat”). In rare cases it may trigger life-threatening allergic reactions (anaphylaxis), which can be usually resolved by injecting a single dose of epinephrine into the outer thigh with an EpiPen®.

Allergies, autoimmune illnesses, and Type 2 diabetes have become so common that we forget that they may be markers of immune incompetence that may affect the ability of the body to optimize health. The increase in allergies is an early indicator that something harmful is affecting the body. People who have allergies, autoimmune illnesses, diabetes, or other disorders are possibly the “canaries in the mine” for the rest of the population. In earlier times before carbon monoxide and other poisonous gases could be measured with instruments, miners used a canary as a poisonous gas meter. If the canary died, the miners would exit the mine before they would die of the poisonous gases.

There are many factors that contribute to the radical increase in asthma, rhinitis, allergies, Type 2 diabetes, and autoimmune disorders such as excessive hygiene; lack of breast feeding and introducing foreign foods too early in the first year of a baby’s life; ingestion of acetaminophen (Tylenol) by a pregnant mother during the first year of a baby's life; low Omega-3 levels during pregnancy; increased exposure to plastics and other endocrine disruptors; stress, etc. Many of these factors are outside of our control. However, diet and the ingestion of residual herbicides and pesticides in food appear to be a major risk factor.
In the last 30 years there has been a radical change in our diet. The food may look and even taste the same, but it is totally different. Almost all grains, corn, soy, cotton, processed foods, and meats contain low levels of Monsanto-produced herbicide Roundup® and other herbicides and pesticides, and are genetically modified to be herbicide tolerant to Roundup®. Roundup® was first introduced in 1974 by Monsanto and is the most widely used herbicide for farm and urban use. The active ingredient is glyphosate with numerous other inert ingredients. The inert ingredients may not inhibit the growth of weeds; however, they may be harmful to humans.

According to the U.S. Department of Agriculture, as of 2012, 99% of durum wheat and 97% of spring wheat have been treated with herbicides as more and more crops are genetically modified to be herbicide tolerant. It is now used on grain crops, rice, seeds, alfalfa, dried beans, peas, sugar cane, and sweet potatoes (Swanson et al., 2014). As Roundup® and equivalent herbicides are used, more and more illnesses—including food allergies such as gluten intolerance—have increased as shown in Figure 1.

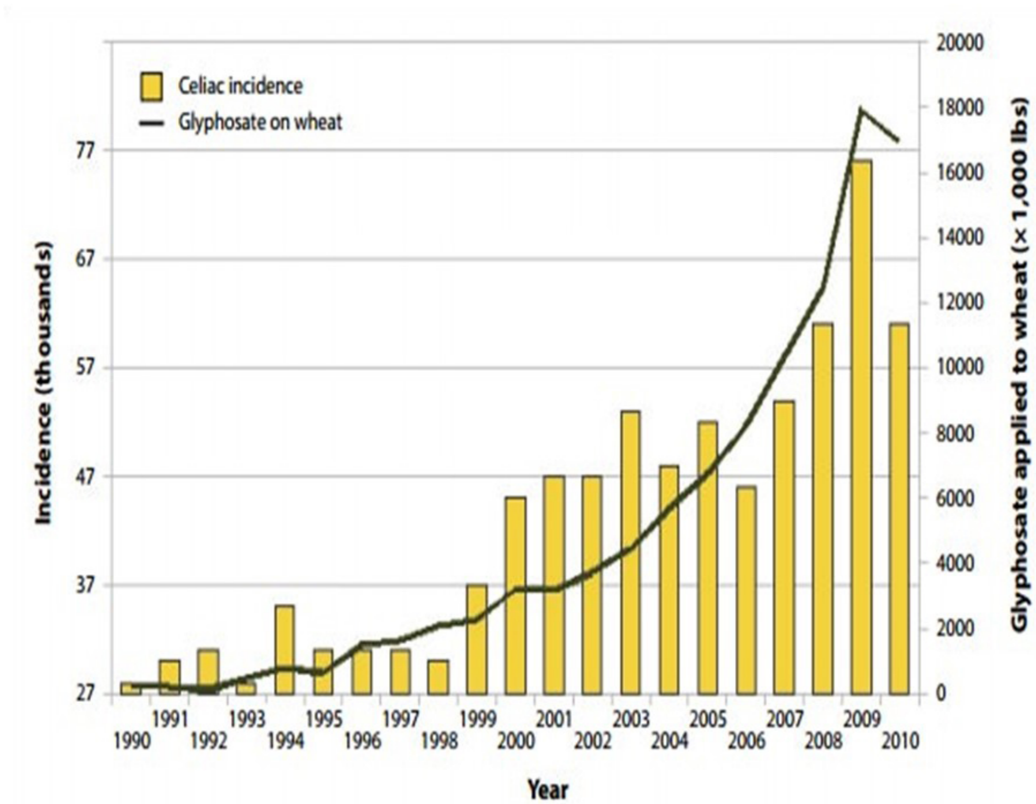

Figure 1. Correlation between increase in celiac disease (gluten intolerance) and increase in use of the herbicide glyphosate (Roundup®) on genetically modified grain (Samsel &Seneff, 2013).

In addition, the common wheat harvest protocol in the United States is to drench the wheat fields with Roundup® several days to allow crops to dry down for a uniformity of plant material at harvest before the combine harvesters work through the fields, as the practice allows for an earlier, easier, and bigger harvest (Sarah, 2014; Swanson et al., 2014). This means that almost all of the grain and grain products contain residue of Roundup®. Presently, more than 95% of all grain, corn, and soy are genetically modified to be herbicide tolerant to Roundup® as shown in Figure 2.

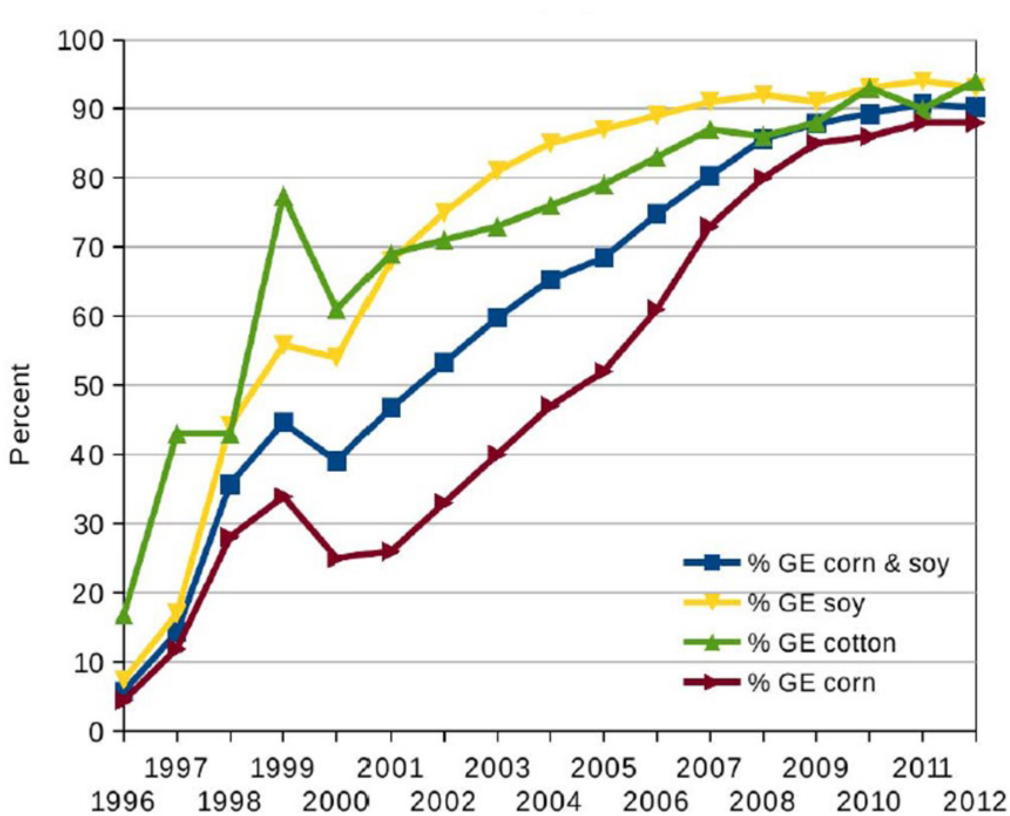

Figure 2. Adoption of genetically engineered (GE) crops in U.S. (Swanson et al., 2014).

In the USA glyphosate is the most widely used herbicide, with about 250 million pounds applied to U.S. farms and even lawns every year. Glyphosate and many other herbicides and pesticides are in our food, animal fodder, and thus in the meat, clothing, water supply, and even air. Almost all human and animal food now contains low levels of glyphosate and its inert but poisonous additional ingredients.

When plotting the increased application of glyphosate with the occurrence of chronic diseases over the last 35 years, Swanson et al. (2014) showed that the correlation is greater than 0.9 and highly significant for obesity (R = 0.96), diabetes (R = 0.98), end stage renal disease death (R = 0.97), Crohn's disease and ulcerative colitis (R = 0.94), death due to intestinal infection (R = 0.97), autism in children (6–21 years; R = 0.99), deaths from senile dementia (R = 0.99), and death from Alzheimer's (R = 0.93). Figures 3 and 4 shows the correlation of diabetes and autism and increased application of glyphosate.

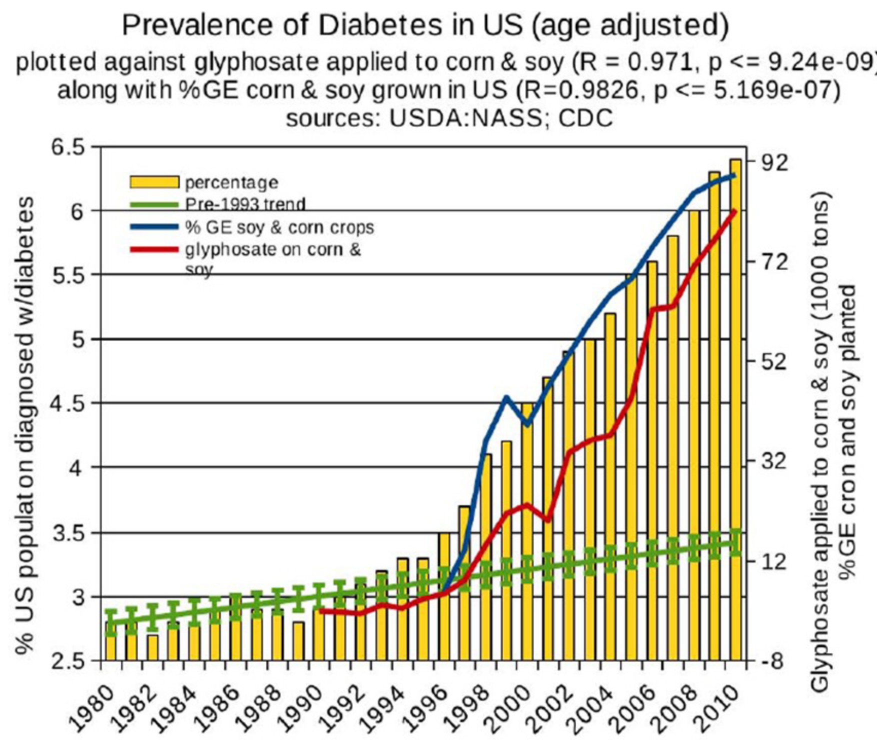

Figure 3. Correlation between age-adjusted diabetes prevalence and glyphosate applications and percentage of U.S. corn and soy crops that are genetically engineered (Swanson et al., 2014).

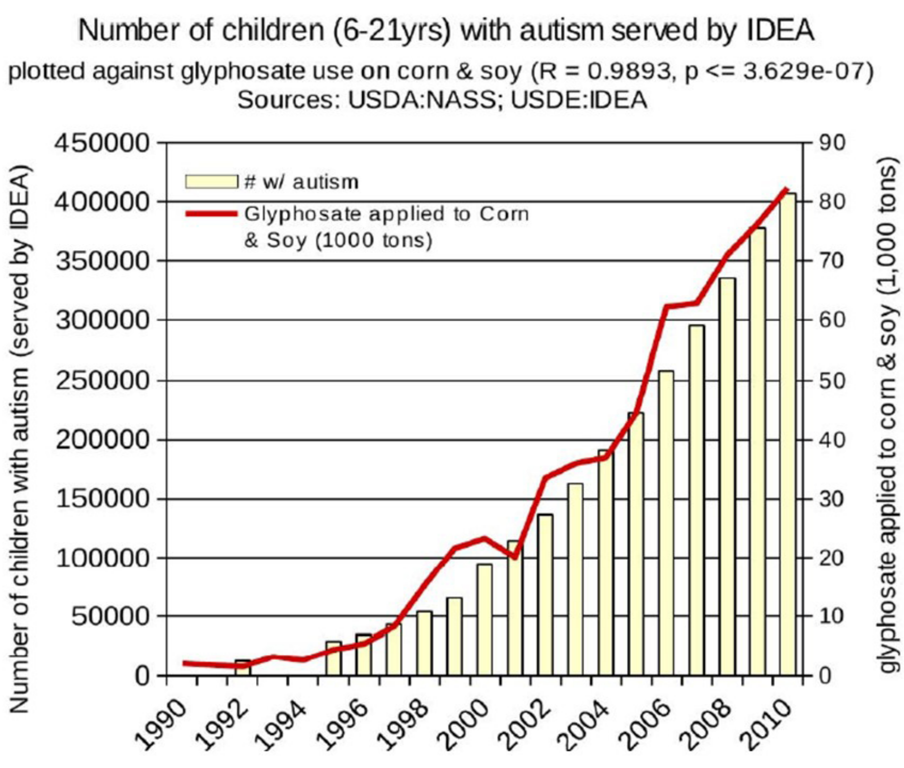

Figure 4. Correlation between children with autism and glyphosate applications (Swanson et al., 2014).

Correlations are not proof and similar correlations could be plotted between increased production of plastics, high-fructose corn syrup, cell phone use, and anti-depressant and ADHD medications. Correlations may suggest a possible relationship, which should be investigated. It is very difficult to investigate the correlation because most people unknowingly have ingested glyphosate. When using naturalistic observations such as comparing people who eat only organic versus non-organic foods, there are many other variables that could account for the differences.

The hypothesis that Roundup® residues in food is harmful is clear from a biological perspective. The purpose of using glyphosate and its inert ingredients is to act as an herbicide and biocide to suppress weed growth and act as a drying agent to improve harvest. As human beings are biological organisms, glyphosate and its inert ingredients will have similar effects. It affects our cellular metabolism and especially our bacteria that live in our gut and are necessary for our health. As Samsel and Seneff (2013) point out, "it kills the beneficial bacteria in our gut, leading to the steep rise in intestinal diseases." Specifically, Shehata et al. (2012, p. 350) found that "highly pathogenic bacteria as *Salmonella Entritidis*, *Salmonella Gallinarum*, *Salmonella Typhimurium*, *Clostridium perfringens* and *Clostridium botulinum* are highly resistant to glyphosate. However, most of beneficial bacteria such as *Enterococcus faecalis*, *Enterococcus faecium*, *Bacillus badius*, *Bifidobacterium adolescentis* and *Lacto-bacillus* spp. were found to be moderate to highly susceptible" (as cited in Swanson et al., 2014, p. 10).

Given the very strong correlations of increased disease with increased use of Roundup®, the evidence that glyphosate disrupts gut bacteria balance and cellular metabolic processes; kills human embryonic, placental, and umbilical cord cells; and acts as endocrine disrupters, the recent decision by the International Agency for Research on Cancer (IARC; 2015), which is the specialized cancer agency of the World Health Organization, that glyphosate is possibly carcinogenic to humans (Group 2A), I strongly recommend avoiding glyphosate and other types of herbicide- and pesticide-contaminated foods. **Use the precautionary principle and eat only organic foods.**

If the radical increase of allergy and immune incompetence is linked to the increase of chronic exposure to glyphosate, then avoiding glyphosate and other pesticide- and herbicide-laced foods may possibly reverse the allergy and immune incompetence. Numerous participants have reported that when they adapt a holistic lifestyle that included stress management and eating only organic foods, their immune system became more competent. Some experienced their food allergy to disappear. This was reported recently by a 25-year-old young woman who previously had cervical dysplagia with HPV. She was able to reverse both the dysplasia and eliminate the high strains of HPV (her last Pap test results were normal and the HPV finally gone), and in addition her nut allergy also disappeared (Peper, 2015). As she stated, "I was able to rid myself of a nut allergy that I developed when I was 19. I frequently had trouble breathing; therefore, I went to an allergist and they told me I had a nut allergy to peanuts (4 out of 4) and tree nuts (2 out of 4). This past July, knowing how truly healthy I had become and after noticing a little to no reaction when I accidentally consumed a nut, I decided to go back to the allergist. I got the test done, and no signs of a nut allergy came up. I believe it was due to this lifestyle change."

In summary, eat only organic foods when possible and follow the wisdom of numerous countries that have banned the use of Roundup®. This year, the Netherlands followed Russia, Tasmania, and Mexico to ban glyphosate-laced herbicide. Starting now farmers and people in the Netherlands who treat their gardens and lawns will have to find an alternative form of pest control since glyphosate—the main ingredient in Roundup®—is linked to cancer, infertility, birth defects, nervous system damage, and kidney disease (Inhabitat, 2014). This is the path the rest of the world should closely follow.

Author Note

This article is adapted from Peper, E. (2015, January 11). Are herbicides a cause for allergies, immune incompetence and ADHD? [Blog post]. Retrieved from http://peperperspective.com/2015/01/11/are-herbicides-a-cause-for-allergies-immune-incompetence-and-adhd/

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NeuroRegulation

The Impact of Coherence Neurofeedback on Reading Delays in Learning Disabled Children: A Randomized Controlled Study

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Abstract

Introduction: Learning disabilities are a complex problem facing our society and educational system. Dyslexia, or reading disability, is one of the most common learning disabilities, impacting children and adults adversely in a myriad of ways. Traditional programs designed to teach reading enhancement are largely ineffective or require intensive therapy over long periods of time. **Method**: Forty-two school-aged participants were randomly assigned to experimental and control groups. The experimental group received qEEG-guided, individually tailored, two-channel coherence neurofeedback over the left hemisphere. This included two sessions per week for a total of 20 sessions. The control group received typical resource room instruction. All participants received pre- and post-educational measures focused on reading abilities. **Results**: Following the intervention period, the experimental group enhanced their reading scores, while the control group did not. Coherence neurofeedback led to an average enhancement of 1.2 grade levels in reading scores, but resource room instruction led to no such improvement at all. **Conclusion**: Coherence-based neurofeedback would appear to show promise and led to significant gains in reading that outpace those of traditional reading programs and most types of neurofeedback studied in the past. Future clinical and research work in this understudied area is recommended.

Keywords: Neurofeedback; coherence; reading; Dyslexia; learning disability

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Introduction

Within the education system, learning disabilities are the most rapidly growing category for special education services, accounting for approximately 5% of the total student population in the United States (Cortiella & Horowitz, 2014). Dyslexia, or specific reading disability, is one of the most common forms of learning disabilities, with prevalence rates ranging from 5% to 17% (Shaywitz, 1998; Shaywitz, Fletcher, Shaywitz, 1994). Dyslexia involves impairment in reading for both children and adults that would not be anticipated when considering an individual's cognitive ability, motivation, or education (Shaywitz, 1998). Individuals who struggle with reading fall on a continuum, ranging from minimal to severe skill deficits. According to the National Reading Panel (2000), the skills necessary for learning to read include phonemic awareness (understanding sounds or phonemes that make up a spoken word), phonics (associating sounds or phonemes to letters of language, then using this understanding to form words), reading fluency (quickly and accurately reading words), and reading comprehension (ability to read text and process it for its meaning). Additionally, individuals with Dyslexia struggle with spelling, vocabulary, and written expression (Cortiella & Horowitz, 2014).

Further, research suggests that there are neurobiological underpinnings of specific cognitive deficits that are associated with learning disabilities

(Eden & Zeffiro, 1998; Ramus, 2004; Shaywitz & Shaywitz, 2004). McCandliss and Noble (2003), provided a thorough review of the neurological deficits associated with developmental Dyslexia. Based on the understanding that phonological processing is a fundamental procedure required for reading, many researchers studied the superior temporal gyrus (STG) due to its association with this process. McCandliss and Noble outlined 11 studies examining the STG and its functioning with comparisons between individuals with and without Dyslexia. Studies have found that individuals with Dyslexia show less activity within the STG when challenged by phonological processing. Further, another brain region associated with developmental Dyslexia, that was highlighted in the literature according to McCandliss and Noble, is the left occipito-temporal extrastriate visual system. This visual system is located by the fusiform gyrus, which is responsible for the automaticity of word recognition in skilled readers. McCandliss and Noble discussed several functional neuroimaging studies that indicated the left fusiform gyrus' specific association with visual word form perception, and its lack of involvement with perception of other visual stimuli. Additionally, it was reported that the visual word form area was not associated with false graphemes or auditory words, but only "visually presented alphabetic characters," supporting the specific function of the left fusiform gyrus (McCandliss & Noble, 2003, p. 200).

Temple et al. (2003) conducted a study that supported the findings reviewed by McCandliss and Noble (2003). This study conducted functional Magnetic Resonance Imaging (fMRI) scans on 20 children with Dyslexia before and after completing an intervention focused on improving auditory processing and oral language skills. Results found differences in the left temporo-parietal cortex and the left inferior frontal gyrus when performing phonological tasks; where after the intervention, children with Dyslexia had improved reading and increased activity in the mentioned brain areas with task performance.

These studies outlined above by McCandliss and Noble (2003) and Temple et al. (2003) illustrate the neurobiological basis for reading difficulty. Identification of brain regions associated with Dyslexia is pivotal for developing intervention methods that specifically target neurobiological functioning as a means to improve reading ability. Dyslexia's high occurrence within adult and child populations draws attention to the need for research to focus on efficacious interventions methods for reading difficulties.

Interventions and Efficacy

The Orton-Gilligham (OG) approach (Sheffield, 1991) is a common reading intervention method that allows trained teachers, tutors, or specialists to provide a structured, multisensory, and cumulative method to individuals in need of reading instruction. The multisensory element of this technique incorporates auditory, kinesthetic, and visual pathways for learning to help children use phonemic awareness, the alphabetic principles (sound to symbol relationship), decoding, encoding, fluency, and comprehension (Ritchey & Goeke, 2006). These researchers reviewed OG and OG-based programs for reading instruction and found mixed results after reviewing 12 studies. A total of five of the 12 studies indicated that when compared to control interventions, OG instruction resulted in enhanced reading outcomes, while one indicated no significant differences after including covariates, two reported that alternate instruction was more beneficial, and four reported that OG instruction was beneficial for at least one reading skill, but not all (Ritchey & Goeke, 2006). Overall, Ritchey and Goeke were unable to clarify the effectiveness of OG or OG-based intervention strategies. Further, the What Works Clearinghouse (WWC) reached the same conclusion as Ritchey and Goeke. WWC examines the efficacy of research centered on education. OG studies reviewed by WWC did not meet WWC evidence standards, indicating that the efficacy of OG-based interventions is inconclusive at this time (U.S. Department of Education, Institute of Education Sciences [IES], 2010a).

The Wilson Reading System (WRS; Wilson, 1998) is a remedial program for both children and adults who have had difficulty with other teaching techniques for learning how to read. The WRS uses OG principles to teach phonemic awareness, alphabetic principles, vocabulary, fluency, and comprehension with multisensory principles. The WRS program was designed to be implemented over the course of one to three years through a cumulative 12-step sequence (Wilson & O'Connor, 1995). In a data review completed by Wood (2002), large cohort study reports using the WRS program were analyzed and found to have an average improvement of 0.38 standard deviations (*SD*) on the Woodcock Reading Mastery Test total reading cluster over a 1-year intervention period. Improvements were seen across all subtests on the test, including Word Identification, Word Attack, Passage Comprehension, and the Basic Skills

Cluster. The WWC reviewed nine studies that implemented the WRS program, and reported that WRS may have a positive impact on an individual's understanding of alphabetic principles, but little to no effect on fluency and comprehension skills (U.S. Department of Education, Institute of Education Sciences [IES], 2010b). The WRS program appears to be minimally efficacious, but does not consistently improve all skill areas necessary for higher-level reading.

Lindamood-Bell Learning Processes (LMB; 2005) were designed to focus on building reading and comprehension skills through helping individuals understand the "process" of language. This goal is achieved through helping learners acquire proficiency in phonemic awareness, symbol imagery (phonologic and orthographic processing), and concept imagery (oral and written language). According to the clinical statistics from LMB, word reading improved by 0.60 *SD* and sentence/paragraph reading improved by 0.35 *SD* over the course of one year of instruction. The WWC reviewed one research study for the Lindamood Phonemic Sequencing (LiPS) program, and found that LiPS may have a positive impact on an individual's understanding of alphabetic principles and reading fluency, no effect on reading comprehension, and possible negative effects on writing skills (U.S. Department of Education, Institute of Education Sciences [IES], 2008).

Another important intervention method to consider with Dyslexia is reading instruction within the context of a special education resource classroom, as opposed to a general education classroom. In a longitudinal study conducted by Bentum and Aaron (2003), reading achievement of children with learning disabilities who were instructed in a resource room was examined. The first group of children with learning disabilities contained 230 individuals who had a previous diagnosis of a reading disability and were re-evaluated after 3 years of resource room instruction. The second group of children with learning disabilities contained a total of 64 children who were in a resource room for a total of 6 years, where re-evaluation occurred twice, each after 3 years. Pre- and post-test scores for reading achievement and IQ testing were compared for both groups. Results found that instruction within the learning disability resource room did not improve word recognition or reading comprehension skills. Additionally, students within the resource room actually experienced a decrease in spelling scores for both student groups. Finally, results indicated that children who had received special education in the resource room for 6 years demonstrated a decrease in performance on verbal IQ testing (Bentum & Aaron, 2003). Bentum and Aaron's findings are alarming in that the goal of the special education resource room is to provide a more individualized, intensive education setting to help improve difficulties in learning. If special education resource rooms are ineffective, then what other intervention methods can we look to for helping struggling readers? One new and revolutionary intervention method that has been studied in the literature for learning disabilities involves the use of Neurofeedback (NF).

EEG and Neurofeedback with Dyslexia

Electroencephalography (EEG) has become a widely accepted and utilized brain imaging method, but the scope of how EEG can be used for research has yet to be established (Michel & Murray, 2012). EEG records the electrical activity of the brain with electrodes on the scalp and has recently been used in studies of individuals with learning disabilities. Learning disability studies using EEG have seen clear differences in brain activity when comparing individuals with and without learning disabilities. One example is that decreased connectivity is found between brain regions responsible for visual symbols and language sounds for individuals with Dyslexia (Shaywitz, Gruen, & Shaywitz, 2007), likely illustrating why it is often harder for struggling readers to apply alphabetic principles. Additionally, EEG research has found that children with learning disabilities, specifically Dyslexia, have increased theta activity and decreased alpha and beta activity when compared to children without learning disabilities (Fernández et al., 2002; Lubar et al., 1985). With this knowledge researchers have started to use EEG biofeedback or NF to help treat learning disabilities. NF trains participants to direct their own EEG activity through operant conditioning.

Fernández et al. (2003) conducted a study to examine how NF treatment with children who have learning disabilities would affect their EEG activity and behavior. The study included 10 children with learning disabilities that had theta to alpha absolute power ratios that were higher than average. Then, to maintain similar IQ, socioeconomic status, gender, and the Test of Variables of Attention (TOVA) scores, subjects were divided into a control and experimental group. The TOVA is a computerized assessment measure that helps screen for attention disorders like Attention-Deficit/Hyperactivity Disorder (ADHD). NF was provided to both groups for a total of twenty 30-min sessions, with approximately two sessions per week.

The control group received noncontingent reinforcement, while the experimental group had NF that targeted a subject's brain region with the highest theta/alpha ratio. Reinforcement in the experimental group was contingent on the theta/alpha ratio falling below a threshold, which when achieved would signal a sound for reinforcement. Results found improved performance on IQ testing, as well as decreased delta, theta, alpha, and beta bands' absolute power in the experimental group. These changes were not found with the control group, signifying the possible effectiveness of NF as a treatment option for children with learning disabilities.

In a study conducted by Orlando and Rivera (2004), NF was administered to sixth-, seventh-, and eighth-grade students identified with learning disabilities. Pre- and post-test cognitive and reading measures were administered to determine if NF would improve basic reading, reading comprehension, total reading, and IQ scores. Students were randomly assigned to either the control or experimental group, with a total of 10 students in the experimental condition and 14 in the control condition. Students in the experimental group received, on average, no more than 45 min of NF per session, for a total of 28 sessions. Results found that NF had a positive outcome on the treatment condition with an increase of 0.36 *SD*, versus students within the control condition who had a decrease of 0.33 *SD*. The NF administration protocol was not specified within the study.

Additionally, Thornton (2006) has reported that auditory and reading memory increased by more than three *SD* when using a targeted protocol based on qEEG for children with learning disabilities and/or ADHD. With research supporting the efficacy of NF as a treatment method for learning disabilities, the current research study seeks to examine how EEG coherence training might impact reading abilities in students diagnosed with Dyslexia.

Method

Participant Characteristics

This study involved 42 children who were previously, and independently, identified with a learning disability (Dyslexia). The Winthrop University Hospital IRB approved participation in this study and the procedures used. All subjects' parents or legal guardians provided written consent. Participants were interviewed and completed neuropsychological and educational testing by a qualified administrator. To be diagnosed with a learning disability, educational age equivalent scores had to be 1.5 to 2 years delayed compared to chronological age. None of the participants had any other neurological or psychiatric diagnosis that would account for the delays. All 42 participants had delays on measures of reading or reading comprehension. The demographic characteristics of the samples are provided in Table 1.

Table 1
Demographics for the total sample, broken down by experimental (coherence) and control (resource) groups.

Descriptives

						95% Confidence Interval for Mean			
		N	Mean	*SD*	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
Age	Coherence	21	12.105	1.8857	.4115	11.247	12.964	8.9	15.5
	Resource	21	11.954	1.7669	.3856	11.150	12.759	8.8	15.1
	Total	42	12.030	1.8065	.2787	11.467	12.593	8.8	15.5
Handedness	Coherence	21	1.190	0.4020	.0880	1.010	1.370	1.0	2.0
	Resource	21	1.240	0.4360	.0950	1.040	1.440	1.0	2.0
	Total	42	1.210	0.4150	.0640	1.080	1.340	1.0	2.0
Gender	Coherence	21	1.190	0.4020	.0880	1.010	1.370	1.0	2.0
	Resource	21	1.240	0.4360	.0950	1.040	1.440	1.0	2.0
	Total	42	1.210	0.4150	.0640	1.080	1.340	1.0	2.0
Race	Coherence	21	1.100	0.3010	.0660	0.960	1.230	1.0	2.0
	Resource	21	1.140	0.3590	.0780	0.980	1.310	1.0	2.0
	Total	42	1.120	0.3280	.0510	1.020	1.220	1.0	2.0
Medication	Coherence	21	0.240	0.4360	.0950	0.040	0.440	0.0	1.0
	Resource	21	0.240	0.5390	.1180	−0.010	0.480	0.0	2.0
	Total	42	0.240	0.4840	.0750	0.090	0.390	0.0	2.0

Instruments

All participants were administered a battery of neuropsychological and intellectual tests. Reading abilities were measured with the Woodcock-Johnson Tests of Achievement III (WJ III; Woodcock, McGrew, & Mather, 2007) and the Gray Oral Reading Test-4 (GORT-4; Wiederholt & Bryant, 2001). The WJ III reading scores included letter word identification, reading fluency, and reading comprehension subtests. Letter word identification asks participants to read a list of words to measure word identification. Letter word identification has a reliability of .91 for children and adolescents and a reliability of .94 for adults. Reading fluency asks participants to read statements and determine whether the statement is true or false. Three minutes are given to complete as many questions as possible. Questions gradually increase in difficulty level. Reading fluency has a reliability of .90 for children, adolescents, and adults. Passage comprehension begins with matching a pictograph representation of a word with the actual picture of the object followed by multiple choice. Multiple choice format requires a person to point to a picture. The final section of the test requests participants to identify a word missing from a paragraph. Passage comprehension has a reliability of .83 for children and adolescents and .88 for adults. The GORT-4 is a reading test measuring fluency and comprehension. A person is asked to read a paragraph out loud and then answer questions about the paragraph. GORT-4 is reported to have .90 reliability. The tests were administered to control and experimental group participants before and after treatment.

All subjects also underwent qEEG assessment data collection before and after intervention. EEG data was obtained under two conditions, eyes closed and eyes open. A stretchable electrode cap embedded with 19 sensors attached to the scalp was used to collect data, with frontal reference, prefrontal ground, and linked ears. Each recording lasted 20 min, where 10 min were spent in both conditions. EEG acquisition involved recording and digitizing EEG readings based on the International 10/20 System of electrode placement utilizing the Deymed Diagnostic (2004) TruScan 32 Acquisition EEG System. This system included 32 channels with sampling at 128 cycles per second and filtering between 0.1–40 Hz. All recordings were done with impedance less than 5 kΩ. The common mode rejection ratio for this system is 102 dB and the isolation mode rejection ratio is 140 dB. The reliability and validity of quantitative EEG (qEEG) have been sufficiently assessed and confirmed (Thatcher, 2010). We have previously shown qEEG data to be useful in impacting outcome of NF intervention for children on the autistic spectrum (Coben & Myers, 2010; Coben & Padolsky, 2007). All EEG data was subjected to manual artifacting procedures conducted by a professional with more than 30 years' experience. qEEG data analysis included the use of the Neurometric Analysis System (NxLink, 2001; John, Prichep, Fridman, & Easton, 1988) and NeuroGuide (Applied Neuroscience, Inc.; Thatcher, Walker, Biver, North, & Curtin, 2003), both of which are FDA approved. Specific coherence analyses were conducted with the NeuroRep (Hudspeth, 1999) connectivity analysis system.

The experimental group participated in NF sessions as the active treatment. The NeuroCybernetics EEGer Training System (NeuroCybernetics Inc., 2006) was used to perform connectivity-guided EEG biofeedback training. The sensors (Grass Silver Disc 48" Electrodes with SafeLead protected terminals; Grass SafeLead, 2006) were applied to the subject's scalp to measure EEG activity. The signal was then fed back to the subject in visual and aural form based on relative amplitude/threshold values. The visual feedback consisted of simple graphics (presented in the form of computer games), providing a continuous display of the ratio of amplitude to threshold for each stream of data. The aural reward consisted of a prerecorded sound file of a short 0.25-s beep, occurring no more often than once per every half second and activating when specific amplitude/coherence conditions were met (NeuroCybernetics Inc., 2006).

Procedure

All 42 patients diagnosed with a learning disability underwent neuropsychological, IQ, and educational testing, and qEEG assessment prior to intervention in a private clinical practice setting. Educational testing and qEEG assessment were completed following intervention. Reading scores for the two groups were based on the WJ III and the GORT-4. All subjects were already receiving resource room assistance at school but no other active interventions. The 42 participants were randomly assigned to an experimental and control group with 21 in each group. The experimental group received NF training as the active treatment and the control group received their resource room assistance but no NF.

Neurofeedback Protocols

The 21 participants that made up the experimental group received 20 sessions of two-channel connectivity-guided EEG coherence NF two times a week. Treatment was personalized to each individual on the basis of his or her original qEEG findings for power and coherence. Based on each participant's qEEG analysis, areas showing the most prominent hypocoherence (low coherence) were targeted for training. All maximal hypocoherence connections indicated by the qEEG were located on the left side of the brain. Of the 21 participants receiving coherence training, the most common connection found to be too low was the occipital-parietal region to the frontal-temporal. The second most common hypocoherence identified was the parietal to medial temporal connections. Less common was the hypocoherence connection between temporal-parietal to frontal regions with only three of the subjects receiving this training. All coherence protocols also included inhibiting excessive amplitude based on significant qEEG findings over those regions.

Protocol designs were different for each individual. Rewarding for coherence increases was matched to the frequencies showing the greatest hypocoherences. For most participants this included delta, theta, and often alpha bands as well. This was combined with amplitude inhibits for low frequencies (delta-theta) for 17 of 21 subjects. There was also a second inhibit for most subjects that included alpha and low beta frequencies. Lastly, a third inhibit was common for higher frequencies, often in the 20–30 Hz range. These individual sessions were run for no longer than 20 minutes of actual training.

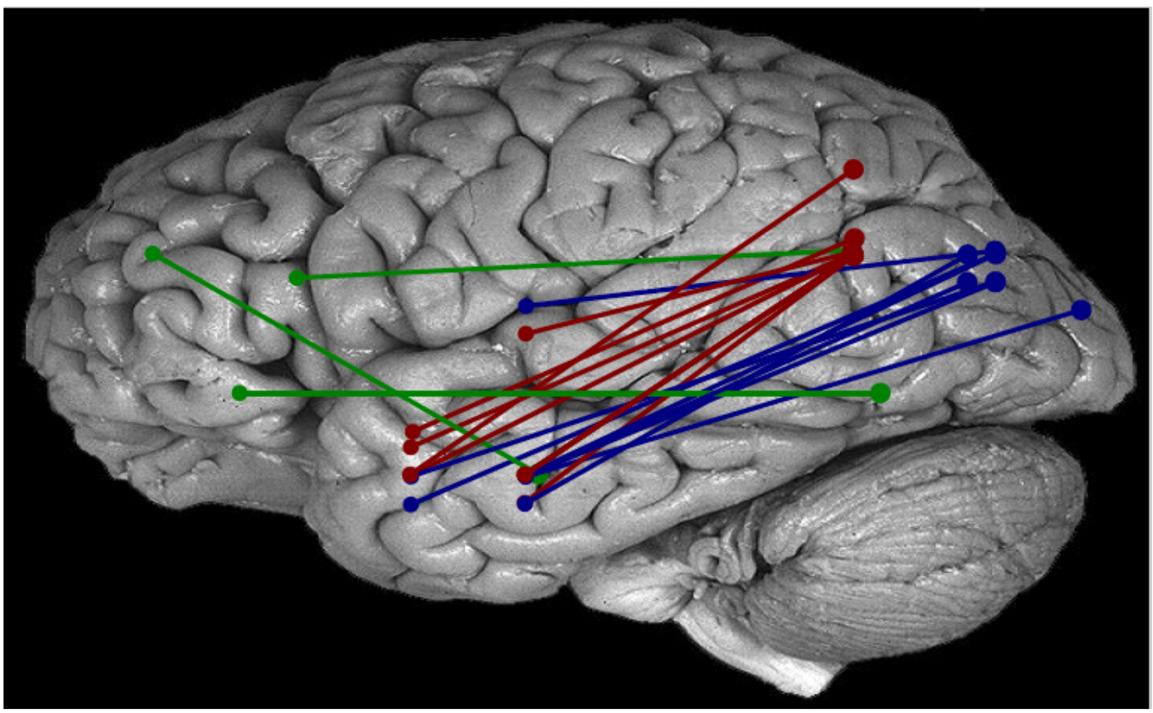

Figure 1. Graphic representation of two-channels involved in NF protocol for each subject in the experimental group. Represented are those trained from occipital-temporal (blue), parietal-temporal (red), and temporal-parietal-frontal (green).

Results

The primary aim of this research was to compare if reading scores changed significantly in the experimental group as compared to the control group following the intervention period. When one compares these two groups, there was no significant difference for age of the samples (t = 0.27, ns), handedness (z = 0.38, ns), gender (z = 0.38, ns), race (z = 0.48, ns), medication (t = 0, ns), or baseline reading scores (t = 0.99, ns). When baseline scores in reading were compared to the subject's age (reading delay), there was a mild indication that the control group (2.7 ± 0.28) had less of a delay than the experimental group (3.22 ± 0.52) but this difference was not statistically significant (t = 1.85, p = .07). As a result, one may conclude that any differences in reading scores and change in reading scores are unlikely to be due to these factors. Detailed demographic descriptive statistics are shown in Table 1 above and descriptive statistics for delays in reading are shown in Table 2 below.

Table 2
Reading delay in years for the total sample, experimental (coherence) and control (resource) groups.

Descriptives

						95% Confidence Interval for Mean			
		N	Mean	*SD*	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
Reading Delay	Coherence	21	3.220	1.1422	.2492	2.700	3.739	1.6	5.3
	Resource	21	2.697	0.6073	.1325	2.421	2.974	1.9	4.1
	Total	42	2.958	0.9414	.1453	2.665	3.252	1.6	5.3

An analysis of variance (ANOVA) was performed with group (coherence vs. resource) as the independent variable and pre- and post-treatment reading scores serving as the dependent variables. As presented above, there was no significant difference between reading scores at baseline, but there was at post-tests after the intervention period ($F = 7.557$, $p < .01$). Post-hoc tests showed that this change in reading scores was due to the fact that the experimental group improved upon their reading scores, while the control group did not.

Table 3
Descriptive statistics for reading age equivalent (reading age 1) at baseline and at follow-up (reading age 2).

Descriptives

						95% Confidence Interval for Mean			
		N	Mean	*SD*	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
Reading Age 1	Coherence	21	8.886	1.0011	.2185	8.430	9.341	7.0	10.2
	Resource	21	9.257	1.4045	.3065	8.618	9.896	6.6	12.0
	Total	42	9.071	1.2192	.1881	8.691	9.451	6.6	12.0
Reading Age 2	Coherence	21	10.129	1.2021	.2623	9.581	10.676	8.0	12.0
	Resource	21	9.062	1.3101	.2859	8.466	9.658	7.0	11.3
	Total	42	9.595	1.3541	.2089	9.173	10.017	7.0	12.0

Table 4
One-way ANOVA (group x reading scores).

ANOVA

		Sum of Squares	df	Mean Square	*F*	Sig.
Reading Age 1	Between Groups	1.449	1	1.449	0.974	.330
	Within Groups	59.497	40	1.487		
	Total	60.946	41			
Reading Age 2	Between Groups	11.947	1	11.947	7.557	.009
	Within Groups	63.232	40	1.581		
	Total	75.179	41			

Comparison of the groups showed a significant difference in reading change scores (time 1 – time 2). When age equivalent scores on reading tests were used as the dependent variable there was a significant difference between the two groups ($t = 12.8$, $p < .001$). The experimental group (coherence training) enhanced their reading scores by a mean of 1.243 years, while the control group had a small decrease in reading scores of 0.2 years. These changes are depicted in Figure 2.

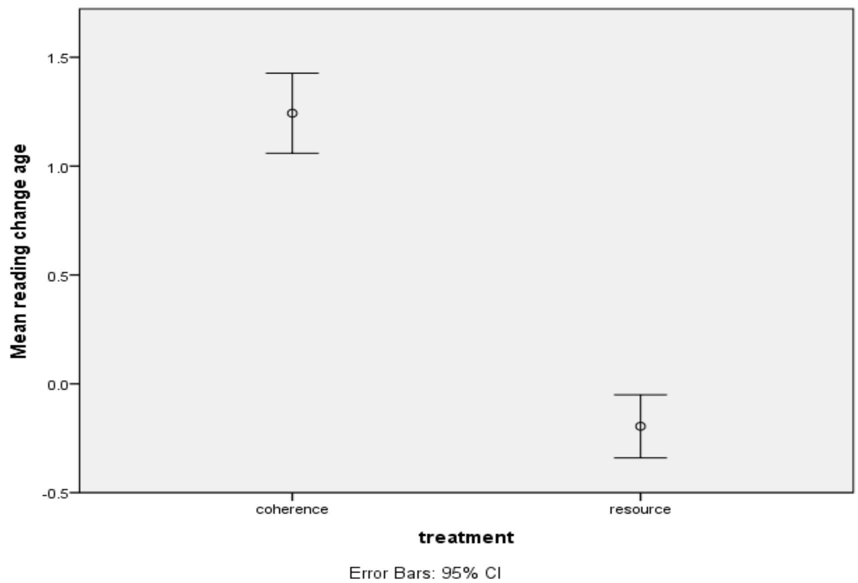

Figure 2. Change in age equivalent reading scores by group.

We also calculated an index of delay in reading called percentage reading delay based on their age and how far delayed they are in reading scores. We then measured their improvement on this index over the course of training/intervention. Not surprisingly, there was again a difference between the groups (t = 13.45, $p < .001$) with the experimental group showing greater change. The experimental group (coherence training) improved by 40%, while the control group (resource room) declined by 7%. These results are shown in Figure 3.

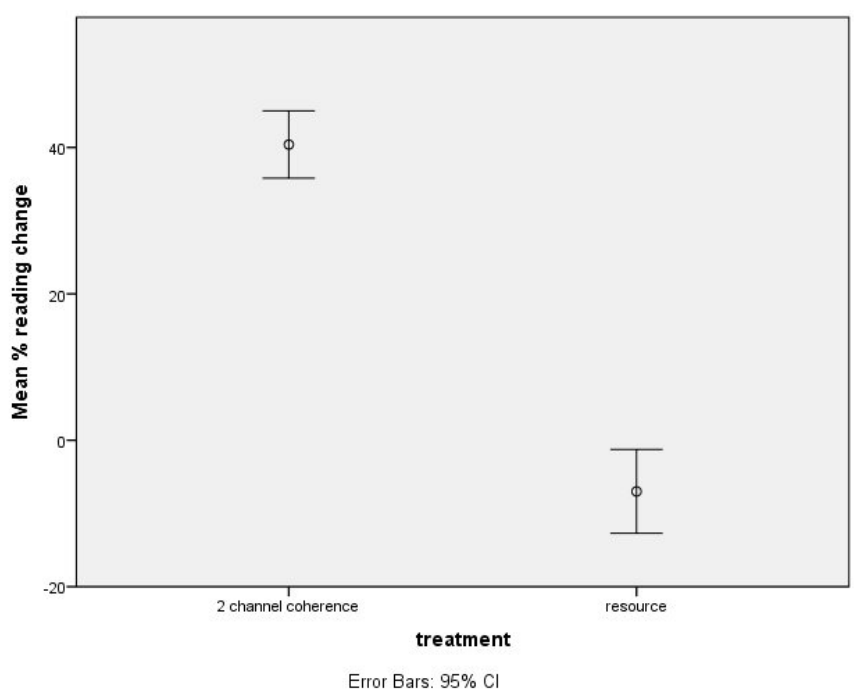

Figure 3: Change in percentage reading delay by group.

Conclusion

Remedial approaches for children with learning disabilities have been found to have limited effectiveness. This is important given the number of children in need of remedial services and the escalating cost to treat children with learning disabilities in schools. As such, it is of tremendous importance to not only identify effective interventions but also interventions that are financially sustainable.

The current study used an experimental design to examine the effectiveness of NF on improving reading performance in children identified with reading disorders in comparison to a matched control group receiving standard educational interventions. Forty-two children with reading delays were randomly assigned to an experimental group that received coherence-based NF and a control group that received resource room instruction. Those that received NF improved upon their reading scores, while those in the control group did not. The average improvement of the experimental group was 1.2 grade levels in reading scores over the course of only 20 NF sessions (total treatment duration of only 10 hours).

These findings compare favorably and exceed the efficacy of other interventions available to help children with reading problems. Traditional reading programs like the OG approach have not been able to show consistent efficacy (Ritchey & Goeke, 2006; U.S. Department of Education, Institute of Education Sciences [IES], 2010a). Similarly, the Fast ForWord language intervention program has not proven to have efficacy for reading improvement compared to comparison groups (Strong, Torgerson, Torgerson, & Hulme, 2011). The Lindamood-Bell learning program has been shown to be mildly beneficial, but requires at least a full year of instruction to achieve these aims (Lindamood-Bell Learning Processes, 2005). It is also very interesting to note that interventions like resource room instruction tend to have very little impact on reading abilities in children with reading delays (Vaughn & Wanzek, 2014). Our findings are certainly consistent with this.

With this in mind, the search for effective reading interventions is critical. There is some evidence that NF training can enhance academic abilities in children with learning disabilities. Orlando and Rivera (2004) showed a moderate effect from NF compared to a no treatment control group, but even this effect took an average of seven months or longer. Nazari, Masonezhad, Hashemi, and Jahan (2012) showed in six single subject cases of NF changes in coherence associated with improved academic abilities. Of course, their paper lacked experimental design to draw any firm conclusions. Lastly, Breteler, Arns, Peters, Giepmans, and Verhoeven (2010) conducted a study of 19 children using qEEG-guided NF training but found no impact on reading abilities, but improvements in spelling only. Their potential impact may have been mitigated by pairwise instead of multivariate coherence analyses and its impact on the type of training they chose (see Coben, Mohammed-Rezazadeh, & Cannon, 2014). Our current study has double the sample size of these others and has corrected many methodological flaws discussed above. Our findings suggest a dramatic enhancement of reading abilities in a short time frame and suggest an important avenue for future clinical and research endeavors.

Despite these encouraging findings, our research has some of its own limitations that should be addressed with future work. Our sample may have been biased by the hope of clinical gain, even though they knew there was only a 50% chance of receiving the active treatment. While our randomization to experimental and control groups was a positive feature, all participants knew which group they were in and there was never an attempt to blind them or the experimenters. Future work that is single- or double-blinded in some way may overcome this weakness. Lastly, this data was gathered at a time when we did two-channel coherence training. Since this time, other advanced techniques have been developed in the field of NF including multivariate four-channel NF (Coben, 2014), low-resolution brain electromagnetic tomography (LORETA) NF (Cannon, Congedo, Lubar, & Hutchens, 2009) and others that may be able to enhance the efficacy of this work even further.

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NeuroRegulation

Proceedings of the 2015 ISNR Conference: Keynotes, Invited, and Student Award Presentations

Selected Abstracts of Conference Presentations at the 2015 International Society for Neurofeedback and Research (ISNR) 23rd Conference, Denver, Colorado, USA

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KEYNOTE PRESENTATIONS

Developmental Trauma: Effects of Abuse and Neglect on CNS Development and a Possible Role for Neurofeedback to Reverse the Damage

Bessel van der Kolk, MD
Medical Director of The Trauma Center, Boston, Massachusetts, USA
Professor of Psychiatry at Boston University Medical School, Boston, Massachusetts, USA
Co-Director of the National Center for Child Traumatic Stress Complex Trauma Network, Boston, Massachusetts, USA

This keynote will discuss some of the well-established and direct affects of trauma on developing brains and specific brain functions responsible for attention, concentration, regulating emotions, and engaging in satisfying relationships. Dr. Kolk and colleagues are currently studying whether neurofeedback can reverse those brain changes. The importance of this pursuit is evident when considering that many traumatized children and adults continue to feel chronically on edge, scared, agitated, collapsed, and helpless, even after exposure to treatment and medications. To deal with this they often try to cope with alcohol or drugs. Medications may make life more manageable but they also affect motivation and curiosity, and rarely really lead to increased focus, relaxation, and engagement. Thus this lecture will review the way trauma impacts brain development and show the effects of neurofeedback.

The Neuropsychopathology of Traumatic Brain Injury

Mark Gordon, MD
Owner and Medical Director of Millennium-TBI, Encino, California, USA

In this presentation, Dr. Gordon will walk through some of the science that has helped his team provide treatment to patients where no improvement was thought possible. Some cases will be presented to illustrate the approach to diagnosis and treatment of Traumatic Brain Injury (TBI) for those who have failed to respond to traditional care. He will discuss at length the influence and relevance of neuropsychopharmacology, neuropsychobehavioral characteristics, and neuroplasticity to the diagnosis of TBI. Both genetic and epigenetic influences on neuroplasticity will be described, as will the details of hormonal mechanisms regulating reactive emotions from the limbic system, which influence intelligence and emotional presence. Additionally, the creation, importance, and delicate balance of neurosteroids with regard to behavioral reactions and mental well-being will be explained.

Mindful Creativity

Sayyed Mohsen Fatemi, PhD
Associate, Department of Psychology, Harvard University, Massachusetts, USA

This talk will explicate how Langerian mindfulness opens up a new horizon for exploring the novel possibility in the world of mind and body. In view of a distinction between meditation-based mindfulness and Langerian mindfulness, the talk will elucidate how Langerian mindfulness would give rise to developing new avenues of creativity with implications for health and well-being. In line with neuroplasticity and its focus on our power to influence the function and the structure of the brain, the talk will propound how Langerian mindfulness may provide alternative ways of looking at schema, cognition, thinking, and decision-making.

Neuromodulation (TMS, tDCS, tRNS, tACS, neurofeedback): Working Mechanisms

Dirk DeRidder, MD, PhD
Founder and director of the BRAI^{2}N (Brain Research Center for Advanced, Innovative and Interdisciplinary Neuromodulation), Antwerp, Belgium

The brain is an information-processing machine adjusting itself to the environment. Information processing is performed to reduce uncertainty, which is inherently present in a changing environment. Perception can be seen as Bayesian inference, where an intention-driven prediction is actively looked in the environment to update the prediction. The percept itself is an emerging property of network activation, processing the information at different oscillation frequencies for each subnetwork. Brain-related symptoms or diseases are associated with both activity, and even more importantly, connectivity changes. Using the brain's adaptive characteristics can be advantageous in retraining the brain by reshaping its networks. This is the purpose of neurostimulation and neurofeedback. Whereas neurostimulation interferes directly with activity and connectivity, neurofeedback or operant conditioning likely exerts its effect by interfering with the brain's Bayesian updating mechanisms.

A conceptual model of brain functioning can help to understand mechanisms involved in neurofeedback. This model relates delta oscillations to controlling basic homeostatic activity and a delta can be considered a carrier wave for higher oscillation frequencies, most likely beta activity. Theta is a memory-related carrier wave integrating beta3 and gamma activity by theta-beta and theta gamma nesting. Theta oscillations cover short- and long-range connections, whereas beta3 and gamma oscillations are more locally restricted in widely distributed areas. Alpha oscillations are thalamically driven and can be linked to attentional processes. Delta and beta1-2 is intermediate in its connectivity range. Theta/beta cross-frequency coupling possibly encodes memory-based predictions of future events/stimuli. In order to update the prediction, alpha is used as scanning frequency sampling the environment for salient information. The prediction error or change is encoded in gamma. Thus correct predictions about the environment will be encoded by beta activity, which therefore represents a status quo, whereas wrong predictions or insufficient input from the environment will be represented by beta/gamma cross-frequency coupling. Thus neurofeedback attempts to modulate these oscillatory networks, thereby normalizing predictions or processing of prediction errors. This results in changing functional and effective connectivity as well as cross-frequency coupling.

INVITED PRESENTATIONS

The Institute for Advanced Technology and Public Policy: Operation Headstrong

Honorable Sam Blakeslee, PhD[1], and Lance Iunker[2]
[1]Former California State Senator; Founder of the Institute for Advanced Technology and Public Policy, California Polytechnic State University, San Luis Obispo, California, USA
[2]Program Director, Institute for Advanced Technology and Public Policy, California Polytechnic State University, San Luis Obispo, California, USA; Retired U.S. Army Veteran

The Institute for Advanced Technology is a think tank that seeks solutions to societal issues through technology, and then to shape public policy to make those solutions increasingly accessible. Currently the institute has four projects. One is *Digital Democracy*, an open government web-based tool. Two is *Connect Academy*, a tablet-based technology-in-the-classroom project geared towards lower income and challenged background schools seeking to incentivize parent participation in their child's learning. Three is *CalWave*, a sustainable wave energy project. The final project is *Operation Headstrong*, which utilizes emerging technology in neurofeedback therapy to improve the lives of veterans suffering from PTSD and TBI.

Lance Iunker, an Iraq War veteran, will give an overview about Operation Headstrong. He will share his personal story about being wounded in Iraq and his struggles with PTSD and anxiety. His personal success story will demonstrate how neurofeedback therapy has helped him and he is now trying to help other veterans with neurofeedback therapy.

STUDENT AWARD WINNERS – PLENARY PRESENTATIONS

Effects of Neurofeedback on Cognitive Profiles of College Students with ADHD

Alycia Roberts, MA, and Scott Decker, PhD
University of South Carolina, Columbia, South Carolina, USA

Neurodevelopmental disorders such as ADHD represent a major national problem. There are increasing numbers of students in schools requiring special education services as a result of ADHD, and each of these students costs the U.S. education system approximately $5,000 per year (Robb et al., 2011). There are additional societal costs associated with the disorder, and ADHD can be debilitating for individuals with the disorder and their families (i.e., Barkley & Murphy, 2010; Ginsberg, Långström, Larsson, & Lichtenstein, 2013). The most common treatments are stimulant medication and behavioral training (i.e., Pelham & Fabiano, 2008), but recently neurofeedback (EEG biofeedback) has been receiving a lot of press. Both the American Academy of Pediatrics and the American Academy of Child and Adolescent Psychiatry have endorsed neurofeedback as a viable option for the treatment of ADHD (AAP, 2012; Lofthouse, Arnold, Hersch, Hurt, & DeBeus, 2012).

Methods: The current study is a randomized controlled study investigating the effects of LORETA neurofeedback on a college population with ADHD. The study used a pre-test, multiple post-test design with delayed treatment to provide stronger evidence of its effectiveness. Both qEEG and behavioral data were collected to determine if there were changes in brain activity, and if these changes were evident on popular measures of cognitive ability (i.e., Woodcock-Johnson III) and attention (CPT-II).

Results: This presentation will provide group level analyses and case study reports of individuals from both conditions. Preliminary data are promising, suggesting the effectiveness of neurofeedback in a college population. The results of the full study will be presented.

Objectives: This 30-min presentation will provide a brief overview of the literature regarding the use of neurofeedback with clinical populations, specifically individuals with ADHD. It will also provide a detailed account of the methodology used in the randomized control study described above, including the successes and limitations of the project. Finally, the results of the study will be discussed both regarding group level statistics, and matched control case studies to demonstrate the impact of the training protocol on the individual level, which is a primary area of interest for practitioners.

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Using Neurofeedback to Lower Anxiety Symptoms Using Individualized qEEG Protocols: A Pilot Study

Stephanie Dreis, Angela Gouger, Michael Russo, Edward Perez, and Mark S. Jones, DMin
The University of Texas at San Antonio, San Antonio, Texas, USA

Anxiety disorders affect approximately 40 million Americans ages 18 and over (NIMH, 2015). Various biofeedback modalities have been implemented by clinicians in the treatment of anxiety including electromyography (EMG), peripheral temperature, and electrodermal response (EDR) prior to the popularization of neurofeedback (Price & Budzynski, 2009). Numerous studies illustrate the use of neurofeedback in correlation with symptom reduction in anxiety specifically but not limited to: frontal alpha asymmetry related anxiety (Kerson, Sherman, & Kozlowski, 2009), psychiatric clients diagnosed with anxiety disorders (Cheon et al, 2013), performance anxiety in dancers (Singer, 2004), and anxiety symptoms related to post-traumatic stress disorder (PTSD; Walker, 2009). A study by Scheinost et al. (2013) showed participants with contamination anxiety having significantly more neural connectivity changes after undergoing neurofeedback treatment in comparison with the sham feedback group. Although many of the studies use set protocols on all patients, Hammond (2009) suggests the preferential nature of viewing the raw EEG when creating an individualized treatment protocol. This is due to other potentially confounding variables such as: co-morbid psychiatric conditions, medical issues, or effects from medication that the participants may possess.

Prior research was closely examined in determination of each participant's protocol for this study. Although qualitative and small-scale quantitative studies show reduction in anxiety symptoms, large-scale studies or quantitative electroencephalography (qEEG)-driven protocols are non-existent. The creation of this pilot study intends to assess whether qEEG-guided amplitude neurofeedback is viable in symptom reduction of anxiety. Eight participants were prescreened to assess for anxiety. Two did not finish the treatment; therefore, their information was not used. Ages ranged from 15 to 52 (mean age 33.83). Half were women. Four of the participants identified as Hispanic/Latino and two identified as Caucasian. One participant had previous experience with neurofeedback, two participated in counseling during the study, five have had previous counseling experience, and three of the participants were currently taking medication. Pre- and post-assessments to monitor behavior and symptoms were given to the participants. Assessments for adults included the Zung Self-Rating Anxiety Scale and the Adult Behavior Checklist (ABCL). Assessments for minors and their guardians included Screen for Child Anxiety Related Disorders (SCARED) and the Youth Behavior Checklist (YABCL). A qEEG was used to determine protocols for each participant. Participants were to receive 30-min neurofeedback treatment sessions twice a week totaling 17 sessions. The range of attended session was 12–16, mean session attendance was 13.67.

Results will be known May 1st, 2015. Results will include the outcomes of pre- and post-assessments and qEEGs. An interesting finding includes having a participant with previous neurofeedback treatment use visualization techniques to produce anxiety and then use neurofeedback to help reduce anxiety. The current study has several limitations, such as a small sample size and no control group. Corrective suggestions are mentioned for future studies.

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STUDENT AWARD WINNERS – POSTER PRESENTATIONS

Affective Virtual Reality Exposure with Physiological Monitoring: Application for Emotional Reactivity Testing in Autism

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Background: Children with autism spectrum disorder (ASD) typically suffer from impairment in social skills, emotion recognition, and expression, and are at high risk of anxiety. They prefer to stay in a more protective and controllable environment. Virtual Reality (VR) is proven to be effective in a wide range of treatment sessions, such as exposure for patients with addictive disorders or social anxiety disorders (Meehan, Razzaque, Insko, Whitton, & Brooks, 2005). However, it is very likely that the "standard" emotional response to the same VR scenarios between children on ASD and typical developed people would be different. Therefore, it is a reasonable approach to measure the differences in physiological responses during VR environment immersion, in order to design VR-based training or therapy sessions best suitable for ASD.

Objectives: The study is based on using affective VR as a tool to induce emotional responses and measure autonomic nervous system (ANS) activity of children on ASD (Casanova et al., 2014) and in a group of typically developing control subjects. The main aim of this study is to characterize differences in autonomic reactivity between these two groups and select more usable measures for functional reactivity assessment, useful for social skills training targets.

Methods: Three affective VR scenarios are designed and chosen to evoke physiological responses during exposure to emotionally positive, negative, and neutral context. The hardware to provide VR is an Oculus Rift Development Kit 2, and the software platform is Unity 4.6 Pro with C# as developing language. Autonomic nervous system variables are measured and recorded online by sensors attached to subjects during exposure the VR scenes. The autonomic dependent variables (Boucsein, 2012) include heart rate (HR), heart rate variability (HRV) measures (LF and HF, LF/HF ratio), skin conductance response (SCR), number of non-specific SCR (NS.SCR) and respiration rate (RSP), along with several derived parameters. The system allowed monitoring the scenarios to synchronize it with autonomic recording using specific markers of events. Each scenario takes around 5 min for subjects to explore; one session requires exploration of all three scenes, which takes up to 20 min in total, including configuration, VR and sensors mount time. Recorded physiological data was analyzed using synchronized events and triggers from VR scenes for each emotional script. The subjects consisted of a group of five children with ASD and 10 typical controls.

Results and Conclusions: Preliminary results comparing skin conductance responses demonstrate a difference between ASD group and the control group. In particular, the frequency of NS.SCR to negative VR scenarios was significantly different between groups, with ASD group having higher, less differentiated NS.SCR across all conditions. SCR showed significant Emotion (neutral, negative) X Group (ASD, controls) interaction. Heart rate responses and HRV measures showed group differences across emotional scripts. Application of VR with emotionally laden scripts in persons with ASD allows us to compare their ANS responses for better understanding of specifics of their emotional responsiveness, and use it for affective reactivity diagnostic and therapeutic purposes, including social skills training and biofeedback.

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EEG Coherence of Mu Rhythm in Successful and Unsuccessful Golf Putting Performance in Skilled Golfers

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In the sport area, golf putting is a motor skill that requires precise motor planning and a high level of concentration. Leocani (1997) demonstrated that the frontal and sensorimotor cortices are areas related to the planning and control of the motor skill. Previous study suggested that coherence analysis is a useful tool for understanding the functional connectivity between different cortical areas (Babiloni et al., 2011). Based on the findings of reduced mu power during the better motor preparation at premotor and sensorimotor cortices (Arnstein, Cui, Keysers, Maurits, & Gazzola, 2011; Sabate, Llanos, Enriquez, & Rodriguez, 2012), this study aimed to further investigate whether difference in mu coherence would be observed between successful and unsuccessful performance in precision motor control skill. In this study we recruited 35 skilled golfers. None of the participants had neurologic disease. All participants agreed with the experimental procedure and filled out the informed consent. According to this percentage, participants had to increase or decrease their putting distance in the next warm-up series. This process was repeated until the participant's distance of 50% accuracy was determined. The participants performed a total of 40 putts in four separate blocks (interblocks interval of about 1 min) at an artificial golf green while Electroencephalography (EEG) were recorded and mu coherence (Fz-C3, Fz-C4, Fz-P3, Fz-P4, Fz-O1, Fz-O2, Fz-T3, Fz-T4) was derived. 2 (performance: successful performance, unsuccessful performance) x 2 (time: T2 = −2s ~ −1s, T1= −1s ~ 0s) x 8 (coherence sites: Fz-C3, Fz-C4, Fz-P3, Fz-P4, Fz-O1, Fz-O2, Fz-T3, Fz-T4) ANOVA revealed a significant interaction effect between performance and coherence sites. Post hoc simple main effect analysis indicated that the mu coherence for successful putting performance at FZ-C4 was smaller than that of unsuccessful performance. The results suggested that decreasing communication between motor planning and motor control of the left arm was related to better golf putting performance.

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Interaction Between EEG Control Training and EEG State Discrimination Training

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It is commonly argued that the mechanism of action of biofeedback involves increasing awareness of subjective correlates of one's physiological state (Frederick, 2007, 2012). However, the relationship between awareness and control of physiological states is largely unexplored. Kamiya (1968) reported that those trained in alpha discrimination later showed superior performance in an alpha production task, but this finding was never replicated. Therefore, the present study seeks to determine whether subjects given standard neurofeedback (or "control") training will do better on EEG state discrimination (or "awareness") training, or vice versa. In a preliminary investigation, six subjects were given 4–7 sessions (median 7) of the following: (1) 5 min in which high alpha amplitude was rewarded; (2) 5 min during which low alpha was rewarded; (3) a repeat of (1); (4) a repeat of (2); followed by (5) 40 trials of alpha state discrimination training. Four subjects achieved a total of five criterion sessions (binomial $p < .05$) in the discrimination task. These five successful sessions occurred on days when the participant also succeeded in maximizing the amplitude difference between the high and low alpha reward conditions (average rank 2 out of 6). However, this apparent relationship was confounded by a strong effect of time on both variables. The mean amplitude difference between the high and low alpha reward conditions showed a positive learning curve, with session number explaining r^2 = 49% of the variance. Similarly, performance in the discrimination task increased over time with session number explaining r^2 = 46% of the variance. All five criterion sessions occurred in the fifth or later session. Shorter times between sessions appeared to improve discrimination performance. The five criterion sessions had a mean 4.4 days since the previous session, compared to 8.2 for the remaining sessions (previously seen in Frederick, 2012). A similar effect was not seen for the control task. A larger sample size is needed to evaluate the significance of these findings. Future studies will compare the success of learning between these two tasks alone vs. combined to examine whether there are synergistic effects.

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Exploring the Effects of Neurofeedback Training on Subjective and Objective Performance in Elite Athletes

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Neurofeedback (Reinecke et al., 2011) training programs are increasingly used as strategies for enhancing athletic performance, due to their focus on increasing self-awareness and self-regulation (Faridnia, Shojaei, & Rahimi, 2012). However, there is a need for more randomized controlled studies of the efficacy of these training programs using both subjective and objective performance measures.

This randomized controlled trial was designed to study the effects of a neurofeedback training program on neurocognitive (EEG) and subjective self-report measures in an elite athlete population (university-level/Division I). The sample of elite athletes for this study was comprised of university-level NCAA Division I athletes from several different sports. The neurofeedback training protocol involves 10 hr of Alpha enhancement training at occipital and parietal lobe sites. We hypothesize that participants receiving Alpha training will show demonstrable changes in EEG profile. During Phase I of data collection, researchers collected pre- and post-training data on 17 participants (eight in the neurofeedback group, nine in the control group). Data collection is still ongoing, but preliminary data suggest there could be significant findings that have not reached statistical significance due to lack of power. To further investigate this, the researchers are analyzing the neurofeedback and control groups' pre-post data to determine (a) whether greater neuro-electric change occurred in the neruofeedback treatment group and (b) whether these objective changes are correlated with self-report performance measures. Limitations and future directions, including a description of Phase II of the data collection process, will be presented.

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Daytime Cortical Arousal Among Patients with Comorbid Insomnia and Major Depressive Disorder

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Background: Insomnia is common in patients with major depressive disorder (MDD); they complain of falling asleep and awakening in the daytime. One of the neuropsychopathological mechanisms of insomnia is cortical hyperarousal. Previous studies explored cortical activities at pre-sleep and sleep stages among patients with primary insomnia and MDD, as well as the physiological arousal in the daytime among patients with chronic insomnia. There were few studies that explored clearly the psychopathological mechanism among patients comorbid with MDD and insomnia. The purpose of this study was to explore the daytime cortical arousal among patients comorbid with MDD and insomnia.

Methods: Fifty patients comorbid with MDD and insomnia were the MDD group that was compared with 35 healthy controls in beta power of electroencephalogram (EEG). All of the participants filled out the Pittsburgh Sleep Quality Index (PSQI). The resting EEG with eye-closed were measured for 5 min via 19-channel BrainMaster equipment (BrainMaster Technologies, Inc., Bedford, Ohio), where the spectrum analyses showed the beta power (13–32 Hz; as a cortical hyperarousal index) at Fz and Cz.

Results: This study found that:
(1) After controlling the medication effects, there were positive correlations between PSQI total score, the habitual sleep efficiency, use of sleep medications, and beta power at Fz and Cz.
(2) There were higher absolute and relative beta power at Fz and Cz in the MDD group than that of in healthy controls.
(3) After controlling the medication effect, the MDD group with high sleep disturbance had higher relative beta power at Fz and Cz than that of the MDD group with low sleep disturbance.

Conclusion: This study indicated that poor sleep quality was associated with daytime cortical arousal. Patients with MDD had higher cortical arousal at the frontal and central areas than that of healthy controls. These phenomena may reflect the daytime cortical hyperarousal that was found among patients comorbid with MDD and insomnia.

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Neuromodulation Therapy Based on an Integration of Prefrontal rTMS and Neurofeedback for the Treatment of Autism

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Background: The study is based on an underlying neuropathological model of autism, which emphasizes "minicolumnar" pathology (Casanova, 2007; Casanova et al., 2006) and cortical lateral inhibition deficits resulting in behavioral abnormalities and executive dysfunctions. We propose that neuromodulation based on low-frequency repetitive TMS over prefrontal area will enhance lateral inhibition through activation of inhibitory double bouquet interneurons and will be accompanied by EEG alteration that can be operantly conditioned using neurofeedback (NFB) immediately after rTMS session. In prior studies in children with ASD we demonstrated post-TMS improvements in executive functions (Casanova et al., 2012; Sokhadze, El-Baz, Sears, Opris, & Casanova, 2014), as well as positive effects of prefrontal neurofeedback in ASD (Wang et al., 2014). In the current study each rTMS session was followed by NFB training that we predicted to result in a synergetic response.

Objectives: The overall aim of the study was to investigate behavioral responses, ERP indices of information processing, and coherence of evoked and induced gamma oscillations in children with ASD enrolled either in 18 weekly sessions of combined rTMS-NFB training group or in the wait-list group. The goal of our study was to investigate whether error rate, accuracy, frontal and parietal ERPs and gamma coherence, and clinical behavioral evaluation outcomes will show positive changes in the treatment group as compared to wait-list group.

Methods: We used 18 weekly sessions of 0.5 Hz rTMS bilaterally over prefrontal cortex (around F3-F5 and F4-F6), 90% of motor threshold, 200 pulses, followed by prefrontal (FPz) neurofeedback in 20 children with ASD (14.9 years). Another group of children with ASD (N = 22, 15.6 years) was tested twice within 4 months. Baseline and post-treatment (TMS-NFB or wait) assessments used selective attention tests with EEG/ERP recording and clinical behavioral evaluations (ABC; Aman & Singh, 1994; and RBS-R; Bodfish, Symons, & Lewis, 1999).

Results: Post-TMS-NFB evaluations showed decreased irritability and hyperactivity on ABC, and decreased total repetitive behaviors scores on RBS. Between group difference in error rate was significant, with the TMS-NFB group showing decrease of error rate (F = 5.62, p = .02). Magnitude of the frontal N100 decreased, while amplitude of the P200 to target stimuli increased post-TMS-NFB, demonstrating more effective recognition of targets (F = 5.25, p = .027). Similar effects were expressed as well in the parietal P3b. The treatment group showed increase coherence of induced gamma to targets between frontal and temporal sites (F3-T7, F = 6.67, p = .14). Neurofeedback sessions resulted in linear regression of the theta/ratio and increase of gamma power over 18 sessions of treatment.

Conclusions: Improved clinical behavioral evaluation outcomes along with behavioral (RT, accuracy) and functional EEG/ERP measures post-TMS-NFB treatment are indicative of more efficient processing information post-treatment. The study represents a pilot translational clinical research exploration where rTMS and neurofeedback were combined, and treatment effects were compared with a wait-list group using clinical, behavioral, and cognitive outcome measures. Preliminary results are very encouraging and warrant further, more rigorous, controlled clinical trials to assess efficacy of proposed integrated neuromodulatory intervention for autism treatment.

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The Clinical Use of Neurofeedback Treatment for Major Depression Disorder

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Background: Cortical hyperarousal was found in patients with major depressive disorder (MDD). The neurofeedback (NFB) is a kind of clinical intervention program for regulating brain activity and decreasing cortical hyperarousal. The purpose of this study was to explore the efficacy of NFB among patients with MDD.

Methods: Two-way mixed model and counterbalanced design was applied in this study. Twenty patients with MDD were randomly assigned to the NFB group and control group. There were nine MDD patients (mean age was 48.33 ± 4.80 years; two male and seven female) who participated in the NFB group that included 60 min weekly for 6 weeks. The protocol of NFB included sensor motor rhythm (SMR) uptrain and beta downtrain. The control group included 11 MDD patients (mean age was 46.27 ±13.21 years; three male and eight female) that were treated as usual. There was no significant difference between the NFB group and control group in age (t = 0.44, p = .66) and gender (χ^2 = 0.07, p = .80). A 5-min resting baseline of electroencephalogram (EEG) was recorded at Cz by BrainAvatar (BrainMaster Technologies, Inc., Bedford, Ohio) before and after NFB training. The EEG power spectrum was analyzed by MATLAB® R2008a (MathWorks, Natick, Massachusetts) and EEG insight (Delorme & Makeig, 2004) for beta power (13–32 Hz).

Results: There was a group * time interaction effect at pre-intervention and post-intervention between two groups, $F(1,18) = 4.86$, $p < .05$, $\eta_p^2 = .025$. The post hoc comparison found lower beta power at post-intervention than that at pre-intervention in the NFB group (17.87 ± 5.78 μV^2 and 21.70 ± 8.55 μV^2); however, higher beta power at post-intervention than that at pre-intervention in the control group (13.01 ± 7.88 μV^2 and 10.99 ± 6.58 μV^2).

Conclusion: This study indicated that NFB can decrease beta power that may decrease cortical hyperarousal among patients with MDD.

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Examining Correlations Between the TOVA and the Evoke Continuous Performance Test

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Children and adults with attention issues frequently show impaired performance on neuropsychological tests of attention. The Test of Variables of Attention, or TOVA, is a continuous performance test (CPT) that is widely used to assess whether a person has ADHD, as well as if a person would be a candidate for Neurofeedback training. The TOVA has also been used as a key measure in Neurofeedback studies that show how Neurofeedback can lead to improvements in attention (Gruzelier, Foks, Steffert, Chen, & Ros, 2014; Lubar, Swartwood, Swartwood, & O'Donnell, 1995; Thompson & Thompson, 2005). The TOVA is a 21.6-min-long test, in which there are two black squares in a white box. The top square is the target to which clients must respond quickly and accurately, while inhibiting their response to the bottom square, which is not the target.

The TOVA has many measures of assessing attention, but there are four main measurements that are often examined as key variables: reaction time, reaction time variability, commission errors, and omission errors. Response time is the average time it takes a subject to respond correctly to a target.

Response time variability is a measure of variability for accurate responses (Leark, Greenberg, Kindschi, Dupuy, & Hughes, 2007). Commission errors occur when a subject fails to inhibit a response and presses the button to a non-target. Omission errors occur when a participant does not respond to a target and fails to press the button. Large deviations from the norm on any of these measures can indicate significant attention issues. While the TOVA test is considered a valid assessment of attention, would other tests that assess attention have similar results?

This study will investigate how the Evoke Neuroscience attention test correlates with the TOVA. The Evoke CPT is a 10-min test that can be used to assess attention issues. In the Evoke test, subjects must respond to a big blue circle but not push a button when a small blue circle pops up on the screen. During the Evoke CPT, the subject also undergoes a 19-channel EEG analysis, ERP analysis, and heart rate analysis, all of which allow clinicians to assess a client in multiple modalities simultaneously. Response time, response time variance, commission errors, and omission errors are presented in the Evoke assessment. This study will look at whether there are correlations between these four main measures in both the TOVA and the Evoke attention test by having subjects take both tests. We aim to recruit around 40 to 50 subjects for this study using both children and adults. Results with a smaller sample have been promising so far. There was a strong positive correlation between the percentage of omission errors in both tests $r(23) = .740$, $p < .0005$. As for reaction time, there was a strong correlation between reaction time scores $r(23) = .796$, $p < .0005$. Substantial correlations between the results would mean that if a client needed a multimodal assessment, or if a clinician or client were short on time, they could rely solely on the Evoke test to assess whether Neurofeedback training would be appropriate for a client.

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EEG Patterns Under Baseline, Erect, and Slouch: Body Postures Affect our Brain, Time to Memory Recall, and Correct Rate of Words Recall

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Background: Erect and slouch postures were related to energy level and the recall of positive and negative memories. Previous studies found that EEG patterns were related to different postures. The purpose of this study was to explore the EEG patterns under posture of baseline, erect, and slouch.

Methods: Twenty-eight healthy college students were recruited in this study (mean age was 20.64 ± 1.06 years with 25 male and three female). ProComp Infiniti 6.0 (Thought Technology Ltd, Montreal, Quebec, Canada) was used to detect participants' EEG at Cz under posture of baseline, erect, and slouch with their eyes closed. EEG amplitudes of delta, theta, alpha, beta, low beta, and high beta were analyzed.

Results: This study found that there was significant higher slow wave amplitude (theta and alpha) at Cz under baseline than that under erect, $F(2, 27) = 20.74$, $p < .001$, $\eta_p^2 = .43$, and slouch posture, $F(2, 27) = 7.08$, $p < .01$, $\eta_p^2 = .21$; as well as higher delta amplitude at Cz under baseline than that under erect posture, $F(2, 27) = 5.38$, $p < .01$, $\eta_p^2 = .17$. There was higher high beta at Cz under slouch than that under baseline and erect, $F(1.26, 27) = 11.16$, $p < .01$, $\eta_p^2 = .29$.

Conclusion: This study found that higher slow wave EEG under baseline than that under slouch and erect might indicate that more relaxed state at baseline. The posture of slouch and erect may need more effort that was related to lower slow wave. The delta amplitude of erect was significantly lower than baseline and it indicated the possibility that erect posture might make people to be in a more alert situation. On the other hand, higher beta activity under slouch posture may relate to higher cortical arousal.

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The Relationships Between Heart Rate Variability and Electroencephalography Under Erect and Slouch Postures

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Background: Body posture influences on our emotional states have been confirmed. Heart and brain interaction are related to our health and emotion regulation. Heart rate variability (HRV) is an index for heart autonomic activation, and electroencephalography (EEG) is an index of brain activity. This study was to explore the relationships between HRV and EEG under postures of baseline, erect, and slouch.

Methods: Twenty-eight healthy college students (age 20.64 ± 1.06 years; female/male = 25:3) were invited to measure electrocardiography (ECG) and electroencephalography (EEG) by ProComp Infiniti 6.0 (Thought Technology Ltd, Quebec, Canada) under the following sequences: baseline, erect, and slouch posture. The interbeat intervals of ECG were transformed to HRV indices (SDNN, LF, HF, and LF/HF ratio) and the amplitude of delta, theta, alpha, and beta of EEG were analyzed. The change scores of HRV and EEG indices were calculated. The subjective emotion rating of happiness and depression were collected after erect and slouch posture.

Results: In erect posture, there were positive corrections between SDNN and amplitude of theta and alpha (r = .42, p < .05; r = .43, p < .05); as well as LF and amplitude of theta and alpha (r = .41, p < .05; r = .38, p < .05). However, there was no relationship between HF and LF/HF ratio with EEG. In slouch posture, there was no correction between HRV and EEG indices. For the subjective emotion rating, there was higher happiness score at erect posture than that at slouch posture (64.50 and 59.62; t = 2.38, p < .05); as well as higher of depression score in slouch posture than that in erect posture (24.97 and 19.14; t = −2.71, p < .05).

Conclusion: In the erect posture, participants may tend to have higher happiness emotion than that at slouch posture; this situation may related to better vagal regulation and higher relaxation state. There were higher depression emotion in slouch posture than that at erect posture; however, there was no significant correction between HRV and EEG.

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EEG Patterns Under Different Body Postures and Emotion Stages

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Background: Previous study found that erect and slouch of body posture related to positive and negative emotion. Participants reported more positive emotion under erect posture; on the other hand, participants reported more negative emotion under slouch posture. This study explored EEG patterns under different body posture combined with positive/negative emotion recall.

Methods: Twenty-eight healthy college students were included in this study. The mean age was 20.64 years (SD = 1.06) with three male and 25 female. Lartin square design and counterbalance design was applied in this study. The Cz electroencephalogram (EEG) were recorded by ProComp Infiniti 6.0 (Thought Technology Ltd, Quebec, Canada) under the following sequences with eyes-closed baseline, erect with happiness recall, erect with depressive recall, slouch with happiness recall, and slouch with depressive recall. Each experimental stage was measured in 1 min to detect the EEG. The amplitudes of delta (1–4 Hz),

theta (4–8 Hz), alpha (8–12 Hz), and beta (12–32 Hz) were analyzed under five experimental stages.

Results: There were significant differences between five stages in delta, theta, and alpha amplitudes, the post hoc comparison found that there were higher delta, theta, and alpha at baseline than that at other stages ($F = 5.37$, $p < 0.01$; $F = 6.34$, $p < 0.001$; and $F = 3.70$, $p < 0.05$, respectively). On the other hand, there were significant differences between five stages in beta amplitude ($F = 4.01$, $p < 0.5$), the post hoc comparison found that there was higher beta amplitude under slouch with happiness recall than that at erect with happiness recall; as well as higher beta amplitude under baseline than that at erect with depressive recall.

Conclusion: Higher slow wave activity may relate to relaxation stage under resting baseline than other postures. Slouch posture with happiness recall is a kind of inconsistent condition that may increase brain activity.

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The Relation Between Psychophysiological Stress Profile and Integrated Visual and Auditory Performance in Iranian National Football Players (Under 14 Years)

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In the present study, the relation between Integrated Visual and Auditory (IVA) performance and Psychophysiological Stress Profile in Iranian national football players (under 14 years) was investigated. Based on previous works, psychophysiological stress profile is assessed during periods of rest and cognitive or perceptual and stressful tasks in order to understand the state of the autonomic nervous system and its responses to stressful stimuli. Stress assessment provides a holistic picture of what the mind/body of the athlete is doing at rest and during competitive tasks. This psychophysiological profile includes Heart Rate (HR), Heart Rate Variability (HRV), Blood Volume Pulse (BVP), Skin Conductance (SC), Temperature (T), Electromyography (EMG) and Respiration Rate (RR) responses at rest and under stress. In order to evaluate integrated visual and auditory performance, the IVA test was used (Turner & Sandford, 1995). The IVA is a test of visual and auditory attention and impulse control. In IVA test, visual and auditory in response control (RC) and attention scales were explored. The paired *t* test showed that there are significant differences between rest and stress situation in Heart Rate, Heart Rate Variability, Skin Conductance, and Respiration Rate ($p < 0.01$). Based on results, in this group HR, RR, and SC responses are more sensitive to stress situation. At rest, there are correlations between HRV and attention ($p = 0.001$, $r = -0.8$), HRV and response control ($p = 0.001$, $r = -0.8$) and also SC and response control ($p = 0.044$, $r = -0.56$). In addition, when changes in psychophysiological responses from resting to the stress situation were considered, visual response control was correlation with RR ($p = 0.031$, $r = -0.6$), SC ($p = 0.03$, $r = -0.6$) and BVP ($p = 0.001$, $r = -0.8$). These results indicated that response control (error of commission, consistency, and stamina) especially in visual aspect is more related to stress responses.

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Intra-hemispheric Functional EEG Coherence of Theta Rhythm in Successful and Unsuccessful Golf Putting Performance in Skilled Golfers

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In the sport area when the athlete sustains attention for competition, there is a characteristic for achieving a superior athletic performance of precision sports, especially for golf players. When they are putting, that demands a high level of visuospatial motor control. Previous study has demonstrated that the frontal midline theta reflected higher levels of sustained attention and was associated with performance in golf putting (Kao, Huang, & Hung, 2013) and basketball free throw (Chuang, Huang, & Hung, 2013). In addition, the coherence analysis can provide more information about functional connectivity between different cortical areas in the brain. Therefore, the purpose of this study was to further investigate within the same hemisphere which cortical area connected with the other frontal area would play an important role in the successful and unsuccessful performance. We recruited 36 skilled golfers. All of the participants passed the eligibility of using the following exclusion criteria: history of psychiatric, neurologic, cardiovascular, or neuroendocrine diseases. All participants agreed with the experimental procedure and filled out the informed consent. The total of 40 golf putting at an artificial golf green; each block were 10 putts. The Coherence analysis 2 (performance: successful performance, unsuccessful performance) x 2 (time: T2 = −2s ~ −1s, T1 = −1s ~ 0s) x 8 (coherence sites: F3-C3, F3-P3, F3-O1, F3-T3, F4-C4, F4-P4, F4-O2, F4-T4) ANOVA observed a significant interaction effect between performance and coherence sites, and we wanted to check this result. The post hoc simple main effect analysis indicated that the theta coherence of F3-P3 for successful performance in the brain was smaller than of the unsuccessful performances. The parietal cortex area has been associated with the somatosensory perception and integration of visual-spatial information (Schmidt & Lee, 2011), the findings of present study suggests that sustained attention in integration of sensory-motor information was associated with golf putting performance.

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The Comparison Between Sensorimotor Rhythm and Frontal Midline Theta During Successful and Unsuccessful Putting Performance in Skilled Golfers Under Pressure

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Introduction: Sensorimotor rhythm (SMR) is related with inhibition of irrelative sensorimotor information (Bowers, Saltuklaroglu, Harkrider, Wilson, & Toner, 2014) and frontal midline theta (Fmθ) is a good indicator of optimal attentional engagement (Kao, Huang, & Hung, 2013). Both of them are attention systems, but SMR suppresses irrelative external sensorimotor information to enhance activity focused on expected sensory features, and Fmθ reflects internal attention about action monitoring and cognitive control of sustained attention. Past studies have been shown that pressure could damage attention. However, it is still unclear whether SMR or Fmθ would be damaged under pressure.

Purpose: The aim of this study was to examine and compare between SMR and Fmθ during successful and unsuccessful putting performance in pressure situations.

Methods: Thirty-one skilled golfers performed 40 putts at an individualized difficulty level of 50% putting success rate. Successful performances were those trials that made a hole, whereas unsuccessful performances were those that failed. In accordance with the International 10-20 system, electrode sites of brain waves were recorded on F3, F4, C3, C4, P3, P4, T3, T4, O1 and O2. Electrical reference was located on the left and right ear mastoids (A1, A2), and the ground electrode was located on FPz. Electrode impedance was kept below 5 kΩ. In addition, band-pass filter was set at 1–30 Hz. EEG data 2 s prior to the putting of the selected trials were segmented into two, and 1-s epochs for subsequent analysis. The sampling frequency was 500 Hz.

Results: Two-factor analysis of variance, 2 (performance: good, bad) x 2 (time: T1, T2) demonstrated a significant effect of performance X time interaction in Fmθ but not in SMR. Follow-up simple main effect analysis revealed: unsuccessful performance exhibited a larger decrease prior to putting. Moreover, the main effect of time of SMR and Fmθ was significant.

Conclusions: Skilled golfers, no matter successful or unsuccessful putts, inhibited irrelative sensorimotor information and consumed less attentional resources prior to putting in pressure situations.

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A Randomized Controlled Trial Testing the Acute Impact of a Neurofeedback Device on Physiological Reactivity

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Background: Stress regulation is an essential skill for a healthy functioning brain. As neuroscientists, we ask ourselves, “Is it possible for us to teach our brains to master this skill?” If so, can brief neurofeedback interventions be effective in significantly reducing levels of stress? These are questions that this study set out to answer. There is ample evidence that many stress-related disorders are characterized physiologically by imbalances or rigidity in the autonomic nervous system (Berntson et al., 1997; Berntson & Cacioppo, 2004; Thayer, Friedman, & Borkovec, 1996; Watkins, Grossman, Krishnan, & Blumenthal, 1999). The efficacy of a course of neurofeedback therapy in the treatment of stress and anxiety has been established (Hammond, 2005; Moore, 2005; Sherlin, Gevirtz, Wyckoff, & Muench, 2009; Sherlin, Muench, & Wyckoff, 2010). The goal of this experiment is to assess the efficacy of one 20-min session of neurofeedback training on decreasing stress levels as compared to a placebo sham condition.

Methods: Participants in this study are individuals reporting mild, moderate, or severe levels of stress. The experiment begins and ends with the completion of the State-Trait Anxiety Inventory (STAI), so that the participant’s perceived stress will be compared before and after the training session. An EEG brain assessment (Fz, C3, Cz, C4, Pz) of stress level using the Versus headset will also be compared before and after the training session. Throughout the experiment, brain activity is monitored and feedback to the participant is provided through the Versus brain training game “Neuroballoons.” In the SHAM condition, the participants watch a prerecorded Neuroballoons training session, so they perceive themselves to be receiving feedback, but they are not. The brain training game uses operant conditioning to reinforce a participant for producing the desired, relaxed and calm yet alert, brain state by moving up levels and earning points. EEG data, physiological measures such as skin conductance, blood volume pulse, temperature, and EMG, and the STAI used as a self-report measure, are collected, stored, and analyzed to better understand the efficacy of the Versus training game on stress. Arguably, the most important aspect of the study methodology is the pre and post brain assessments taken using the Versus headset. At the beginning and end of the experiment, the participant engages in a NeuroPerformance Assessment (NPA). This assessment contains both an eyes-closed and continuous performance task (CPT) portion. This assessment provides important information regarding the participant’s brain activity both before and after the brief intervention.

Results: A repeated measures ANOVA will be used to analyze all continuous efficacy endpoints (pre-post change in EEG, NPA variable, physiological measures, and STAI responses) with treatment group as the between-groups variable and measurement time point as the within-groups variable. Changes in these measures are useful in assessing the efficacy of the brain training game in modulating stress. Additional data analysis will include examining correlations between an individual’s perceived stress, as indicated on the STAI, and their physiological stress demonstrated through bodily recordings.

Conclusion: This investigation is currently in process. The most current ANOVA and correlation data will be presented at the time of the conference.

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Results of the Neurofeedback Training in a Group of Adolescents in Conflict with the Law in Hermosillo Sonora Mexico, Combining a Protocol of One and Two Channels

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Background: This study is a continuation of a previous study about the impact of the neurofeedback training in a group of juvenile offenders in the city of Hermosillo, Sonora, Mexico. In that study we reported the scores of the subscales of the WISC IV and the Stroop task in a protocol of Neurofeedback training (NFT) of one channel. In this study we reported the results in the subscales of the WISC IV, WAIS, and Stroop task in a group of juvenile offenders with a protocol of one and two channels combined.

Objective: The main objective of this study is to determine the effect of Neurofeedback training in the score of WISC IV, WAIS, and the Stroop task (Golden, 1978) in adolescents in conflict with the law housed in a Confinement Center after implementation of combining a protocol of one and two channels.

Methods: Participants: Eleven juvenile offenders, five participants were males and six female. The group ranged ages from 14 to 20 years, mean age of 16.73 years. All the participants are housed in a confinement center at the city of Hermosillo, Sonora. The training protocol selected consists of 39 sessions of 20 min each in order to increase beta (16–20 Hz), alpha (8–13 Hz) and coherence in beta and SMR (13–15 Hz). The training to increase alpha waves requires participants to relax with their eyes closed. The NFT was provided using the ProComp and BioGraph program (version 5.1.2; Thought Technology Ltd., Montreal, Canada). A sampling rate of 256 Hz with 2-s epochs was utilized. Skin impedance was less than 5 KΩ. NFT was based on a protocol proposed by Dr. Romano Micha.

Results: Pre- and post-training scores were compared. The Wilcoxon signed-rank test were performed to determine the changes in pre- and post-training scores from the WISC IV and WAIS; paired sample *T*-tests were performed to assess changes in pre- and post-training scores from the Stroop task. Significant differences were found at perceptual reasoning, and the processing speed indexes of WISC IV, and verbal and performance scores of the WAIS, as well as the scores of IQ in both. At the Stroop task, we found significant differences in the task of read, name color, name color in words, and the predicted score of name color in words task.

Conclusion: In spite of finding some statistical differences at the analysis data, it's very important to have a bigger sample of subjects that help to consolidate the impact of the NFT; in this study we have the opportunity of work with both sexes, male and female; however, we need more subjects for analysis and to research gender differences.

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Treating Postconcussion Syndrome with Neurofeedback + HRV Training: Why Is It Effective?

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Patients presenting 2 to 12 years after suffering traumatic brain injuries that crippled their ability to work or continue their studies and severely impaired their family and social relationships have all recovered within a year of starting neurofeedback (NFB) combined with heart rate variability (HRV) training at our center. All these patients had plateaued in their recovery and most had been discharged from conventional medical rehabilitation programs. This presentation will review the assessment, testing, and intervention that is done, showing how it leads to a prescription for treatment that produces positive change. We will also outline the neuroanatomical underpinnings of why neurofeedback combined with heart rate variability training works in people who have suffered brain injuries.

Though testing carried out in hospital settings, including MRI and CT scans, may not detect the neurophysiological changes that underlie the symptoms that the patient is experiencing, quantitative EEG and evoked potentials (ERPs) can reveal the effects of damage caused by stretching and twisting of axons that occurs when there is sudden deceleration or rotational forces during a traumatic brain injury (TBI). To detect this diffuse axonal injury (DAI), ERPs are particularly important for reflecting reduced brain speed. TBI will often have a negative impact on the right and/or left insula, which in turn relates to changes in heart rate variability. Thus our postconcussion assessment measures qEEG, ERPs, HRV and, using continuous performance tests, includes standardized measures of attention, impulsivity, and variability of response time. This in-house assessment is combined with online neuropsychological testing that produces scores for memory, attention span, impulsivity, and response time variables, in addition to scores from questionnaires regarding medical health, depression, and anxiety. All this can be accomplished in a half-day assessment that will be outlined in the talk.

Next we present the neuroanatomical underpinnings regarding why, how, and with what effect, LORETA *Z*-score NFB can be used in conjunction with some combination of regular biofeedback, HRV training, transcranial direct current stimulation (tDCS), passive infrared feedback (pIR), and metacognitive strategies, in addition to dietary interventions, to bring a client back to high-level functioning. The theoretical aspects of this presentation will be supported by case examples including a PhD candidate in artificial intelligence, an author, a graduate student in finance, and an athlete. Pre-post measures of HRV, scores on continuous performance tests, EEG and ERP variables, and self-ratings will be presented to support the findings of normalized qEEG correlating with other measures that show improved functioning.

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Theoretical Underpinnings of Performance Psychology for Neurofeedback Training

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As neurofeedback and biofeedback training protocols become more established in athletics and other performing venues, the ultimate success of this training depends on the quality of the practitioner's understanding of performance psychology. Improvements in the office mean little if the performer does not transfer them to their performances. Additionally, advances in research investigating the use in your feedback for performance enhancement are limited without a solid theoretical foundation for interpreting and guiding this research. The purpose of this oral presentation is to discuss a comprehensive theory of the psychology of high performance and how this theory has influenced clinical applications with professional athletes and athletes at the United States Olympic Training Center.

Although the field of sport and performance psychology has been around since the mid-1980s, there has been no overarching theory of performance excellence until recently. Most of sport psychology has been built upon the development of atheoretical mental skills building interventions. At best these interventions have been grouped into models of skill development. This has left unexamined the etiology, nature, course, and diagnosis of performance issues. The dual processing theory of performance (Portenga, 2012) has been proposed as an integrative approach to understanding the psychology of high performance. This theory was developed by an examination of neuropsychology research and filtered through over a decade of experience working with professional and Olympic athletes. This theory has influenced the work of the American Psychological Association's Coalition for the Psychology of High Performance.

After introducing the theoretical aspects of the psychology of high performance, the presentation will turn to clinical applications. We begin by discussing the implementation of a biofeedback and neurofeedback training program at the United States Olympic Training Center in Colorado Springs. A key component of this training program has been an emphasis on translating skill development into performance improvement. We will also discuss the integration of biofeedback and neural feedback within professional sports and in private practice.

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Frontal Gamma Asymmetry: Examining Precognitive Responses to Soft Skill Self Reports

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Objective: The purpose of this study was to explore associations between self-reported rank ordering of a set of 23 job-related soft skills and frontal gamma (38 to 42 Hz) asymmetry emerging during exposure to the same set of soft skills.

Method: In the original study, 14 individuals responded to the TriMetrix® DNA (Target Training

International, Scottsdale, AZ) soft skill assessment and then were exposed to a randomized list of the same soft skills' key words while collecting quantitative electroencephalographic (qEEG) data. The process examined the asymmetry in the frontal cortex, identifying gamma bursts, to assess underlying preconscious decisions behind these self-reported responses, at the moment of decision-making.

Methods in Progress: In addition to expanding the number of participants involved in the research, a correlational study is underway to match real-time data between BrainAvatar software (BrainMaster Technologies, Bedford, OH) and a wireless bluetooth collection process using MUSE (InteraXon, Ontario, Canada). Lastly, because of unexplained variably in some of the original data, additional cross-referencing with other personal attribute tools is also being pursued and will be included during the presentation.

Results: This study provides preliminary evidence that an evoked, emotionally laden response results in corresponding brain activity and suggests evidence of a match to self-reported soft skills.

Conclusions: When a client holds strong beliefs, it may be easier to develop skills for which they have little or no previous experience than to tackle a developmental plan encumbered by self-doubt, or worse, total aversion to the concept.

Significance: In addition to providing support for a new approach to validating self-reporting assessments, this process may offer insights into how humans make decisions; thus, exposing underlying precognitive beliefs and related emotions that ultimately lead to our behaviors. The cross-referencing of the results with wireless collection tools, if found to be reliable, can move data collection from a laboratory setting to any number of real-life applications. Administering these protocols in real-world contexts, such as during coaching sessions, job interviews, and possibly even in psychotherapeutic milieus (given proper ethical constraints), are promising areas for additional study, to evaluate the impact of potentially exposing hidden decision-making mechanisms of the preconscious mind. As data collection technology advances, so must our ability to pursue new applications, but always with an eye on supportive research and analysis. In trial runs, we have been able to see gamma asymmetry in real time, while conducting client interviews, thus exposing for discussion emotionally sensitive mental triggers. All of these studies build on the concept and power of the science of self.

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Impact of Sensorimotor Rhythm (SMR) Neurofeedback on Quality of Life in Patients with Medically-Refractory Seizures

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Rationale: Published studies suggest that augmentation of the sensorimotor rhythm (SMR), a commonly used neurofeedback protocol for patients with epilepsy, changes thalamocortical regulatory systems and increases cortical excitation thresholds (Sterman, 2000; Sterman & Bowersox, 1981;Sterman & Egner, 2006). As such, SMR augmentation can be an effective means of reducing seizure frequency in patients with drug-refractory seizures (Sterman, 2000; Sterman & Bowersox, 1981; Sterman & Egner, 2006; Tan et al., 2009). Recent meta-analyses assessing multiple modalities of neurofeedback training in patients with medically refractory epilepsy showed that up to 80% of patients had a post-therapy reduction in seizure frequency (Sterman, 2000; Sterman & Bowersox, 1981; Sterman & Egner, 2006; Tan et al., 2009). However, data on neurofeedback outcomes outside of seizure frequency are currently limited. Epilepsy-specific quality of life measures have been used to measure constructs such as: seizure worry, emotional well-being, energy/fatigue, cognition, medication effects, and social function—which are all considered to be important aspects of overall patient well-being.

Methods: The records for all consecutive patients trained using SMR neurofeedback in the Neurofeedback Clinic at the University of Colorado Hospital prior to March 2015 (n = 9) were retrospectively reviewed. Data on patient demographics, duration of epilepsy prior to training, seizure types and frequencies, antiepileptic drugs (AEDs), degree of seizure control, psychiatric and medical comorbidities, imaging results, neurophysiological results, and the duration of neurofeedback training were abstracted and analyzed. Patients in this clinic routinely complete the Quality of Life in Epilepsy-31 (QOLIE-31) survey as a part of their clinic intake interview and at intervals throughout their training. Patients also report seizure frequency and neurobehavioral symptom severity before each session.

Results: 214 total training sessions were reviewed. Mean patient age was 47.4 ± 5.9 years with mean duration of epilepsy prior to training of 18.7 ± 3.6 years. Eight of nine patients had focal onset epilepsy. Four of nine patients had a structural lesion on MRI that correlated with their seizure focus. Seven of nine patients had a history of comorbid mood disorder. The average total QOLIE-31 baseline score in our patients was 49.3 ± 8.8. Seven patients completed follow-up QOLIE-31 surveys after an interval of training with an average score of 54.9 ± 6.5. Seventy-eight percent of the patients had improvement in their QOLIE-31 scores with training. On average, the largest improvements were in the seizure worry and cognitive subscores of the QOLIE-31.

Conclusions: In this small case series, SMR neurofeedback training modestly improved short-term follow-up QOLIE-31 scores in patients with epilepsy. Larger studies are needed to determine the psychosocial constructs that may underlie changes in quality of life after neurofeedback training in patients with epilepsy.

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QEEG Studies of the Acute Effects of the Visionary Tryptamine DMT

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Introduction: The rich therapeutic potential of psychedelic drugs, now informed by recent breakthroughs in psychedelic brain science, is experiencing a renaissance, as a resurgence of research is documenting the success of psychedelic therapies in the treatment of a wide range of mental disorders. In parallel, a renewed interest in plant-derived entheogens is attracting western seekers, heading to the Amazon and elsewhere, eager to experience soul reconnection amidst the social and economic turmoil of our times.

Objective: The objective of this exploratory research was to examine the quantitative electroencephalography (qEEG) correlates of the psychoactive smoked inhalation of exogenous tryptamine DMT (DMT) action. Known as a potent visionary, DMT is ubiquitous in nature and has also been localized in the brain and peripheral tissues of mammals, including humans. The exact function of this endogenous DMT is the subject of ongoing neuropharmacological research. An earlier qEEG study examined the acute effects of the entheogenic plant Salvia divinorum (Acosta-Urquidi, 2008), delivered by smoked inhalation of Salvia 10x extract. This experience was applied to the present DMT study.

Methods: Two sources of DMT were tested: high purity synthetic 5-methoxy-*N*,*N*-dimethyltryptamine (5-MeO-DMT) and *N*,*N*-Dimethyltryptamine (N,N-DMT) from a natural extract of the Acacia Mimosa hostilis root bark. The rapid onset (ca. 10–20 seconds) and time course of effects (5–15 min) were similar to the Salvia studies. DMT was delivered by smoked inhalation and dosage was adjusted to elicit an effective “trip” (ca. 20–30 mg for N,N-DMT; 2–5 mg for 5-MeO-DMT). Healthy volunteers (age 25–60; n = 15 men, n = 8 women) were tested. A Mitsar 201 amplifier, 10-20 system electrocap, 19 channels referential linked ears montage, 0.5–40 Hz bandwidth was employed. Artifacted raw data was analyzed with Neuroguide software (Applied Neuroscience, Florida). Protocol consisted of: 5–10 min baseline control (resting eyes closed) was first obtained, followed by the DMT test condition, lasting 5–15 min. When subjects recovered, a video recorded their subjective experience. A recovery post-DMT reading was made at 10–20 min. A statistical comparison (Paired *t*-tests, correlated samples) of absolute power values for all EEG bands between baseline vs. DMT tests and post-recovery conditions was achieved for all subjects. The DMT-induced profound alterations in consciousness were correlated with shifts in the qEEG metrics analyzed. The rapid onset (10–20 s), short acting (5–15 min), and the reversible nature of the effects made such a study feasible. This work is also neurophenomenological in character, as it attempts to correlate EEG brain states to the subjective "trip reports". The time course and intensity of the subjective experience correlated with the magnitude of the observed qEEG effects.

Results: A statistical comparison of absolute power for all bands (mean ± SEM, p values two-tailed) yielded, for N,N-DMT: Delta (22.19 ± 3.46 vs. 18.48 ± 3.6, n = 18, NS); Theta (17.97 ± 3.54 vs. 10.06 ± 1.05, $p < .018$, n = 17); Alpha (133.65 ± 27.06 vs. 17.18 ± 4.37, $p < .0012$, n = 17); Beta1 (16.23 ± 4.16 vs. 5.63 ± 1.9, $p < .002$, n = 17); Beta2 (5.26 ± 0.66 vs. 2.73 ± 0.4, $p < .0001$, n = 16); Beta3 (2.63 ± 0.48 vs. 2.21 ± 0.33, $p < .013$, n = 6). For High Beta increase (2.74 ± 0.8 vs. 4.53 ± 1.13, $p < .05$, n = 10). The most consistent effect was a robust suppression of Alpha, obtained for both N,N-DMT and 5-MeO-DMT (Alpha decreased on average 72%, n = 6). During recovery, some subjects showed Alpha rebound increased power post-DMT (average 43% increase, $p < .0107$, n = 9). A DMT-induced reversible shift in FFT spectra from Alpha to Theta was recorded in some subjects. Also, very signifcant hypercoherence in all bands (especially Beta) was measured in most subjects. Gamma power (35–40 Hz) was also increased in some subjects. Full reversibility of the effects was measured typically at 15–20 min post-DMT. At this time, rebound Alpha increase was correlated with a report of "being in peace, a calmed state of well-being." The significance of these findings is discussed with reference to DMT receptor pharmacology mechanisms and promising therapeutic outcomes. Ongoing studies are reporting that 5-MeO-DMT is a very effective tool in treatment of addiction disorders. Neurofeedback applications to recreate some features of these numinous highly beneficial, healing experiences are envisioned.

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Case Studies and EEG Analyses in the Treatment of Misophonia with Neurofeedback Training

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Misophonia is a recently discovered disorder in which sufferers are prompted to severe emotional reactions in response to everyday noises (and sometimes sights). Onset is usually in youth and becomes progressively worse with age. At its most severe the sufferers have committed suicide or become totally disabled and unable to participate in the daily tasks of living and social interaction. The authors have been involved in the treatment of the condition primarily through the use of LORETA *Z*-score neurofeedback. In addition, the recorded EEGs of numerous sufferers have been examined and studied to see if any common patterns or dysregulations can be found. The presentation will detail the findings of these analyses as well as detail the outcomes of treatment for a representative group of sufferers.

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Neurofeedback and Anxiety-Regulation in Archery Performance

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Sport performance is an issue with growing contemporary interest. Neurofeedback has been proven to be useful for enhancing performance in athletes and "has been shown to have potential for quieting the mind to improve performance in archery" (Hammond, 2007, p. 1). The aim of this research is to measure improvement in archery athletes' performance based on neurofeedback training and learning anxiety-regulation skills. The athlete population for participation in the study was all amateur level in Colombia, ages 17 to 50.

There are limitations in opportunity for the sport of archery as a professional athlete. In addition, the conditions for sport development such as coach availability, the counseling of a sport psychologist, and proper training equipment are inconsistent. Thus, the present research focuses on the combined neurofeedback and anxiety-regulation. The primary variables used were anxiety, attention, and emotional control among specific variables related to the archery performance (score). Intervention was applied to 10 athletes from Bogotá Archery League, starting with qEEG for choosing the protocol. The participants attended 30 sessions of neurofeedback training and 15 sessions of cognitive behavioral training (mindfulness) focused on anxiety-regulation; the last five sessions they trained in the field, where the target was to improve their proprioception, being aware of their technique among others learned in sessions.

The analysis will be within subject paired *t*-test design, comparing score results and the anxiety results, and trend measures for comparing brain waves changes around seven sessions per location/protocol. The results of the outcome study will be presented and will be the generation of an intervention protocol that could improve the performance of pre-elite athletes and development of new instruments for the Colombian athlete population. Also, there is opportunity to transfer the learning from the results to other sports disciplines, especially in precision sports. This research was funded by Convocatoria 626 Colciencias-Coldeportes 2013.

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